Center for Mindfulness

in Medicine, Health Care, and Society

Mindfulness-Based Stress Reduction (MBSR) Professional Education and Training

Scientific Papers from The Stress Reduction Clinic and
The Center For Mindfulness in Medicine, Health Care, and Society
2013-1982

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Compiled and Edited by
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II. Bibliography of Mindfulness-Based Stress Reduction

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Mindfulness practice leads to increases in regional brain gray matter density

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Therapeutic interventions that incorporate training in mindfulness meditation have become increasingly popular, but to date little is known about neural mechanisms associated with these interventions. Mindfulness-Based Stress Reduction (MBSR), one of the most widely used mindfulness training programs, has been reported to produce positive effects on psychological well-being and to ameliorate symptoms of a number of disorders. Here, we report a controlled longitudinal study to investigate pre–post changes in brain gray matter concentration attributable to participation in an MBSR program. Anatomical magnetic resonance (MR) images from 16 healthy, meditation-naïve participants were obtained before and after they underwent the 8-week program. Changes in gray matter concentration were investigated using voxel-based morphometry, and compared with a waiting list control group of 17 individuals. Analyses in *a priori* regions of interest confirmed increases in gray matter concentration within the left hippocampus. Whole brain analyses identified increases in the posterior cingulate cortex, the temporo-parietal junction, and the cerebellum in the MBSR group compared with the controls. The results suggest that participation in MBSR is associated with changes in gray matter concentration in brain regions involved in learning and memory processes, emotion regulation, self-referential processing, and perspective taking.

1. Introduction

Mindfulness meditation has been reported to produce positive effects on psychological well-being that extend beyond the time the individual is formally meditating. Over the last three decades mindfulness meditation practices have been increasingly incorporated into psychotherapeutic programs, to take advantage of these benefits (cf. Baer, 2003; Grossman et al., 2004). A large body of research has established the efficacy of these mindfulness-based interventions in reducing symptoms of a number of disorders, including anxiety (Roemer et al., 2008), depression (Teasdale et al., 2000), substance abuse (Bowen et al., 2006), eating disorders (Tapper et al., 2009), and chronic pain (Grossman et al., 2007), as well as improving well-being and quality of life (e.g., Carmody and Baer, 2008). Mindfulness meditation involves the development of awareness of present-moment experience with a compassionate, non-judgmental stance (Kabat-Zinn, 1990). It has been suggested that this process is associated with a perceptual shift (Carmody, 2009), in which one's thoughts and feelings are recognized as events occurring in the broader field of awareness.

Neuroimaging studies have begun to explore the neural mechanisms underlying mindfulness meditation practice with techniques such as electroencephalography (EEG) (Davidson et al., 2003; Slagter et al., 2007) and functional magnetic resonance imaging (MRI) (Farb et al., 2007; Lutz et al., 2008; Farb et al., 2010; Goldin and Gross, 2010). Recently, several cross-sectional anatomical MRI studies have demonstrated that experienced meditators exhibit a different gray matter morphometry in multiple brain regions when compared with non-meditating individuals (Lazar et al., 2005; Pagnoni and Cekic, 2007; Hölzel et al., 2008; Luders et al., 2009; Vestergaard-Poulsen et al., 2009; Grant et al., 2010). While most of the brain regions identified have been reported in only one of these studies, the divergent results are likely due to differences in participant characteristics, type of meditation, and data analysis methods (see Table 1). Group differences in the hippocampus and the right anterior insula, however, have each been identified in at least two of the studies. Furthermore, activation in both regions has been reported during meditative states (hippocampus (Lazar et al., 2000; Hölzel et al., 2007); insula (Farb et al., 2007; Lutz et al., 2008)). The hippocampus is known to be critically involved in learning and memory processes (Squire, 1992), and in the modulation of emotional control (Corcoran et al., 2005; Milad et al., 2007), while the insula has been postulated to play a key role in the process of awareness (Craig, 2009) — functions which have been shown to be important in the process and outcomes of mindfulness training (Bishop et al., 2004; Shapiro et al., 2006; Ortner et al., 2007).

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Table 1
Overview of morphometric studies on meditation.

Study	Meditation tradition	*N* meditators/ controls	Morphological measures	Regions identified greater in meditators than controls
Lazar et al. (2005)	Insight	20/15	Cortical thickness	Right anterior insula and right middle and superior frontal sulci
Pagnoni and Cekic (2007)	Zen	13/13	Gray matter volume (VBM in SPM5)	Meditators showed no age-related decline in the left putamen as compared to controls
Hölzel et al. (2008)	Insight	20/20	Gray matter density (VBM in SPM2)	Left inferior temporal lobe, right insula, and right hippocampus
Vestergaard-Poulsen et al. (2009)	Tibetan Buddhist	10/10	Gray matter density and volume (VBM in SPM5)	Medulla oblongata, left superior and inferior frontal gyri, anterior lobe of the cerebellum and left fusiform gyrus
Luders et al. (2009)	Zazen, Vipassana, Samatha and others	22/22	Gray matter volume (VBM in SPM5)	Right orbito-frontal cortex, right thalamus, left inferior temporal lobe, right hippocampus
Grant et al. (2010)	Zen	19/20	Cortical thickness	Right dorsal anterior cingulate cortex, secondary somatosensory cortex

VBM: voxel-based morphometry (Gaser), SPM: Statistical Parametric Mapping, (Wellcome Department of Cognitive Neurology, London).

A growing body of literature has demonstrated that neural systems are modifiable networks and changes in the neural structure can occur in adults as a result of training. For example, longitudinal studies have shown task-specific increases in brain gray matter as an effect of acquisition of abstract information (Draganski et al., 2006), motor skills (Draganski et al., 2004), aerobic training (Colcombe et al., 2006), and cognitive skills (Ilg et al., 2008). Cross-sectional studies have established that differences in regional gray matter are associated with performance abilities (Mechelli et al., 2004; Milad et al., 2005), suggesting that an increase in gray matter corresponds to improved functioning in the relevant area. Studies of experienced meditators have also suggested the possibility of structural plasticity, but their cross-sectional designs did not exclude the possibility of pre-existing group differences, precluding causal conclusions. Here we report a longitudinal study of gray matter changes associated with a mindfulness-based intervention. The focus of the study was to identify brain regions that changed in association with participation in an 8-week Mindfulness-Based Stress Reduction course (MBSR; Kabat-Zinn, 1990). This group program aims to improve participants' mindfulness and well-being, and reduce their levels of perceived stress. The study was an attempt to find objectively measurable neurological changes that could underlie the trait-changes associated with mindfulness practice. Changes in gray matter concentration were investigated using voxel-based morphometry. Focused analyses were conducted for the hippocampus and insula as our predefined regions of interest. Exploratory analyses were then performed on the entire brain and compared with a control group.

2. Methods

2.1. Participants

MBSR participants were recruited among individuals enrolled in four MBSR courses held at the Center for Mindfulness at the University of Massachusetts Medical School. The courses included physician- and self-referred individuals from across New England who were seeking stress reduction. Individuals were included in the study if they self-reported as physically and psychologically healthy and not taking any medications. Further inclusion criteria were as follows: no meditation classes in the past 6 months, no more than four classes in the past 5 years, or 10 classes in their lifetime; 25 to 55 years old; no contra-indications for MRI scanning (i.e., metallic implants, claustrophobia); commitment to attend all eight classes and perform the prescribed daily homework. Eighteen healthy, right-handed individuals were enrolled in the study, eight male and 10 female, with a mean age of: 37.89 years (S.D.: 4.04 years). Due to discomforts during the first MRI scanning session, two participants did not return for the second session. The resulting sample consisted of six male and 10 female participants with a mean age of 38.0 years (S.D.: 4.1 years). Ethnicities were as follows: 13 Caucasians, one Asian, one African American, and one multi-ethnic. Participants had an average of 17.7 years of education (S.D.: 1.9 years). Reimbursement for study participation was a discounted MBSR course fee.

The control sample consisted of 17 participants (11 male and six female) with a mean age of 39.0 years (S.D.: 9.2 years) and an average of 17.3 years of education (S.D.: 1.8 years). Ethnicities were as follows: 13 Caucasians, two Asians, two African American, and one Hispanic. The groups did not differ in age ($t\,(22.3)=0.56$; $P=0.58$), or education ($t\,(30)=-0.56$, $P=0.58$). The study protocol was approved by the Institutional Review Boards (IRBs) of Massachusetts General Hospital and the University of Massachusetts Medical School, and written informed consent was obtained from all participants. A previous publication that investigated neural correlates of changes in perceived stress (Hölzel et al., 2009) included data from this sample.

2.2. Intervention

The MBSR program has been described extensively elsewhere (Kabat-Zinn, 1990). Briefly, it consists of eight weekly group meetings lasting 2.5 h each, plus 1 full day (6.5 h) during week 6 of the course. Formal mindfulness training exercises aim at developing the capacity for mindfulness (awareness of present-moment experiences with a compassionate, non-judgmental stance) and include a body scan, mindful yoga, and sitting meditation. During the body scan attention is sequentially guided through the entire body, observing with non-judgmental awareness the sensations in each region and ending with an awareness of the body "as a complete whole". The mindful yoga typically contains gentle stretching exercises and slow movements that are often coordinated with the breath, with emphasis placed on bringing full awareness to the moment-to-moment experience and a non-harming attitude towards the body. Participants are encouraged to investigate what feels appropriate for themselves and to honor their body's limitations. Sitting meditation practices typically begin with awareness of the sensations of breathing, then evolve to include awareness of different modalities (such as sounds, sight, taste, other body sensations, thoughts and emotions). Later, emphasis is given to open awareness meditation, where the field of awareness is expanded to include anything that appears in consciousness, or a simple awareness of one's presence in the here and now.

Participants received audio recordings containing 45-min guided mindfulness exercises (body scan, yoga, and sitting meditation) that they were instructed to practice daily at home. To facilitate the integration of mindfulness into daily life, they were also taught to practice mindfulness informally in everyday activities such as eating, walking, washing the dishes, or taking a shower. During classes, the formal mindfulness exercises were practiced, questions relating to the practice of mindfulness in everyday life were clarified and didactic instruction was given on using mindfulness for coping with stress in daily life. Historically, MBSR participants have reported a wide range of home practice compliance and for this reason study participants recorded the amount of time they spent engaged in mindfulness exercises each day.

2.3. Five Facet Mindfulness Questionnaire

The Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006) is a 39-item scale to measure five factors of mindfulness: Observing (attending to or noticing internal and external stimuli, such as sensations, emotions, cognitions, sights, sounds, and smells), describing (noting or mentally labeling these stimuli with words), acting with awareness (attending to one's current actions, as opposed to behaving automatically or absent-mindedly), non-judging of inner experience (refraining from evaluation of one's sensations, cognitions, and emotions) and non-reactivity to inner experience (allowing thoughts and feeling to come and go, without attention getting caught up in them). Responses to the items are given on a 5-point Likert-type scale (1 = never or very rarely true, 5 = very often or always true). The five subscales have shown adequate to good internal consistency (Baer et al., 2006). Usable data from both time-points were obtained from 14 MBSR and 14 control participants.

2.4. MRI data collection and analysis

All participants were scanned at the Martinos Center for Biomedical Imaging in Charlestown, MA. MBSR participants were scanned during the 2 weeks before (Pre) and after (Post) participation in the program. Control participants were also scanned twice, approximately 2 months apart. There was an average time of 56.25 days (S.D.: 4.5 days) in between scanning sessions for the MBSR group and 65.67 days (S.D.: 11.22 days) for the control group. High-resolution MRI data were acquired with a Siemens Magnetom Avanto 1.5 T scanner with standard head coil. Data sets of the whole brain were collected using a T1 weighted MPRAGE-sequence, consisting of 128 sagittal slices ($1.0 \times 1.0 \times 1.3$ mm, TI = 1000 ms; TE = 3.39 ms; TR = 2730 ms). Image analysis was performed with voxel-based morphometry (VBM) tools within the Statistical Parametric Mapping (SPM5) neuroimaging statistical software (Wellcome Department of Cognitive Neurology, London, www.fil.ion.ucl.ac.uk/spm/software/spm5/) based in MATLAB 7.1, release 14 (Mathworks Inc., Natick, MA, USA), using default settings unless otherwise specified. VBM permits an automated voxel-wise whole brain statistical comparison of MRI scan (Ashburner and Friston, 2000). Images were manually aligned to the anterior commissure and then segmented into gray and white matter in native space (i.e., before normalization, using the 'Native Space' segmentation option implemented in SPM5). For each individual, the (unmodulated) gray matter segmentations of the Pre and Post images were spatially co-registered. Normalization parameters were calculated for the Pre scan and were applied to both time-points (trilinear interpolation, $2 \times 2 \times 2$ mm), to make sure that regional differences between the images were not removed by scan-specific spatial normalization (Driemeyer et al., 2008; Ilg et al., 2008). Images were smoothed using an 8-mm full width at half maximum Isotropic Gaussian Kernel.

We computed exploratory whole brain analyses as well as region of interest (ROI) analyses. The ROI contained the bilateral hippocampi and bilateral insulae and was created using the WFU Pickatlas software (Maldjian et al., 2003) and based on the parcellation of Tzourio-Mazoyer et al. (2002). A paired *t*-test within the MBSR group was first performed in SPM5, in order to identify those brain regions with significantly increased gray matter concentration following participation in the MBSR program. Since our ROI analysis was spatially focused, we chose to correct for multiple comparisons within the ROI (bilateral hippocampi and insulae) using the voxel-wise method implemented in SPM5. Given the very large number of voxels in the whole brain analysis, a voxel-wise method for preventing false positives seemed too conservative and leads to a substantial loss of statistical power (Forman et al., 1995; Friston et al., 1996). We therefore chose to use a cluster-wise method for the exploratory whole brain analysis and corrected for multiple comparisons across the entire brain using the method implemented in SPM5 (Friston et al., 1994). In order to exceed the threshold of $P < 0.05$, clusters had to exceed a size of 250 voxels. Statistical parametric maps were initially thresholded with $P = 0.01$, uncorrected. *P*-values < 0.05, corrected for multiple comparisons, were considered significant for both the exploratory whole brain analysis as well as the ROI analysis.

Following the paired *t*-test within the MBSR group, follow-up tests were then conducted within the identified regions to test for significance compared with the control group. Values from the identified clusters were extracted for each person and each time-point using the Marsbar toolbox (Brett et al., 2002). A repeated measures **analysis of variance** (ANOVA) was then performed for each cluster in the Statistical Package for the Social Sciences (SPSS), with group (MBSR and control group) as the between-subjects factor and time-point (Pre and Post) as the within-subjects factor. Since groups were not identical in age and gender, these variables were controlled by entering them as nuisance variables.

3. Results

3.1. Amount of mindfulness practice

MBSR participants reported spending an average of 22.6 h (S.D.: 6.3 h) engaged in formal homework exercises over the 8-week course (average = 27 min per day). In detail, the amount of body scan practice ranged between 335 and 1002 min (mean: 699 min, S.D.: 217 min), yoga between 103 and 775 min (mean: 327 min, S.D.: 194 min), and sitting meditation between 0 and 755 min (mean: 332 min, S.D.: 211 min). The three measures were not significantly correlated with each other: body scan and yoga: $r = -0.042$, $P = 0.87$; body scan and sitting: $r = -0.26$, $P = 0.33$; yoga and sitting: $r = 0.49$, $P = 0.06$, $N = 16$.

3.2. Improvements in mindfulness

Repeated measures ANOVAs confirmed significant group-by-time interactions for three of the five mindfulness subscales (acting with awareness: F (1,26) = 16.87, $P < 0.001$; observing: F (1,26) = 7.09, $P = 0.013$; non-judging: F (1,26) = 4.61, $P = 0.041$; describing: F (1,26) = 1.95, $P = 0.175$; non-reactivity: F (1,26) = 2.79, $P = 0.107$). Paired *t*-tests confirmed significant increases in the MBSR group (acting with awareness: t (13) = 3.665, $P = 0.003$; observing: t (13) = 4.218, $P = 0.001$; non-judging: t (13) = 3.580, $P = 0.003$), but not the control group (observing: t (13) = −0.698, $P = 0.498$; acting with awareness: t (13) = −1.991, $P = 0.068$; non-judging: t (13) = 0.657, $P = 0.523$; two-tailed). That is, MBSR participants significantly increased their mindfulness scores on these three scales.

3.3. Gray matter changes in a priori regions of interest

The paired *t*-test within the MBSR group identified a small cluster in the left hippocampus with increased gray matter concentration (peak voxel MNI coordinates *x*, *y*, *z*: −36, −34, −8; t (15) = 6.89; voxel level $P = 0.014$, corrected for multiple comparisons with FWE correction; cluster size $k = 30$; Fig. 1). The averaged gray matter concentration within this cluster was then extracted for each individual at each time-point using the Marsbar toolbox and further analyses were performed in SPSS. A repeated measures ANOVA (two groups × two time-points; age and gender as nuisance variables) showed a significant group × time interaction (F (1,29) = 4.92; $P = 0.035$). There was no difference in gray matter concentration within this cluster between the two groups at the Pre time-point (2-

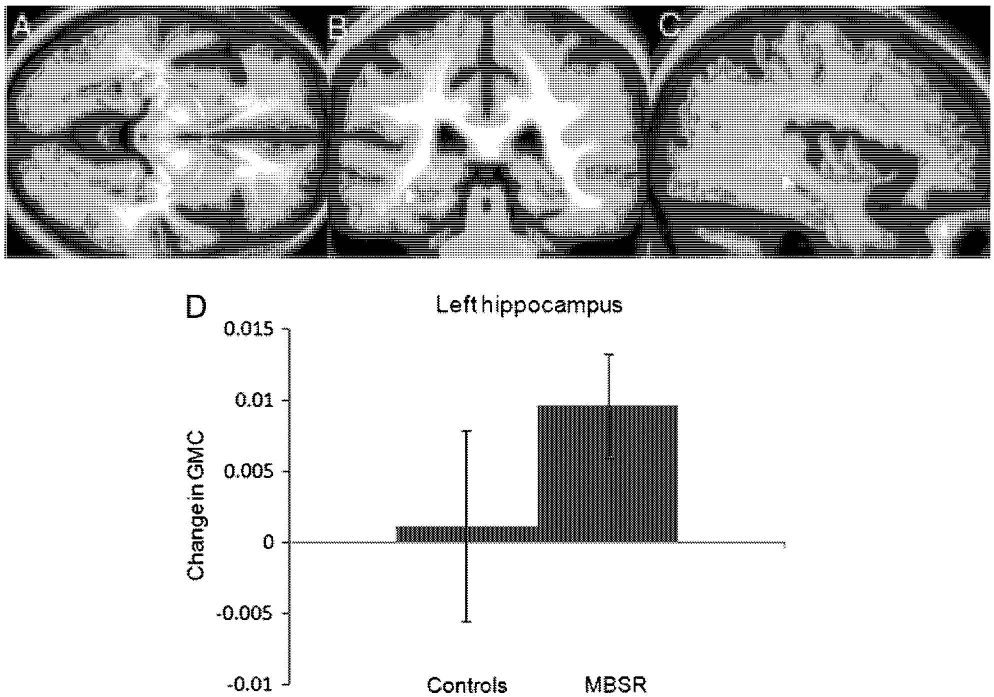

Fig. 1. Region of interest analysis identifies gray matter concentration increases in the left hippocampus (MNI coordinates $x=-36$ (C), $y=-34$ (B), $z=-8$ (A)) in the MBSR group. Voxels (thresholded at $P=0.01$ and masked for the regions of interest) are overlaid over the group-averaged brain. D: Change in gray matter concentration (GMC) within the cluster in the left hippocampus from the Pre to the Post time-point in the MBSR and the control group; error bars show 95% confidence interval.

sample t-test for equal variances; $t\ (31)=0.06$; $P=0.956$) and the control group did not show a change in gray matter concentration from the Pre to Post time-point (paired t-test; $t\ (16)=0.343$; $P=0.736$). Pre to Post changes in the other regions of interest were not significant, and changes in the *a priori* regions were also not correlated with the amount of mindfulness homework practice or with changes in the FFMQ. Furthermore, we performed a paired t-test within the control group in SPM5 and applied the same thresholds. No significant voxels were associated with increase or decrease in gray matter concentration from Pre to Post in the control group. To summarize, analyses of gray matter concentration changes in the ROI analysis supported significant increases in the left hippocampus in the MBSR group, confirming that structural changes in this region are detectable within 8 weeks following the participation in this mindfulness training program.

3.4. Whole brain analysis

Exploratory analysis of the entire brain (paired t-test in SPM5) revealed four clusters with significantly greater gray matter concentration at the Post compared with the Pre time-point in the MBSR group (Table 2). One cluster was located in the posterior cingulate cortex (PCC; Figs. 2A and 3A), one in the left temporo-parietal junction (TPJ; Figs. 2B and 3B), and two clusters were located in the cerebellum (Figs. 2A and C, 3C and D). One of the two clusters identified in the cerebellum was centered in the vermis and extended into the brainstem, encompassing several pontine nuclei in the brainstem. The second cerebellar cluster was located more laterally, including parts of the left lobule X and VIII, i.e., lateral parts of the posterior and flocculonodular lobe. No regions showed a significant decrease in gray matter concentration following the MBSR intervention.

Table 2
Increase in gray matter concentration from Pre- to Post-MBSR training in the exploratory whole brain analysis within the MBSR group.

Region (peak of cluster)	Cluster size k	Cluster-level P-value	MNI coordinates of the peak voxel (x, y, z)	T of peak voxel
Posterior cingulate gyrus	418	0.004	−4, −34, 32	5.07
Cerebellum Lobule 8 − L	329	0.018	−28, −38, −48	5.31
Cerebellum, Vermis, Lobule 1–2	499	0.001	4, −40, −24	5.03
Temporo-parietal junction (peak in middle temporal gyrus)	291	0.036	−50, −48, 20	5.08

P-values are corrected for multiple comparisons for the whole brain.

For each of the four clusters, the averaged values were then extracted for each individual and each time-point using the Marsbar toolbox (Brett et al., 2002), and repeated measures ANOVAs (two groups × two time-points), with age and gender entered as nuisance variables, were performed in SPSS. Group × time interactions were significant for all four regions, indicating that increases in gray matter concentration were significantly greater in the MBSR than in the control group: PCC ($F\ (1,29)=50.124$; $P<0.001$), TPJ ($F\ (1,29)=11.456$; $P=0.002$), cerebellar vermis/brainstem ($F\ (1,29)=11.292$; $P=0.002$), lateral cerebellum ($F\ (1,29)=9.806$; $P=0.004$).

Change in gray matter concentration in the control group was not significant for the clusters in the TPJ ($t\ (16)=-0.87$; $P=0.40$), cerebellar vermis ($t\ (16)=-0.15$; $P=0.88$), or lateral cerebellum ($t\ (16)=0.273$; $P=0.79$), but there was a decrease in the PCC cluster ($t\ (16)=-4.121$; $P=0.001$). Independent sample t-tests (with equal variances) at the Pre time-point indicated that the groups did not differ in gray matter concentration in the PCC ($t\ (31)=0.24$; $P=0.81$), TPJ ($t\ (31)=0.85$; $P=0.40$) and the lateral cerebellum ($t\ (31)=-1.41$; $P=0.17$), but the control group had greater gray matter concentration in the cerebellar vermis cluster ($t\ (31)=2.84$; $P=0.008$). The amount of homework practice and the change in mindfulness scores (FFMQ) were not correlated with changes in the identified clusters. Furthermore, we performed a paired t-test within the control group in SPM5 and applied the same thresholds. No significant clusters were identified to increase or decrease in gray matter concentration from Pre to Post in the control group. To summarize, exploratory analyses identified increases in gray matter

Fig. 2. Increase in gray matter concentration in the MBSR group from Pre- to Post-intervention in the exploratory whole brain analysis. A: cluster in the posterior cingulate cortex and cerebellum (sagittal slice at $x = -2$); B: cluster in the left temporo-parietal junction (peak in the middle temporal gyrus; sagittal slice at $x = -52$); C: cluster in the cerebellum and brainstem (axial slice at $z = -28$). Significant clusters within the whole brain (clusters with $P < 0.05$, corrected for multiple comparisons across the entire brain, initial voxel-level threshold of $P = 0.01$) are overlaid over the group-averaged normalized structural MPRAGE image.

concentration in regions in the PCC, TPJ, and cerebellum in the MBSR, but not the control group over the 8-week period, suggesting that participation in an MBSR course causes structural changes in these brain regions.

4. Discussion

This study demonstrates longitudinal changes in brain gray matter concentration following an 8-week Mindfulness-Based Stress Reduction course compared with a control group. Hypothesized increases in gray matter concentration within the left hippocampus were confirmed. Exploratory whole brain analyses identified significant increases in gray matter concentration in the PCC, TPJ, and the cerebellum.

The hippocampus has been postulated to play a central role in mediating some of the benefits of meditation, due to its involvement in the modulation of cortical arousal and responsiveness (Newberg and Iversen, 2003), and morphological differences between meditators and non-meditators in the hippocampus have previously been reported (Hölzel et al., 2008; Luders et al., 2009). The hippocampus also contributes to the regulation of emotion (Corcoran and Maren, 2001; Corcoran et al., 2005; Milad et al., 2007) and the structural changes in this area following mindfulness practice may reflect improved function in regulating emotional responding. In contrast to these increases, several pathological conditions (e.g., major depression (Sheline, 2000), post-traumatic stress disorder (Kasai et al., 2008)) are associated with decreased density or volume of the hippocampus. And while the precise mechanisms of hippocampal volume decrease are not known, a number of factors such as neuronal loss through chronic hypercortisolemia, glial cell loss, stress-induced reduction in neurotrophic factors, or stress-induced reduction in neurogenesis may contribute to this (Sheline, 2000). Furthermore, smaller hippocampi have also been

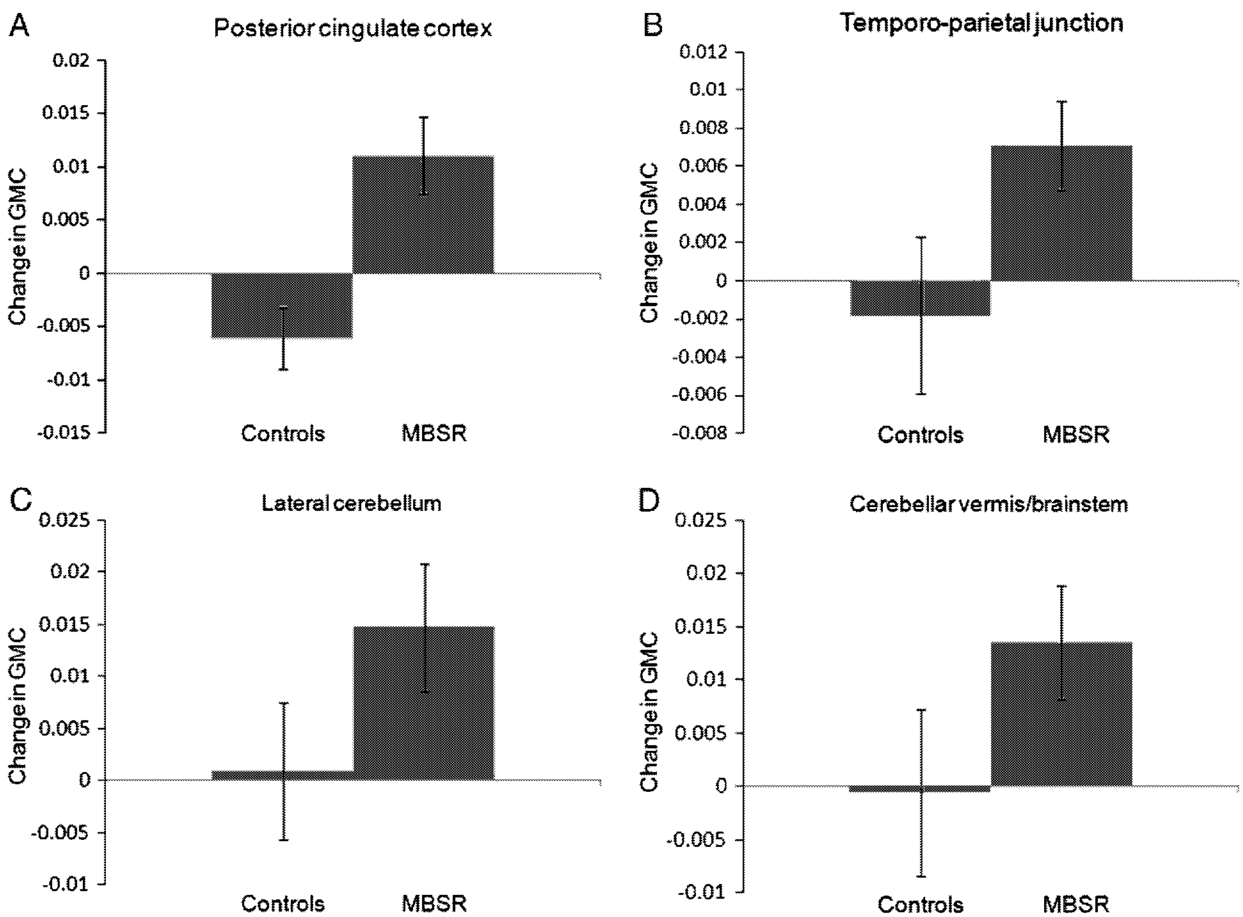

Fig. 3. Change in gray matter concentration (GMC) within the clusters in the posterior cingulate cortex (A), the temporo-parietal junction (B), the lateral cerebellum (C) and the cerebellar vermis/brainstem (D) in the MBSR and control group. Error bars show 95% confidence interval.

shown to constitute a risk factor for the development of stress-related psychopathology (Gilbertson et al., 2002). However, the hippocampus is a region well known for its ability to remodel synapses and generate new neurons (Gage, 2002), and volume loss in this region seems to be reversible (Gould et al., 2000; Jacobs et al., 2000). For example, treatment with selective serotonin reuptake inhibitors (SSRIs)– aside from improvement of stress disorder symptoms – has been found to lead to an increase in hippocampal volume (Vermetten et al., 2003) and it has been suggested that some of the behavioral effects of antidepressant treatment might depend on neurogenesis in the hippocampus (Santarelli et al., 2003). Future research will be needed to investigate whether similar neural mechanisms contribute to improvements in mental health following a medication-free behavioral intervention. We previously reported that changes in perceived stress were correlated with structural changes in the amygdala in a study that included subjects in the present study, and changes in stress were not correlated with changes in the hippocampus (Hölzel et al., 2009). However, the structural changes in the hippocampus identified here might be related to improvements in one of the other well-being-related variables that have been reported to improve following participation in an MBSR course.

The insula is known to be impacted in interoceptive/visceral awareness (Critchley et al., 2004) as well as in empathic responses (Singer et al., 2004). More generally, a recent review points to the fundamental role of the insula in human awareness, or consciousness (Craig, 2009). Given that mindfulness meditation constitutes training in interoception and conscious awareness, and based on the findings of previous studies which described functional as well as morphological differences in the insula between meditators and non-meditators (Lazar et al., 2005; Hölzel et al., 2008; Lutz et al., 2008), we hypothesized structural increases in the current study. However, the Pre–Post comparison within the MBSR group was not significant. It is possible that greater amounts of practice are required to produce structural changes in this region. It is also possible that previously identified differences between meditators and non-meditators were unrelated to the meditation training, but rather pre-existing. Furthermore, a recent study revealed that meditators did not show superior performance in an interoceptive task (Khalsa et al., 2008), challenging the assumption that enhanced cortical thickness and functional activation in the insula in meditators are related to better interoceptive awareness. Future studies that include a longer training program and assess interoceptive awareness Pre and Post intervention could help address these contradictory findings.

It has been suggested that the TPJ is a crucial structure for the conscious experience of the self, mediating spatial unity of self and body (Blanke et al., 2005), or embodiment (Arzy et al., 2006), and impaired processing at the TPJ may lead to the pathological experience of the self, such as disembodiment or out-of-body experiences (Blanke et al., 2005). Furthermore, the TPJ is also involved in social cognition, i.e., the ability to infer states such as desires, intentions, and goals of other people (Van Overwalle, 2009) and there is evidence of greater activation of this region during feelings of compassion in meditators (Lutz et al., 2008). Mindfulness training involves both the establishment of an awareness of oneself as a 'complete whole' (Kabat-Zinn, 1990), and the cultivation of compassion. The morphological changes in the TPJ might be associated with increases in compassion attributed to meditation training (Shapiro et al., 2005) and the cultivation of an embodied self.

Correspondingly, several studies suggest that the PCC is engaged when assessing the relevance or significance of a stimulus for oneself (Gusnard et al., 2001; Schmitz and Johnson, 2007) and it has been suggested to be particularly important for the integration of self-referential stimuli in the emotional and autobiographical context of one's own person (Northoff and Bermpohl, 2004). These functions also are closely related to mindfulness practice, which involves the introspective observation of phenomenal experiences as they are encountered (Kabat-Zinn, 1990). Structural increases might be related to the repeated activation of this region during this process. Interestingly, the hippocampus, TPJ, and PCC (as well as parts of the medial prefrontal cortex not identified in the present study) form a brain network (Vincent et al., 2006) that supports diverse forms of self-projection (Buckner and Carroll, 2007), including remembering the past, thinking about the future (Schacter et al., 2007), and conceiving the viewpoint of others (Saxe and Kanwisher, 2003). These abilities have been suggested to share a common set of processes, by which autobiographical information is used adaptively to enable the perception of alternative perspectives (Buckner and Carroll, 2007). Literature on the mechanisms of mindfulness proposes that the positive benefits of the practice might be mediated by a perceptual shift that modulates the internal representation of the self (Shapiro et al., 2006; Carmody, 2009) and it is possible that structural changes in the brain network involved in the projection of oneself into another perspective may underlie this perceptual shift.

One of the two extensive clusters identified in the cerebellum was located in lateral parts of the posterior and flocculonodular lobe, and the other one was located in the vermis, reaching into the brainstem. Aside from the well-known function of the cerebellum in the integration of sensory perception, coordination, and motor control (Marr, 1969), this structure also plays a crucial role in the regulation of emotion and cognition. Lesions of the cerebellum have been found to lead to a constellation of cognitive, affective and behavioral abnormalities, the so-called "cerebellar cognitive affective syndrome" (Schmahmann et al., 2007). It has been suggested that in the same way that the cerebellum regulates the rate, force, rhythm, and accuracy of movements, it also regulates the speed, capacity, consistency, and appropriateness of cognitive and emotional processes (Schmahmann, 2004), i.e., it modulates behavior automatically around a homeostatic baseline. Given the importance that the regulation of emotions and cognition play in healthy psychological functioning, the morphological changes in these regions might contribute to the positive effects of mindfulness meditation on the salutary changes in well-being.

Regions within the brainstem were found to increase in gray matter concentration over the 8 weeks. These regions appear to include the area of the locus coeruleus, nucleus raphe pontis, pontine tegmentum, and the sensory trigeminal nucleus (Naidlich et al., 2009). The regions of gray matter differences between meditators and non-meditators in the cerebellum and brainstem identified by Vestergaard-Poulsen et al. (2009) do not appear to overlap with the ones identified here. The locus coeruleus is the site of synthesis and release of the neurotransmitter norephinephrine, while the raphe nuclei release serotonin. The modulation of the serotonin system has been profoundly effective for the treatment of a wide range of mood and anxiety disorders, as evidenced by the widespread use of SSRIs (Masand and Gupta, 1999). The norephinephrine system of the locus coeruleus is thought to optimize behavioral performance by modulating arousal, regulating the interplay between focused vs. flexible responding to environmental demands, or selective vs. scanning attention (Aston-Jones et al., 2000; Aston-Jones and Cohen, 2005). Considerable evidence exists that the neurons of this system are important in a variety of cognitive, affective, and other behavioral functions, as well as associated clinical dysfunctions (e.g., depression, anxiety, sleep, and circadian disorders; for discussion, see Aston-Jones, 2002). It is also one of the primary sites for the mediation of the stress response as well as a site of action of antidepressant drugs (Brady, 1994). Several studies have documented the positive impact of mindfulness-based programs on symptoms of anxiety and depression (Baer, 2003; Kuyken et al., 2008; Roemer et al., 2008), as well as improvements in sleep patterns (Carlson and Garland, 2005; Ong et al., 2009) and attention (Jha et al., 2007). The morphological changes reported here might contribute to some of these enhancements.

While significant Pre–Post changes in the TPJ, PCC, and cerebellum have been found in the present study, it is unclear why previous cross-sectional studies of meditators have not identified group differences in these regions. It is possible that small differences existed but were not detected due to the lack of power in the previous small cross-sectional studies, or that structural changes are transient and change might be maximal when a skill is newly acquired (Driemeyer et al., 2008).

It should be noted also that MBSR is a multifaceted group program and some positive effects may result from components not specific to meditation or mindfulness, such as group social interaction, stress education, or gentle stretching exercises. Exercise is known to increase neurogenesis in the hippocampus (van Praag et al., 1999). Since it also plays a crucial role in long-term memory consolidation and learning, structural changes might be related to general learning that occurred during the MBSR course analogous to those found in a study of medical students learning new information (Draganski et al., 2006). Comparing the brain gray matter concentration changes in the MBSR group to those of a wait-list control group, the current study did not allow differentiating between the effects of these different components. Indeed, the absence of a positive correlation between the change in gray matter concentration and the amount of homework suggests that the number of minutes of formal homework exercise is not the primary driving force behind the effects, but that the MBSR program as a whole influences the morphological changes. Future studies employing an active control condition that includes the mindfulness-nonspecific components of the program (e.g., MacCoon et al., 2008) would help isolate the specific effects of meditation. Also, the current study investigated physician- and self-referred individuals seeking stress reduction, and generalizations should therefore be limited to this population of stress individuals. Future studies will be required to test whether findings extend to non-stressed individuals as well as individuals suffering from mental disorders. Finally, the current study employed a rather small sample size and replication is necessary.

The adult nervous system has the capacity for plasticity, and the structure of the brain can change in response to training (Gage, 2002; Draganski et al., 2004; Colcombe et al., 2006; Driemeyer et al., 2008). It is generally assumed that the increased gray matter results from repeated activation of a brain region (May et al., 2007; Ilg et al., 2008) and previous studies have shown activation during meditation in brain regions identified here (Lou et al., 1999; Lazar et al., 2000; Newberg et al., 2001; Hölzel et al., 2007; Lutz et al., 2008). The cellular mechanisms underlying training-induced neuroanatomical plasticity are not yet understood, however. An extensive body of research during the last decade has established that MBSR leads to improvements in psychological health and well-being (Grossman et al., 2004; Carmody et al., 2009). Demonstrating morphological increases in regions associated with mental health, the data presented here suggest a plausible underlying neural mechanism, namely, that such increases represent enduring changes in brain structure that could support improved mental functioning. Knowledge of the neurobiological mechanisms of behavioral interventions is indispensable to their effective and targeted use.

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Mindfulness training for coping with hot flashes: results of a randomized trial

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Abstract

Objective: The aim of this study was to analyze the effect of participation in a mindfulness training program (mindfulness-based stress reduction, [MBSR]) on the degree of bother from hot flashes and night sweats.

Methods: This study was a randomized trial of 110 late perimenopausal and early postmenopausal women experiencing an average of 5 or more moderate or severe hot flashes (including night sweats)/day. A wait-list control (WLC) was used with 3-month postintervention follow-up. The main outcome was the degree of bother from hot flashes and night sweats in the previous 24 hours. Secondary measures were hot flash intensity, quality of life, insomnia, anxiety, and perceived stress.

Results: Baseline average (SD) hot flash frequency was 7.87 (3.44) and 2.81 (1.76) night sweats/day. Mean (SD) bothersomeness score was 3.18 (0.55; "moderately bothered/extremely bothered"). All analyses were intention to treat and were controlled for baseline values. Within-woman changes in bother from hot flashes differed significantly by treatment arm (week × treatment arm interaction, $P = 0.042$). At completion of the intervention, bother in the MBSR arm decreased on average by 14.77% versus 6.79% for WLC. At 20 weeks, total reduction in bother for MBSR was 21.62% and 10.50% for WLC. Baseline-adjusted changes in hot flash intensity did not differ between treatment arms (week × treatment arm interaction, $P = 0.692$). The MBSR arm made clinically significant improvements in quality of life ($P = 0.022$), subjective sleep quality ($P = 0.009$), anxiety ($P = 0.005$), and perceived stress ($P = 0.001$). Improvements were maintained 3 months postintervention.

Conclusions: Our data suggest that MBSR may be a clinically significant resource in reducing the degree of bother and distress women experience from hot flashes and night sweats.

Key Words: Mindfulness – Menopause – Hot flashes – Sleep – Quality of life – Perceived stress.

Approximately 40% of postmenopausal women report that their hot flashes and night sweats negatively affect their quality of life by interfering with their work, leisure, mood, concentration, sleep, and sexual activity.[1] Hormonal therapy (HT) provided relief for most women, but after publication of its possible health risks,[2-5] the search for other treatments of similar efficacy has not yet been successful.[6] Although nonhormonal oral therapies offer some relief, their adverse effects and cost may prohibit their use for many women.[7-11] Women's need for relief from their hot flashes is indicated by the substantial number of women who resume oral HT despite the possible risks,[12-14] and by the number of women turning to complementary and alternative treatments[15,16] despite a lack of evidence for their efficacy.[17-20]

A substantial proportion of women report negative emotions in association with their hot flashes, including psychological distress, social embarrassment, and anxiety.[21-25] This distress is also associated with greater reported hot flash frequency[24,26] and may lead women to evaluate their hot flashes as more bothersome, over and above the frequency at which they occur.[21,23,26-40] Thus, women's distress may reflect not only the severity of their physical symptoms but also their psychological reactions to these unpredictable and socially problematic bodily states.[21,23,26-35,41] Programs designed to affect these reactions, however, have focused mainly on reducing hot flash frequency and have had mixed and limited results,[20,35,42-47] In recognition of the opportunity this approach represents, however, two National Institutes of Health–convened panels[48,49] have recommend the investigation of new behavioral treatments to increase women's resilience to hot flashes.

Mindfulness training involves women learning to recognize and discriminate more accurately between the components of

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experience such as thoughts, feelings, and sensations and developing a nonreactive awareness of these components.[50] The psychological distance created through mindfulness reduces the urgency of thoughts and affective states, enabling the person to observe, appraise, and be less reactive to events in their internal and external environment.[51] After an initial feasibility study,[35] our group tested the effect of participation in a widely available mindfulness training program (mindfulness-based stress reduction [MBSR]) on the degree of bother that women experienced from their hot flashes. MBSR has been shown to be effective in supporting women in coping with a wide range of symptom-related challenges,[52] including reduced sleep disturbance,[53,54] perceived stress,[55] anxiety,[56,57] and panic.[58,59] We also examined changes in hot flash intensity (hot flash frequency × severity) and in four psychosocial variables affected by hot flashes.

METHODS

Study population and eligibility criteria

Participants were women in the late menopausal transition and early postmenopause[60] experiencing an average of 5 or more moderate or severe hot flashes (including night sweats)/day during the past week. The frequency and severity criteria were chosen to maximize eligibility in relation to hot flash prevalence,[60-63] and are consistent with other studies,[64-67] and reviews.[60,68-71]

Additional criteria included willingness to keep a daily diary of the time and intensity and bother from hot flashes and endeavoring to maintain present exercise, dietary pattern, and dose of any soy supplements or menopausal remedies (including isoflavone intake). Exclusion criteria included medical conditions or medications that may affect hot flashes (such as a history of thyroid disease or use of selective estrogen receptor modulators). Women with breast cancer were eligible 6 months after the completion of their treatment. Women were asked to report the initiation of any medications during the study, and those taking selective serotonin reuptake inhibitors (SSRIs) and anxiolytics and were asked to maintain their present dose or to report immediately any change. The study was approved by the University of Massachusetts Medical School's (UMMS) Institutional Review Board.

The target sample size, after accounting for attrition, was 50 women/treatment arm, as recommended by Sloan et al.[72] Using these recommendations, this sample size yields an estimated effect size for the between-arm difference of 0.58 SDs, equivalent to approximately 3 units/day for hot flash intensity; smaller between-group differences are unlikely to be clinically meaningful.

Recruitment

Multiple strategies were used for recruitment, such as newspaper, radio, and cable advertising; UMMS intranet messaging and poster displays; a "Tell a Friend" campaign that encouraged women to pass the word to a friend or colleague; presentations at work sites and at a menopause symposium; health fairs and community events; Registry of Motor Vehicle Electronic Billboard; provider referral; and a direct mail campaign. Advertisements offered eligible women the opportunity to participate at no cost in the MBSR program as a possible means of managing their hot flashes. Enrollment took place between November 2005 and September 2007 and comprised eight cycles of women enrolled at 3-month intervals to coincide with the beginning of the four MBSR class cycles that run through the year at UMMS Center for Mindfulness, Worcester, MA.

After a telephone interview to establish eligibility, women completed the daily hot flash diary over the following 7 days to confirm eligibility and provide baseline hot flash data. At the following clinic interview, the study manager scanned the completed diary to confirm hot flash eligibility, explained the behavioral demands of the intervention and assessment procedures, and completed the informed consent process. Women who consented to participate completed the preprogram assessment questionnaires and were then randomly assigned to the intervention or to a wait-list control (WLC) group. Women completed the study assessments again at the end of intervention and at 20 weeks after enrollment and returned them by mail. Randomization was performed using Stata's ralloc command, which generates a sequence of group assignments randomly permuted in blocks of several sizes. The size and order of the blocks are also random: block sizes of 4 and 6 were used in this study. The programmer generated the random allocation sequence and uploaded the table containing the random sequence of group assignments to an Access database. Based on this table, the participant was automatically assigned to a group by the study manager clicking the "Randomize" button. All data entry personnel were blinded to group allocation.

Intervention

Women randomized to the intervention arm were able to select one of three concurrent MBSR classes (evening and daytime). Classes were conducted by Center for Mindfulness instructors who were blinded to the study outcomes. Classes comprised approximately 25 participants and included others who had been referred and self-referred to the MBSR program with a variety of diagnoses and stress-related conditions. As such, study participants were a minority in each class and did not have to reveal to others their reason for being in the class, unless they chose to do so.

The MBSR protocol has been described in detail elsewhere.[73] Briefly, participants attended eight weekly 2½-hour classes, plus an all-day class on a weekend day during the sixth week. The curriculum included training in mindfulness through (1) a body scan, a gradual moving of attention through the body from feet to head while lying in a supine position, bringing awareness particularly to bodily sensations; (2) sitting meditation, in which attention is brought to the flow of bodily sensations (particularly the sensations of breathing), thoughts, and emotions; and (3) mindful stretching exercises, intended to develop awareness during movement. In-class didactic material emphasized the application of mindfulness in everyday life and contained suggestions for its application in responding to distressing symptoms and stressful situations. A variety of informal mindfulness practices were assigned between sessions, and class participants received two CDs of guided instruction to be practiced at home for 45 minutes, 6 days/week.

Control

Control participants were assigned to a wait-list comparison group and offered participation in the MBSR program at no cost after their final study assessments.

Outcome measures

The primary outcome measure was overall degree of bother from hot flashes and night sweats in the previous 24 hours.[74] Bother was recorded in a hot flash diary in which women also recorded the number of mild, moderate, and severe hot flashes and night sweats. Hot flash diaries have been used to measure severity of hot flashes and degree of bother in a number of clinical trials.[72,75] Women completed the diary each day during the intervention period (9 weeks) and for 1 week during the 12, 16, and 20 follow-up weeks and returned them by mail. Bother was reported at the end of each day on a 4-point scale, with a range of "not at all" (1), "slightly bothered" (2), "moderately bothered" (3), and "extremely bothered" (4). Weekly scores (averaging daily scores for 7 days) were computed to smooth out day-to-day variability. All participants received weekly contact/reminder calls from study staff to check on possible problems related to the study intervention and/or to be reminded of completing their hot flash diaries.

Secondary outcomes included hot flash intensity, psychosocial measures of stress/distress (quality of life, subjective sleep quality, anxiety, and perceived stress), and treatment adherence. The hot flash intensity score was calculated as the sum of hot flashes, weighted by the severity ratings (mild, 1, through severe, 3). Scales for the psychosocial variables included the following. (1) *Menopause-Related Quality of Life*[76] is a validated self-administered instrument listing 29 menopause-related symptoms in four domains: vasomotor, physical, psychosocial, and sexual. Women report the degree of bother that they have experienced from each symptom over the past month. A lower score represents better quality of life. (2) *Women's Health Initiative Insomnia Rating Scale* (WHIIRS)[77,78] is a validated 5-item scale of subjective sleep quality that assesses sleep initiation and maintenance. Higher scores are indicative of poorer sleep quality. (3) *Hospital Anxiety and Depression Scale–Anxiety* (HADS-A)[79] is a 7-item self-administered measure assessing anxiety. Higher scores indicate greater psychological morbidity. HADS-A has been found to be valid and reliable for nonpsychiatric medical populations,[80] is widely used as a screening instrument in clinical settings,[81] and is not confounded by somatic symptoms of anxiety that relate also to physical disorders. A cutoff of 8 or higher is usually recommended for clinically significant anxiety.[80,82] HADS-A was added to the assessments a few months after enrollment started, as findings[21,22,24] on the possible relationship of anxiety to hot flashes emerged. Baseline data were available for 66% of participants. (4) *Perceived Stress Scale* (PSS; 14-item version)[83] posits that people appraise potentially threatening or challenging events in relation to their available coping resources and measures the degree to which situations in life are appraised as unpredictable, uncontrollable, and overwhelming. Higher scores indicate a greater degree of perceived stress.

Treatment adherence was assessed by percent intervention attendance (MBSR classes attended/total classes × 100) and the amount of reported home practice. Information about the latter was gathered through a log in which women recorded the number of minutes of formal mindfulness practiced each day during the intervention and during each of the 12-, 16-, and 20-week hot flash diary follow-ups. During the intervention, the completed logs were returned each week by placing them in a locked box in the MBSR classroom, which was collected by the study manager. Logs were not seen by the MBSR instructors.

In addition, information on demographics, socioeconomic status, medical history, smoking, previous meditation experience, yoga or tai-chi experience, and a number of variables known to affect hot flashes, such as body mass index, alcohol intake, and physical activity, was collected.

Statistical methods

The two treatment arms were characterized at baseline using frequencies for categorical variables and means and SDs for continuous variables. To assess the effect of the intervention on hot flash bother and intensity, percent change from baseline was modeled using linear-mixed modeling[84] as a function of week (weeks 1-9, 12, 16, and 20, treated as a categorical variable to allow for nonlinear trajectories), treatment arm, and their interaction, with adjustment for baseline value of the outcome being modeled to account for possible regression to the mean.[85] Similar analyses were conducted for the psychosocial variables, modeling change from baseline at weeks 9 and 20; absolute change rather than percent change was modeled because these scales have established clinical norms. All analyses were intention to treat. Primary analyses included all participants with a baseline measure and at least one follow-up measure. To assess the impact of missing data, analyses were repeated carrying the last observation forward; in all cases, results were similar (data not shown). Adjustment for baseline characteristics[86] that differed by treatment arm had little impact on treatment-related differences; thus, results adjusted only for the baseline outcome value are presented.

RESULTS

One hundred ten women aged between 47 and 69 years (mean ± SD age, 53 ± 4.9 years) consented to participate, with 57 randomized to the MBSR intervention and 53 to the WLC. The flow of participants through the study is reported in the CONSORT diagram (Fig. 1). Primary analysis included 92 women for bother; 99 women were included in the analysis

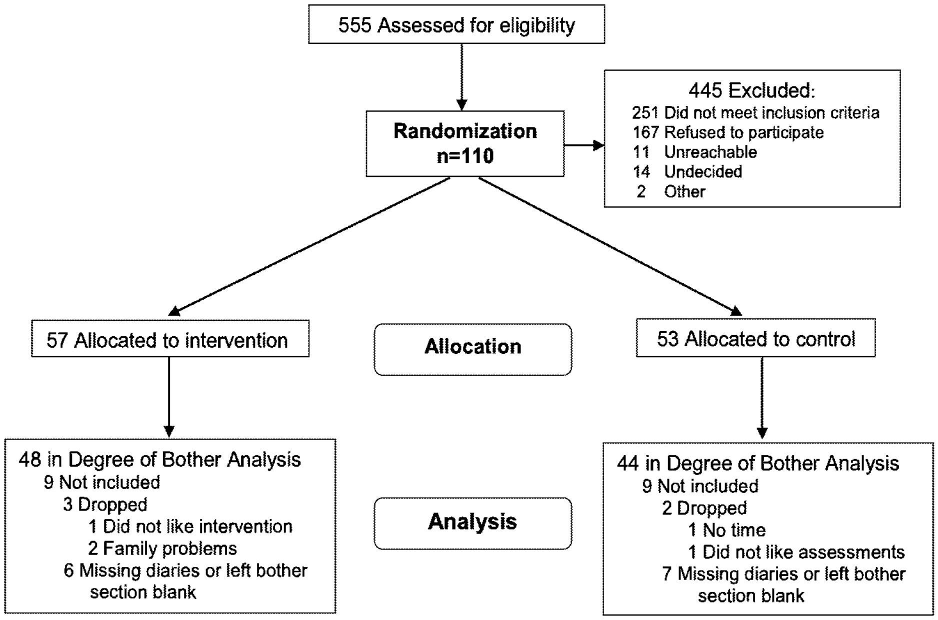

FIG. 1. CONSORT diagram: flow of participants through the study.

for hot flash intensity. Retention was 90.9% overall, 87.7% for the MBSR arm, and 94.3% for the control arm. Retention data and reasons for dropping are specified in Figure 1. For the diary outcomes, 63.6% of the women provided degree of overall bother on at least 80% of diaries, and 74.5% provided hot flash number and severity on at least 80% of diaries. There were no differences at baseline between women who provided relevant data on at least 80% of the diaries and those who did not.

The baseline characteristics of the study sample are shown in Table 1. Study participants were predominantly white (99%) and married (71%), with at least post–high school education (92%), and working full time (65%). At baseline, women reported an average (SD) of 8.12 (3.49) hot flashes/day and 2.8 (1.75) night sweats/day. As would be expected, daytime hot flash frequency and hot flash intensity were highly correlated (Spearman correlation = 0.91), consistent with the correlation (0.95) of Sloan et al.[72] The mean (SD) bother score was 3.19 (0.56). Expressed in the original scale, this is between "moderately bothered" and "extremely bothered." The mean insomnia score at baseline (11.85) was approximately at the 85th percentile for that scale[78] and above the cutoff (≥10) indicating problematic sleep disturbance.[77] The sample PSS mean (23.9) at baseline was 0.5 SD above the norm for US women.[87] With the exception of anxiety and bother, other baseline characteristics were similar between groups. The mean MBSR arm HADS-Anxiety was significantly higher than that of the WLC (9.6 vs 7.4; $P = 0.019$) and was above the cutoff (≥8) for possible/probable clinical anxiety.[88]

Degree of bother from hot flashes

Percent change in bother, controlling for baseline bother, is illustrated in Figure 2. At the end of the intervention (week 9), the MBSR arm had decreased on average by 14.77% (95% CI, 7.94%-21.61%; $P < 0.0001$) versus 6.79% for WLC (95% CI, −0.24%-13.81%; $P = 0.062$; MBSR-WLC difference, $P = 0.116$). With adjustment for baseline bother, mean bother in the MBSR participants was 2.71 (95% CI, 2.49-2.93), and in the WLC participants, it was 2.82 (95% CI, 2.60-3.04). Between weeks 9 and 20, MBSR arm bother decreased an additional 6.85% (95% CI, −0.33-14.02; $P = 0.065$) versus 3.71% in the WLC (95% CI, −3.39%-10.81%; $P = 0.308$; MBSR-WLC difference, $P = 0.544$). At 20 weeks, the total baseline-adjusted reduction in bother for MBSR was 21.62% (95% CI, 13.29-29.95; $P < 0.0001$) and 10.50% (95% CI, 2.11-18.88; $P = 0.016$) for WLC (MBSR-WLC difference, $P = 0.070$). The corresponding baseline-adjusted means on the original scale were 2.50 (95% CI, 2.25-2.75) for MBSR and 2.72 (95% CI, 2.47-2.97) for WLC, in the "slightly bothered" to "moderately bothered" range. Overall trajectories for within-woman change differed significantly by treatment arm (week × treatment arm interaction, $P = 0.042$).

Daytime hot flash intensity

Percent change in daytime hot flash intensity is presented in Figure 2. Overall, trajectories did not differ between treatment arms (week × treatment arm interaction, $P = 0.692$). At the end of the intervention, hot flash intensity in the MBSR arm had decreased on average by 32.25% (95% CI, 19.87%-44.63%; $P < 0.0001$) versus 20.69% in WLC (95% CI, 8.41%-32.97%; $P = 0.0013$; MBSR-WLC difference, $P = 0.198$). Between weeks 9 and 20, average additional decrease for MBSR was 12.31% (95% CI, 0.14%-24.48%; $P = 0.050$) versus 6.28% in WLC (95% CI, −5.42%-17.97%; $P = 0.295$; MBSR-WLC difference, $P = 0.485$). At 20 weeks, the total baseline-adjusted reduction in hot flash intensity was 44.56% (95% CI, 31.81-57.31; $P < 0.0001$) for MBSR and 26.97% (95% CI, 14.44-39.50; $P < 0.0001$) for WLC

TABLE 1. *Baseline characteristics of study groups*[a]

Characteristic		Total sample (n = 110)	Wait list (n = 48)	MBSR (n = 57)	P^b
Age, y		53.1 (4.9)	53.8 (4.4)	52.5 (5.4)	0.169
White		99 (1)	100 (48)	98.2 (54)	0.534
Hispanic/Latina		1 (1)	0 (0)	1.8 (1)	
Marital status	Married/living with partner	71.3 (77)	67.9 (36)	74.5 (41)	0.447
	Single/widowed	28.7 (31)	32.1 (17)	25.5 (14)	
Education	High school	8.4 (9)	7.8 (4)	8.9 (5)	0.641
	College or some college	56.1 (60)	60.8 (31)	51.8 (29)	
	Postgraduate	35.5 (38)	31.4 (16)	39.3 (22)	
Employment	Working full time	65.4 (70)	67.9 (36)	63.0 (34)	0.737
	Working part time	18.7 (20)	15.1 (8)	22.2 (12)	
	Retired	4.7 (5)	3.8 (2)	5.6 (3)	
How hard to pay for the very basics (food, heating, etc)	Not very hard at all	75.5 (71)	70.5 (31)	80.0 (40)	0.283
	Somewhat hard, or very hard	24.5 (23)	29.5 (13)	20.0 (10)	
Smoking	Current	7.8 (8)	6.3 (3)	9.3 (5)	0.910
	Former smoker	43.1 (44)	43.8 (21)	42.6 (23)	
	Never	49.0 (50)	50 (24)	48.1 (26)	
Physical activity	None/light	16.7 (18)	13.7 (7)	19.3 (11)	0.181
	Moderate	45.4 (49)	39.2 (20)	50.9 (29)	
	Intense	38.0 (41)	47.1 (24)	29.8 (17)	
Alcohol intake (no. of drinks during the past month)		3.7 (7)	5.2 (9.5)	2.33 (2.9)	0.642
Soy/isoflavone supplements, % taking		6.4 (6)	3.8 (2)	8.9 (5)	0.679
Had previous meditation experience		38.3 (41)	34.6 (18)	41.8 (23)	0.444
Practices yoga or tai-chi		11.8 (11)	11.4 (5)	12.2 (6)	0.895
BMI		28.2 (6.4)	26.53 (4.7)	29.8 (7.3)	0.247
Hot flashes frequency, average/d		8.12 (3.49)	7.59 (3.16)	8.16 (3.72)	0.127
Night sweats, average/night		2.8 (1.75)	2.89 (1.92)	2.73 (1.6)	0.637
Hot flashes intensity score (frequency × severity)		18.96 (9.88)	17.37 (9.29)	20.44 (10.25)	0.120
Hot flashes overall bothersome score		3.19 (0.56)	3.07 (0.54)	3.29 (0.55)	0.035
Hospital Anxiety and Depression Scale–Anxiety		8.6 (4.0)	7.4 (3.3)	9.6 (4.3)	0.019
Perceived stress		23.9 (8.1)	23.2 (8.6)	24.5 (7.7)	0.392
Insomnia score (subjective sleep quality)		11.9 (4.2)	11.4 (4.0)	12.3 (4.4)	0.269
Overall QOL		4.28 (1.02)	4.22 (1.0)	4.33 (1.1)	0.588

Missing observations were omitted. MBSR, mindfulness-based stress reduction; BMI, body mass index; QOL, quality of life.
[a]Values are means (SD) or % (n).
[b]Fisher's exact test, *t* test, or Wilcoxon test.

(MBSR-WLC difference, $P = 0.057$). Corresponding results for daytime hot flash frequency were very similar, as would be expected, given the very high correlation between the two outcomes, and thus are not presented here.

Changes in psychosocial variables, controlling for baseline values, are shown in Table 2 and illustrated in Figure 3.

Quality of life

The mean preoperative/postoperative intervention (week 9) difference in overall quality of life scores was significantly larger in the MBSR group. Subsequent within-woman change between 9 and 20 weeks did not differ by treatment arm. The change in the MBSR quality of life means between baseline

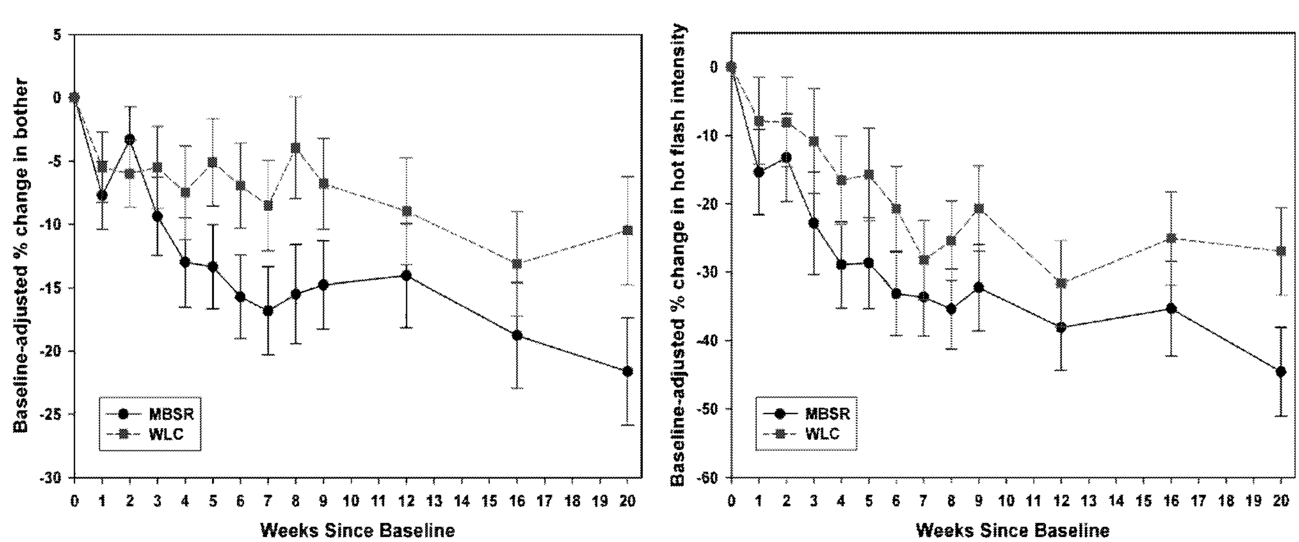

FIG. 2. Mean percent change since baseline (SE) in hot flash bother and hot flash intensity, adjusted for baseline values, by treatment arm weekly during the intervention (weeks 1-9) and at 12-, 16-, and 20-week follow-up. MBSR, mindfulness-based stress reduction; WLC, wait-list control.

TABLE 2. *Changes in psychosocial outcomes at study weeks 9 and 20 for MBSR and wait-list control participants*

	Baseline to 9-wk change			9- to 20-wk change		
	MBSR arm, mean (SE)	Control arm, mean (SE)	*P*	MBSR arm, mean (SE)	Control arm, mean (SE)	*P*
Overall QOL	−0.71 (0.14)	−0.26 (0.13)	0.022	−0.27 (0.12)	0.00 (0.12)	0.114
Sleep quality	−2.68 (0.55)	−0.60 (0.54)	0.009	−0.36 (0.57)	−0.13 (0.55)	0.766
HADS-Anxiety	−3.05 (0.53)	−0.80 (0.54)	0.005	0.65 (0.51)	0.26 (0.50)	0.586
Perceived stress	−4.04 (0.80)	−0.22 (0.78)	0.001	−0.73 (0.70)	0.38 (0.55)	0.262

MBSR, mindfulness-based stress reduction; QOL, quality of life; HADS, Hospital Anxiety and Depression Scale.

and 20 weeks (4.3-3.3) represents a clinically significant improvement in overall quality of life.[89]

Sleep quality

Average preoperative/postoperative intervention change in sleep quality was significantly greater in the MBSR arm than in the WLC. Although subsequent within-woman change did not differ significantly by treatment arm, the difference between the group's means at 20 weeks (11.1 WLC vs 8.9 MBSR) remained larger than the difference of 0.5 SDs, which was considered clinically meaningful for this scale. The MBSR arm mean had improved to below the cutoff indicative of problematic sleep disturbance (≥10).[77]

HADS anxiety

Between baseline and the end of the intervention, there was a significant reduction in anxiety scores in the MBSR arm compared with the WLC. The between-arm difference in mean within-woman change between weeks 9 and 20 was not significant. At the end of the intervention, the MBSR mean (6.5) had decreased into the subclinical range (<8) and remained so at 20 weeks (7.2).

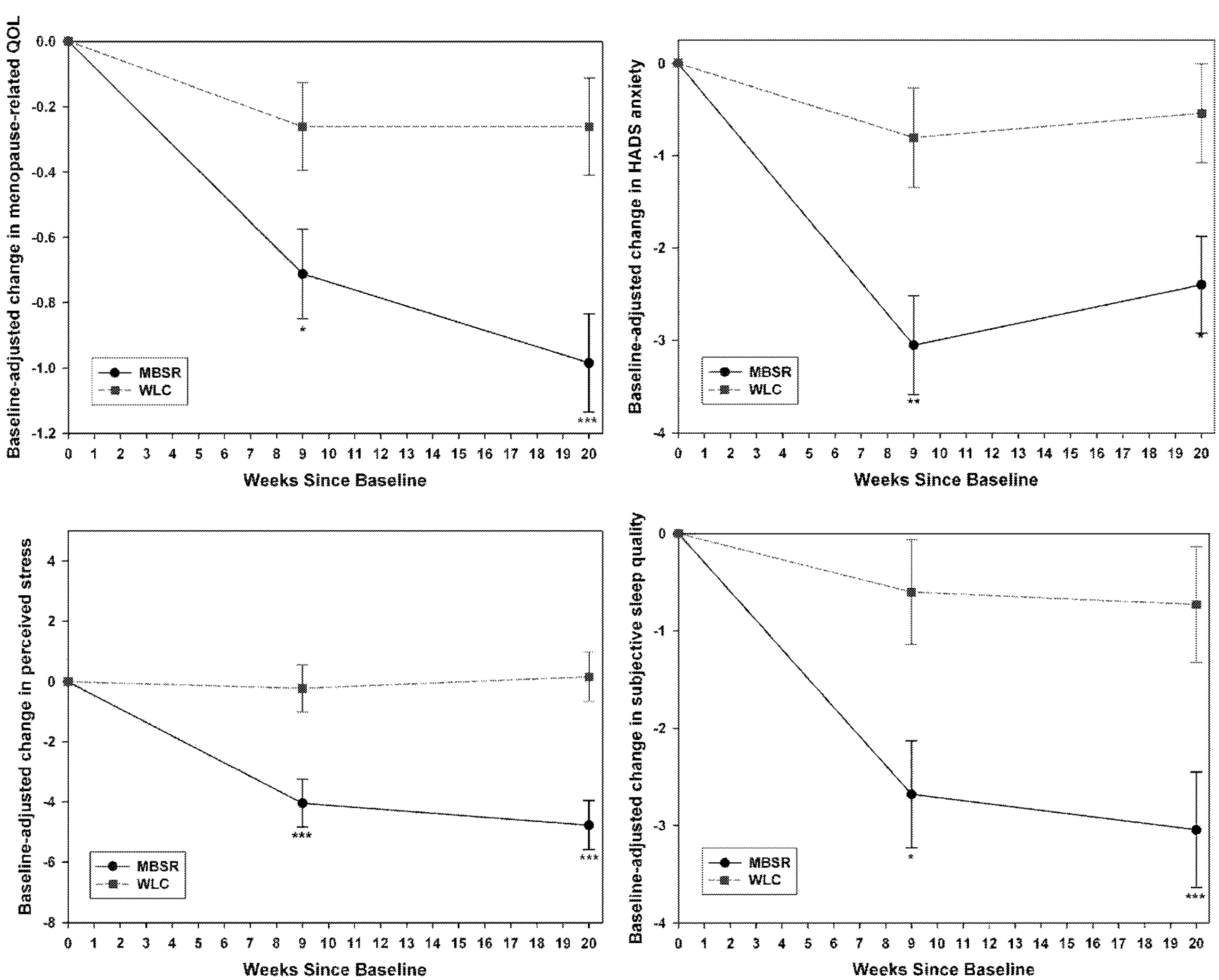

FIG. 3. Mean absolute change since baseline (SE) in psychosocial outcomes, adjusted for baseline values, by treatment arm at weeks 9 and 20. For between-arm differences, $^{*}P < 0.05$, $^{**}P < 0.01$, and $^{***}P < 0.001$. MBSR, mindfulness-based stress reduction; WLC, wait-list control; QOL, quality of life; HADS, Hospital Anxiety and Depression Scale.

Perceived stress

Between baseline and the end of the intervention, the MBSR arm had a significantly larger reduction in perceived stress than did the WLC. There was no difference in the arms between weeks 9 and 20. The mean score for the MBSR arm at the end of intervention (20.1) and at 20 weeks (20.4) had decreased to the normative value for US women on this scale.[87]

Intervention adherence

The average MBSR class attendance was 81%. The average (SD) reported out-of-class mindfulness practice was 35.0 (19.6) minutes/day during the intervention and 24.8 (19.3) minutes/day during the follow-up period.

DISCUSSION

The reported health risks associated with the use of HT[2-4] have left women seeking other treatments for hot flashes. In view of the role of psychosocial factors in hot flash distress and bother,[2123-41] we tested the effect of participation in MBSR on hot flash bother, intensity, and psychological distress. The MBSR arm reported a significantly greater reduction over time in the degree of overall bother from their hot flashes and night sweats compared with the WLC group; after 9 weeks, hot flash bother had declined by an average of 14.77% in the MBSR arm versus 6.79% in the WLC arm. This between-arm difference was maintained after the intervention (weeks 9-20), and at 20 weeks, hot flash bother in the MBSR arm was reduced by 21.62% versus 10.50% in controls. Expressed in the conceptual labels for categories of degree of bother, the sample mean at baseline was moderately/extremely bothered. At 20 weeks, the baseline-adjusted means were in the "slightly bothered" to "moderately bothered" range, and trajectories for within-woman change differed significantly by treatment arm. Although the clinical significance of change in bother has yet to be established, our result stands in contrast to trials of cognitive behavioral interventions to reduce hot flash bother, which found no reduction.[25,45] It also compares favorably with a trial of venlafaxine (a serotonin-norepinephrine reuptake inhibitor) versus placebo on hot flash frequency, which found an 18% reduction in bother (there was a 6% increase in the placebo arm) associated with the reductions in hot flash frequency.[75] Significantly, however, even the relatively mild adverse effects of the drug caused women to discontinue its use in the long term. In addition, the 44.56% reduction in hot flash intensity at 20 weeks in the present trial compares favorably with the 49% to 55% (depending on the dose) reduction in hot flash intensity achieved with citalopram (an SSRI), which was recommended as an effective treatment for hot flashes.[11]

The clinically meaningful improvements in quality of life[89] and sleep quality[77] are also notable. Reductions in sleep quality occur in about 40% of women during perimenopause,[90] and women experiencing distress from hot flashes report disturbed sleep[37,91] that leads to fatigue and reduced quality of life.[92] The results of the present study are consistent with these prior findings. The mean sleep disturbance score at baseline (11.85) was more than 1 SD above the WHIIRS norm for white women (50-59 years; mean ± SD, 6.45 ± 4.43[77]) and above the scale cutoff for problematic sleep disturbance (≥10).[77] At 20 weeks, the MBSR arm mean (8.8) had improved to below that cutoff. Furthermore, the improvement represented by the difference in the MBSR WHIIRS means at baseline and 20 weeks (12.3-8.8 = 3.5) compares favorably with the mean reduction (5.0) in this scale at 12 weeks in women embarking on HT.[93] In contrast, the sleep scores in the WLC arm did not change (11.4-11.1) over that period and remained in the range for problematic sleep disturbance.

The clinical importance of stress and the role of mental distress in hot flash frequency, severity, and bother[21,23,24,26,36-40] highlight our positive findings in these dimensions. Higher perceived stress scores are associated with immune dysregulation in a dose-response manner[94] in older adults[95,96] and with work absenteeism.[97] In this respect, the study sample perceived stress mean at baseline (23.9) was 0.5 SD above the norm for that scale for US women (20.2; SD, 7.8).[87] At the end of intervention and at 20 weeks, the MBSR arm means (20.2 and 20.4, respectively) had declined to the population norm, whereas the WLC arm means were unchanged from baseline (23.2, 23.3, and 23.4). The magnitude of the reduction in PSS means is comparable with other studies of MBSR with stressed populations.[55] The degree of mental distress among women in the sample is suggested by the baseline HADS-Anxiety mean score (8.6) being at the clinical cutoff (≥8) for that scale.[88] The MBSR arm mean score decreased from 9.6 at baseline to 6.5 at the end of intervention and was within the nonclinical range. The consistency of these findings contrasts with other behavioral programs intended to affect psychological distress in perimenopausal women, which have had mixed and limited results.[20,35,42-47]

Several other features of the results warrant comment. First, the improvement in bother from hot flashes was not accompanied by a significant reduction in hot flash intensity, suggesting that participation in MBSR may be useful to women in coping better with their existing hot flashes. Second, the improvements observed in the MBSR arm during the intervention were maintained at 3 months of follow-up even without postprogram "booster" sessions. Finally, it is noteworthy that the MBSR procedure was not altered for the purposes of the present study, nor were the participants instructed to apply their mindfulness training in any specific way to their menopausal symptoms. Rather, participants attended the same "real world" MBSR program (rather than one adapted to this population) that is widely available in the United States and Europe, and the dropout rate (12.3%) was similar to that reported in studies of MBSR with nonclinical samples (15%[52,55]).

This study has a number of limitations. Most notably, it did not include an active control program, and so, it was not possible to estimate the degree to which similar improvements in hot flash bother might result from a comparison program that incorporated such factors as the additional attention that

MBSR women received through interaction with classmates and instructors. However, although studies of pharmacological treatments to reduce the frequency and/or intensity of hot flashes report a placebo effect of up to 30%,[72] behavioral programs to support coping with (rather than reducing) hot flashes have not indicated that a placebo effect can be expected in a subjective variable such as bother.[18] A menopause education group that was well received by perimenopausal women raised their knowledge of menopause but had no significant impact on the bother they experienced from hot flashes.[98] In addition, the SSRI trial (referred to in the previous section)[11] that found a reduction in hot flash intensity similar to that found in the present study reported an intensity reduction in the placebo arm that was similar to that observed in our WLC arm (23% and 28% reduction, respectively). The study is further limited by the fact that only 63% of women provided 80% or more of bothersome ratings, although no differences at baseline were found between the women who provided ratings and those who did not. Last, the sample was predominantly white and educated, and, thus, it provides no indication of the feasibility or effectiveness of MBSR for minority women.

CONCLUSIONS

Taken together, our data suggest that MBSR may be a clinically significant resource for reducing the degree of bother women experience from hot flashes and night sweats.

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Stress reduction correlates with structural changes in the amygdala

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Stress has significant adverse effects on health and is a risk factor for many illnesses. Neurobiological studies have implicated the amygdala as a brain structure crucial in stress responses. Whereas hyperactive amygdala *function* is often observed during stress conditions, cross-sectional reports of differences in gray matter *structure* have been less consistent. We conducted a longitudinal MRI study to investigate the relationship between changes in perceived stress with changes in amygdala gray matter density following a stress-reduction intervention. Stressed but otherwise healthy individuals ($N = 26$) participated in an 8-week mindfulness-based stress reduction intervention. Perceived stress was rated on the perceived stress scale (PSS) and anatomical MR images were acquired pre- and post-intervention. PSS change was used as the predictive regressor for changes in gray matter density within the bilateral amygdalae. Following the intervention, participants reported significantly reduced perceived stress. Reductions in perceived stress correlated positively with decreases in right basolateral amygdala gray matter density. Whereas prior studies found gray matter modifications resulting from acquisition of abstract information, motor and language skills, this study demonstrates that neuroplastic changes are associated with improvements in a psychological state variable.

Keywords: stress; amygdala; gray matter; MRI; mindfulness

INTRODUCTION

Acute stress initiates hormonal and behavioral responses that enable an organism to make adaptations to environmental demands (Chrousos, 2000). The amygdala has been implicated in both human and animal studies as playing a crucial role during stress responses, including the detection of stressful and threatening stimuli and the initiation of adaptive coping responses (LeDoux, 2000; Hasler *et al.*, 2007). Amygdala-dependent cognition is facilitated during stressful conditions—a useful function for fear-related learning (Shors and Mathew, 1998; Sapolsky, 2003). However, prolonged exposure to stress increases the risk of being affected by a number of mental and physical illnesses (Johnson *et al.*, 1992; Chrousos, 2000; Sapolsky, Romero, & Munck, 2000).

Aberrant amygdala function has been consistently demonstrated across several stress-related psychopathologies. For example, exaggerated amygdala activation has been found in trait anxiety (Stein *et al.*, 2007), post-traumatic stress disorder (PTSD; Rauch *et al.*, 2000; Shin *et al.*, 2004, 2005), social phobia (Birbaumer *et al.*, 1998; Evans *et al.*, 2008; Phan *et al.*, 2006), depression (Drevets *et al.*, 1992; Abercrombie *et al.*, 1998; Sheline *et al.*, 2001; Siegle *et al.*, 2002; Dougherty *et al.*, 2004) and impulsive aggression (Coccaro *et al.*, 2007).

Reports of differences in gray matter structure of the amygdala in pathologic stress conditions have been less consistent (Drevets *et al.*, 2008). While some studies found enlarged amygdala volumes in subjects with affective disorders (Altshuler *et al.*, 1998; Strakowski *et al.*, 1999; Frodl *et al.*, 2002; Lange and Irle, 2004; Weniger *et al.*, 2006), others did not find altered volumes or reported volume reductions (Sheline *et al.*, 1998; Mervaala *et al.*, 2000; Frodl *et al.*, 2003; Frodl *et al.*, 2008). Amygdala findings for patients suffering from PTSD and other anxiety disorders have also been mixed (Gurvits *et al.*, 1996; De Bellis *et al.*, 2000; Gilbertson *et al.*, 2002; Massana *et al.*, 2003; Siegle *et al.*, 2003; Wignall *et al.*, 2004; Milham *et al.*, 2005; Karl *et al.*, 2006; Atmaca *et al.*, 2008; Woon and Hedges, 2008; Hayano *et al.*, 2009). One study with healthy individuals failed to find a correlation between chronic life stress and gray matter volume in the amygdala (Gianaros *et al.*, 2007). These inconsistencies in the literature might result from a number of factors that can impact gray matter measures, such as gender (Wilke *et al.*, 2007), genetics

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(Meyer-Lindenberg *et al.*, 2006) and volumetry method (Doty *et al.*, 2008).

In contrast to studies of humans, the stress literature with animals is more consistent. Several studies have shown that prolonged stress exposure leads to increases in measures of amygdala structure in rodents (Vyas *et al.*, 2002, 2003; Mitra *et al.*, 2005). Increased dendritic length and increased arborization were reported within the basolateral complex of the amygdala and in the extended amygdala as a result of exposure to chronic immobilization stress (Vyas *et al.*, 2002, 2003). Differences between the results from the human and animal studies might be due to methodological differences. First, the human studies have often investigated amygdaloid volume using MRI, while animal studies have used invasive techniques to look at specific cellular changes within this structure. Second, while most human studies have been cross-sectional investigations of pathologic conditions, the animal studies have been longitudinal, with presumably healthy animals undergoing a controlled chronic stress manipulation. While individual differences are difficult to control and can confound findings in cross-sectional studies, in longitudinal studies these variables remain constant, allowing researchers to selectively vary the factor of interest. However, to our knowledge, no longitudinal neuroimaging studies have examined the influence of stress on amygdala morphology in healthy human beings.

Here, we report a longitudinal MRI study in humans that investigated the correlation between changes in perceived stress and changes in amygdaloid gray matter density following a stress-reduction intervention. Mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1990) is a popular 8-week program developed to help individuals reduce their stress levels and increase psychological well-being. Mindfulness is defined as the non-judgmental awareness of present moment experiences (Kabat-Zinn, 1990). Participants practise meditation techniques designed to increase awareness of present moment experiences such as thoughts, emotions and physical sensations. They also learn to use this awareness in responding more skillfully to stress in their everyday lives. Numerous studies have demonstrated the efficacy of this program in reducing subjective reports of stress and increasing well-being (e.g. Chang *et al.*, 2004; Carmody and Baer, 2008). However, the underlying neural mechanisms of these changes are largely unknown. Since the amygdala has been repeatedly shown to be involved in, and responsive to, an individual's experience of stress, we hypothesized that changes in perceived stress would be associated with changes in amygdala gray matter density. Correlations within the whole brain were also explored on an exploratory basis.

METHODS AND MATERIALS

Twenty-seven participants (41% males; mean age 35.2 years; SD 6.7 years) who reported high levels of stress during the previous month were enrolled in the study. Individuals were eligible if their score on the perceived stress scale (PSS; Cohen and Williamson, 1988) was $\geq$1 SD above the population mean. The PSS is a validated self-report questionnaire widely used for assessing an individual's self-perception of stress. The PSS has 14-, 10- and 4-item versions and has been shown to yield adequate reliability and validity (Cohen *et al.*, 1983; Cohen and Williamson, 1988). In this study, the 4-item version was used to screen potential subjects while the 10-item version was used to assess change in perceived stress before and after the training. Participants gave their responses on a 5-point Likert scale, ranging from never (0) to very often (4). Inclusion criteria was based on the population means according to Cohen *et al.* (1983; Cohen and Williamson, 1988), namely 4.2 (SD 2.8) for females and 4.7 (SD 3.1) for males.

Further exclusion criteria were: current psychiatric illness or medical illness, ineligibility for MRI scanning (claustrophobia, metallic implants, pregnancy, etc.), or significant previous meditation or yoga experience. The protocol was approved by the Massachusetts General Hospital Institutional Review Board. Written informed consent was obtained from all study participants and they were compensated for completion of assessment procedures.

All participants completed the 8-week MBSR program, consisting of weekly group meetings and daily home mindfulness practises, including sitting meditation and yoga. The sample described here includes participants from two similar studies that both assess the effect of MBSR on brain structure. Sixteen participants received the standard MBSR class held at the Center for Mindfulness at the University of Massachusetts Medical School. Eleven subjects received a shorter version of the MBSR course held at Massachusetts General Hospital that consisted of only 12 contact hours (versus the standard 23 h) and 20 min daily homework practise (versus the standard 40 min). The intervention has been comprehensively described elsewhere (Kabat-Zinn, 1990). Classes took place between April 2005 and June 2008 and were led by several instructors. One enrolled participant was excluded from the data analyses due to non-adherence to home practise requirements (<4 h total of home practise). Data from 26 healthy, right-handed individuals (44% males; mean age 35.7 years, SD 6.3 years) were included in the analyses. Home practise logs demonstrated that participants reported an average of 19.77 h (SD 6.53 h) of prescribed out-of-class mindfulness practise over the 8-week study period. To test whether the amount of practise had an influence on the improvement in stress, a Pearson correlation between the number of hours of mindfulness home practise and the change in PSS scores was performed in SPSS ('Statistical Package for Social Sciences, Release 12.0.2.', 2004).

Participants were scanned at the Martinos Center for Biomedical Imaging in Charlestown, MA. Pre-intervention scans were acquired approximately 1 week before the intervention began and post-intervention scans were acquired within the 2 weeks following the intervention. High-resolution MRI data were acquired with a Siemens

Magnetom Avanto 1.5 T scanner, using a T1-weighted, magnetization-prepared rapid acquisition gradient echo (MP-RAGE) sequence, consisting of 128 sagittal slices (voxel size: $1.0 \times 1.0 \times 1.3$ mm, TI = 1000 ms; TE = 3.39 ms; TR = 2730 ms; flip angle 7° and matrix 256×256 mm).

Anatomical MR images were compared for differences in gray matter density using voxel-based morphometry (VBM; Gaser, 2008), within the SPM5 neuroimaging statistical software (www.fil.ion.ucl.ac.uk/spm/software/spm5/) based in MATLAB 7.1, release 14 (Mathworks Inc., Natick, MA, USA). VBM permits an automated voxel-wise whole-brain statistical comparison of MRI scans. Images were first manually aligned to the anterior commissure after which gray matter, white matter and cerebral spinal fluid components were segmented within native space. We analyzed unmodulated images, which contain the probability within each voxel for being gray matter, i.e. the proportion of gray matter to other tissue types within a region (Good *et al.*, 2001). For each individual, the gray matter segmentations of the post-intervention time-point were co-registered to the image of the pre-intervention time-point. The normalization parameters were calculated for the pre-intervention image only and then applied to the post-intervention image to make sure that regional differences between the images were not removed because of scan-specific normalization. Images were smoothed at 8-mm full width at half maximum with an Isotropic Gaussian Kernel.

Improvement in PSS (post-intervention score minus pre-intervention score; where negative values indicate decreases in PSS scores and positive values indicate increases) was used as the predictive regressor for changes in gray matter density (post-intervention image minus pre-intervention image; where negative values represent a decrease in gray matter density and positive values indicate increases) in a regression analysis. The significance threshold was defined as $P < 0.05$, corrected for multiple comparisons (false discovery rate) within the search region (height threshold = 0.01, uncorrected). The region of interest was defined as the bilateral amygdalae, according to Tzourio-Mazoyer *et al.* (2002). Exploratory correlation with gray matter density in the whole brain was performed at a significance threshold of $P < 0.01$ (uncorrected, 10 voxels).

RESULTS

PSS scores decreased pre- (mean 20.7; SD 5.6) to post-intervention (mean 15.2; SD 4.7; T = 3.7; df = 25; $P < 0.001$), indicating that the participants benefited from the course. The internal consistency of the PSS was high at both the pre- and post-intervention evaluation (Cronbach's-α values 0.85 and 0.81, respectively), confirming an adequate reliability of the scale.

To assess whether the amount of individual meditation home practise predicted the improvement in stress, the number of minutes of meditation practise that participants reported on daily logs was correlated with the magnitude of their reduction in stress. With a Pearson correlation coefficient of $r = 0.35$, the amount of training was mildly correlated with the improvement in stress, though this correlation did not reach statistical significance ($P = 0.079$; df = 25).

Pre- to post-intervention analyses of the MRI data in SPM confirmed a correlation between change in PSS scores and change in gray matter density within the right amygdala (cluster size: 10 voxels, MNI coordinates of peak voxel $x = 32$, $y = 0$, $z = -26$; voxel-level $T = 3.18$; $P = 0.042$, multiple comparisons correction within the amygdala search territory; Figure 1). Larger decreases in perceived stress were associated with larger decreases in amygdaloid gray matter density. The identified region appears to be located in basolateral/lateral regions of the amygdala, based on the atlas by Mai *et al.* (1997). The correlation of the change in perceived stress and amygdala gray matter density within the left amygdala was not significant.

Controlling for age and gender did not change the significance of the results in the right amygdala (cluster size: 9 voxels, MNI coordinates of peak voxel $x = 32$, $y = 0$, $z = -26$; $T = 3.13$; $P = 0.045$). There were no significant correlations between change in gray matter density and age, nor any group differences between males and females, either in the amygdala or within the whole brain.

No other brain loci were significantly correlated with PSS change scores when exploratory whole brain analyses were performed in SPM, even at a liberal significance threshold of $P < 0.01$ (uncorrected, 10 voxels). There was also no correlation between PSS values and gray matter density at the pre-intervention time-point. Finally, there was no significant pre- to post-intervention decrease in amygdala gray matter density, i.e. no main effect of the MBSR intervention in the amygdala; however, pre- to post-changes were identified in other brain regions and are reported elsewhere (Hölzel *et al.*, under review).

DISCUSSION

The present study investigates the potential relationship between changes in perceived stress and morphological changes in the amygdala. As predicted, there was a significant correlation between changes in PSS scores and changes in amygdaloid gray matter density. The more participants' stress levels decreased, the greater the decrease of gray matter density in the right amygdala.

The amygdala is widely regarded as one of the most important limbic structures in prevailing models of stress states and anxiety disorders. It receives information from sensory modalities and projects to other subcortical structures, thereby mediating stress-related behavioral and physiological effects such as stress-hormone release, blood pressure elevation and facial expression of fear (LeDoux, 2000). The cluster identified here appears to be located in the lateral/basolateral region of the amygdala (Mai *et al.*, 1997). The basolateral region has been proposed to serve

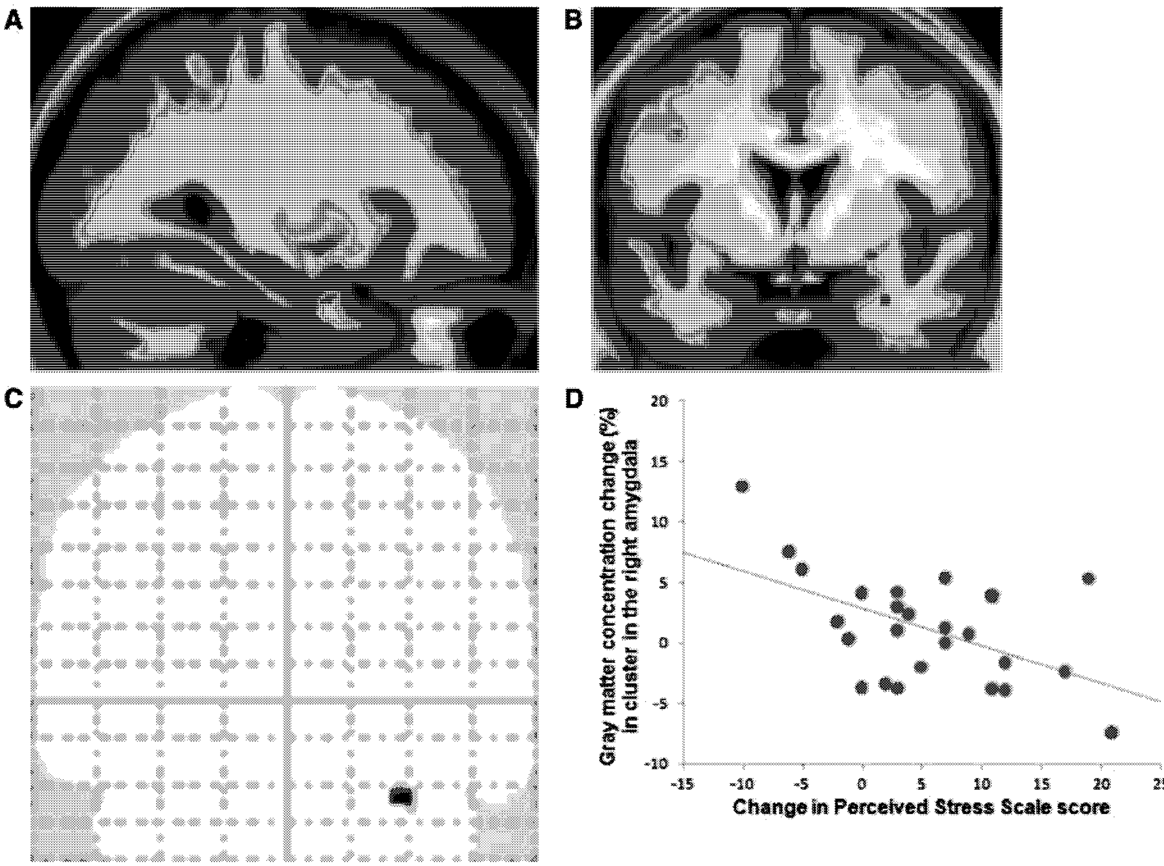

Fig. 1 (**A–C**) Location of positive correlation between gray matter density change in right amygdala and change in PSS score. Identified cluster overlaid on group-averaged sagittal (A) ($x = 32$) and coronal (B) ($y = 0$) structural image. (C) The coronal glass brain image illustrates that no other brain regions were correlated even at a liberal statistical threshold of uncorrected $P < 0.01$. (**D**) Average percent change (post-intervention minus pre-intervention) in gray matter density within the identified cluster extracted from each individual plotted against change in PSS scores. For illustrative purposes, voxel values within the identified cluster in the right amygdala were extracted and averaged using Marsbar (Brett *et al.*, 2002), and values on the *x*-axis were reversed.

as the site for the relay of sensory information from subcortical and cortical sensory areas to the central nucleus of the amygdala during anxiety responses (Campeau and Davis, 1995). Evidence of stress-related plasticity in these regions has previously been found in animal studies, including increased dendritic length and arborization within the basolateral complex of the amygdala (Vyas *et al.*, 2002; Mitra *et al.*, 2005). Strikingly, the basolateral amygdaloid sub-region identified in these rodent studies corresponds to the region identified here. Cytoarchitectural modifications such as those observed in rodent studies could potentially contribute to the increased gray matter density observed in a subset of the individuals in the present study. However, studies designed to establish the cellular mechanisms underlying the observed differences in amygdaloid gray matter in humans would require postmortem investigations.

Our results indicated an association between changes in stress levels and morphometric changes in the right, but not the left amygdala. It has been suggested that the right amygdala mediates an initial, fast and perhaps automatic stimulus detection, followed by a more evaluative and discriminative response by the left amygdala (Morris *et al.*, 1998; Wright *et al.*, 2001; Glascher and Adolphs, 2003; Costafreda *et al.*, 2008). Based on this model, our data suggest that this stress reduction intervention may strongly impact the participants' initial reaction to stimuli. This is consistent with a recent study demonstrating decreased autonomic arousal (skin conductance response) to affective stimuli following a stress reduction course similar to the one in this study (Ortner *et al.*, 2007). However, further research will be required to directly test any relationship between gray matter changes and reactions to stimuli.

Previous longitudinal structural MRI studies in humans have shown that repeated activation of a neural region, either while learning new skills (Draganski *et al.*, 2004; Ilg *et al.*, 2008) or through transcranial magnetic stimulation (May *et al.*, 2007), leads to an increase in the corresponding regional gray matter, whereas cessation of activation leads to a decrease. It seems plausible that this pattern could apply to the present findings—that changes in stress facilitate changes in amygdala activity, which in turn mediate changes in gray matter density. Interestingly, in rats, removal of experimental stressors after a period of chronic exposure did not lead to a reversal of the identified amygdaloid neuronal hypertrophy, or to the reversal of the associated enhanced anxiety-like behaviors within the observed time-frame of 21 days (Vyas *et al.*, 2004). Our results suggest that ameliorating the subjective experience of stress through a behavioral intervention may actually decrease amygdala gray matter density in humans. This finding is particularly interesting as it suggests that an active re-learning of emotional responses to stress (such as taught in MBSR) can lead to beneficial changes in neural structure and well-being even when there is presumably no change in the person's external environment. Future research will be required to address whether stress-induced alterations in the basolateral complex of the amygdala might influence a person's susceptibility to anxiety and other affective disorders (Sajdyk *et al.*, 1999; Shekhar *et al.*, 2003).

Gianaros *et al.* (2008) recently reported that lower gray matter volume in the bilateral amygdala predicted greater stressor-related amygdala activation, as well as greater blood pressure reactivity. However, the complexity and heterogeneity of amygdala subnuclei, in addition to the low spatial resolution of neuroimaging methods, make interpreting this seemingly contradictory finding difficult. As methods and technology improve, future studies could consider how effects of stress may vary across the several heterogeneous subregions of the amygdala. It should also be noted that Gianaros *et al.* (2008) investigated gray matter volume, which is distinct from gray matter density examined in the present study. The biological differences underlying these two neuroimaging techniques remain unclear.

Although a correlation was found between changes in amygdaloid structure and perceived stress, the present study did not show a significant overall main effect of the training on amygdaloid gray matter density. Thus, the results do not support the conclusion that MBSR training *per se* leads to decreases in gray matter in this region. As reported elsewhere (Hölzel *et al.*, under review), main effect analyses on a sub-cohort of the study participants did reveal significant changes in hippocampal, inferior temporal lobe, posterior cigulate, temporo-parietal and cerebellar gray matter density, though these regions were not correlated with changes in perceived stress.

The scatter plot (Figure 1D) illustrates that amygdaloid gray matter density increased for some participants, though it should be noted that a lot of those subjects also reported increases in perceived stress following the MBSR program. Some of the participants with improved perceived stress scores appear to have slight increases in gray matter density, but these small deviances may reflect noise. Alternatively, changes in amygdala gray matter may be temporally delayed relative to changes in perceived stress, perhaps requiring habitual activation in this region to subside prior to longer term structural changes. The results do support a bidirectional correlation; further work will be required to determine the precise relationship between the self-report measure and cellular changes. PSS values and gray matter density were not correlated at the pre-intervention time-point. This is in line with previous findings (Gianaros *et al.*, 2007) and is not unexpected, as numerous factors can influence brain gray matter variables (Meyer-Lindenberg *et al.*, 2006; Wilke *et al.*, 2007). Importantly, we assessed the relationship between the change in one variable, namely perceived stress and changes in gray matter density within the amygdala. By employing a longitudinal design most within-subject variables were kept relatively constant, while the factor of interest, perceived stress, varied. Some behavioral variables, such as smoking, diet or exercise, and psychological factors (e.g. neuroticism) can also co-vary with changes in perceived stress, however, and might mediate or drive the relationship between changes in perceived stress and structural changes (cf., Gianaros *et al.*, 2007). These variables were not assessed in the current study, and so it is unknown if the relationship between perceived stress and gray matter observed here is direct or indirect.

Several previous cross-sectional studies have investigated the impact of mindfulness meditation on brain morphology by comparing groups of experienced mindfulness meditators to nonmeditators (Lazar *et al.*, 2005; Pagnoni and Cekic, 2007; Hölzel *et al.*, 2008; Luders *et al.*, 2009). These studies identified several regions of altered brain morphology, but none within the amygdalae. However, none of these studies assessed the participants' perceived stress levels. Again, these data highlight the limitations of the cross-sectional study design. The unique hypothesis-driven, focused analysis employed in the present study revealed a novel link between changes in amygdaloid gray matter density and decreases in self-reported stress following stress-reduction training, marking a significant advance in our understanding of the association between both. Whereas previous studies have demonstrated that gray matter modifications can result from the acquisition of abstract information (Draganski *et al.*, 2006), motor skills (Draganski *et al.*, 2004) and language skills (Mechelli *et al.*, 2004), this is the first study to demonstrate neuroplastic changes associated with changes in a measure of a psychological state.

Conflict of interest

None declared.

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How Long Does a Mindfulness-Based Stress Reduction Program Need to Be? A Review of Class Contact Hours and Effect Sizes for Psychological Distress

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The mindfulness-based stress reduction (MBSR) program was designed to be long enough for participants to grasp the principles of self-regulation through mindfulness and develop skill and autonomy in mindfulness practice. It traditionally consists of 26 hours of session time including eight classes of 2-1/2 hours and an all-day class. The circumstances of some groups exclude them from participating in this standard form and a number of trials have evaluated programs with abbreviated class time. If lower program time demands can lead to similar outcomes in psychological functioning, it would support their utility in these settings and might lead to greater participation. However, the effect of variation in class hours on outcomes has not been systematically studied. To obtain preliminary information related to this question we examined effect sizes for psychological outcome variables in published studies of MBSR, some of which had adapted the standard number of class hours. The correlation between mean effect size and number of in-class hours was nonsignificant for both clinical and nonclinical samples and suggests that adaptations that include less class time may be worthwhile for populations for whom reduction of psychological distress is an important goal and for whom longer time commitment may be a barrier to their ability or willingness to participate. However, the standard MBSR format has accrued the most empirical support for its efficacy and session time may be important to the development of other kinds of program outcomes. The result points to the importance of empirical studies systematically examining this question. © 2009 Wiley Periodicals, Inc. J Clin Psychol 65: 627–638, 2009.

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The duration of the mindfulness-based stress reduction (MBSR) program was designed by Kabat-Zinn to be long enough that participants could grasp the principles of self-regulation through mindfulness and develop skill and autonomy in mindfulness practice (Kabat-Zinn, 1982). The current standard form involves 26 hours of session time consisting of eight weekly classes of 2-1/2 hours each plus an all-day 6-hour class on a weekend day during the sixth week (Kabat-Zinn, 1990). In its earlier forms the program ranged from 20 to 24 hours of class time; meeting for eight or ten weekly 2-hour sessions and sometimes including the all-day session (Kabat-Zinn, 1982) (Kabat-Zinn & Chapman-Waldrop, 1988; Kabat-Zinn, Lipworth, & Burney, 1985; Kabat-Zinn et al., 1992).

For some clinical groups, such as in-patient populations, some cancer patients, and some cardiovascular patients, mindfulness training may provide an opportunity for reduction in suffering, but the circumstances of their condition may mean that the demands of MBSR in its standard form exclude them from the possibility of participating. For other groups, such as students and caregivers, the time demands of the standard program can represent a significant strain in an already overcommitted schedule and the class time requirements may be sufficient reason for them to decline participation. For example, Minor, Carlson, Mackenzie, Zernicke, and Jones (2006) reported that the length of the program was a reason for some potential participants to decline an MBSR group for caregivers of children with chronic illnesses. Similarly, recruitment data from a recent clinical trial of the 8-week MBSR program showed that of 131 apparently eligible potential participants who declined to participate when contacted by the recruiter, 59 (45%) gave a reason related to the time required for the classes (Carmody, 2008). An increasing number of trials of MBSR are being published in the professional literature and, in recognition that an 8-week program is not feasible for some groups, several of these studies describe and evaluate a program with abbreviated class contact time. If an 8-week program is, in fact, necessary for participants to experience reductions in psychological distress, abbreviated programs can reasonably be expected to find poorer outcomes. However, the MBSR protocol has not been systematically studied for the effect on outcomes of variation in hours participants spend in class. Preliminary to the study of this question it is useful to examine whether the magnitude of measured outcomes in published studies are related to the programs' class time demands.

As an initial step in this process, we examined effect sizes for psychological outcome variables in several published studies of MBSR that had reduced the standard number of class contact hours, and informally compared them to studies using the standard number of contact hours with a similar population. For example, Speca, Carlson, Goodey, and Angen (2000) describe an MBSR program with a sample of patients with cancer that used seven 1-1/2-hour weekly classes and eliminated the day-long class, resulting in a total in-class time of 10.5 hours. Despite the considerably smaller amount of class contact time than in standard MBSR, mean pre- and post-MBSR effect size for the psychological outcome scores was .75 (a medium-to-large effect; .72 on the Profile of Mood States [POMS], McNair, Lorr, & Droppelman, 1992). This is very similar to the effect size of .71 found by Kabat-Zinn (1982) for the psychological measures (.74 on the POMS) in chronic pain patients who received 20 hours of class time. In a second study with cancer patients, Carlson, Speca, Patel, and Goodey (2003) extended the program to eight weekly classes and added a half-day (3-hour) class on a weekend day in the sixth week to be more consistent with the standard format. That addition of 4 1/2 hours of class contact time was associated with a mean pre- and post-MBSR effect size of only .20 for psychological distress variables (.06 on the POMS), a much smaller effect than in their previous study. The authors attributed this smaller effect size to a floor effect due to the lower initial distress scores of the sample compared with those of their previous study.

A recent report by Jain and colleagues (Jain et al., 2007) of a randomized trial of an MBSR program with 12 hours of class time found a pre- and post-MBSR effect size of 1.36 (Cohen's *d*) in the General Severity Index (GSI) of the Brief Symptom Inventory (BSI; Derogatis, 1992), a measure of overall psychological distress. In a recent report of outcomes from an 8-week program comprising 26 hours of class time, Carmody and Baer (2008) found an effect size of .65 for the same measure. Participants in these two studies reported similar levels of distress at preprogram assessment (*T* score range 62–64). At the most extreme end of the program time spectrum a recent trial by Klatt, Buckworth, and Malarkey (2008) found an effect size of .61 in a program consisting of 6 in-class hours. Finally, in a recent meta-analysis of MBSR outcomes, Grossman, Niemann, Schmidt, and Walach (2004) reported a mean between-groups effect size at posttreatment for all mental health scales of .62 for a trial in which MBSR included 20 hours of class time (Shapiro, Bootzin, Figueredo, Lopez, & Schwartz, 2003) and a similar effect size (.56) for a trial in which MBSR included 28 hours of class time (Williams, Kolar, Reger, & Pearson, 2001). Both studies used nonclinical samples (students or community volunteers).

These comparisons suggest that reductions in the number of MBSR in-class hours may not necessarily lead to compromised outcomes and points to the fact that more systematic study of the relationship between hours of MBSR class time and effect sizes in psychological outcomes is warranted. Evidence that programs with lower time demands can lead to similar outcomes in psychological functioning variables would support the potential utility of shorter programs in settings where reduced time demands might lead to greater participation. Because this question has not previously been studied, the present project begins an examination of the question by reviewing the published literature on effect sizes of MBSR on measures of psychological distress in adults and an exploratory analysis this relationship. Based on the comparisons just described, we predicted that the number of in-class hours would not be systematically related to extent of improvement in psychological functioning.

Method

Using Medline (http://www.ncbi.nlm.nih.gov/pubmed/) and PsycINFO (http://www.apa.org/psycinfo/) databases, the published literature was searched for studies of the effects of MBSR on psychological distress measures, including general distress or global severity of psychological symptoms, negative mood or affect, stress, depression, and anxiety. Reference lists for all articles obtained and for recently published reviews of this literature were examined for additional articles. Studies were included if they were published in English, investigated the effects of MBSR in a group format with adult participants, conducted pre- and post-MBSR comparisons for psychological distress measures, and reported means and standard deviations, *t* values for matched-pairs (pre and post) *t* tests, or the statistical significance (p) of the change in distress. Studies that provided only percentage decrease in distress were not included. Unpublished studies, conference presentations, and dissertations were not included. Studies of other mindfulness-based interventions, such as dialectical behavior therapy (Linehan, 1993) and mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002) were also not included. Thirty studies meeting these criteria were identified. Studies of MBCT were excluded because although the MBCT protocol is very similar to MBSR, MBCT was developed for participants currently in remission from major depressive episodes. Its primary purpose is the prevention of relapse over the long term and substantial, immediate pre- and post-MBCT changes in psychological distress might therefore not be expected. Applications of MBCT for other problems are emerging, but this literature is still quite small and it seems important to establish the efficacy of standard MBCT for these applications before exploring adaptations in session time.

For all studies, pre- and post-MBSR (within-group) effect sizes (d) were computed for all measures of psychological distress in the group receiving MBSR. These effect sizes reflect the degree of change over the course of treatment in standard deviation units. For most studies, we computed d by dividing the difference between pretreatment and posttreatment score for each instrument by the pooled standard deviation (SD) of the two time points. When means and standard deviations were not provided, effect size was calculated from t values or statistical significance. All calculations of effect sizes used formulas described by Rosenthal (Rosenthal, 1984). Because our primary question of interest was the relationship between degree of change with treatment and number of in-class hours, pre- and post-MBSR effect sizes were used in most of our analyses. However, for those studies that included control groups, between-groups effect sizes (d) at posttreatment also were computed. These effect sizes reflect the magnitude of the difference between the treatment and control groups at the conclusion of treatment, also in standard deviation units. They were computed by dividing the difference between MBSR group and the control group score at posttreatment by the pooled standard deviation of the two groups. When means and standard deviations were not provided, effect sizes again were calculated from t values or statistical significance.

Results

Session Information

Table 1 presents session data and other characteristics for all included studies. Number of sessions ranged from 4 (one study) to 10 (three studies). The most frequent number of sessions was eight (24 of 29 studies, or 83%). Length of weekly sessions ranged from 1 hour (1 study) to 2.5 hours (10 studies). The mode was 2.0 hours (12 studies), and the mean was 121 minutes. Seven studies used sessions of 1.5 hours. The all-day (or in some cases, half-day) session was included in 13 of 30 studies (43%). Length of this session ranged from 3 to 8 hours. Three of these studies used half-day sessions (3.0 or 3.5 hours), whereas 10 included sessions of 6–8 hours. Total in-class hours, including the all-day or half-day if it was held, ranged from 6 (one study) to 28 (two studies) with a mean of 18.8 hours ($SD = 5.90$ hours). The median was 17.7 hours and the mode was 16 hours (7 studies).Total in-class hours for one study (6 in-class hours; Klatt et al., 2008) fell more than two standard deviations below the mean and therefore might be considered an outlier on this variable.

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Table 1
Effect Sizes, Session Data, and Other Characteristics of Published Studies of the Effects of Mindfulness-Based Stress Reduction (MBSR) on Psychological Distress in Adults

Study	*N* for MBSR goup	Participants	Psychological distress measures	Control group	Mean pre-post *d*	Mean between-group *d* at post	Number of sessions	Session length hours	All-day session hours	Total in-class hours	Weekly assigned practice minutes
Anderson et al., 2007	39	Healthy adults	BAI, BDI, PANAS	Wait list	.58	.01	8	2.0	0	16	–
Carlson & Garland, 2005	63	Cancer patients	SOSI, POMS	None	.50	–	8	1.5	3.0	15	270
Carlson et al., 2003	42	Cancer patients	SOSI, POMS	None	.20	–	8	1.5	3.0	15	–
Carmody & Baer, 2008	174	Stress/illness	BSI, PSS	None	.83	–	8	2.5	6.0	26	270
Chang et al., 2004	28	Students	PSS	None	.51	–	8	2.5	0	20	270
Davidson et al., 2003	25	Healthy adults	STAI	Wait list	.64	.42	8	2.5	7.0	27	360
Gross et al., 2004	20	Organ transplant	CES-D, STAI	None	.51	–	8	2.5	0	20	225
Grossman et al., 2007	39	Fibromyalgia	HADS	Support	.62	.36	8	2.5	7.0	27	315
Jain et al., 2007	27	Students	BSI	Wait list relaxation	1.37	.61 .53	4	1.5	6	12	–
Kabat-Zinn, 1982	51	Chronic pain	POMS, SCL-90R	None	.71	–	10	2.0	0	20	270
Kabat-Zinn et al., 1992	22	Anxiety	BAI, BDI, HAM-A&D	None	.97	–	8	2.0	7.5	23.5	270
Klatt et al., 2008	22	Working adults	PSS, PSQI,	Wait list	.61	.10	6	1.0	0	6	80
Koszycki et al., 2007	26	Social anxiety	BDI, social anxiety	CBGT	1.07	-.75	8	2.5	7.5	27.5	180
Kutz et al., 1985	20	Psychotherapy	POMS, SCL-90R	None	.72	–	10	2.0	0	20	315
Marcus et al., 2003	21	Substance use	PSS	None	.14	–	8	2.5	0	20	342
Minor et al., 2006	44	Parents	POMS, SOSI	None	.62	–	8	2.0	0	16	270
Ramel et al., 2004	22	Mood, anxiety	BDI, STAI	Wait list	.34	.44	8	2.0	3.5	19.5	259
Randolph et al., 1999	78	Chronic pain	BSI, POMS	None	.19	–	8	2.0	6.0	22	270
Reibel et al., 2001	104	Mixed medical	SCL-90R, SF36-MCS	None	.57	–	8	2.5	7.0	27	120
Robinson et al., 2003	24	HIV+	POMS, PSS	TAU	.10	.11	8	2.5	8.0	28	315
Rosenzweig et al., 2003	125	Medical students	POMS	Didactic	.21	.20	10	1.5	0	15	120
Roth et al., 1997	79	Mixed medical	BAI, SCL-90R	None	.83	–	8	2.0	0	16	210
Roth & Robbins, 2004	68	Mixed medical	SF36-MCS	No treat	.97	1.11	8	2.0	0	16	222
Sagula & Rice, 2004	39	Chronic pain	BDI, STAI	Wait list	.72	.49	8	1.5	0	12	140

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Table 1.
Continued

Study	*N* for MBSR goup	Participants	Psychological distress measures	Control group	Mean pre-post *d*	Mean between-group *d* at post	Number of sessions	Session length hours	All-day session hours	Total in-class hours	Weekly assigned practice minutes
Shapiro et al., 2007	54	Counsg students	PANAS, PSS, STAI	No treatment	.87	.66	8	2.0	0	16	–
Speca et al., 2000	53	Cancer	POMS, SOSI	Wait list	.75	.60	7	1.5	0	10.5	–
Tacon et al., 2004	27	Breast cancer	STAI (state)	None	1.38	–	8	1.5	0	12	–
Tacon et al., 2003	9	Heart disease	STAI (state)	Wait list	.94	1.34	8	2.0	0	16	–
Vieten & Astin, 2008	13	Pregnant women	CES-D,PANAS, PSS,STAI	Wait list	.82	.17	8	2.0	0	16	140
Williams et al., 2001	35	Healthy/stressed	SCL-90R	Education	.47	.47	8	2.5	8.0	28	420

Note. CBGT = Cognitive behavioral group therapy; HIV = human immunodeficiency virus; TAU = treatment as usual; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory; BSI = Brief Symptom Inventory; CES-D = Center for Epidemiologic Studies Depression Scale; HADS = Hospital Anxiety and Depression Scale; HAM-A = Hamilton Rating Scale for Anxiety; HAM-D = Hamilton Rating Scale for Depression; PANAS = Positive and Negative Affect Scales; POMS = Profile of Mood States; PSQI = Pittsburgh Sleep Quality Index; PSS = Perceived Stress Inventory; SCL-90R = Symptom Checklist 90 Revised; SF36-MCS = Short Form 36 Mental Component Summary; SOSI = Symptoms of Stress Inventory; STAI = State Trait Anxiety Inventory.

Effect Sizes

Many studies used mixed populations (general medical or psychotherapy) and several used nonclinical samples (students or healthy volunteers). In such samples, effects of MBSR are likely to include reductions in a range of psychological distress variables, including anxiety, depression, negative affect, and stress (although nonclinical samples may have smaller reductions due to floor effects). Similarly, samples with a specific medical problem (such as cancer, chronic pain, fibromyalgia, or heart disease) are likely to be experiencing mixed symptoms of psychological distress. Not surprisingly, most studies included two or three measures covering several types of distress or negative affect. Because it was not apparent that any particular measure should be more likely to change with treatment, effect sizes for all measures of psychological distress were averaged within studies, creating a single mean effect size for each study. Pre- and post-MBSR effect sizes ranged from .10 to 1.38, with a mean of .66 ($SD = .33$). When each mean effect size was weighted by the study's sample size, overall mean effect size was .63. This finding is consistent with the pre- and posttreatment effect sizes reported by Baer (2003) and by Grossman et al. (Grossman et al., 2004).

Because the included studies used a wide variety of populations, dependent variables, and methods, we examined differences in mean effect size related to several study characteristics. Results are given in Table 2. Because of the small number of effect sizes available, statistical analyses were not conducted in all cases and results of these analyses must be interpreted cautiously. Findings suggested no differences between clinical and nonclinical samples in mean pre- and posttreatment effect size for psychological distress (ds = .65 and .66, respectively). This difference was not statistically significant ($F = .01$, $p = .95$). Among the clinical samples, mean pre- and posttreatment effect size for those with specific medical problems such as cancer, heart disease, chronic pain, or fibromyalgia, did not appear to differ from those with psychological complaints such as mood or anxiety disorders or general stress (mean ds = .60 and .62, respectively). Mean pre- and posttreatment effect size did not

Table 2
Mean Effect Size by Selected Study Characteristics

Characteristic	*N*	Mean *d*	*SD*
Type of sample			
Clinical	20	.65	.34
Nonclinical	10	.66	.31
Type of problem			
Specific medical	11	.60	.37
Psychological/general stress	6	.62	.36
All-day session			
Included	13	.60	.37
Not included	17	.70	.29
Type of dependent variable			
General distress	18	.66	.32
Depression	8	.65	.15
Anxiety	13	.77	.31
Stress	11	.56	.32
All studies: pre–post-MBSR	30	.66	.32
MBSR vs. any control post-MBSR	16	.39	.47
MBSR vs. no treatment post-MBSR	11	.54	.40

Note. MBSR = mindfulness-based stress reduction.

appear to differ between studies including the all-day (or half-day) session and studies not including it (mean *d*s = .60 and .70, respectively). This difference was not statistically significant (F = .65, $p = .43$). Mean effect sizes appeared roughly similar across several types of dependent variables, including general distress, anxiety, depression, and stress (although perhaps slightly higher for anxiety), ranging from .55 to .77. Finally, when MBSR was compared to a no-treatment or wait-list control group ($N = 11$ studies), mean effect size was .54 ($SD = .40$), which is slightly smaller than the mean pre- and posttreatment effect size, though still a medium-size effect. When all studies comparing MBSR to any control group were included ($N = 16$ studies), mean effect size was somewhat smaller ($d = .39$, $SD = .47$). This is not surprising, because some of the control conditions were active treatments, which (unlike no-treatment controls) are expected to produce beneficial effects in participants. In one study (Koszycki, Benger, Shlik, & Bradwejn, 2007), MBSR participants were significantly less improved than those in the comparison group (cognitive–behavioral group therapy), although both groups had improved significantly, and the mean between-group effect size was therefore negative ($d = -.75$), although the pre-and posttreatment effect size was large and positive.

Relationships Between In-Class Hours and Mean Effect Sizes

When computed in the entire sample of 30 studies, the correlation between mean pre- and posttreatment effect size and number of in-class hours was nonsignificant ($r = -.25$, $p = .18$). Although statistically nonsignificant, the magnitude of the correlation falls within a range that would be significant with a somewhat larger sample (Cohen, 1977). The relationship also is in the unexpected direction (with longer versions of MBSR showing smaller effects). This puzzling finding could be related to two studies (Jain et al., 2007; Tacón, Caldera, & Ronaghan, 2004) whose mean effect sizes fell more than two standard deviations above the mean for all studies and therefore might be considered outliers. These studies had mean effect sizes of 1.37 and 1.38, respectively, and both included only 12 in-class hours, which falls near the low end of the distribution. When this analysis was repeated with these two outliers removed, the correlation again was nonsignificant ($r = -.08$, $p = .69$, $N = 28$ studies), and was small enough to be clinically or practically meaningless even in a very large sample.

We also correlated mean effect size with in-class hours in the subset of studies that used clinical samples ($N = 20$). This correlation was nonsignificant ($r = -.22$, $p = .34$). When we eliminated the one study identified as a potential outlier that also used a clinical sample (Tacón et al., 2004), the correlation again was nonsignificant ($r = -.08$, $p = .76$, $N = 19$ studies) and small enough to be meaningless in a larger sample with greater power. Finally, we correlated in-class hours with mean between-group effect size at posttreatment for those studies ($N = 11$) that had included a no-treatment or wait-list control group. This correlation also was nonsignificant ($r = .11$, $p = .75$).

Although most studies did not report the extent of home practice in which participants engaged, 23 of 30 studies reported the amount of home practice assigned. Minutes per week of assigned home practice are given in Table 1 and ranged from 80 to 420, with a mean of 245.78 minutes ($SD = 85.13$). The median and mode were both 270 minutes per week (45 minutes per day for 6 days). The correlation between assigned practice minutes per week and mean pre- and posttretment effect size for psychological distress was nonsignificant ($r = -.25$,

$p = .25$, $N = 23$ studies). Although statistically nonsignificant because the small sample size power is low, this correlation would be significant in a somewhat larger sample. This correlation also is in the unexpected direction, with greater assigned practice time associated with smaller effect sizes. This result is not related to the two outliers identified earlier because neither of them reported assigned practice time; therefore, they were not included in this analysis. Two of the 23 studies had assigned practice times that were approximately two standard deviations above or below the mean (420 assigned minutes per week, Williams et al., 2001; 80 assigned minutes per week, Klatt et al., 2008). When recalculated without these two studies, this correlation was unchanged ($r = -.25$, $p = .27$, $N = 21$ studies). This finding must be interpreted cautiously because it reflects only assigned practice time. Actual practice time was rarely reported. Some previous studies have found significant relationships between actual practice time and outcomes (Carmody & Baer, 2008; Kristeller & Hallett, 1999), whereas others have not (Astin, 1997; Davidson et al., 2003).

Discussion

Kabat-Zinn (1982) designed the MBSR program to be an intensive training experience in mindfulness and its integration into everyday life. It sought to provide participants with sufficient autonomy in mindfulness practice as well as an understanding of its role in self-regulation. Although the earliest studies of MBSR used slightly varying formats, the sequence of eight weekly 2 1/2-hour classes with a 6-hour all-day class in Week 6 (total of 26 hours class time) has come to be the accepted standard MBSR format. Because the circumstances of some populations may prevent them from enrolling in a program of this length however, in the interest of maximizing accessibility a number of MBSR studies have adapted the program to better suit these peoples' situations. It appears that self-reported mindfulness increases with the amount of formal home mindfulness practice participants report doing and that the increases in mindfulness appear to mediate increases in well-being (Carmody & Baer, 2008; Lau et al., 2006); however, the significance of MBSR class time demands in facilitating the program's observed effects have not been systematically studied. As a preliminary step in this enquiry, we examined the relationship between the number of class hours employed in published trials of MBSR and the effect sizes for measures of psychological distress. In this brief analysis, no significant relationship was found. We also found no evidence that shortened versions of MBSR are less effective than the standard format in reducing psychological distress and our review suggests that shortened versions of MBSR merit further study. Experimental trials in which versions of MBSR with differing numbers of contact hours are directly compared would provide more conclusive information on this question.

Reductions in measures other than psychological distress were not addressed in this analysis and it remains possible that number of in-class hours is an important factor in medical or biological outcomes, such as brain and immune function measures (see Davidson et al., 2003). Such variables were assessed in too few of the studies examined here to allow statistical analyses. In addition, other dimensions of the person may be affected that are not captured in these or other psychological scales. Similarly, variables that have been proposed as possible mechanisms by which mindfulness training may lead to beneficial outcomes, such as increased mindfulness, reduced rumination, reduced fear of emotion, increases in self-compassion (Shapiro, Carlson, Astin, & Freedman, 2006) or spirituality (meaning and peace, and faith) (Carmody, Reed, Merriam, & Kristeller, 2008) have rarely been measured in studies of MBSR. Total session time may be important to the development of such outcomes. It is also possible that the number of in-class hours influences the maintenance of improvements over time. Follow-up analyses were reported in very few of the studies examined here and relationships between in-class time and long-term improvement in psychological distress could not be examined. Finally, other factors, in addition to in-class hours, also may influence outcomes such as the spacing of the classes and the level of experience of the instructors and the degree to which they embody the principles of MBSR. This latter factor is widely believed to be an important determinant of outcome and it is possible that highly skilled instructors are necessary to obtain optimal outcomes in shortened versions of MBSR. There has been no systematic study of this variable, however, and published articles typically do not describe in detail the level of experience of the instructors. Given that such factors may obscure a relationship between in-class hours and outcomes, it is important that future studies measure these variables.

The findings of this brief review point to the importance of more systematic studies to determine the effects of several aspects of MBSR, including time spent in class, amount of homework practice and experience, spacing of the class sessions, and skills of the instructors, on both immediate and long-term outcomes. Until more information is available, the standard 8-week format for MBSR has accrued the most empirical support for its efficacy, and may be the format of choice for many applications. Our findings suggest, however, that adaptations of MBSR that include less class time than the traditional format may be worthwhile for populations for whom reduction of psychological distress is an important goal and for whom a lesser time commitment may be an important determinant of their ability or willingness to participate.

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An Empirical Study of the Mechanisms of Mindfulness in a Mindfulness-Based Stress Reduction Program

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S. L. Shapiro and colleagues (2006) have described a testable theory of the mechanisms of mindfulness and how it affects positive change. They describe a model in which mindfulness training leads to a fundamental change in relationship to experience (reperceiving), which leads to changes in self-regulation, values clarification, cognitive and behavioral flexibility, and exposure. These four variables, in turn, result in salutogenic outcomes. Analyses of responses from participants in a mindfulness-based stress-reduction program did not support the mediating effect of changes in reperceiving on the relationship of mindfulness with those four variables. However, when mindfulness and reperceiving scores were combined, partial support was found for the mediating effect of the four variables on measures of psychological distress. Issues arising in attempts to test the proposed theory are discussed, including the description of the model variables and the challenges to their assessment. J Clin Psychol 65: 1–14, 2009.

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Mindfulness practice originated in Buddhist traditions where it occupies a central place in a system designed to lead to the cessation of mental suffering (Thera, 1992). In that

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context, mindfulness is a way of employing attention to afford the practitioner insight into the impermanent nature of the personal self. Insight is posited to occur through the recognition of conditioned chains of mental processes and the attendant woes that follow from these. Mindfulness was introduced into secular therapeutic settings through the pioneering work of Kabat-Zinn (Kabat-Zinn, 1982, 1990) who developed mindfulness-based stress reduction (MBSR), and Linehan (1993), who developed dialectical behavior therapy for borderline personality disorder. More recently developed interventions including mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002) and acceptance and commitment therapy (ACT; Hayes, Strosahl, & Wilson, 1999) also rely heavily on the integration of mindfulness skills. Although reviews of mindfulness-based programs have supported their efficacy in enhancing well-being and improving symptoms in a number of disorders, the psychological mechanisms of action and the Western psychological constructs that may be related to mindfulness and its clinical effects have not been clearly explicated.

S. L. Shapiro, Carlson, Astin, and Freedman (2006) have presented an interesting model of the mechanisms by which mindfulness training may have its effects on well-being. The model is based on a definition established by Kabat-Zinn (1994), which posits that mindfulness arises from the simultaneous cultivation of three components: (a) clear intention as to why one is practicing, such as for self-regulation, self-exploration, or self-liberation; (b) an attention characterized by the observation of one's moment-to-moment experience without interpretation, elaboration, or analysis; and (c) a quality of attending characterized by an attitude of acceptance, kindness, compassion, openness, patience, nonstriving, equanimity, curiosity, and nonevaluation. S. L. Shapiro et al. posit that mindfulness cultivated in this way facilitates a fundamental shift in perspective they call *reperceiving*. Reperceiving is described as a change in relation to perceived experience and appears to be similar to or synonymous with terms such as *decentering*, *defusion*, and *distancing*. These terms are widely used in the recent literature on mindfulness-based treatments and refer to an ability to observe one's thoughts and feelings as temporary events in the mind not necessitating particular responses, rather than as reflections of the self that are necessarily true or important (Fresco, Segal, Buis, & Kennedy, 2007; Hayes et al., 1999). S. L. Shapiro et al. (2006) describe reperceiving as a metamechanism of change that results in greater clarity, objectivity, and equanimity and facilitates additional direct mechanisms such as self-regulation, values clarification, cognitive and emotional flexibility, and exposure. These latter may be outcomes in themselves, or, in turn, contribute to or become mechanisms for other outcomes such as symptom reduction.

Mindfulness-based stress reduction (MBSR) is one of the most widely known clinical programs designed to give instruction and experience in mindfulness practice, as well as guidance and suggestion in integrating mindfulness into everyday life to facilitate increased well-being and reductions in psychological distress. Reviews (R. A. Baer, 2003; Grossman, Niemann, Schmidt, & Walach, 2004; Salmon et al., 2004) have shown that participation in the MBSR program is associated with reductions in a number of measures of psychological distress and reported medical symptoms. A recent study of MBSR participants found that time spent formally practicing mindfulness predicted increases in the self-reported tendency to be mindful in daily life, which, in turn, mediated reductions in stress and improvements in psychological functioning (Carmody & Baer, 2008).

Changes related to participation in MBSR afford an opportunity to examine empirically elements of Shapiro and colleagues' posited model. The present study tested several of the associations predicted by their model. Study participants were adults with stress-related problems who completed a packet of self-report measures before and following participation in a 7-week (eight-session) MBSR program. If the model is valid, then changes in mindfulness should predict changes in self-regulation, values clarification, cognitive and behavioral flexibility, and exposure. Further, these changes should be mediated by changes in reperceiving or decentering.

Method

Participants

Participants were adults enrolled in 17 MBSR classes at the University of Massachusetts Medical School's Center for Mindfulness between September 2006 and July 2007. Participants reported a wide range of problems including illness-related stress, chronic pain, anxiety, and personal and employment-related stress. Class leaders were MBSR instructors certified through the Center for Mindfulness MBSR teacher certification program. Each class included approximately 20–25 participants of whom about half were referred by their health care practitioner and half were self-referred. Participation in the program was on a self-pay basis. All program participants were asked on the intake questionnaire whether their self-report responses could be used for research purposes, on the condition that they were not identified as individuals. Three-hundred twenty (68%) of the 473 who enrolled in the program consented to the use of their data and the 309 (97%) of those consenting who provided data at both pre- and post-MBSR were included in analyses. Of these 309, 278 (90%) attended six or more of the eight weekly sessions, whereas 7 participants attended five sessions or fewer. The all-day session in Week 6 was attended by 260 (84%) of these participants. Attendance data for 24 participants were unavailable.

The mean age of the sample was 49.50 years ($SD = 11.36$, range = 19–77) and 68% were women. Most were married (60%) or cohabitating (7%), whereas 16% were single; 14% were separated, divorced, or widowed; and 3% did not answer this question. Most participants reported white collar and professional occupations. Differences between the participants who failed to provide both pre- and posttreatment data ($N = 11$) and the rest of the sample ($N = 309$) were examined using one-way analysis of variance and chi-square analyses. No significant differences were found for demographic variables (age, gender, marital status) or for any of the dependent variables as measured at either pre- or posttreatment. However, because the subgroup with incomplete data is so small, these analyses may have had insufficient power to detect differences. Visual inspection suggested that those with only pre-MBSR data ($N = 6$) may have had slightly lower perceived stress levels than those with complete data, whereas those with only post-MBSR data ($N = 5$) may have had slightly more medical symptoms. On balance, however, the 309 participants included in analyses appear to be representative of the slightly larger group that consented to participate.

Procedures

Participants completed baseline questionnaires immediately prior to preprogram orientation sessions held during the 3 weeks prior to the beginning of each group. The MBSR program consisted of eight weekly classes of 2-1/2 hours each, with an all-day class held on a weekend day during the sixth week. Postprogram questionnaires were completed during the last class of the program. Participants were given two compact discs (CDs) containing four 45-minute tracks of instructions for home mindfulness practice and were asked to practice for 45 minutes each day.

Measures

S. L. Shapiro et al. (2006) do not recommend specific measures for testing their model. They suggest that the Meta-cognitions Questionnaire (Wells & Cartwright-Hatton, 2004) might be used to assess the attentional component, but that the scale focuses on cognitions and does not include attention to emotions or sensations. We chose the following instruments because they appear consistent with the descriptions of the variables in the model.

Mindfulness. We assessed mindfulness in several ways. Our primary measure was the Five-Facet Mindfulness Questionnaire (FFMQ; R. A. Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006), a 39-item inventory assessing multiple facets of mindfulness. The FFMQ has been shown to have strong psychometric characteristics, including adequate to good internal consistencies for all facets and significant correlations in predicted directions with a variety of other constructs (R. A. Baer et al., 2006, 2008). Although test-retest reliability has not been evaluated, for a previous version of this measure (Kentucky Inventory of Mindfulness Skills; R. A. Baer, Smith, & Allen, 2004), these figures were .65 and .83 for the Observing and Nonjudging scales, respectively. Although the entire FFMQ was administered to maximize consistency with the definition of mindfulness used by S. L. Shapiro et al. (2006) only selected subscales were used for most analyses. For example, one of three critical elements of the mindfulness definition is attention, which they describe as "observing the operations of one's moment-to-moment, internal and external experience" (p. 376). This was measured with the Observing scale from the FFMQ because it closely matches this definition of attention. The Observing scale assesses the tendency to observe or notice internal and external present-moment experiences. A second critical element of this mindfulness definition is attitude, described as the qualities one brings to attention. These qualities include patience, nonjudging, compassion, and acceptance. We assessed attitude in two ways. For most of the analyses described later, we used the Nonjudging and Nonreactivity scales of the FFMQ, which measure the tendency to respond to one's experiences with a nonjudgmental, nonreactive, and accepting attitude. In addition, because these scales do not include items that explicitly mention patience or compassion, we examined responses to several additional items written for this purpose.

The third critical element of mindfulness that S. L. Shapiro and colleagues (2006) posit as essential in mindfulness is intention, or the reasons for engaging in mindfulness practice. An earlier study (D. H. Shapiro, 1992) with a sample of experienced meditators found that the primary intentions for engaging in meditation practice included self-regulation, self-exploration, and self-liberation (wisdom, spirituality, compassion, peace of mind). We assessed the strengths of these intentions in our sample by asking participants at program entry to rate their reasons for wanting to learn mindfulness on a 5-point Likert scale (1 = *Not at all important for me*, 5 = *Very important for me*). Two statements reflected each of these three types of intention. The content of the two self-regulation items included coping better with stress, pain, or emotions, and feeling better physically and emotionally. The two self-exploration items described increasing self-awareness and self-understanding. The two self-liberation items described increased spirituality, wisdom, or insight, and increased peace of mind.

Reperceiving. As described by S. L. Shapiro et al. (2006), reperceiving involves a fundamental shift in perspective that allows the practitioner to adopt the stance of witness to moment-to-moment experience and which they describe as similar to the Western psychological construct of decentering (Safran & Segal, 1990). The recently developed Experiences Questionnaire (EQ; Fresco et al., 2007) is designed to assess decentering and has demonstrated good psychometric properties, including internal consistency of .83 and significant convergent correlations with related constructs. Test-retest reliability has not been examined. It includes 11 items rated on a Likert scale.

Self-management/self-regulation. This is described as the capacity to maintain stability of functioning in the face of unpleasant internal states and to be less controlled by particular emotions and thoughts. We chose the Self-Regulation Scale (SRS; Diehl, Semegon, & Schwarzer, 2006) to assess this component of the model. The authors describe this scale as a measure of attention in the interest of keeping a favorable emotional balance, an important component of self-regulation. It includes the ability to focus attention on a given task, to regulate internal (thoughts, feelings) and external distractions, and to work toward a desired outcome or goal. The scale includes elements of cognitive, emotional, and behavioral self-regulation, with an emphasis on attentional self-regulation. With its central emphasis on learning to direct attention in specific ways, it seems ideal for assessing the outcomes of MBSR. Diehl et al. (2006) report good psychometric properties for this instrument, including internal consistency of .82, test-retest reliability of .62, and significant convergent correlations with related constructs.

Values clarification. S. L. Shapiro et al. (2006) describe this element of their model as recognition by individuals of what they truly value and is meaningful for them in their lives. We chose the Purpose in Life Scale from the Scales of Psychological Well-Being (SPWB; Ryff, 1989) to assess this variable. High scorers on this scale hold beliefs that give life purpose, feel clear about what they are trying to accomplish in life, and have a sense of meaning, purpose, and goal-directedness. Strong psychometric properties have been reported for all scales of the SPWB (Ryff, 1989; Ryff & Keyes, 1995; Ryff & Singer, 2006), including internal consistencies above .87, test-retest reliabilities above .81, and strong convergent validity correlations.

Cognitive, emotional, and behavioral flexibility. S. L. Shapiro et al. (2006) describe this variable as adaptive and flexible in responding to the environment. We chose the Environmental Mastery Scale from the SPWB (Ryff, 1989) to assess this construct. High scorers on this scale have a sense of competence in managing their environment, can make effective use of the opportunities the environment affords, and can either choose, create, or modify environments to suit their needs.

Exposure. Several authors have argued that the practice of mindfulness functions as exposure to internal experiences, including sensations, cognitions, and emotions (R. Baer, 2003; Kabat-Zinn, 1982; Linehan, 1993). Similarly, S. L. Shapiro et al. (2006) suggest that willingness to remain in contact with unpleasant internal experiences is an important outcome of mindfulness practice. To assess this variable, we chose a subset of items from an experimental version of the Acceptance and Action Questionnaire (Bond et al., 2008). Example items include "If an unpleasant memory comes into my head, I try to get rid of it" (reverse-scored) and "When I feel uneasy, I do whatever I can to get rid of those feelings" (reverse-scored). High scorers, therefore, are endorsing high levels of willingness to be exposed to unpleasant internal experiences. In our sample, internal consistency (alpha) for these items was .76 (adequate) and item-total correlations ranged from .42 to .66. Test-retest reliability has not been reported.

Symptoms and perceived stress. Psychological symptoms were measured with the anxiety and depression items of the Brief Symptom Inventory (BSI; Derogatis, 1992). To include the spectrum of symptoms only the total score (Global Severity Index) is reported here. Internal consistency and test-retest reliability for the Global Severity Index are both .90 (Derogatis, 1992). Reductions in the Anxiety and Depression scales of the BSI have been shown in several studies of MBSR (Carmody, Reed, Merriam, & Kristeller, 2008; S. Shapiro, Schwartz, & Bonner, 1998). Medical symptoms were measured with the Medical Symptom Checklist (MSCL; Kabat-Zinn, 1982), which lists 110 common medical symptoms. Participants check those they have experienced in the last month. Although internal consistency and test-retest reliability have not been reported, significant reductions in the MSCL have been reported in many studies of MBSR (Kabat-Zinn, 1987; Kabat-Zinn & Chapman-Waldrop, 1988; Kabat-Zinn, Lipworth, & Burney, 1985; Kabat-Zinn et al., 1992; Williams, Kolar, Reger, & Pearson, 2001). Perceived stress was measured with the Perceived Stress Scale (PSS; S. Cohen, Kamark, & Mermelstern, 1983; S. Cohen & Williamson, 1988), a widely used and well-validated 10-item scale assessing the extent to which situations during the past month have been perceived as unpredictable, uncontrollable, and overwhelming. Participation in MBSR has been associated with reductions in perceived stress (Carmody, Crawford, & Churchill, 2006). The authors of the scale reported both internal consistency and test-retest reliability to be high, and significant convergent correlations with related constructs were obtained.

Table 1
Means and Standard Deviations, Paired Sample t Tests, and Pre- and Post-MBSR Effect Sizes for All Variables

	Pre-MBSR		Post-MBSR			
Variable	*M*	*SD*	*M*	*SD*	*t*	*d*
Mindfulness facets (FFMQ)						
Observe	25.67	5.44	30.20	4.81	−16.41***	.95
Describe	26.82	6.48	29.69	6.06	−11.38***	.66
Act with awareness	22.91	5.34	27.13	4.94	−15.96***	.92
Nonjudge	24.09	7.10	29.37	5.92	−17.21***	.99
Nonreact	18.51	4.11	23.04	3.85	−18.93***	1.10
Decentering (EQ)	31.15	6.97	39.77	6.32	−21.63***	1.29
Attentional self-regulation (SRS)	30.48	6.14	35.07	5.38	−14.95***	.88
Environmental mastery (PWB)	34.33	7.97	39.29	7.73	−14.92***	.86
Purpose in life (PWB)	37.13	7.04	40.98	6.91	−11.65***	.68
Exposure	13.86	3.77	16.07	3.83	−9.60***	.56
Perceived stress (PSS)	20.90	6.73	14.59	5.94	17.73***	1.02
Medical symptoms (MSCL)	19.15	11.91	12.18	9.53	14.10***	.81
Psychological symptoms (BSI)	13.09	8.68	7.33	0.38	12.93***	.74

Note. MBSR = Mindfulness-based stress reduction; FFMQ = Five-Facet Mindfulness Questionnaire; EQ = Experiences Questionnaire; SRS = Self-Regulation Scale; PWB = Psychological Well-Being Scale; PSS = Perceived Stress Scale; MSCL = Medical Symptom Checklist; BSI = Anxiety and Depression items from Brief Symptom Inventory. $^{***}p < .001$.

Results

Changes From Pre- to Post-MBSR

Changes in all variables from pre- to post-MBSR can be seen in Table 1. Paired-sample t tests showed that all variables changed significantly and in the expected directions. Pre- and post-MBSR effect sizes (Cohen's d) were computed using a formula suggested by Rosenthal (1984) for matched-pairs data ($d = t/df$). Effect sizes for all variables were moderate to large.

Intentions

Intentions for self-regulation, self-exploration, and self-liberation were assessed at pre-MBSR using two items each on a 5-point Likert scale. The two items were summed to derive a score for each type of intention. Therefore, possible scores for each type of intention ranged from 2 to 10. For self-regulation, the mean was 9.34 ($SD = 1.09$). For self-exploration, the mean was 8.35 ($SD = 1.81$). For self-liberation, the mean was 8.26 ($SD = 1.64$). Thus, most participants reported very high levels of all three types of intention, and variability was low. Correlations between intentions at pre-MBSR and extent of change in other variables over the course of the intervention were computed. Very few were significant (only slightly more than would be expected by chance), and these were small. For example, participants with the highest intentions for self-regulation showed slightly greater changes in perceived stress and environmental mastery (rs = .17 and .16, respectively, ps < .01). In general, it appears that very high levels of intention for self-regulation, self-exploration, and self-liberation were present in the sample, but variability was too low to allow significant relationships with other variables to emerge.

Because the intention variable was largely unrelated to the other variables of interest, it was not included in the remaining analyses.

Testing Mediation Models

S. L. Shapiro and colleagues (2006) suggest that increased mindfulness will lead to increased reperceiving or decentering, which, in turn, will lead to improvements in four dependent variables: self-regulation, values, flexibility, and exposure. We conducted several tests of this element of their model. First, we examined relationships between mindfulness and reperceiving (decentering). For the mindfulness variable, we used the sum of the Observing (attention) and Nonjudging and Nonreactivity (attitude) scales of the FFMQ. Each of these subscales includes seven or eight items. Coefficient alpha for this three-facet version of the FFMQ was .90. Reperceiving was measured by the EQ. Mindfulness and reperceiving were very strongly correlated at pre-MBSR ($r = .81$, $p < .0001$) and at post-MBSR ($r = .74$, $p < .0001$). These two variables also were strongly correlated in degree of change from pre- to post-MBSR ($r = .73$, $p < .0001$). In addition, for both of these variables, pre- and posttreatment change was significantly correlated with pre- and posttreatment change in the four proposed dependent variables (self-regulation, values, flexibility, and exposure). These intercorrelations satisfied the first requirement for mediation as described by Baron and Kenny (1986) and can be seen in Table 2.

The next step in testing mediation is to enter both the independent variable (IV; pre- and posttreatment change in mindfulness) and the proposed mediator (pre- and posttreatment change in reperceiving) into a regression equation as simultaneous predictors of the dependent variable (DV). Support for mediation is found if the beta

Table 2
Correlations Between Pre- and Post-MBSR Change Scores for Mindfulness and Reperceiving and Pre-and Post-MBSR Change Scores for Other Variables

Change in	Change in reperceiving	Change in mindfulness
Reperceiving (EQ)	--	.73**
Self-regulation (SRS)	.59**	.56**
Flexibility (Environmental mastery: PWB)	.40**	.45**
Values (Purpose in life: PWB)	.42**	.43**
Exposure (willingness)	.22**	.39**
Perceived stress (PSS)	.48**	.51**
Psychological symptoms (BSI)	.32**	.37**
Medical symptoms (MSCL)	.14*	.18**

Note. Mindfulness measured by three facets of Five-Facet Mindfulness Questionnaire (observe, nonjudge, nonreact). MBSR = Mindfulness-based stress reduction; EQ = Experiences Questionnaire; SRS = Self-Regulation Scale; PWB = Psychological Well-Being Scale; PSS = Perceived Stress Scale; BSI = Anxiety and Depression items from Brief Symptom Inventory; MSCL = Medical Symptom Checklist. $^{*}p < .05$. $^{**}p < .01$

Table 3
Regression Analyses Showing Prediction of Pre- and Post-MBSR Change in Four Dependent Variables by Pre- and Post-MBSR Change in Mindfulness and Reperceiving (Entered Simultaneously) in MBSR Participants

Dependent variable	Variables entered	*B*	*SE*	β	*p*
Self-regulation	FFMQ change	.12	.03	.25	.0001
	EQ change	.31	.05	.41	.0001
Values	FFMQ change	.13	.04	.25	.002
	EQ change	.20	.07	.24	.003
Flexibility	FFMQ change	.18	.04	.35	.0001
	EQ change	.13	.07	.15	.06
Exposure	FFMQ change	.16	.03	.47	.0001
	EQ change	−.07	.05	−.12	.13

Note. MBSR = mindfulness-based stress reduction; FFMQ = Five-Facet Mindfulness Questionnaire (sum of observe, nonjudge, and nonreact facets); EQ = Experiences Questionnaire.

coefficient for the IV drops significantly when the mediator is included in the model. We tested mediation four times, once for each of the proposed DVs, and found little support for the proposed mediation model. In most cases, the beta coefficient for the IV dropped only slightly, and the IV (mindfulness) remained a significant predictor of the DV. The pattern of findings was also very similar when we tested an alternative model in which reperceiving is the IV and mindfulness is the mediator. Thus, the findings do not support a sequential model in which improvements in mindfulness lead to improvements in reperceiving (decentering), at least as measured by the instruments used here. A more defensible interpretation is that mindfulness and reperceiving/decentering are highly overlapping constructs, both of which improve over the course of MBSR. Table 3 shows regression analyses in which both mindfulness and reperceiving were entered simultaneously as predictors of each of the four DVs. In most cases, both are significant predictors, and mindfulness may be a stronger predictor than reperceiving for some variables. However, because mindfulness and reperceiving are so highly correlated, the problem of multicollinearity makes these beta coefficients difficult to interpret (J. Cohen, Cohen, West, & Aiken, 2003).

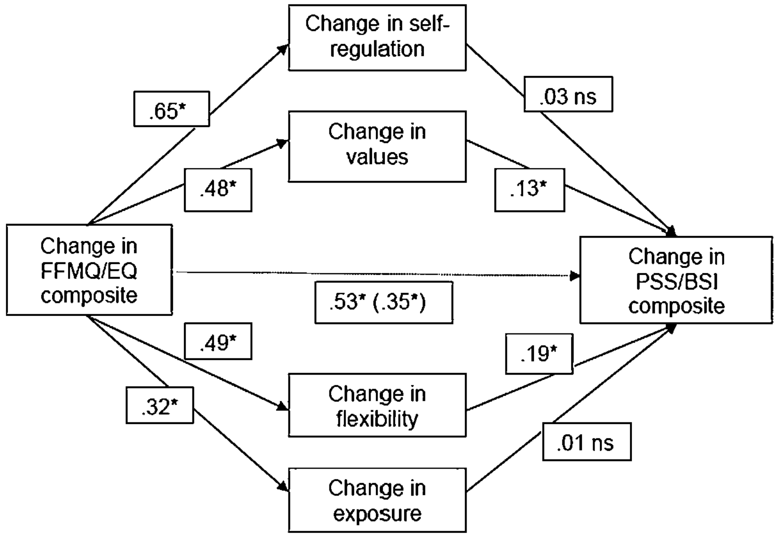

Figure 1. ns = not significant; FFMQ = Five Facet Mindfulness Questionnaire; EQ = Experiences Questionnaire; PSS = Perceived Stress Scale; BSI, Brief Symptom Inventory.

We conducted these analyses a second time using the items that we had written specifically for this study to assess the attitude component of mindfulness. The pattern of findings was virtually identical. Because these items have not been previously validated, they are not considered further.

Additional Mediation Analyses

The model described by S. L. Shapiro et al. (2006) also suggests that changes in the four variables described earlier (self-regulation, values, flexibility, and exposure) may serve as mechanisms leading to reductions in psychological symptoms. To test this model, we took two preliminary steps. First, because mindfulness and reperceiving/decentering were so highly correlated, we created a composite variable by converting these two variables to z-scores and averaging them. Thus, pre- and posttreatment change in the mindfulness/reperceiving composite variable served as the IV for the following analysis. Similarly, because changes in psychological symptoms and perceived stress also were highly correlated ($r = .66$), we converted these two variables to z-scores and averaged them. Thus, pre- and posttreatment change in the psychological symptoms/stress composite variable served as the DV (We did not include medical symptoms because its relationships with other variables were considerably weaker.). To maintain consistency, pre- and posttreatment changes in the four potential mechanisms (self-regulation, etc.) also were converted to z-scores. These four potential mediators were tested simultaneously in a combined model shown in Figure 1. Results are consistent with partial mediation of the relationship between increased mindfulness/reperceiving and psychological symptom/stress change. Two of the proposed mediators (values and flexibility) were significant predictors of the DV. However, the beta coefficient for the relationship between mindfulness/reperceiving and symptoms/stress remained significant (.35), suggesting that there is a direct relationship between mindfulness/reperceiving and stress/symptoms that is not entirely mediated by the variables measured here. S. L. Shapiro et al. (2006) note the possibility that decentering may also have direct effects on symptoms and so the remaining significant correlation between mindfulness/reperceiving and symptom variables could perhaps be expected.

Discussion

The primary goal of this study was to test several predictions based on the theory proposed by S. L. Shapiro et al. (2006) of how the practice of mindfulness leads to beneficial outcomes. A large sample of MBSR participants completed measures of relevant variables at pre- and posttreatment. Both mindfulness (as measured by scales of the FFMQ) and reperceiving/decentering (as measured by the EQ) showed significant increases from pre- to postintervention. The four variables proposed as potential mechanisms of action (self-regulation, cognitive, behavioral, and emotional flexibility, values clarification, and exposure) also increased significantly over the course of treatment, and levels of symptoms and stress were significantly reduced. Although mindfulness, reperceiving, and the other four variables changed in the predicted directions and degree of change was significantly intercorrelated among all variables, evidence for mediation, according to the criteria of Baron and Kenny (Baron & Kenny, 1986) was weak. Increases in reperceiving were not found to mediate the relationship between improvements in mindfulness and the other four dependent variables. A more plausible interpretation of our findings is that mindfulness and reperceiving (decentering) are highly overlapping constructs and that both of these variables change with participation in MBSR. However, values clarification and increases in cognitive, emotional, and behavioral flexibility were found to be partial mediators of the relationship between a composite mindfulness/reperceiving variable and psychological symptom reduction.

There has been lively debate about whether mindfulness is best understood as a technique or a disposition—whether the construct is more accurately understood through the mental behaviors employed in its cultivation or as a quality of consciousness (Brown, Ryan, & Creswell, 2007). S. L. Shapiro et al. (2006) suggest that the practice of mindfulness leads to a different relationship to experience described as decentering or reperceiving. The use of these terms may contribute to increased conceptual clarity in the discussion of these complex issues. However, the very high correlations between the measures of mindfulness and reperceiving used here (FFMQ and EQ) suggest that the tendencies to be mindful and decentered in daily life, as measured by these instruments, are very similar. Future refinements in the definition and measurement of these two variables may help to clarify their relationships, including to what extent they are distinct and whether they develop simultaneously or sequentially as a regular mindfulness practice is initiated and maintained.

Although S. L. Shapiro et al. (2006) give central importance to the intention with which people approach mindfulness practice, our findings revealed very few significant relationships between participants' reported intentions for practicing mindfulness and any of our other variables. As might be expected in the context of a stress-reduction program, participants rated self-regulation the most highly of the three types of intentions measured (9.34 from a possible high of 10). Nevertheless, they rated intentions for self-exploration and self-liberation very highly also (8.35 and 8.26, respectively) and variability across participants was low. However, our methods for assessing these intentions had not been previously validated and they were administered only at pre-MBSR. Further investigation of the role of intentions for mindfulness practice in a clinical population will require more discussion about whether types of intentions can be meaningfully separated in this population. More discriminating measures than the items used in the present study also will be required. Future studies might ask participants about their intentions for each practice session, assess intentions at both pre- and post-MBSR, or assess intentions more comprehensively.

Other measurement issues must be noted. Our reliance on self-report measures was a potential limitation of this study necessitated by the phenomenological nature of S. L. Shapiro et al.'s model. Self-report methods can be subject to response biases, and it is possible that MBSR participants who agreed to have their responses used for research purposes (68%) were more motivated to report positive changes. Because S. L. Shapiro et al. (2006) do not suggest particular measures that would be useful in testing their theory, where possible we chose existing scales for which there is some evidence of validity and reliability. We used the FFMQ to assess mindfulness because it is based on factor analyses of several recently developed mindfulness questionnaires, and therefore provides an empirically based integration of current thinking about how mindfulness may be conceptualized and measured (R. A. Baer et al., 2006). Although Baer and colleagues (2008) found that scores on the Observing scale of the FFMQ were not predictive of psychological adjustment in nonmeditating samples, in the present sample, the Observing scale was positively correlated with well-being and negatively correlated with symptoms at both pre- and post-MBSR, and in keeping with expectation scores on this scale increased significantly from pre- to postprogram. The present sample had all agreed to participate in a meditation-based program; thus, it is possible that the relationship between the Observe scale and psychological adjustment in nonmeditators is moderated by willingness to engage in meditation or openness to experience in general. We used the only measure of reperceiving (decentering) of which we are aware (EQ). For self-regulation, we chose a measure that is well validated, brief, and appears to capture elements of self-regulation that are closely related to the stability of emotional and attentional functioning skills taught in MBSR. However, other measures of self-regulation may have yielded different findings. In the case of flexibility, we chose the Environmental Mastery subscale from Ryff's (1989) Well-Being Scale, which is consistent with the discussion of S. L. Shapiro et al. (2006). Since our data were collected, the construct of psychological flexibility has been more clearly articulated within the literature on acceptance and commitment therapy and the Acceptance and Action Questionnaire-II (AAQ-II; Bond et al., 2008) has been developed to assess it. Whether this conceptualization is consistent with S. L. Shapiro et al. (2006) is unclear. Finally, our only unpublished measure consisted of items from the experimental item pool for the AAQ-II assessing willingness to maintain contact with unpleasant cognitions and emotions. Although the content of these items is consistent with the discussion of S. L. Shapiro et al. (2006), this subset of items has not been previously published.

The present findings are consistent with a number of previous studies (R. A. Baer et al., 2008; Carmody & Baer, 2008; Lau et al., 2006) that have shown that changes in scores on mindfulness scales mediate the relationship between meditation practice and well-being. Several authors, however, have noted (Carmody et al., 2008; Grossman, 2008) that it remains unclear whether operational definitions of mindfulness in the clinical literature, or respondents' semantic understandings of mindfulness scale items, concord with the original meaning of the term in the Buddhist system. Although this issue merits ongoing dialogue, mindfulness is only one arm in that system which is oriented toward the reduction of suffering. From a more immediate clinical perspective, a more fruitful focus may be delineating the qualities of attending to experience that lead to well-being as reported by participants in mindfulness training and finding the most accessible ways of cultivating those qualities, while at the same time keeping in view the possibility of more penetrating investigation into the underlying processes of consciousness. Overall, we agree with S. L. Shapiro et al. (2006) that mindfulness represents a rich and complex phenomenon, and that testable theories are important in advancing our understanding of how mindfulness-based interventions lead to beneficial outcomes in clinical settings. Sound methods for assessment of variables such as mindfulness, decentering, and self-regulation are essential for testing such theories. Continued research that is sensitive to the wide range of theoretical perspectives and methodological approaches that can be brought to bear on these important questions is clearly needed.

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Mindfulness in Medicine

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Mindfulness in Medicine

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MINDFULNESS REFERS TO A MEDITATION PRACtice that cultivates present moment awareness. In the past 30 years, interest in the therapeutic uses of mindfulness has increased, with more than 70 scientific articles on the topic published in 2007. Meditation practices, including mindfulness, have come to the attention of neuroscientists investigating consciousness and affect regulation through mental training and to psychotherapists interested in personal development and interpersonal relationships. In this Commentary, we define mindfulness, consider possible mechanisms, explore clinical applications, and identify challenges to the field.

Mindfulness and Its Relationship to Medicine

Mindfulness involves attending to relevant aspects of experience in a nonjudgmental manner. Historically a Buddhist practice, mindfulness can be considered a universal human capacity proposed to foster clear thinking and openheartedness. As such, this form of meditation requires no particular religious or cultural belief system. The goal of mindfulness is to maintain awareness moment by moment, disengaging oneself from strong attachment to beliefs, thoughts, or emotions, thereby developing a greater sense of emotional balance and well-being.

The original purpose of mindfulness in Buddhism—to alleviate suffering and cultivate compassion—suggests a potential role for this practice with medical patients and practitioners.[1] Much cardiovascular disease, diabetes, cancer, and other chronic illness is caused or exacerbated by modifiable lifestyle factors, and lifestyle modification constitutes primary or ancillary treatment for most medical condi-

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tions. An aim of mindfulness practice is to take greater responsibility for one's life choices. Thus, mindfulness may promote a more participatory medicine by engaging and strengthening an individual's internal resources for optimizing health in both prevention of and recovery from illness. For intractable disease, meditative techniques that alter and refine awareness may modulate the subjective experience of pain or improve the ability to cope with pain and disability.

Implicitly, at least, mindfulness has always been part of good medical practice, facilitating the physician's compassionate engagement with the patient. Epstein[2] suggests that "mindfulness is integral to the professional competence of physicians" in promoting effective clinical decision making and reducing medical errors. Indeed, the connection between medicine and meditation is underscored by their shared etymological origins in the Latin word *mederi*, which means "to heal."

Mechanisms

There are many ways that mindfulness might influence susceptibility to, or ability to recover from, disability and disease. These may include (1) decreased perception of pain severity; (2) increased ability to tolerate pain or disability; (3) reduced stress, anxiety, or depression; (4) diminished usage of, and thereby reduced adverse effects from analgesic, anxiolytic, or antidepressant medication; (5) enhanced ability to reflect on choices regarding medical treatments (eg, decision to seek a second opinion); (6) improved adherence to medical treatments; (7) increased motivation for lifestyle changes involving diet, physical activity, smoking cessation, or other behaviors; (8) enriched interpersonal relationships and social connectedness; and (9) alterations in biological pathways affecting health, such as the autonomic nervous system, neuroendocrine function, and the immune system. Most of these possibilities have not been rigorously examined. Nevertheless, psychological stress has been linked to numerous medical conditions.

Moreover, preliminary data suggest that mindfulness practice has a profound and perhaps unique effect on brain function. In a study using functional magnetic resonance imaging in 27 undergraduate students in Los Angeles, California, Creswell et al[3] found that individual disposition toward mindfulness was associated with widespread prefrontal cortical activation and reduced bilateral amygdala activity during an affect-labeling task, after controlling for various psychometric covariates. Using electroencephalogram (EEG), Lutz et al[4] found that highly experienced Buddhist monks produced, during meditation, long-distance phase synchrony (suggestive of large-scale neural coordination) and gamma activity with a higher amplitude than any reported in a state of health. Davidson et al[5] randomly assigned participants in a corporate setting to a mindfulness-based stress reduction group or a wait list control group and reported increased left-sided anterior activation by EEG (patterns associated with positive emotional experience) in the stress reduction group. This group also demonstrated a greater increase in antibody titers to influenza vaccine, and the magnitude of the EEG change predicted the magnitude of antibody response. Tang et al[6] reported that undergraduates in a Chinese university randomly assigned to a mind/body intervention that included mindfulness showed lower salivary cortisol and higher salivary IgA concentrations in response to psychological stress (mental arithmetic task) compared with control students who were given an intervention of equal intensity that focused on relaxation. Thus, mindfulness training may be an effective way to positively regulate brain, endocrine, and immune function, influencing physiological and psychological variables important to well-being.

Clinical Applications

Pain, stress, coping, and quality of life comprise the original focus of medical research into mindfulness. In 1982, Kabat-Zinn[7] reported descriptive data from medical patients with chronic pain of 6 months to 48 years' duration who received training in mindfulness-based stress reduction. Among the 51 participants who completed the program (88% of the 58 total enrolled), perceived pain decreased significantly during the intervention, with half reporting a reduction of at least 50%. In a study of 109 patients, aged 27 to 75 years, with various types of cancer, Speca et al[8] found that compared with a wait-list control group, those randomly assigned to the mindfulness group experienced improvements of 65% in mood disturbance and 31% in symptoms of stress. Others have found beneficial effects of mindfulness training on acceptance of pain, severity of general medical symptoms, physical functioning, and ability to cope with daily life.

Recently, a number of specific medical conditions have become the subject of study. Based on research involving individuals with a history of 3 or more episodes of major depression,[9] the National Health Service in the United Kingdom recommends mindfulness-based cognitive therapy. Mindfulness training has shown preliminary evidence of efficacy in the treatment of psoriasis, type 2 diabetes, sleep disturbance, attention-deficit hyperactivity disorder, and other conditions. Mindfulness, or lack thereof, may have special relevance for obesity and eating disorders. In one study, lean and obese young adults were given a meal of soup in special bowls that, unbeknownst to them, slowly refilled as their contents were consumed. These individuals ate 73% more than those who consumed soup from normal bowls. Of particular note, they did not believe they had consumed more, nor did they report being more satiated than the other participants.[10] Thus, mindfulness could inform not only the choice of what to eat but also the awareness of having eaten enough. In a pilot study, a small group of young women with bulimia nervosa reported a reduction in emotional and behavioral extremes and greater self-acceptance after mindfulness training.[11] The use of mindfulness training in pain, hypertension, myocardial ischemia, inflammatory bowel disease, human immunodeficiency virus, and substance abuse is presently under investigation in research supported by the National Institutes of Health (NIH).

Mindfulness training may also have applications in medical education and quality of care. Shapiro et al[12] reported that premedical and medical students randomly assigned to mindfulness training, compared with a wait-list control group, showed reduced psychological distress and increased empathy. Grepmair et al,[13] in a randomized controlled trial, examined the course of 124 psychiatric inpatients treated by 18 pyschotherapy interns. Patients of interns who had received mindfulness training did significantly better on measures of symptom severity compared with patients of interns who had not received this training. Mindfulness may also play a role in medical error reduction. Groopman[14] suggests that most misdiagnoses do not result from lack of knowledge but from faulty thinking, including anchoring errors (snap judgment), attribution errors (stereotyping), and other cognitive traps. He proposes that these cognitive errors can be avoided by paying attention to the process of thinking, a metacognitive practice of self-reflection akin to mindfulness.

Limitations of Current Research

The available research on mindfulness has major limitations, precluding any definitive assessment of effectiveness at this time.[15] Published clinical studies frequently have small numbers of participants, lack an active control group, and include only subjective end points. Most of these studies do not adequately consider participant characteristics (making it difficult to generalize the effects to other groups), treatment methods (relating to reproducibility), study staff protocol adherence and participant skill acquisition (treatment fidelity), and relevant covariates (confounders and mediators). Moreover, the lack of consensus about working definitions of mindfulness and other meditative practices impedes comparative studies. These limitations, although not unusual in a nascent field, need to be addressed in future research.

Conclusion

The current age has been referred to as one of "continuous partial attention." E-mail, cell phones, and other technology invade nearly every moment of waking life. Economic pressures demand ever-increasing productivity, even as time to enjoy the fruits of labor declines. These factors adversely affect the health care system overall and diminish the patient-physician relationship. In this context, mindfulness may hold promise as a potential way to help prevent and treat disease, increase ability to cope with pain and chronic illness, reduce stress in patients and practitioners, foster compassion, improve quality of care and reduce medical errors. High-quality, mechanism-oriented studies and randomized controlled trials of mindfulness in medicine are needed.

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Mindfulness, spirituality, and health-related symptoms

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Abstract

Objective: Although the relationship between religious practice and health is well established, the relationship between spirituality and health is not as well studied. The objective of this study was to ascertain whether participation in the mindfulness-based stress reduction (MBSR) program was associated with increases in mindfulness and spirituality, and to examine the associations between mindfulness, spirituality, and medical and psychological symptoms. **Methods:** Forty-four participants in the University of Massachusetts Medical School's MBSR program were assessed preprogram and postprogram on trait (Mindful Attention and Awareness Scale) and state (Toronto Mindfulness Scale) mindfulness, spirituality (Functional Assessment of Chronic Illness Therapy—Spiritual Well-Being Scale), psychological distress, and reported medical symptoms. Participants also kept a log of daily home mindfulness practice. Mean changes in scores were computed, and relationships between changes in variables were examined using mixed-model linear regression. **Results:** There were significant improvements in spirituality, state and trait mindfulness, psychological distress, and reported medical symptoms. Increases in both state and trait mindfulness were associated with increases in spirituality. Increases in trait mindfulness and spirituality were associated with decreases in psychological distress and reported medical symptoms. Changes in both trait and state mindfulness were independently associated with changes in spirituality, but only changes in trait mindfulness and spirituality were associated with reductions in psychological distress and reported medical symptoms. No association was found between outcomes and home mindfulness practice. **Conclusions:** Participation in the MBSR program appears to be associated with improvements in trait and state mindfulness, psychological distress, and medical symptoms. Improvements in trait mindfulness and spirituality appear, in turn, to be associated with improvements in psychological and medical symptoms.

Keywords: Mindfulness; Mindfulness-based stress reduction; Meditation; Spirituality; Medical symptoms; Psychological symptoms

Introduction

The field of behavioral medicine has been giving increased attention to the area of spirituality, religiousness, and health [1]. While spirituality and religion have historically been inextricably associated with each other and the terms have often been used interchangeably, for many people they have become distinct and independent constructs [2] that separate religious observance and ritual from spiritual experience. Spirituality has become differentiated from religiousness and the practice of religious behavior to emphasize more humanistic values and personal qualities in which a person's sense of meaning and purpose in life beyond material values plays a central role [3,4]. In this sense, spirituality has emerged as an important component of quality of life and well-being both in the general population [5] and in patients dealing with illnesses such as cancer [6]. However, although there is considerable

Abbreviations: MBSR, mindfulness-based stress reduction; UMMS, University of Massachusetts Medical School; FACIT-Sp, Functional Assessment of Chronic Illness Therapy—Spiritual Well-Being Scale; TMS, Toronto Mindfulness Scale; MAAS, Mindful Attention Awareness Scale; SCL-90-R, Hopkins Symptom Checklist 90—Revised; MSCL, Medical Symptom Checklist; GSI, Global Severity Index; SOC, sense of coherence.

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evidence of the beneficial effect of religiosity on health and longevity [7–9], the relationship between spirituality (independent of religious practice) and health is not as well studied [2,10].

All religious traditions maintain that spirituality can be developed through training, but the secular nature of many people's lives, together with the fact that 82% of Americans express a need for greater spiritual growth [2], makes it important to ascertain whether spirituality can be developed other than through traditional religious practice. Further, since such an approach would differ from the religious behaviors associated with greater health, it is important also to determine whether changes in spirituality also are related to health.

Mindfulness has its roots in Buddhism and is a practice that has long been associated with spiritual development [11,12]. It has been defined as intentionally paying attention to present-moment experience (physical sensations, perceptions, affective states, thoughts, and imagery) in a nonjudgmental way, thereby cultivating a stable and nonreactive awareness [13,14]. Mindfulness meditation is the practice that has been traditionally used for the systematic development of mindfulness.

The mindfulness-based stress reduction (MBSR) program provides instructions in mindfulness meditation in a secular context, without the Buddhist cultural and religious overlay. The program has been intentionally designed to give instructions and practice in the integration of mindfulness into everyday life as support in dealing with stressful life situations [15]. Participants learn that attention can be brought to notice whatever thoughts, feelings, and sensations are appearing in awareness, while at the same time remaining aware of the capacity to maintain the focus of attention on these contents without moving toward maladaptive conditioned reactivity or attention deliberately redirected to a wider field of awareness or to a different object. A recent meta-analysis of controlled and observational studies of the health benefits of the MBSR program [14] found that it was useful for patients with a broad range of chronic disorders, and the reported changes in distress have been found to endure on 3-month [16], 6-month [17], 3-year [13], and 4-year [18] follow-ups. It has been suggested that a capacity to bring mental processes under greater voluntary control and directing them in beneficial ways gives the person a greater sense of control [19]. When thoughts and feelings no longer threaten to overwhelm the person [20,21], psychological and physical well-being is fostered by allowing for the emergence of alternative responses. Furthermore, the development of this openness and acceptance of present-moment experience, coupled with nonreactive self-observation and capacity for choosing the focus of attention fostered by mindfulness, may in turn be valuable in self-regulatory behavior that is consistent with the person's wider needs and values [22].

While a considerable body of published research reports the health-related benefits of participating in mindfulness training through interventions based on the MBSR program [14], the need to confirm mindfulness as a critical component of change has resulted in the publication of operational definitions and several scales purporting to assess mindfulness [23–26]. In its original descriptions, mindfulness is a subtle notion and the most appropriate method of assessment, including whether it is possible validly to assess it using paper-and-pencil tests remains a topic of debate [27]. In the spirit of this open question, exploring scores on different scales from the same sample provides an opportunity to determine whether similar estimates of mindfulness result and also begins an examination of the possible relationship of mindfulness with existing psychological constructs. The aim of the present study was to ascertain whether participation in the MBSR program is associated with increases in mindfulness and spirituality, and to examine the associations between changes in mindfulness, spirituality, and self-reported medical and psychological symptoms.

Methods

Participants and setting

Study participants comprised 44 participants in four concurrent MBSR classes held during the fall of 2004 at the University of Massachusetts Medical School (UMMS) Stress Reduction Program in Worcester, MA. The mean age of the sample was 47.8 years (range, 20–72 years), and 75% (33) were female. Approximately half of the participants were referred by a health care practitioner, and half were self-referred. Participation in the MBSR program was on a self-pay basis.

Demographic characteristics

Participants reported their age, gender, marital status, occupation, income, education level completed, and prior meditation experience.

Measures

The *Functional Assessment of Chronic Illness Therapy—Spiritual Well-Being Scale* (FACIT-Sp) is a 12-item scale designed to measure spiritual well-being independent of religious beliefs. It has been adapted for use with nonmedical populations and comprises two subscales: meaning and peace (eight items) and faith (four items) [6]. FACIT-Sp has been found to be valid and reliable [28] and is part of the FACIT battery [29] that is used to assess quality of life associated with chronic illness. Scale items are contained in Appendix A.

The *Toronto Mindfulness Scale* (TMS) is a 10-item state-type scale that assesses the capacity of a respondent to evoke mindfulness—a self-regulatory state in which thoughts, feelings, and sensations are observed as events in the field of awareness without overidentifying with them or elaborating on them and without reacting to them in an automatic habitual pattern on reactivity [30]. TMS items were developed using expert opinion from highly experienced mindfulness meditation instructors. It has been found to be valid, reliable, and sensitive to change.

The *Mindful Attention Awareness Scale* (MAAS) is a 15-item trait-type scale that assesses mindfulness as enhanced attention to and awareness of current experience or present reality [23]. It was developed to be valid within the general population regardless of meditation experience. It has been shown to be psychometrically sound, to discriminate between mindfulness practitioners and others, and to be associated with well-being.

The *Hopkins Symptom Checklist 90—Revised* (SCL-90-R) is a 90-item self-report symptom inventory used to assess the psychological symptom status of medical patients. The SCL-90-R contains nine subscales, and a global index of psychological distress, the Global Severity Index (GSI), can be calculated. Only the GSI and scores on the anxiety and depression subscales were computed in the present study. Studies of the MBSR show significant reductions in GSI, anxiety, and depression associated with participation in the program [16,31,32].

The *Medical Symptom Checklist* (MSCL) is a list of 115 common medical symptoms. Respondents are asked to check those that they have experienced as bothersome in the past month [33]. A number of studies of the MBSR program have shown significant reductions in the MSCL [16,34–37].

Home mindfulness practice

Participants were given a folder of seven color-coded logs—one color for each of the 7 weeks of the MBSR program. They were asked to record the number of minutes of formal (meditation practice) and informal (becoming mindful in everyday activities) MBSR home practices they performed each day.

Intervention

The foundation and methodology of the MBSR program have been described in detail elsewhere [15]. Briefly, the program focuses on the cultivation of mindfulness through formal meditation practices (sitting meditation, body scan, and mindful yoga) and on the integration of this capacity into everyday life as a coping resource for dealing with intensive physical symptoms and difficult emotional situations. It also includes group interactions about the challenges and achievements participants experience upon integrating mindfulness into their lives and stressful situations [38]. Participants attended eight weekly 2.5-h classes, plus an all-day class on a weekend on the sixth week. Participants were given two CDs containing mindfulness meditation instructions and were asked to practice at home by listening to the CD for 45 min each day. They were also given suggestions for bringing mindfulness practice into everyday activities and moment-to-moment experience.

Procedures

Prospective MBSR attendees arriving for a preprogram orientation session received a study information sheet outlining the requirements for participation in the study and a consent form approved by the UMMS Institutional Review Board for them to sign if they decided to participate. Those who signed the consent form were given a package containing preprogram study questionnaires for them to complete either before or immediately after the orientation session. The items in the state-type mindfulness instrument (TMS) are to be completed in reference to a preceding period of quiet sitting, and this instrument was completed during the orientation session following a 5-min period of quiet sitting. Participants returned their home mindfulness practice logs each week by placing them in a locked box in the classroom. Completed logs were not seen by the class instructor. Postprogram assessment was completed during the final MBSR class, and completed questionnaires were collected by a study assistant.

Statistical methods

A comparison of patient characteristics used in the analysis with patient characteristics in dropouts was performed using t tests for comparing means of continuous values and using Fisher's Exact Tests for dichotomous outcomes. Analysis of variance was used to compare demographics and outcomes across the four MBSR classes. Mean changes in scores were computed (post-MBSR−pre-MBSR), and 95% confidence intervals (95% CIs) were estimated. The associations of continuous variables were graphically examined for linearity by fitting Lowess curves to the data. Since there were differences in concurrent classes in some outcomes, we adjusted for class using random-effects models. Changes in scores were modeled using mixed-model linear regression, with participants nested with class. In all models for change in scores, we adjusted for the baseline value of the score. An α level of .05 was used for statistical significance.

Because there is as yet limited clinical meaning in the literature for mindfulness and FACIT-Sp scores and because the scales have different numbers of items and score ranges, these variables were rescaled to a 0–10 scale. This enables a more meaningful visual comparison between scores on these scales and provides a standard interpretation of regression coefficients. The SCL-90-R and the MSCL are reported using their original values because of their well-established psychometric properties and their wide use in MBSR outcome studies. To enable a comparison of the relative degree of change across all variables, median percent changes were reported on the basis of scores standardized to a 0–10 scale. Multivariate regression models were fit using an all-subsets approach, examining the impact on coefficients (effect sizes) with the inclusion and order of inclusion of additional covariates to the model. There were no covariates that were substitutes for each other (except in the case of subdomains), so competing models did not have to be presented.

Mindfulness practice was measured in minutes of reported formal and informal practices. Since a small number of outlying (high) values skewed the distribution, we have reported median minutes of practice. Spearman correlation coefficients were estimated as a measure of the association of mindfulness practice with spirituality, mindfulness scores, and symptom scores. Regression analyses examined both the scores and possible transformations for the association of outcomes with practice.

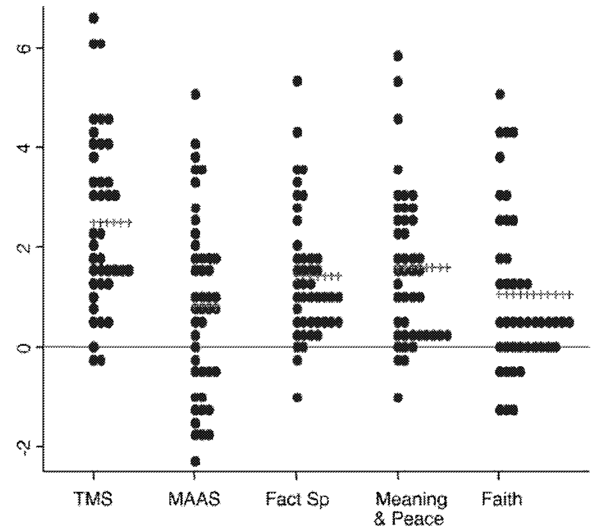

Fig. 1. Distribution of changes in mindfulness and spirituality: rescaled (1–10) scores.

Results

One hundred seventeen participants enrolled in one of the four MBSR classes held in the fall of 2004; of these, 62 (52%) consented to be part of the present study. Fifty-two (84%) of the study participants completed the program. An additional eight participants did not have complete information for FACIT-Sp and the SCL-90-R at either baseline or follow-up, resulting in complete information for 44 participants. A comparison of the 18 participants for whom there was incomplete information or who did not complete the program with the 44 "completers" indicated no statistically significant differences in any of the baseline demographic or study variables, and estimated differences were <10% between the two groups for all values. The analysis of the impact of the MBSR program was performed with the 44 completers.

Changes in scores

Following participation in the MBSR program, there were statistically significant improvements in the mean scores on spirituality (Total FACIT-Sp and each subscale), mindfulness (TMS and MAAS), psychological distress (GSI and the anxiety and depression subscales), and reported medical symptoms (MSCL). Table 1 shows the pre-MBSR and post-MBSR program scores (raw and rescaled), 95% CIs, and the median percent score change from baseline. The TMS and FACIT-Sp meaning and peace subscale showed the largest median increases (50% and 24%, respectively), and similar degrees of reduction were found in symptom indices (with decreases ranging from 27% to 50%), with MSCL scores showing an average drop of 5.8 reported symptoms. There were no significant associations of baseline demographic characteristics with changes in mindfulness, spirituality, or symptom scores. The distributions of score changes, illustrating the large proportions of patients who reported some improvement (>90% in the case of the TMS and FACIT-Sp), are shown in Figs. 1 and 2.

Table 1
Raw and rescaled scores pre-MBSR and post-MBSR

	Pre-MBSR				Post-MBSR					
	Raw scores		Rescaled (1–10)		Raw scores		Rescaled (1–10)		Median % score change from	
Variable	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	baseline	95% CI
TMS	18.62	6.80	4.65	1.70	28.14	7.59	7.04	1.90	50.00	1.93, 3.04
MAAS	51.55	14.87	4.87	1.98	57.66	10.60	5.69	1.41	16.91	0.26, 1.37
FACIT-Sp	24.18	10.61	5.04	2.21	30.95	9.88	6.45	2.06	22.65	1.02, 1.81
Meaning and peace	17.00	6.99	5.31	2.18	22.09	6.53	6.90	2.04	23.86	1.13, 2.05
Faith	7.18	4.93	4.49	3.08	8.86	4.90	5.54	3.06	19.64	0.56, 1.54
MSCL	21.25	14.47			15.48	12.12			−27.64	−8.41, −3.14
GSI	0.91	0.71			0.53	0.51			−36.63	−0.53, −0.22
Depression	1.30	0.96			0.73	0.80			−43.20	−0.79, −0.36
Anxiety	0.93	0.90			0.52	0.58			50.00	0.63, −0.19

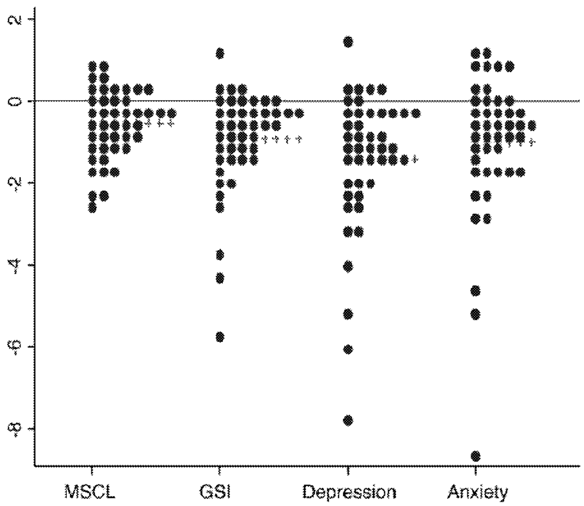

Fig. 2. Distribution of changes: MSCL and GSI rescaled (1–10) scores.

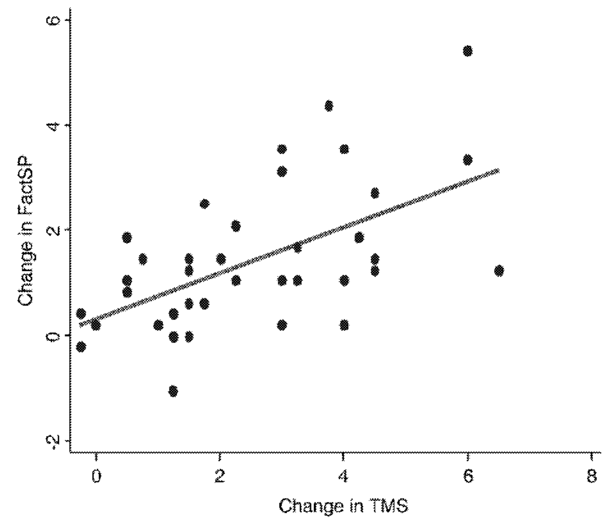

Fig. 3. Association between changes in TMS and FACIT-Sp scores.

Unadjusted association of changes in scores

The mindfulness scores on MAAS and the TMS were not correlated at baseline (r=.15, P=.35), and changes in the scores on these scales were also not associated (r=.08, P=.63). There were, however, significant associations between changes in mindfulness scores on both scales and changes in spirituality scores. Table 2A shows the results of regression analyses examining the associations between spirituality and mindfulness scores adjusted for baseline spirituality scores. Increases in both MAAS and the TMS predicted increases in FACIT-Sp scores. The estimated effect was larger for the TMS (β=0.40, P=.001; cf., β=0.28, P=.005), but the effects were not significantly different from each other. The same was true for their effect on the separate subscales, meaning and peace (TMS: β=0.45, P=.001; MAAS: β=0.29, P=.01) and faith (TMS: β=0.30, P=.029; MAAS: β=0.23, P=.08). Figs. 3 and 4 depict changes in FACIT-Sp that were associated with changes in state (TMS) and trait (MAAS) mindfulness.

Table 2B shows the relationship between changes in mindfulness and spirituality scores and changes in reported medical symptoms (MSCL) and psychological distress (GSI and the depression and anxiety subscales). Increases in trait mindfulness scores (change in MAAS) were significantly associated with decreases in both medical symptoms and psychological distress (MSCL: β=−1.97, P=.001; GSI: β=−0.11, P=.001; Depression: β=−0.17, P=.001; Anxiety: β=−0.10, P=.015), but associations with changes in state mindfulness (changes in the TMS) were not statistically significant, although effect sizes were similar to those of MAAS for change in anxiety (β=−0.08, P=.054). Figs. 5 and 6 depict changes in the MSCL that are associated with changes in the TMS and MAAS.

Increases in spiritual well-being scores (Total FACIT-Sp) showed a statistically significant association with reductions in scores in reported medical symptoms (β=−2.27, P=.007) and in psychological distress, both in the GSI (β=−0.13, P=.002) and in the depression (β=−0.25, P=.001) and anxiety subscales (β=−0.15. P=.004). The association between changes in spirituality and changes in medical symptoms was primarily accounted for by the association of changes in meaning and peace items, rather than in faith items (β=−2.26. P=.001; cf., β=−0.30, P=.679).

Multivariable models were fit for the change in spirituality scores using changes in state (TMS) and trait

Table 2A
Associations between mindfulness and spirituality scores

Predictors (independent variables)	Predicted (dependent variables) {regression coefficient [95% CI] P value}		
	ΔFACIT-Sp	ΔMeaning/Peace	ΔFaith
ΔMAAS	0.28 [0.09, 0.47] .005	0.29 [0.07, 0.51] .010	0.23 [−0.03, 0.49] .08
ΔTMS	0.40 [0.22, 0.58] .001	0.45 [0.23, 0.66] .001	0.30 [0.03, 0.58] .029

Linear mixed model, with class attended used as a random effect.
Each cell represents a separate model (regression).
Coefficients represent predicted change in the dependent variable (second row) for each unit of change in the independent variable (left column), after adjusting for the dependent variable at baseline.
Rescaled scores were used for a more meaningful comparison.

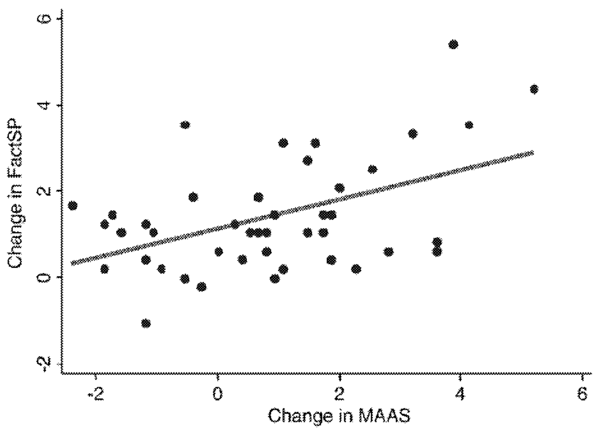

Fig. 4. Association between changes in MAAS and FACIT-Sp scores.

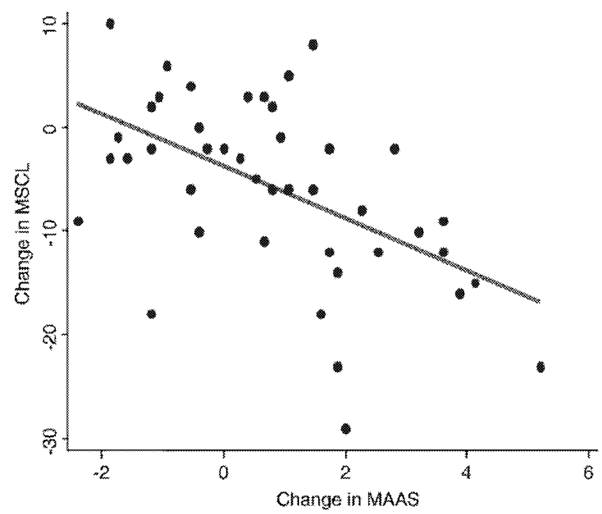

Fig. 5. Associations between changes in MSCL and MAAS scores.

(MAAS) mindfulness measures. Models for changes in medical symptoms (MSCL) and psychological distress (GSI and the depression and anxiety subscales) were fit using changes in mindfulness and spirituality scores. Table 3 lists the estimated coefficients of statistically significant factors included in each multivariable model (adjustment for baseline values of the dependent variable were used regardless of significance). Estimated associations were similar to unadjusted models.

Changes in spiritual well-being (FACIT-Sp) were found to be independently associated with both changes in trait (MAAS) (β=.26, P=.001) and changes in state (TMS) (β=0.38, P=.001) mindfulness scores. The strength of these associations was driven more by the association of changes in mindfulness scores with changes in meaning and peace than with changes in faith (overall R^2=.56 for ΔMeaning/Peace; R^2=.24 for ΔFaith), although effect sizes were similar. Reductions in reported medical symptoms (MSCL) were jointly associated with both changes in trait (MAAS) mindfulness and changes in spiritual well-being (Total FACIT-Sp), with the association driven by the change in the meaning and peace subscale. An association between reductions in medical symptoms and the state (TMS) mindfulness measure was not found, but higher state mindfulness scores at baseline were associated with greater reductions in medical symptoms. Reductions in psychological distress (GSI) and in depression were associated with increases in trait (MAAS) mindfulness and in spiritual well-being (Total FACIT-Sp). Changes in spiritual well-being (Total FACIT-Sp) show about the same strength of association with changes in both depression and anxiety. After adjusting for change in spiritual well-being (FACIT-Sp), there is no significant association between change in MAAS and change in anxiety, and the effect (coefficient) is reduced by 40% from a weak unadjusted association (β=0.06, P=.15; data not shown in the table).

Home mindfulness practice was computed as the average of the number of minutes of daily formal and informal practices reported in completed and returned logs. The median number of minutes per day of reported formal practice was 31 min. That for reported informal practice was 7 min. On regression analysis, no association was found between formal, informal, or total home mindfulness practice and changes in state or trait mindfulness scores, medical symptoms, or psychological distress. Correlations were both

Table 2B
Associations between mindfulness and spirituality scores and medical and psychological symptoms

Predictors (independent variables)	Predicted (dependent variables) {regression coefficient [95% CI] P value}			
	ΔMSCL	ΔGSI	ΔDepression	ΔAnxiety
ΔMAAS	−1.97 [−3.08,−0.86] .001	−0.11 [−0.16,−0.05] .001	−0.17 [−0.27,−0.08] .001	−0.10 [−0.17,−0.02] .015
ΔTMS	−0.30 [−1.66, 1.07] .671	−0.05 [−0.11, 0.01] .101	−0.08 [−0.18, 0.01] .091	−0.08 [−0.16, 0.00] .054
ΔFACIT-Sp	−2.27 [−3.91,−0.63] .007	−0.13 [−0.21,−0.05] .002	−0.25 [−0.38,−0.13] .001	−0.15 [−0.25,−0.05] .004
ΔMeaning/Peace	−2.26 [−3.60,−0.93] .001	−0.11 [−0.17,−0.04] .002	−0.19 [−0.30,−0.09] .001	−0.12 [−0.21,−0.04] .006
ΔFaith	−0.30 [−1.73, 1.12] .679	−0.05 [−0.12, 0.02] .169	−0.12 [−0.24,−0.01] .035	−0.08 [−0.17, 0.01] .075

Linear mixed model, with class attended used as a random effect (unadjusted associations).

Each cell represents a separate model (regression).

Coefficients represent predicted change in the dependent variable (second row) for each unit of change in the independent variable (left column), after adjusting for the dependent variable at baseline.

Rescaled scores were used for a more meaningful comparison.

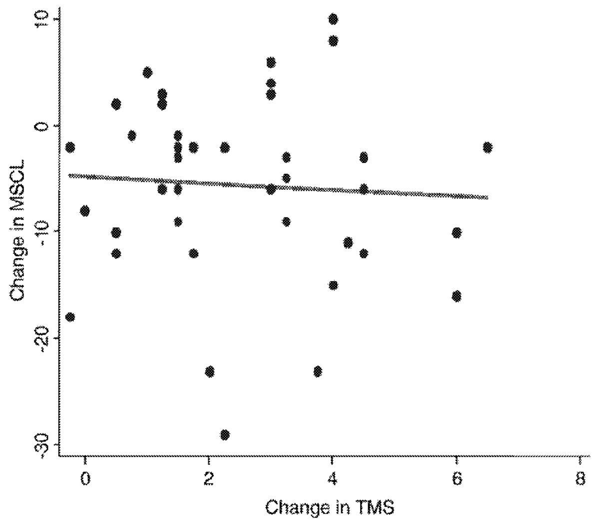

Fig. 6. Associations between changes in MSCL and TMS scores.

positive and negative (ranging from −.14 to .21). The only statistically significant association with outcomes was the association with change in anxiety scores (Spearman r=−.32 P=.04), indicating that anxiety scores decrease with more home mindfulness practice. Nonsignificant associations with medical symptoms and psychological distress (MSCL, GSI, and the depression subscale) were in the same direction, with correlations ranging from −.07 to −.26 (P>.05).

Discussion

Significant increases in mindfulness and spirituality scores and reductions in reported medical symptoms and in psychological distress were associated with participation in the MBSR program. The substantial reductions in medical symptoms and psychological distress, ranging from a median reduction of 50% in anxiety to a 28% reduction in reported medical symptoms, are consistent with other reports of MBSR outcomes [14]. The largest changes in process variables (mindfulness and spirituality) were in state mindfulness scores (a 50% median change from baseline), with trait mindfulness and spirituality scores improving by percentages ranging from 17% for state mindfulness scores to 24% for scores on the meaning and peace subscale. The utility of the rescaling of outcome values to a standardized (1–10) scale can be seen in considering raw scores on the Spiritual Well-Being Scale. The meaning and peace subscale appears to change substantially more than the faith subscale, but when the scores are scaled to reflect the different numbers of items on each of the subscales, the changes on the two are much more similar (24% vs. 20%). The program completion rate (85%) found here, which is considered high for behavioral programs [39], is consistent with that found in other studies of the MBSR program [36] with medical and nonmedical populations.

While there is a considerable body of published research reporting the health-related benefits of participating in the MBSR program [14], the program includes a number of experiential components in addition to mindfulness training, such as group support, attention from the instructor, and so on, raising a question on the degree to which observed effects are mediated by mindfulness training and how that might be assessed. As described in traditional Buddhist texts, mindfulness is quite a subtle construct, and different facets are emphasized in different traditions [27,40]. A publication of an operational definition of mindfulness [41] in the psychology literature was accompanied by lively commentaries from a number of authorities, describing both potential opportunities and authentic concerns about this development. Questions in the debate range from whether the assessment of mindfulness through standard self-report paper-and-pencil methods is possible [42], to such issues as appropriate scale validation criteria and whether the semantic meaning of some scale items is equivalent for respondents with different levels of experience in mindfulness practice. While this debate remains an evolving one, several mindfulness scales are now referred to in the literature [23–26]. Scores on the scales have been reported to increase in association with participation in mindfulness-based programs, but correlations between the scales range from .31 to .67 [40]. Baer et al. [40] have suggested that the scales may be tapping into different aspects of mindfulness, and they have derived a five-factor structure using items from several published and unpublished measures of everyday mindfulness with naïve undergraduates. The TMS was not included because its item responses are made in relation to a prior period of quiet sitting rather than asking about respondents' experience of their everyday life. Baer et al. found that items from MAAS help define one factor that captures the dimension of acting mindlessly and being "automatic." While improvement on this factor would mean a decrease in such patterns and greater well-being, it would not necessarily relate to experiences that arise during actual meditation practice. Another measure, the Freiburg Mindfulness Inventory (FMI) [24], loaded on two factors, consistent with the findings of a multifactorial structure for that scale by Leigh et al. [43].

Measures of spirituality also have criterion reference problems. Many use the terms "spirituality" and "religiousness" interchangeably, gauge the frequency with which respondents engage in religious or spiritual activities, and make explicit reference to belief in the existence of God as a criterion for spirituality. FACIT-Sp has the advantage of being secular in nature, making the scale most suitable for examining spirituality in a secular context such as the MBSR program (see Appendix A for items contained in FACIT-Sp).

There have been anomalous results in some studies using mindfulness and spirituality scales. A cross-sectional study of a sample of undergraduate students examining the relationship between spirituality, mindfulness, and substance abuse [43] found that scores on the FMI and the Spiritual

Table 3
Multivariate associations between medical symptoms checklist and SCL-90-R scores and mindfulness and spirituality scores

Predictors (independent variables)	Dependent variables (unadjusted) {regression coefficient [95% CI] P value}						
	ΔFACIT-Sp	ΔMeaning/Peace	ΔFaith	ΔMSCL	ΔGSI	ΔDepression	ΔAnxiety
Baseline	−0.16 [−0.30,−0.03] .015	−0.24 [−0.40,−0.08] .003	−0.09 [−0.25, 0.06] .224	−0.21 [−0.35,−0.07] .003	−0.37 [−0.51, 0.22] .001	−0.21 [−0.41,−0.01] .04	−0.54 [−0.70,−0.39] .001
ΔMAAS	0.26 [0.11, 0.42] .001	0.27 [0.08, 0.46] .005	0.23 [−0.03, 0.48] .081	−1.32 [−2.48,−0.18] .024	−0.08 [−0.14,−0.02] .010	−0.10 [−0.18,−0.01] .03	
ΔTMS	0.38 [0.22, 0.54] .001	0.43 [0.23, 0.62] .001	0.28 [0.02, 0.55] .038				
Δ FACIT-Sp					−0.08 [−0.17,−0.00] .046	−0.15 [−0.27,−0.03] .02	−0.15 [−0.25,−0.05] .004
ΔMeaning/Peace				−1.84 [−3.23,−0.44] .010			
TMS at baseline				−1.22 [−2.33,−0.11] .032			

Each column represents one regression analysis.
Blank cells represent nonsignificant associations.
TMS scores at baseline were related to reductions in the MSCL (P=.032) but are probably artifacts.

Transcendence Index (STI) [44] were not correlated. Whereas the STI predicted lower levels of drinking, the FMI dimension that tapped into a greater awareness of bodily sensations predicted smoking and binge drinking. While such an outcome raises questions about the validity of the scale, the FMI has been validated only with experienced Buddhist meditation practitioners and may not be suitable for use with respondents without mindfulness meditation experience. In addition, the STI total score includes "spiritual" and "God" subscales, which were not reported separately. The items ask respondents about their relationship with God, and the scale may reflect a definition of spirituality that is less secular than that of FACIT-Sp and less suitable for assessing the construct in a secular training program. In a recent study of an abbreviated MBSR program [45] that included the Index of Core Spiritual Experiences (INSPIRIT) [46], no improvements were found from preprogram to postprogram, but INSPIRIT also makes explicit reference to belief in the existence of God as a criterion for spirituality and may also be unsuitable for assessing spirituality in relation to mindfulness meditation.

Despite these concerns, the administration of two different mindfulness scales in a sample taking part in a mindfulness training program provides an opportunity to determine whether the scales result in similar estimates of and changes in mindfulness. It is also an opportunity to explore possible mechanisms by which mindfulness-based programs exert their effects on well-being by examining whether mindfulness, as it is assessed by these scales, is related to existing psychological constructs. The TMS and MAAS were chosen for the present investigation because they are the only published scales that have been validated with both Buddhist meditation practitioners and MBSR participants and because they take different approaches to assessing mindfulness. The items on the TMS are derived from traditional meditation instructions designed to evoke a mindful state[1] and ask respondents to rate their retrospective experience during a prior short period of quiet sitting. MAAS items ask respondents to rate their experience of daily activities, and the items purportedly reflect qualities of daily experiences that are expected to result for someone who was being more or less mindful as he goes through his day.[2] It has been described as a dispositional measure of mindfulness [47].

In the present study, scores on both the TMS and MAAS increased significantly preprogram to postprogram, but neither baseline nor changes in scores on the two scales were correlated. This finding is consistent with the results reported by Bishop [30] and also with studies comparing scores on other state and trait measures of the same

[1] Example items: "I remained open to whatever thoughts and feelings I was experiencing" and "I noticed how my feelings expressed themselves in my body as physical sensations."

[2] Example item: "It seems as if I am 'running on automatic' without much awareness of what I'm doing."

construct. While lack of a relationship might be expected at baseline in participants who were naïve to mindfulness practice, TMS items reflect instructions in eliciting a mindful state, and changes in scores on that scale could reasonably be expected to be reflected in increases in trait mindfulness after 8 weeks of mindfulness training. The fact that they were not found in this sample raises questions about the generality of the transference of formal mindfulness meditation training into everyday mindfulness over this period of time, and/or the validity of one or both of the scales. In addition, while both state and trait mindfulness scores were associated with increases in spirituality, the substantial improvements in state mindfulness over the course of the MBSR program were not associated with reductions in medical symptoms or psychological distress in the way that smaller changes in trait mindfulness scores were. This may also be a function of inherent fluctuations in state measures, as contrasted with trait measures, and warrants further investigation, possibly by administering the state scale weekly over the course of the 8-week program in a larger sample size and by using a cluster analysis of the patterns of change over the course of the 8 weeks. The result may also indicate that the following of instructions in mindfulness practice take longer than 8 weeks to lead to the improvements in everyday mindfulness reflected in MAAS. Future research should assess the broader range of mindfulness dimensions captured by the full five-factor assessment and continue to explore how various aspects of mindfulness and spirituality may relate to symptom outcome.

The significant associations found between improvements in mindfulness scores and improvements in spirituality indicate that these dimensions may be developed in a secular context. Given that 82% of Americans are reported to express a desire for greater spiritual growth [2], the MBSR program may provide one secular way for people to realize this. Furthermore, the robust association between improvements in spirituality and reductions in reported medical symptoms and psychological distress contributes to the emerging view that spirituality may be associated with health, independent of religious affiliation [48], and may be a significant component of public health and behavioral programs that promote it. Mindfulness meditation training is associated with reductions in rumination [45], and Bishop et al. [49] hypothesize that TMS scores are associated with reductions in emotional distress through improved affect tolerance and reduced rumination. It may be that the ability to reduce mental preoccupation with day-to-day stressors may be a contributing mechanism through which mindfulness affects symptom change and well-being; with the mind less preoccupied with daily worries, the person may more deeply experience a sense of spiritual well-being. In the developmental model of mindfulness proposed by Shapiro et al. [50], attending to one's experience with particular intention, attention, and attitude (i.e., mindfully) leads to a fundamental shift in perspective in which what was previously seen as "subject" becomes "object" and in which identity begins to shift from the contents of awareness to awareness itself. It is postulated that this shift allows for greater self-regulation, values clarification, cognitive and behavioral flexibility, and greater exposure, which result in positive health outcomes. The finding in the present study—that changes in the Meaning and Peace factor on the spirituality scale accounted for a substantial part of the association with reductions in scores on reported medical symptoms and psychological distress—may point to another dimension of experience that is affected by a shift in perspective associated with mindfulness training.

The increases in meaning and peace are also consistent with the report of Kabat-Zinn and Salmon [51], who found significant increases in the sense of coherence (SOC) scores associated with participation in the MBSR program. A person's sense of meaning plays an important part in the SOC construct, and higher SOC scores have been associated with greater health and resilience to stress [52,53]. The greater role of the Meaning and Peace factor is also consistent with earlier findings with cancer patients in which changes in this factor, in contrast to the Faith factor, contributed to a greater sense of well-being, despite high levels of cancer symptoms such as pain and fatigue [4]. This much smaller role of faith-related items in observed associations with health outcomes is intriguing and warrants further study.

The lack of a significant association between amount of home practice and program outcomes is consistent with the findings of Davidson et al. [54], who investigated the relationship between participation in the MBSR program and immune function but did not find a relationship between reported home practice and immune response to an influenza virus. However, other investigators [55] have found relationships between home practice and therapeutic improvement in binge eating, although primarily between eating-focused meditation practice and eating symptoms rather than the amount of practice of formal meditation. Given the importance ascribed to home practice in MBSR classes, the role of this aspect of mindfulness training warrants a more systematic investigation.

The study is limited by the fact that there was no control group, and so the level of absolute changes in scores resulting from participation in the MBSR program has no comparison group. However, the study's main aim was to estimate the associations of changes in study variables, and the lack of a control group can be considered to have less impact on these analyses. Another limitation is that scales used to assess mindfulness must be regarded as experimental at their present stage of development, and future developments of these scales may result in different associations. Furthermore, all study outcomes are from self-report. Subsequent studies should be undertaken to measure the associations of spirituality and mindfulness measures with "hard outcomes" such as actual disease indicators or biologic stress markers.

The relationships among mindfulness, meditation practice, spiritual well-being, and improved psychological and physical regulation appear to be complex. However, the results of this study suggest that spiritual well-being, particularly the cultivation of a sense of inner meaning and peace, may occur as a function of mindfulness meditation, even when presented entirely within a secular context, and that this aspect of functioning may be an important element in health and well-being, as suggested by an increasing body of research on spirituality and health [48].

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Appendix AFACIT-Sp Items

Respondents indicate on a 5-point scale how true each statement has been for them during the past 7 days:

Meaning and peace items:

I feel peaceful.
I have a reason for living.
My life has been productive.
I have trouble feeling peace of mind.
I feel a sense of purpose in my life.
I am able to reach down deep into myself for comfort.
I feel a sense of harmony within myself.
My life lacks meaning of purpose.
Faith items:

I find comfort in my faith or spiritual beliefs.
I find strength in my faith or spiritual beliefs.
Difficult times have strengthened my faith or spiritual beliefs.
Even during difficult times, I know that things will be okay.

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Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program

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Abstract Relationships were investigated between home practice of mindfulness meditation exercises and levels of mindfulness, medical and psychological symptoms, perceived stress, and psychological well-being in a sample of 174 adults in a clinical Mindfulness-Based Stress Reduction (MBSR) program. This is an 8- session group program for individuals dealing with stress-related problems, illness, anxiety, and chronic pain. Participants completed measures of mindfulness, perceived stress, symptoms, and well-being at pre- and post-MBSR, and monitored their home practice time throughout the intervention. Results showed increases in mindfulness and well-being, and decreases in stress and symptoms, from pre- to post-MBSR. Time spent engaging in home practice of formal meditation exercises (body scan, yoga, sitting meditation) was significantly related to extent of improvement in most facets of mindfulness and several measures of symptoms and well-being. Increases in mindfulness were found to mediate the relationships between formal mindfulness practice and improvements in psychological functioning, suggesting that the practice of mindfulness meditation leads to increases in mindfulness, which in turn leads to symptom reduction and improved well-being

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An increasing body of research supports physical and mental health benefits of participation in mindfulness training. Recent reviews of the empirical literature (Baer 2003; Grossman et al. 2004; Salmon et al. 2004; Hayes et al. 2006) suggest that several interventions that incorporate mindfulness, including mindfulness-based stress reduction (MBSR) (Kabat-Zinn 1982; Kabat-Zinn 1990), mindfulness-based cognitive therapy (MBCT) (Segal et al. 2002), dialectical behavior therapy (DBT) (Linehan 1993) and acceptance and commitment therapy (ACT) (Hayes et al. 1999); lead to clinically significant improvements in psychological functioning in a wide range of populations. As evidence for the efficacy of these interventions continues to grow, the importance of investigating the mechanisms of action by which mindfulness training exerts salutogenic effects is increasingly recognized (Dimidjian and Linehan 2003; Baer et al. 2006; Hayes et al. 2006; Shapiro et al. 2006). Examination of this question requires methods to assess levels of mindfulness to determine whether individuals engaged in the practice of mindfulness are in fact becoming more mindful over time, and if so, whether these increases are responsible for the positive outcomes observed.

The recent literature includes several newly developed self-report measures of a general tendency to be mindful in daily life (Baer et al. 2004); (Buchheld et al. 2001; Brown and Ryan 2003; Feldman et al. In press). These measures have been shown to be significantly correlated with each other and to have promising psychometric properties (Baer et al. 2006). However, differences in their content and structure suggest some disagreement between researchers about how mindfulness should be defined and operationalized. In particular, the number of components or facets of mindfulness varies widely across instruments. In a recent study of facets of mindfulness, Baer et al. (2006) conducted exploratory factor analysis of the combined item pool from all available mindfulness questionnaires and found that a five-factor structure appeared to capture several distinct but related underlying dimensions. Items with the highest loadings on each of the five factors (and low loadings on all other factors) were combined to form the Five Facet Mindfulness Questionnaire (FFMQ) (Baer et al. 2006), which assesses five elements of mindfulness. These include *observing* (attending to or noticing internal and external stimuli, such as sensations, emotions, cognitions, sights, sounds, and smells), *describing* (noting or mentally labeling these stimuli with words), *acting with awareness* (attending to one's current actions, as opposed to behaving automatically or absent-mindedly), *non-judging of inner experience* (refraining from evaluation of one's sensations, cognitions, and emotions) and *non-reactivity to inner experience* (allowing thoughts and feelings to come and go, without attention getting caught up in them). Examples of items for each factor can be seen in Table 1.

These five facets of mindfulness have shown good internal consistency and correlations in the expected directions with many variables predicted to be related to mindfulness, such as experiential avoidance, thought suppression, openness to experience, and emotional intelligence (Baer et al. 2006). Significant relationships with meditation experience in long-term meditation practitioners also have been documented (Baer et al. 2007), but changes in these facets of mindfulness over the course of a mindfulness-based program in a clinical setting have not been investigated. One purpose of the current study therefore, was to examine whether participation in MBSR is associated with changes in levels of mindfulness, as measured by the FFMQ.

The foundation and methodology of MBSR has been described in detail elsewhere (Kabat-Zinn 1982; Kabat-Zinn 1990). Briefly, it is a group program that focuses on the cultivation of mindfulness through instruction in formal meditation practices (sitting meditation, body scan, mindful yoga), and the integration of this capacity into everyday life as a coping resource for dealing with intensive physical symptoms and difficult emotions (Kabat-Zinn 1994). Participants attend eight weekly 2 1/2 h sessions, plus an all-day session on a weekend day during the sixth week. These sessions include training in formal mindfulness practices as well as group interaction. Class discussion centers around the challenges and achievements participants are experiencing using mindfulness in the face of stressful situations occurring in their everyday lives. In the body scan, participants focus attention sequentially on parts of the body, non-judgmentally noticing whatever sensations may be present in each area. Mindful hatha yoga postures also are practiced to develop awareness during gentle movements and stretching. In sitting meditation, participants use awareness of the sensations of breathing as a baseline attentional focus, while noticing any other sensations in the body, sounds in the environment, and/or cognitions and feeling states that also present themselves to attention. In addition, participants are encouraged to engage in informal mindfulness practice by doing everyday activities (such as eating, walking, washing the dishes, etc) with full awareness of the associated movements, sensations, cognitions and feelings that may be present. Participants are given two CD's containing instructions to guide their formal meditation practices (body scan, yoga, and sitting meditation) and encouraged to practice at home by listening to the CD for 45 min each day throughout the seven weeks of the program (Kabat-Zinn 1990).

The importance of regular out-of-class practice in establishing the capacity for mindfulness in everyday life, and hence its purported benefits, is also clearly stated in other mindfulness-based programs. The manual for MBCT recommends 45 min of daily practice in order to obtain the benefits of participation (Segal et al. 2002) and a recent ACT manual (Hayes and Smith 2005) suggests practicing for 15–30 min per day. In DBT, the importance of regular practice is emphasized, but specific practice goals are determined by clients and their therapists. While this expectation of daily practice is well established in the Buddhist meditation traditions upon which these programs

Table 1 Example items for mindfulness facets

Facet	Example item
Observing	I notice the smells and aromas of things.
Nonreactivity to inner experience	I perceive my feelings and emotions without having to react to them.
Describing	I'm good at finding words to describe my feelings.
Nonjudging of inner experience	I think some of my emotions are bad or inappropriate and I shouldn't feel them. (R)
Acting with awareness	I find myself doing things without paying attention. (R)

Note: R = reverse-scored item (higher scores represent higher levels of mindfulness) draw, there is limited empirical evidence for the effects of home practice in clinical populations.

In a sample of women with binge eating disorder who completed a 6 week mindfulness-based treatment, Kristeller and Hallett (1999) found that time spent in the practice of eating-related mindfulness exercises was significantly correlated with degree of improvement in binge eating. Practice of "mini-meditations," in which participants stop for a few moments at key times during daily activities to practice nonjudgmental awareness of thoughts and feelings, was significantly related to improvements in depressive symptoms. In a subsequent study with a similar population, time spent engaging in eating-related mindfulness exercises was significantly related to improvements in eating control (Kristeller et al. under review). In a study of MBSR with cancer outpatients, Speca et al. (2000) reported that home practice of meditation was significantly related to improvements in mood. In contrast, Astin (1997) found that practice time and symptom improvement were not significantly correlated in a sample of college students completing MBSR. Similarly, Davidson (2003) found no relationship between reported practice time during an MBSR course and degree of change in either biological or self-report measures in a worksite sample of healthy employees. Since most participants in mindfulness-based programs are likely to have many competing time demands, the disclosure of the expectation of lengthy out-of-class practice may act as a barrier to participation for some. For these reasons, and also to further understanding of mechanisms of action, it is important to clarify and confirm the role of home practice in obtaining the program's potential benefits.

In light of the above, the purpose of the present study was to investigate three related questions: (1) Whether participation in MBSR was associated with increases in mindfulness as measured by the FFMQ; (2) if such increases were observed, whether the amount of out-of-class practice of mindfulness was related to improvement in mindfulness scores; and (3) if support for this relationship was found, whether the increases in levels of mindfulness mediate the relationship between mindfulness practice and any observed improvements in psychological functioning and reported medical symptoms. Our outcome variables included measures of medical and psychological symptoms shown in previous research to be associated with significant improvements in MBSR participants (see section on measures below). In addition, because meditation traditions consistently suggest that the practice of mindfulness cultivates positive qualities such as wisdom, compassion, insight, and equanimity (Shapiro et al. 2002), we included a measure of psychological well-being (Ryff 1989) that assesses aspects of psychological health independent of symptom levels. This measure has not been included in previous studies of MBSR.

Methods

Participants

Study participants were drawn from individuals enrolled in the University of Massachusetts Medical School MBSR program in Worcester MA during 2006. While detailed data were not available on participants' diagnoses, the MBSR groups included adults with a wide range of problems including illness-related stress, chronic pain, anxiety, and personal and employment-related stress. Each class included approximately 20–25 participants; about half were referred by their health-care practitioner and others were self-referred. Participation in the program is on a self-pay basis. Self-report data for program evaluation and participant information are routinely collected before the first class, and again at the end of each 8-week group. All participants are asked on the intake questionnaire whether their response information can be used for research purposes, on condition that they are not identified as individuals. The current study includes data from the 96% of the participants who consented to the use of their data for research purposes.

A total of 206 individuals in nine MBSR groups who consented to the use of their data completed the pre-intervention measures. Of these, 10 (5%) attended three or fewer sessions and provided no assessment data at post-intervention. Of the remaining 196, 22 attended four or more sessions but failed to provide post-intervention assessment data. Thus, data at both pre- and post-MBSR were available for 174 participants (85% of those who consented to participate). Of these, 168 (97%) attended six or more of the eight weekly sessions, whereas five participants attended five sessions or fewer. Attendance data for one participant were unavailable. The all-day session in week six was attended by 150 (86%) of these participants.

The mean age of the 174 participants was 47.05 years (SD = 10.26, range 19–68) and 63% were female. Most were married (65%) or cohabitating (9%), whereas 12% were single, 9% were separated, divorced, or widowed, and 5% did not answer this question. Most participants reported white collar and professional occupations. Current or previous participation in psychotherapy was reported by 63% of the sample.

Differences between the participants who failed to provide post-treatment data (N = 32) and the rest of the sample (N = 174) were examined using one-way analysis of variance and chi-square analyses. No significant differences were found for demographic variables (age, gender, marital status, participation in psychotherapy) or for any of the dependent variables as measured at pre-treatment (medical and psychological symptoms, perceived stress, well-being, mindfulness). Thus, the 174 participants included in analyses described later appear to be representative of the slightly larger group that consented to participate.

Procedures

Prospective MBSR participants attend an orientation/information session during the three weeks prior to the beginning of each 8-week group. In these sessions the goals and format of the program are explained and any questions they may have about their participation are answered. Pre-program questionnaires (described below) were completed immediately prior to these orientation sessions. Post-program instruments were completed during the final MBSR session. Home practice data were derived from a mindfulness practice log in which participants recorded the number of minutes of formal and informal mindfulness practice they did each day. Participants placed their completed logs in the slot of a closed purpose-built box that was in the classroom each week. The study assistant collected the logs from the box following each session. Respondents were assured that their responses would not be seen by the instructor. Logs were color-coded by week. Participants who forgot to bring their log to class were asked to fill out a retrospective plain white log for that week.

Measures

Demographic characteristics were assessed at pre-intervention only. Participants reported their age, gender, marital status, occupation, any history of substance abuse, and past or current participation in psychotherapy.

Variables assessed at both pre- and post-MBSR included mindfulness, medical and psychological symptoms, perceived stress, and psychological well-being. Home mindfulness practice was assessed throughout the intervention.

Mindfulness was assessed using the FFMQ (Baer et al. 2006). This instrument was derived from a factor analysis of questionnaires measuring a trait-like general tendency to be mindful in daily life. It consists of 39 items assessing five facets of mindfulness: *observing, describing, acting with awareness, non-judging of inner experience*, and *non-reactivity to inner experience*. Items are rated on a Likert scale ranging from 1 (never or very rarely true) to 5 (very often or always true). The FFMQ has been shown to have good internal consistency and significant relationships in the predicted directions with a variety of constructs related to mindfulness (Baer et al. 2006).

Home mindfulness practice was assessed using a folder of seven color-coded homework logs—one color for each of the seven weeks of the MBSR program. Participants were asked to record the number of minutes of home practice they did each day in each of the formal meditation practices taught in the program (body scan, mindful yoga, sitting meditation) as well as the minutes of informal (becoming mindful in everyday activities) practice.

Psychological symptoms were assessed with the Brief Symptom Inventory (BSI) (Derogatis 1992) which includes 53 items and provides nine sub-scale scores measuring a range of psychological symptoms and somatic complaints. A global severity index (GSI) also can be calculated. Studies of MBSR show significant reductions in GSI, anxiety and depression associated with participation in the program (Shapiro et al. 1998; Williams et al. 2001; Majumdar et al. 2002).

Medical symptoms were assessed using the Medical Symptom Checklist (MSCL) (Kabat-Zinn 1982). This is a list of 115 common medical symptoms and respondents are asked to check those they have experienced as bothersome in the past month. The score is the total number of symptoms checked. While the reliability and validity of the MSCL have not been evaluated, several studies of MBSR have shown significant reductions in the MSCL associated with participation in the program (Kabat-Zinn et al. 1985; Kabat-Zinn 1987; Kabat-Zinn and Chapman-Waldrop 1988; Kabat-Zinn et al. 1992; Williams et al. 2001).

Perceived stress was assessed using the Perceived Stress Scale (PSS) (Cohen et al. 1983; Cohen and Williamson 1988), a widely-used and well-validated 10-item scale that measures the degree to which situations in one's life over the past month are appraised as unpredictable, uncontrollable and overwhelming. It posits that people appraise potentially threatening or challenging events in relation to their available coping resources. A higher score indicates a greater degree of perceived stress. Participation in MBSR has been associated with significant declines in PSS scores (Carmody et al. 2006).

Psychological Well-Being was assessed using the Scales of Psychological Well-Being (Ryff and Keyes 1995) which conceptualize psychological well-being (PWB) as has having six elements: self-acceptance (positive attitude toward one's self, life, and past, including good and bad qualities), positive relations with others (warm, satisfying, trusting relationships), autonomy (independence, ability to resist social pressures and follow own standards), environmental mastery (competence in managing life's demands), purpose in life (goals and direction, sense of meaning), and personal growth (view of self as growing and developing, openness to new experiences). The PWB scales measure these six elements and are available in several lengths. The 54-item version, with nine items per scale, was used in the present study. This version has been shown to have good psychometric properties (Sewell et al. 2004). We used a total score derived by summing the elements of well-being.

Results

Changes in mindfulness facets, well-being, perceived stress and symptoms

Changes in all variables from pre- to post-MBSR (N = 174) can be seen in Table 2. Paired sample *t*-tests showed that all variables changed significantly and in the expected direction. Pre-post effect sizes (Cohen's *d*) were calculated using the formula suggested by Rosenthal (1984) for matched-pairs data ($d = t/\sqrt{df}$). Scores on all mindfulness facets increased significantly pre- to post-program. Effect sizes were large for *observing* and *non-reactivity to inner experience* and moderate for *describing, acting with awareness*, and *non-judging*. Psychological well-being subscales also increased significantly in association with program participation, and showed a large effect size. Medical and psychological symptoms and perceived stress levels all decreased significantly, with moderate to large effect sizes.

Home mindfulness practice

Of the 174 participants who provided both pre- and post-MBSR assessment data, 121 (69.5%) provided some or all of their home practice data. Only these 121 participants are included in the following analyses of practice time. For these 121 participants, the mean number of practice logs provided was 6.16 out of a possible seven (SD = 1.34), and 91% provided five or more of the seven logs. For missing logs, values of zero were entered. Thus, practice times may be under-estimates, as participants may have engaged in mindfulness practice on days for which they completed no logs.

For each of the formal practices, a mean of 97.7% of reported practice times fell between 0 and 45 min. Nearly all of the remaining practice times fell between 46 and 90 min. A few individuals occasionally reported practicing one particular exercise on one specific day for 100–300 min. These latter reports, although extreme,

Table 2 Means and SD's, paired sample *t*-tests, and pre-post effect sizes for all variables

Variable	Pre-MBSR		Post-MBSR		t	d
	M	SD	M	SD		
Mindfulness facets						
Observe	23.79	5.84	28.28	4.72	−11.94**	.91
Describe	26.90	6.42	28.92	6.02	−6.12**	.47
Act with awareness	23.72	5.76	26.49	5.13	−7.60**	.58
Nonjudge	26.34	7.01	30.78	5.86	−8.70**	.68
Nonreact	17.97	4.98	22.19	4.13	−11.09**	.86
Psychological well-being	227.62	37.41	246.55	37.95	−9.77**	.77
Perceived stress	22.13	6.19	15.78	6.33	13.14**	1.02
Symptom measures						
MSCL	21.63	12.09	13.66	9.77	11.83**	.90
BSI-global severity	0.77	0.47	0.53	0.40	8.38**	.65
Somatization	0.55	0.57	0.42	0.48	3.54*	.27
Obsessive-compulsive	1.34	0.82	0.96	0.68	7.61**	.58
Interpersonal sensitivity	0.92	0.85	0.62	0.64	5.86**	.45
Depression	0.81	0.70	0.57	0.65	5.64**	.44
Anxiety	1.04	0.74	0.65	0.53	7.84**	.61
Hostility	0.75	0.65	0.46	0.46	6.84**	.53
Phobic anxiety	0.32	0.51	0.17	0.38	3.83**	.30
Paranoia	0.55	0.61	0.41	0.46	4.15**	.32
Psychoticism	0.54	0.54	0.37	0.45	4.99**	.39

Note. MSCL = Medical Symptom Checklist, BSI = Brief Symptom Inventory

* $p < .01$, ** $p < .001$

represented less than .05% of all reported practice times. To normalize the distribution of practice times and reduce the potential influence of outliers on the analyses that follow, reported daily practice times for each exercise were coded on a 0–10 scale, in which 0 = no practice, 1 = 1–5 min of practice, 2 = 6–10 min, 3 = 11–15 min, and so on, with 10 = greater than 45 min of practice.

Participants were encouraged to engage in out-of-class practice 6 days per week and homework practice logs were requested at sessions two through eight (seven weeks) yielding a maximum total number of 42 expected practice days. While the sequence of introduction of the formal mindfulness techniques could vary in individual classes at the discretion of the instructor, generally during the first two weeks participants were asked to practice the body scan 6 days per week. Mindful yoga was introduced in the third session and participants were asked to practice the body scan and yoga on alternate days during the following two weeks. While short sitting meditation periods were introduced during the first four sessions and participants were encouraged to practice this at home, the 45-min recording of guided sitting meditation was not introduced until the fifth session. At that time, participants were instructed to practice the sitting meditation on alternate days, with their choice of either the body scan or the yoga on the intervening days. After that, they were given considerable flexibility to choose which exercise(s) to practice each day.

Table 3 shows the mean number of days on which participants reported practicing each exercise, together with the mean duration (in min) of practice on each of those days, and the total number of hours of practice over the course of the program. On the average, participants reported practicing the body scan on 19.6 days, for 31–35 min each day that they practiced it. Participants practiced yoga on nearly 17 days, for 16–20 min per day. Sitting meditation was reported on roughly 20 days, for 16–20 min per day. Many participants reported engaging in more than one formal practice on a single day. The average number of days on which any formal practice occurred (body scan, sitting, and/or yoga) was 33.55, or 80% of the 42 assigned days of practice. The average total practice time for all formal practices combined was 31–35 min per day. Informal practice (becoming mindful in everyday activities) was reported on a mean of just under 20 days, for an average of 11–15 min per day.

Relationships between home mindfulness practice and other variables

We examined whether time reported spent in mindfulness practice was related to the extent of change in mindfulness, well-being, and medical and psychological symptoms. For these analyses, daily homework practice times (coded on the 0–10 scale described above) for each exercise were summed, yielding a total reported practice time for each exercise over the course of the 7-week program.

Table 4 shows correlations between total practice time and pre-post changes in all dependent variables. Because of the large number of correlations presented, only those with p values less than .01 are considered significant. These findings suggest that practice time for formal meditation (body scan, yoga, sitting) is associated with many changes in the beneficial direction. Practice of the body scan was significantly related to increases in the mindfulness facets of *observing* and *non-reactivity to inner experience*, increases in psychological well-being, and decreases in interpersonal sensitivity and anxiety. Yoga practice was significantly associated with changes in four of five mindfulness facets (all but *describing*), well-being, perceived stress levels, and several types of psychological symptoms. A similar pattern was seen for total formal practice time (body scan, sitting, and yoga combined). Practice of sitting meditation was significantly associated with changes in two mindfulness facets (*acting with awareness* and *non-reactivity*), psychological well-being, and symptoms of psychoticism (social alienation and concerns about the health of one's mind). In contrast, reported informal mindfulness practice (doing routine activities mindfully) showed no significant relationships with changes in any of the dependent variables. In addition, changes in the *describing* facet of mindfulness were not related to practice times for any of the mindfulness exercises. No significant correlations were found between practice time and change in medical symptoms.

Table 3 Homework practice during MBSR course for 121 participants providing homework data

Mindfulness exercise	Total days practiced		Minutes per day practiced			Total hours practiced
	Mean	SD	Mean	Minimum	Maximum	
Body scan	19.61	9.32	31–35	6–10	>45	10.79
Movement (yoga)	16.92	11.14	16–20	1–5	41–45	5.08
Sitting meditation	19.70	10.98	16–20	1–5	41–45	5.91
Any formal practice	33.55	10.87	31–35	6–10	>45	18.45
Informal practice	19.94	13.69	11–15	1–5	>45	4.3

Table 4 Correlations between total practice time during MBSR course and pre-post changes in other variables for 121 participants providing homework data

	Body scan	Movement (yoga)	Sitting meditation	Total formal practice	Informal practice
Mindfulness facets					
Observe	.29*	.24*	.23	.33*	.21
Describe	.02	.02	.04	.03	.02
Act with awareness	.09	.32*	.26*	.27*	.14
Nonjudge	.08	.26*	.09	.18	.03
Nonreact	.28*	.32*	.26*	.36*	.09
Psychological well-being	.27*	.42*	.32*	.42*	.21
Medical symptoms	.17	.19	.12	.21	.03
Perceived stress	.16	.24*	.23	.26*	.15
Psychological symptoms					
Somatization	.14	.14	.12	.17	–.02
Obsessive-compulsive	.10	.13	.03	.12	.06
Interpersonal sensitivity	.24*	.31*	.19	.31*	.08
Depression	.05	.18	.15	.15	.01
Anxiety	.26*	.25*	.19	.29*	.09
Hostility	.04	.06	–.02	.04	–.12
Phobic anxiety	.15	.33*	.16	.26*	.21
Paranoia	.06	.17	.11	.14	–.09
Psychoticism	.22	.33*	.27*	.33*	.10
Global severity	.21	.32*	.19	.30*	.02

* $p < .01$

Although these findings suggested that greater practice time is associated with increases in mindfulness and well-being and decreases in stress and symptoms, it was important to consider whether pre-treatment levels of mindfulness or psychological functioning were related to participants' likelihood of engaging in their assigned homework exercises. Correlations were therefore computed between total formal practice time during the intervention and pre-treatment scores on the mindfulness facets, perceived stress, medical and psychological symptoms, and well-being. These correlations were non-significant, suggesting that participants' pre-treatment levels of these variables had no significant effect on the amount of assigned home mindfulness practice they reported doing.

Mediation analyses

Because the findings suggested that engaging in formal mindfulness practices was associated with improvements in both mindfulness and symptoms/well-being, our third goal was to test the hypothesis that increases in mindfulness mediate the relationship between reported minutes spent in practice and improved psychological functioning. To examine this question we conducted three mediation analyses using the methods based on linear regression described by Baron and Kenny (1986), supplemented with methods described by MacKinnon et al. (2000). In each case the independent variable (IV) was total formal practice time over the course of the program, created by summing the practice times (coded 0–10 as described earlier) for body scan, sitting meditation, and yoga. Informal practice time was not included in this variable because it was not significantly correlated with changes in other variables. The proposed mediating variable was the degree of change in mindfulness from pre- to post-intervention and was created by summing the pre-post change scores for the *observing, acting with awareness, non-judging*, and *non-reactivity* facets. The *describing* facet was not included in this variable because it was not significantly correlated with practice time. The dependent variables (DV) for the three mediation analyses were pre-post change scores for psychological symptoms (BSI-global severity index), perceived stress (PSS total score), and psychological well-being (PWB total score), respectively.

According to Baron and Kenny (1986), several conditions must be met to show support for a mediational hypothesis. The IV, mediator, and DV all must be significantly inter-correlated. When the IV and the mediator are entered simultaneously into a model predicting the DV, the relationships between the IV and DV must become non-significant, or must be significantly reduced. For the first mediation analysis, in which decrease in psychological symptoms was the dependent variable, all conditions were met. Meditation practice time was a significant predictor of decrease in psychological symptoms ($R = .30$, $F = 11.39$, $p < .01$), and of increase in mindfulness ($R = .42$, $F = 21.95$, $p < .001$). Increase in mindfulness also was a significant predictor of decrease in symptoms ($R = .49$, $F = 46.50$; $p < .001$). When formal practice time and increase in mindfulness were entered simultaneously as predictors of decrease in symptoms, the regression coefficient for practice time dropped to .10 (ns). According to the formula described by MacKinnon et al. (2000), the drop in the regression coefficient from .30 to .10 is significant ($t = 3.57$, $p < .01$). This result is consistent with the hypothesis that the relationship between practice time and psychological symptoms is completely mediated by increases in mindfulness skills. This analysis can be seen in Fig. 1a.

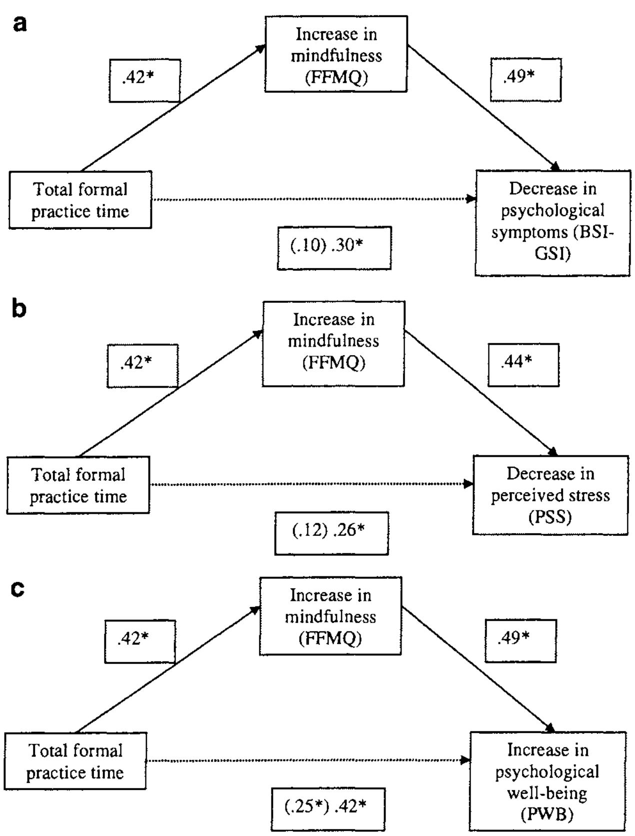

Fig. 1 Mediation of the relationship between formal meditation practice time and pre-post decrease in psychological symptoms as measured by the BSI-GSI (**a**), pre-post decrease in perceived stress as measured by the PSS (**b**), and pre-post increase in psychological well-being as measured by the PWB total score (**c**). In each case, the mediating variable is the sum of pre-post change scores in the *observing, acting with awareness, nonjudging,* and *nonreactivity* facets of mindfulness. All values are beta coefficients. Values in parentheses show relationships between formal practice time and the dependent variable, when the mediating variable is included in the model. *p < .01

A similar pattern was found for the second mediation analysis, in which decrease in perceived stress was the dependent variable. (Fig. 1b). In this case, meditation practice time was a significant predictor of decrease in perceived stress ($R = .26$, $F = 8.30$, $p < .01$) and of increase in mindfulness ($R = .42$, $F = 46.50$, $p < .001$). Increase in mindfulness also was a significant predictor of decrease in perceived stress ($R = .44$, $F = 34.74$, $p < .001$). When formal practice time and increase in mindfulness were entered simultaneously as predictors of decrease in perceived stress, the regression coefficient for practice time dropped significantly ($t = 2.77$, $p < .01$) to .12 (ns), suggesting that the relationship between practice time and perceived stress also is completely mediated by the development of mindfulness skills.

For increase in psychological well-being, only partial mediation was shown (Fig. 1c). In this case, meditation practice time was a significant predictor of well-being ($R = .42$, $F = 24.14$, $p < .001$) and of increase in mindfulness ($R = .42$, $F = 21.95$, $p < .001$). Increase in mindfulness also was a significant predictor of well-being ($R = .49$, $F = 45.95$, $p < .001$). However, when practice time and increase in mindfulness were entered simultaneously as predictors of well-being, the relationship between practice time and well-being remained significant, although the drop in the regression coefficient from .42 to .25 was significant ($t = 3.87$, $p < .01$). This finding suggests that, although increases in mindfulness are important in accounting for improvements in well-being, other variables not included in the model may also be important in accounting for increased well-being.

Discussion

The first goal of this study was to investigate whether participation in MBSR would lead to changes in levels of mindfulness as measured by the FFMQ. If such changes were observed, the second goal was to examine whether extent of home practice of mindfulness meditation was related to changes in mindfulness as well as changes in symptoms and well-being. Finally, if these relationships were found, the third goal was to explore whether increases in mindfulness mediate the relationship between meditation practice and improvements in functioning. Results showed that levels of mindfulness increased significantly from pre- to post-MBSR, with effect sizes in the moderate to large range. Results also showed that the extent of home practice of formal meditation exercises (body scan, yoga, sitting) is significantly correlated with degree of change in most facets of mindfulness (all but *describing*), and several measures of symptoms and well-being, although informal mindfulness practice (doing routine activities mindfully) was unrelated to these outcomes. Finally, increases in mindfulness were shown to completely mediate the relationships between meditation practice over the course of the intervention and improvement in psychological symptoms and perceived stress, suggesting that the improvements in mindfulness that appear to result from regular practice are related to the significant reductions in psychological distress and perceived stress that were observed. Because perceived stress and symptom scores were significantly inter-correlated at both pre- and post-intervention, it is not surprising that mediation analyses for these two variables showed similar findings. Psychological well-being also was significantly intercorrelated with stress and symptoms, yet only partial mediation was shown for this variable, suggesting that other variables not measured here are important in accounting for the relationship between formal practice time and increased well-being.

These findings are important because they provide initial support for a central tenet of several mindfulness-based treatment approaches: that the regular practice of meditation should cultivate mindfulness skills in everyday life, which in turn should lead to improved psychological functioning such as symptom reduction, reduced stress and enhanced well-being. While this expectation is well established in the Buddhist meditation traditions upon which these programs draw, there is limited empirical evidence for the claim in clinical settings (Ramel et al. 2004; Toneatto and Nguyen 2007) and this is the first study to report these associations with a large sample in a clinical context. An alternative explanation—that more mindful people are more likely to practice meditation—was not supported by our findings, which showed non-significant relationships between baseline levels of mindfulness and extent of home practice during the intervention. The findings also provide encouraging support for the validity and utility of the FFMQ in measuring mindfulness. While significant improvements were noted in the *describing* factor of the FFMQ, these changes were not significantly associated with reported practice. This may be because MBSR training does not emphasize verbal labeling of the components of experience to the extent seen in some other mindfulness-based interventions, such as DBT and ACT, which include exercises for labeling of emotions, cognitions, and sensations.

An unexpected finding was the strong association between the mindful yoga form of practice and changes in other variables, including increased mindfulness skills, reduced symptoms, and improved well-being. Practice time for mindful yoga was significantly correlated with more of these variables than were practice times for the body scan or sitting meditation, and yoga was the only formal practice significantly related to increases in the non-judging facet of mindfulness and the global severity index of the BSI. Given that mindful yoga was practiced on fewer days and for fewer total hours than the other formal practices, these results are striking and bear further investigation. As the body scan is assigned for daily practice during the first two weeks and is also a somatically-oriented practice, it may be that the time participants spent in practice of the body scan prepared them to be more mindful of their bodily sensations during the yoga, and hence obtained more benefit from the yoga practice than if they had come to it without prior mindfulness practice. It may also be easier for participants to bring mindful attention to the body while it is moving or stretching as the yoga requires, than while it is still as in the body scan or sitting meditation, and this feature may also facilitate the transfer of the resultant mindfulness into everyday life. The considerably higher average number of reported minutes of body scan practice than the average yoga and sitting practice may represent the initial novelty of practice in the early weeks of participation in the program, which may have waned over subsequent weeks.

Another unexpected finding was the lack of significant relationships between informal practice (doing routine activities mindfully) and extent of change in other variables. Informal practice is often described as an important method for generalizing mindfulness skills learned in formal practices into daily life (Kabat-Zinn 1990). Since no audio recordings are provided to guide informal practice, it is possible that participants in this study had difficulty in providing accurate estimates of the time they spent in informal practice. Better methods of monitoring this type of practice may be helpful in future studies as well as a more detailed investigation of the importance of 'living mindfully' on health and well-being outcomes.

Several symptom measures, including the Medical Symptom Checklist and several scales of the BSI, showed significant improvements from pre- to post-MBSR that were not correlated with the amount of home practice of any of the mindfulness exercises. Home practice is not the only mechanism by which improvements may be obtained in MBSR and it is possible that reductions in these symptoms can be attributed to other potentially important factors not measured here, such as social support from other group members, caring attention from the group leader, the effect of mindfulness together with the physical exercise that comes from yoga, or improved ability to relax. Further, a person who undertakes the commitment of a course such as MBSR may also be motivated to concurrently practice other mind-body techniques or to change or improve other health-related behaviors such as medication and treatment compliance for existing medical or psychological conditions. Future research should attempt to measure these variables, so that other potential mechanisms of change can be studied.

The following limitations of the study should be considered. Most of the participants were well educated, had the financial resources to pay for the treatment and had agreed to take part in a meditation-based program. It cannot be assumed that these findings can be generalized to other populations. In addition, the reported home practice figures should be interpreted with some caution. These analyses included only those participants (N = 121) who provided some or all of their practice data, and values of zero were entered for days for which practice records were not completed. Although instructors did not look at these forms, which were filed by research assistants, participants may have been less likely to complete a practice form for weeks in which they engaged in less homework practice. Thus, if all homework sheets had been completed, average daily practice times might have been lower. On the other hand, if the missing homework sheets had been turned in, and had included values greater than zero, then the figures for total practice time would have been higher. Thus, the figures we used are probably conservative estimates of practice time. In addition, a very small number of reported practice times were extremely high (e.g., 100–300 min of a single exercise on a single day). Because there was no significant correlation between reported practice time and baseline symptom levels, it does not appear that the more severely impaired participants were more likely to practice. Thus, the reasons for these unusual practice times are unclear.

The lack of a control group for this study is also a limitation, The efficacy of MBSR in reducing psychological distress and symptoms of stress has however been shown in previous controlled studies (Shapiro et al. 1998; Speca et al. 2000; Grossman et al. 2004). While the dependent variables in the mediation analysis were changes in symptoms and well-being the primary focus of the study was an examination of the relationships between home practice of mindfulness exercises and change in these outcomes, as well as the relationship of home practice to changes in levels of mindfulness. This latter relationship has not previously been reported. Never the less, the lack of another behavioral program as a suitable control intervention means that our study sheds no light on whether other interventions would result in similar changes. Other stress reduction programs may not require meditation, but they are likely to involve the practice of relaxation and/or cognitive restructuring and it is not known whether such practices lead to increases in mindfulness. Therefore future research should compare MBSR to other stress reduction programs to clarify whether the suggested mechanisms leading to improvement are unique to MBSR and also to assess the potential confounding impact of other health-related behaviors that may also change in participants motivated to undertake such programs.

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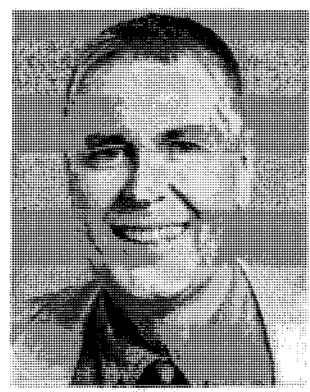

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Mindfulness-Based Stress Reduction in Massachusetts Correctional Facilities

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Mindfulness-based stress-reduction courses were offered in drug units in six Massachusetts Department of Corrections prisons. A total of 1,350 inmates completed the 113 courses. Evaluation assessments were held before and after each course, and highly significant pre- to post-course improvements were found on widely accepted self-report measures of hostility, self-esteem, and mood disturbance. Improvements for women were greater than those for men, and improvements were also greater for men in a minimum-security, pre-release facility than for those in four medium-security facilities. The results encourage further study and wider use of mindfulness-based stress reduction in correctional facilities.

Keywords: *mindfulness-based stress reduction; meditation; stress reduction; substance abuse*

Individual criminal behavior has been attributed to an inadequate ability to effectively deal with severe stress, deprivation, and low self-esteem, and with peer pressure and the codes of behavior of groups such as gangs. These factors can be severely compounded by the injection or ingestion of drugs and alcohol, which offer the user relief from emotional discomfort by impairing or eliminating normal levels of awareness and impulse control.

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Under such circumstances, intense feelings such as fear, frustration, anger, and greed can rapidly result in antisocial behaviors, and the resultant incarceration in correctional institutions brings additional stress, with the possibility of further exacerbating these conditions (Fogel, 1993; Perkins, 1998).

The regular practice of meditation has been shown to help individuals cultivate deep and long-lasting experiences of inner calm, well-being, self-worth, and self-respect (Kabat-Zinn, 1993). For this reason, there has been increasing interest in recent years in the efficacy of meditation-based interventions in correctional institutions as a means of helping inmates deal with the stress of incarceration and to acquire life-long inner resources to decrease the likelihood of continuing criminal behavior and recidivism. The rationale is that through the regular practice of meditation, inmates can grow to be less reactive to intense emotional states without resorting to the use of drugs or other chemical substances (Kabat-Zinn, 1993). There are reports of prison-based studies of Vipassana meditation (Anonymous, 2000; Marlatt et al., 2004; Parks et al., 2003), transcendental meditation (TM; Alexander et al., 2003; Hawkins et al., 2003; Orme-Johnson & Moore, 2003; Shanmugam, 1992), and mindfulness meditation (Murphy, 1995; Perkins, 1998). The present study is based on a program of mindfulness meditation.

Mindfulness is a sustained nonreactive attention to one's ongoing mental contents and processes (physical sensations, perceptions, affective states, thoughts, and imagery) (Grossman, Niemann, Schmidt, & Walach, 2004; Kabat-Zinn, 2005; Miller, Fletcher, & Kabat-Zinn, 1995). Mindfulness is traditionally cultivated through formal training in mindfulness meditation, and the resultant stable, nonreactive awareness appears to act as a resource for more creative responding by bringing mental processes into greater conscious awareness and under greater voluntary control (Shapiro & Walsh, 2002). Moreover, because this natural capacity is under the individual's direct control, it can provide an experience of mastery (self-efficacy), so that thoughts and intense feelings no longer threaten to overwhelm (Teasdale, 1999; Teasdale et al., 2000). For many inmates, this may be their first experience of inner control of mind or body states.

Mindfulness-based stress reduction (MBSR) is an 8-week program of intensive training in mindfulness (moment-to-moment awareness) and its integration into everyday life. MBSR was developed at the University of Massachusetts (UMass) Medical Center in 1979 by Dr. Jon Kabat-Zinn (1990) to provide a coping resource for patients dealing with intense physical symptoms, chronic medical conditions, and difficult emotional situations (Kabat-Zinn, 1994). Since that time, more than 16,000 people with a wide range of disorders and difficult life situations have completed the ongoing program at UMass, and programs based on Kabat-Zinn's model are now widely available throughout the United States and in other countries. The MBSR program has also been used in stressful inner-city community settings (Roth & Creaser, 1997; Roth & Stanley, 2002) and in a therapeutic community for substance abuse treatment (Marcus et al., 2003). Reports have demonstrated a high level of adherence or compliance with the behavioral demands of MBSR (Kabat-Zinn & Chapman-Waldrop, 1988; Speca, Carlson, Goodey, & Angen, 2000; Williams, Kolar, Reger, & Pearson, 2001), with about 85% of enrollees completing the program. A number of studies have demonstrated positive attitudinal, health, and behavioral changes associated with MBSR (Kabat-Zinn, 1982; Kabat-Zinn, Lipworth, & Burney, 1985; Miller et al., 1995). These changes include improvements in psychological and physical well-being and reductions in anxiety and depression (Kabat-Zinn, 1992; Kaplan, Goldenberg, & Galvin-Nadeau, 1993; Teasdale et al., 2000). The changes have been found to endure at 3-month follow-up (Williams et al., 2001), 6-month follow-up (Carlson, Ursuliak, Goodey, Angen, & Speca, 2001) and 4-year follow-up (Kabat-Zinn, Lipworth, Burney, & Sellers, 1987). The MBSR program has also been adapted and integrated into a variety of other clinical and nonclinical settings (Kristeller & Hallett, 1999; Linehan, 1993; Saxe et al., 2001; Teasdale et al., 2000).

Based on the belief that some of the psychological factors that lead to criminal behavior may be changed through the practice of mindfulness (Kabat-Zinn, 1993), the UMass Stress Reduction Clinic and the Massachusetts Council on Criminal Justice agreed to conduct a program of MBSR in prisons in the Massachusetts Department of Corrections system. The MBSR program was one of several options offered in a rehabilitation program for inmates incarcerated as a result of drug-related convictions. The program was not designed or conducted as a formal research study, and limitations imposed by administrative constraints, and the need to adapt to differences among the various prison settings, necessitated some modifications from the way in which MBSR programs are usually conducted at UMass (Kabat-Zinn, 1990) and elsewhere.

Method

MBSR

The foundations and methodology of MBSR have been described in detail elsewhere (Kabat-Zinn, 1990; Santorelli, 1999). Briefly, in the more usual clinical setting, approximately 20 participants attend 8 weekly, 2.5-hour classes and an all-day, mostly silent retreat or intensive experience during the sixth week. During these sessions, participants receive training in mindfulness through a body scan meditation, sitting meditation, and mindful stretching exercises. There is a good deal of group discussion on the integration of mindfulness into everyday life and the application of mindfulness as a method for noticing habitual reactions to stressful situations and more creatively responding (Kabat-Zinn, 1990). Some didactic material on the psychology and physiology of stress reactivity is also presented. Participants are expected to engage in formal mindfulness meditation practice for 45 minutes per day outside of class, guided by audiotapes or CDs that are provided.

Correctional Institution Settings, Environment, and Program

Approximately 2,000 inmates participated in the MBSR program in six correctional institutions in Massachusetts between 1992 and 1996. The programs were offered in the Massachusetts women's prison at Framingham and in five correctional institutions for men—the four medium-security facilities at Shirley, Gardner, Norfolk, and Old Colony and at the minimum-security, pre-release facility at Shirley. The MBSR program was offered as one of a variety of options, in 6- to 8-week blocks, to inmates in drug units within these institutions. The other options included smoking cessation, literacy training, and exercise and walking programs. All were aimed at providing inmates with nondestructive outlets, with the potential to enrich their lives both in prison and after release. Inmates who completed one of the offered rehabilitation programs could earn earlier release.

Each MBSR course was limited to 12 to 20 participants. Facilities and conditions differed somewhat in each institution. At one extreme, there was a quiet private room dedicated to the MBSR program; at the other extreme, classes were held in the corner of a large open gym where other inmates were exercising during the MBSR classes. In the medium-security institutions, inmates were escorted to each class by a correctional officer who, in some settings, remained throughout the classes. Exercise mats, for the mindful stretching, and meditation cushions were not always available in all settings. Depending on each institution's overall program schedule, class sessions varied from 1 to 1.5 hours. In some cases, where individual classes were shorter, two sessions were held per week. Course lengths varied from 6 to 8 weeks. In no case was there an opportunity for the all-day retreat or intensive experience. Opportunities for independent daily meditation practice outside of class were minimal, and shared cells and other constraints of prison life limited the ability to practice alone and in relative quiet. Institutional regulations prevented the use of tape players in cells, but one tape and one player were made available for group practice outside of class. Although no records were kept, many inmates reported using the techniques informally.

Evaluation

During a 30-minute orientation session held 1 week prior to the start of each course cycle, the demands and possible benefits of participation in the MBSR program were explained to inmates. Following this session, inmates completed the set of self-report psychosocial measures described below. Responses obtained at this time were designated "pre-course." A second set of these measures was completed at the end of each course and was designated "postcourse." Only data for inmates with appropriate paired pre- and postcourse self-report measures and an intervening course were included in analyses of course completers. Completion of the course was defined as having attended at least 80% of the classes in the cycle.

Because this program was not conducted as a formal research project, there were no formal controls. However, in some of the settings, institution-specific scheduling and administrative circumstances resulted in significant numbers of inmates completing paired self-report measures (with an intervening period equivalent to that of the MBSR course), without having participated in an MBSR course during that time.[1] A subset of this group then participated in an MBSR course in the following cycle and subsequently completed a third set, post-course, of the self-report measures at the end of the course. These inmates provided the data for what may be characterized as "quasi–waitlist controls."

Another subset of inmates who had completed the usual paired pre- and post-program self-report measures with an intervening MBSR course subsequently completed a third set of evaluation measures after a further course-length interval but without a second intervening MBSR course. These inmates provided the data for what may be characterized as a "quasi–follow-up group."

The following instruments were used in the evaluation.

Cook and Medley Hostility Scale

Derived from items in the MMPI, the Cook and Medley Hostility Scale (Barefoot, Dodge, Peterson, Dahlstrom, & Williams, 1989), a 50-item scale, assesses cognitive, affective, and behavioral components of hostility. Higher scores indicate greater hostility, reflecting distrust, cynicism, and a tendency to respond aggressively. Although the data were analyzed for the six subscales—Hostile Attribution, Hostile Affect, Hostile Aggression, Aggressive Responding, Cynicism, and Social Avoidance—for reasons of space, only total scores are reported.

Rosenberg Self-Esteem Scale

The Rosenberg Self-Esteem Scale (Rosenberg, 1979) is a widely used, 10-item, unidimensional measure of global self-esteem, defined as a favorable or unfavorable attitude or feelings toward oneself. Higher scores indicate greater self-esteem.

Profile of Mood States

Profile of Mood States (McNair, Lorr, & Droppelman, 1992) is a measure of a person's awareness of his or her state of mental buoyancy or distress. The scale assesses the respondent's transient, fluctuating affective states by asking how well each of 65 adjectives describe the respondent's feelings in the past week. Higher scores indicate greater mood disturbance. The scale has been shown to be responsive to MBSR programs (Carlson et al., 2001; Kabat-Zinn, 1982; Kabat-Zinn et al., 1985; Speca et al., 2000) and to other meditation and yoga interventions (Woolery, Myers, Sternlieb, & Zeltzer, 2004). Although data were analyzed from the subscales assessing six dimensions of mood (tension/anxiety, anger/hostility, vigor/activity, depression/dejection, fatigue/inertia, and confusion/bewilderment), for reasons of space, only total mood disturbance (TMD) is presented here.

Statistical Analyses

Change scores were calculated between pre- and post-program values for all variables, and paired t tests were performed to determine within-group differences.

Results

Table 1 shows that records were kept on 1,953 inmates enrolled in 113 MBSR course cycles offered in the drug units within the six correctional

Table 1
Program Enrollment and Completion

	Men		Women		Total	
	n	%	*n*	%	*n*	%
Number of courses offered (all sites)	86		27		113	
Initial enrollment	1,486		467		1,953	
Completion (attending 80% or more of classes in a course)	1,050	71	300	64	1,350	69

settings. The 86 courses offered in the men's units included 66 at the four medium-security facilities and 20 at the minimum-security, pre-release facility. In addition, 27 courses were offered at the women's facility at Framingham. Also shown are course completion rates; for the 1,953 inmates who attended a first class, 1,350 (69%) met the criteria for course completion.

Results for the Cook and Medley Hostility Scale are shown in Table 2.[2] Similar pre-course scores were found at all sites, and post-course scores showed significant reductions (p = .0001) at all sites, suggesting reduced hostility in these inmates. The reductions were greater for the women (9.2%) than for the men (7.0%). The reduction in hostility scores for inmates in the men's minimum-security facility (9.4%) was significantly (p = .05) greater than that of the men in the medium-security facilities (6.4%). All six subscales showed statistically significant post-MBSR course improvement (data not shown).

Changes in scores on the Rosenberg Self-Esteem Scale are shown in Table 3. Statistically significant increases (suggesting increased self-esteem) were found in all settings. A significantly (p = .006) greater percentage increase (8.3%) was found in the women's facility than for all the men (3.8%). Men in the minimum-security, pre-release facility showed greater improvement in self-esteem scores (6.8%) than did the men in the medium-security facilities (3.1%).

As shown in Table 4, improvements in the TMD scores on the Profile of Mood States Scale were the most dramatic. Greater mean baseline distress was found for the women inmates (M = 63.4) than for the men at either the minimum-security, pre-release site (M = 47.6) or the medium-security sites (M = 45.6). Although the women's post-course scores remained relatively high (M = 39), their percentage reductions (38.5%), were significantly greater (p = .0001) than those for the men (28.4%). Total percentage reductions in

Table 2
Cook and Medley Hostility Scale

		Pre-MBSR		Post-MBSR			
	n	*M*	*SD*	*M*	*SD*	% Change	*p*
All sites	948	25.4	8.1	23.5	8.7	7.5	.0001
Women	201	25.4	8.2	23.0	9.1	9.2	.0001
Men	747	25.4	8.0	23.6	8.6	7.0	.0001
Men, minimum	147	25.6	7.9	23.2	9.0	9.4	.0001
Men, medium	600	25.3	8.1	23.7	8.5	6.4	.0001

Note: MBSR = mindfulness-based stress reduction.

Table 3
Rosenberg Self-Esteem Scale

		Pre-MBSR		Post-MBSR			
	n	*M*	*SD*	*M*	*SD*	% Change	*p*
All sites	955	29.3	6.4	30.7	6.7	4.7	.0001
Women	202	28.4	5.6	30.8	5.7	8.3	.0001
Men	753	29.5	6.6	30.6	6.9	3.8	.0001
Men, minimum	147	30.3	5.5	32.4	6.0	6.8	.0001
Men, medium	606	29.3	6.8	30.2	7.0	3.1	.0002

Note: MBSR = mindfulness-based stress reduction.

mood disturbance for the men at the minimum-security, pre-release facility (31.0%) were greater than those of the men in the medium-security facilities (27.7%). All six subscales also showed statistically significant improvements following inmates' completion of the MBSR course (data not shown).

Scores for the subset of inmates whose pattern of participation in the program and sequence of evaluations qualified them as quasi–waitlist controls are shown in Table 5. No significant change ($p > .05$) on any of the three measures was found in the period prior to participation in the MBSR course, but significant changes, comparable to those already described in Tables 2, 3, and 4, were seen in scores following completion of a course. These scores

Table 4
Profile of Mood States—Total Mood Disturbance

		Pre-MBSR		Post-MBSR			
	n	*M*	*SD*	*M*	*SD*	% Change	*p*
All sites	907	49.8	39.7	34.2	36.7	31.2	.0001
Women	196	63.4	43.5	39.0	38.5	38.5	.0001
Men	711	46.0	37.8	32.9	36.1	28.4	.0001
Men, minimum	147	47.6	36.8	32.8	35.3	31.0	.0001
Men, medium	564	45.6	38.0	33.0	36.3	27.7	.0001

Note: MBSR = mindfulness-based stress reduction.

Table 5
Quasi–Waitlist Comparison Group

	n	Mean Change	% Change	*p*
Cook and Medley Hostility				
Pre-MBSR (8-week interval)	180	−0.6	2.4	.17
MBSR course outcomes	180	−2.14	8.6	.0001
Rosenberg Self-Esteem				
Pre-MBSR (8-week interval)	181	0.48	1.6	.39
MBSR course outcomes	181	2.05	6.8	.0001
Profile of Mood States—TMD				
Pre-MBSR (8-week interval)	161	−2.12	5.0	.37
MBSR course outcomes	161	−12.21	30.6	.0001

Note: MBSR = mindfulness-based stress reduction; TMD = total mood disturbance.

provide strong support for the conclusion that the described pre- to post-course improvements are attributable to participation in an MBSR course.

Table 6 shows the results for the subset of inmates characterized above as a quasi–follow-up group. Following completion of the course, this group also showed improvements on all scales (statistically significant for all scales except the Rosenberg) comparable to those described in Tables 2, 3, and 4. The absence of further significant change on any of the measures in the follow-up period suggests that the improvements previously described were maintained in spite of an additional 6 to 8 weeks of incarceration.

Table 6
Quasi–Follow-Up Group

	n	Mean Change	% Change	*p*
Cook and Medley Hostility				
MBSR course outcomes	127	−1.46	5.8	.01
Follow-up (8-week interval)	127	−0.04	0.17	.94
Rosenberg Self-Esteem				
MBSR course outcomes	121	0.84	2.8	.08
Follow-up (8-week interval)	121	0.96	3.1	.11
Profile of Mood States—TMD				
MBSR course outcomes	117	−17.1	32	.0001
Follow-up (8-week interval)	117	+2.37	6.5	.37

Note: MBSR = mindfulness-based stress reduction; TMD = total mood disturbance.

Discussion

The results described herein provide strong support for the feasibility and effectiveness of meditation-based interventions in correctional settings. Particularly important is the fact that these significant improvements were found on widely accepted measures of hostility, self-esteem, and mood disturbance.

The pre-course hostility scale scores for both the men and women (25.4), shown in Table 2, are close to one standard deviation above the norm for the general population and similar to those found in psychiatric populations (Han, Weed, Calhoun, & Butcher, 1995). This finding is not surprising given the circumstances of and leading to incarceration. Given the fact that a prison environment can be a very hostile environment, the demonstration of significantly decreased hostility scores in the 6% to 9% range following participation in an MBSR program in these correctional settings is encouraging. In another study, mindfulness meditation led to small reductions in self-reported anger on the State-Trait Anger Expression Inventory, with a slight decrease in aggressive responding at 1-month follow-up (Murphy, 1995). Although none of the other reported studies of meditation in correctional settings used the Cook and Medley Hostility Scale employed here, a number of them provided evidence of reduced hostile and aggressive attitudes and behaviors for participating inmates. Vipassana meditation training was found to increase more positive behaviors in Tihar Jail in India (Kishore, Verma, & Dhar, 1996), and decreased hostility (Brief Symptom Inventory) in the North Rehabilitation Facility near Seattle (Parks et al., 2003). Similarly, participation in TM programs in a correctional institution led to a decrease in aggression measured on the Buss-Durkee Hostility Inventory (Hawkins et al., 2003) and to decreased aggression (Special Hospitals Assessment of Personality and Socialization Scale) at the maximum-security prison in Walpole, Massachusetts (Alexander et al., 2003).

The significant post-MBSR course improvements (Table 3) in self-esteem provide encouragement that this dimension can also be improved for incarcerated individuals through training in mindfulness meditation. The present findings are similar to results reported for a correctional institution–based TM program, where self-esteem (measured on an ad hoc scale) was shown to increase following program participation (Hawkins et al., 2003).

Baseline TMD scores (46.0) on the Profile of Mood States Scale (Table 4) for male inmates are comparable to those found by Reddon, Marceau, and Holden (1985) for male inmates in a maximum-security psychiatric hospital. The improvements in TMD reported here (38.5% for women and 28.4% for men) are striking and suggest that the affective state of these inmates can be improved substantially by participation in an MBSR program. However, it is noteworthy that even though the women showed a greater percentage of postcourse improvement on the TMD scores; their postcourse scores remained higher (39.0) than those of the men (32.9).

The scores for the subset of inmates characterized as a quasi–waitlist control group are contained in Table 5. There was no significant change for this group on any of the three measures during the interval prior to participating in the MBSR course. During this time, these inmates may or may not have been participating in other activity options, such as the smoking-cessation program or the walking program. Improvements in all three measures were observed following participation in the MBSR course, and the change may reasonably be attributed to participation in the program. Although the follow-up times in this program were shorter than those reported for the MBSR in clinical settings (Carlson et al., 2001; Kabat-Zinn et al., 1987; Williams et al., 2001), the finding that the improvements associated with participation in the program in this setting were maintained for an additional 6 to 8 weeks (Table 6) in the stressful correctional institution environment holds promise for the longer-term endurance of the effects of MBSR programs in supporting inmates in these settings.

Greater improvements were observed for the incarcerated women than for the men on all three of the self-report measures used in this study, and this is consistent with studies of MBSR in noncorrectional populations (Kabat-Zinn, 1984). It is also evident that the improvements on all of the self-report measures for the men incarcerated in the minimum-security, pre-release facility were greater than those observed for the men in the medium-security facilities. A number of factors might be involved in this finding. The minimum-security, pre-release institution staff demonstrated greater cooperation in implementing the MBSR program in their facility. Also, the minimum-security and prerelease facility houses a combination of less serious offenders and inmates who, though previously housed in medium-security facilities, were awaiting or were near release from their incarceration. These factors might have resulted in greater participant motivation and/or an environment more conducive to the MBSR intervention.

The improvements associated with participation in the MBSR program that were found on all three self-report measures (Tables 2, 3, and 4) and the maintenance of those gains on most of the dimensions for at least 6 to 8 weeks (Table 6) are impressive and very encouraging. Nevertheless, these findings have a number of limitations. The scores are derived from self-report, and respondents might have been inclined to "fake good" from a fear that frank responses might at some point count against them in the institution. We had no records of inmates' compliance with the out-of-class program demands. In addition, our study did not include any examination of inmates' behavior before, during, and after their participation in the MBSR program or of the effects of the program on their substance abuse attitudes, such as cravings. Also, we did not have access to inmate demographics (other than their being incarcerated in drug units) and were not able to follow the participating inmates during a longer period. Nor were we able to measure impacts on recidivism rates.

More compelling will be studies measuring recidivism and the extent of involvement with drugs and alcohol after release, as has been done following participation in a Vipassana meditation program (Marlatt et al., 2004; Parks et al., 2003) and TM interventions in two maximum-security institutions (Alexander et al., 2003; Rainforth, Alexander, & Cavanaugh, 2003). Nevertheless, because this study had the advantage of involving a very large number of participants in multiple correctional sites, including men in medium- and minimum-security facilities and women in another facility, our findings offer considerable promise for the wider use of MBSR programs in prison settings and will hopefully serve as a stimulus for future development of formal research studies of MBSR in correctional settings.

Notes

1. These individuals may or may not have been participating in one of the other program options during that time.

2. The numbers of participants reflected in Tables 2, 3, and 4 vary and are considerably less than the number of program participants shown in Table 1. This is because of the rejection of unpaired questionnaires and the rejection of both the pre- and post-course questionnaires if one of them was unreadable, was incomplete, contained multiple answers for questions, or exhibited a simplistic, regular pattern.

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A pilot study of mindfulness-based stress reduction for hot flashes

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ABSTRACT

Objective: A variety of results from both population and laboratory studies suggest that stress and hot flashes (HFs) are correlated and that HFs are more severe in women with lower coping abilities. The objective of this pilot study was to obtain information on the feasibility and effect of participation in a mindfulness-based stress reduction (MBSR) program on HF severity and menopause-related quality of life.

Design: Fifteen women volunteers reporting a minimum of seven moderate to severe HFs per day at study intake attended the eight weekly MBSR classes at the University of Massachusetts Medical School. Participants were assessed for menopause-related quality of life before beginning and at the conclusion of the MBSR program. Women also kept a daily log of their HFs through the course of the 7 weeks of the MBSR program and for 4 weeks after it.

Results: Women's scores on quality-of-life measures increased significantly, and the median reported HF severity, calculated as the weekly average of a daily HF severity score, decreased 40% over the course of the 11 weeks of the assessment period. The women were individually interviewed at the completion of their participation, and the results of the interviews were consistent with the results from daily diaries.

Conclusions: These results provide preliminary positive evidence of the feasibility and efficacy of MBSR in supporting women who are experiencing severe HFs, and it warrants further investigation.

Key Words: Hot flashes – Vasomotor symptoms – Menopause – Mindfulness-based stress reduction – Meditation.

Hot flashes (HFs) and night sweats (HF occurring at night)[1] affect the majority of women at some point during the menopause transition.[2] Many women regard HFs as little more than a nuisance, but 10% to 20% report considerable distress both during the HF and in anticipating further occurrences.[3] HFs detrimentally affect many aspects of women's lives,[4,5] including workplace functioning.[6] An estimated one third of symptomatic women seek medical attention annually, particularly those with greater frequency of or bother from HFs,[2,7] adding considerably to heath care costs.

Until recently, the standard therapy for HFs has been exogenous hormone therapy (HT), which is effective in decreasing HF frequency by 80% to 100%[8] and also in reducing the sleep disruption associated with HFs.[9] Recent randomized clinical trials, however, have suggested increased risks of cardiovascular disease and breast cancer from HT,[10,11] and currently it is recommended only for short-term use.[12] Other nonhormonal pharmaceutical options include antidepressants such as selective serotonin or noradrenergic reuptake inhibitors.[13] Recent trials have shown some promise in their reducing HFs (approximately 50% from baseline in about 60% of women),[14] but they do not appear to

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give the same level of relief from HFs as HT, and there are concerns about the relatively high incidence of side effects.[15] This situation has left a substantial number of women in a position where they must choose between using HT or other pharmaceuticals despite their perceived health risks or side effects and managing their experience of HFs through their own coping strategies.[3] This dilemma has resulted in substantially decreased use of HT[16,17] and led to a greatly increased interest in complementary and alternative medical treatments for HFs. Complementary therapies for menopausal symptoms now constitute one of the largest segments of total spending on alternative therapies[18] although insufficient evidence exists on the effectiveness and/or safety of these treatments for symptoms of menopause.[19]

A relationship between stress and HFs has been demonstrated in a number of correlational, treatment, and laboratory studies.[20] The increased sympathetic nervous response associated with HFs appears similar to changes associated with the stress response,[21] although they do not appear to follow the pattern expected from a neurally mediated "stress" response.[22] They appear more consistent with a centrally mediated thermoregulatory mechanism involved with thermal and hormonal regulation.[23,24] Accordingly, Swartzman and Kemmann[20] have suggested that stressors potentiate rather than precipitate HFs by decreasing the threshold for the triggering of HF at the hypothalamic level and that noradrenergic influences may exert their effects at that level. A number of studies of activities known to reduce central nervous system activation have been evaluated for their effect on HFs. Slow-paced breathing was effective in reducing the frequency of HFs, using both self-report measures and 24-hour ambulatory monitoring,[25] and relaxation training, known also to reduce central nervous system activation, was associated with a reduction in intensity of HFs (with concurrent reductions in accompanying tension/anxiety and depression), but not frequency.[26]

Psychosocial factors also appear to be important in women's psychological reactions to their HFs and the degree of distress and discomfort they experience from both the frequency and intensity of symptoms.[3,20,27,28] Women seeking medical advice due to HFs or reporting distress from HFs appear to have lower stress coping abilities than menopausal women without HFs.[27,28] Further, women with strong beliefs in their ability to control psychological reactions such as anxiety or embarrassment during HFs report less distress and discomfort.[29]

The relationships between stress and HFs and between coping resources and distress from HFs,[30] the results of behavioral studies, and women's own preferences[31] indicate that behavioral treatments that use a multipronged behavioral approach[32] may hold promise for women in dealing with their HFs. Evaluation of stress management programs has been recommended,[33,34] not only for their effect on the frequency and intensity of HFs, but also as a possible support for women in managing their psychological responses to HF sensations by addressing their cognitive appraisal of the event and moderating the subjective feeling of helplessness.[29] A stress reduction intervention that incorporates mindfulness may represent a treatment for alleviating the symptoms and/or the distress of HFs because meditation has been shown to reduce autonomic arousal[35] and also to be associated with reduced emotional distress. Such a program may affect both the physical symptoms of HFs and, if questions of perception and appraisal of HFs are also addressed, the women's coping resources and the degree of bother associated with the experience.

Mindfulness-based stress reduction (MBSR) is a manual-based, group-based program that uses mindfulness meditation as a foundation to address questions of perception, appraisal, and reaction as a coping resource for dealing with intensive physical symptoms, chronic medical conditions, and difficult emotional situations.[36] Mindfulness is defined as a state of sustained attention to the ongoing mental contents and processes (physical sensations, perceptions, affective states, thoughts, and imagery) without thinking about, comparing, or in other ways evaluating them,[37] thereby cultivating a stable and nonreactive awareness.[38] MBSR is similar to cognitive-behavioral therapy (CBT) in that attention is brought to thoughts, but differs from CBT in that no attempt is made to change or modify thoughts. It is suggested that mindfulness fosters psychological and physical well-being by bringing mental processes into attention and the direction of attention under greater voluntary control[39] so that thoughts and feelings no longer threaten to overwhelm.[40] A recent meta-analysis of controlled and observational studies of the health benefits of mindfulness meditation[37] found that MBSR was a useful adjunctive intervention for patients with a broad range of chronic disorders. MBSR has also been shown to be effective in reducing anxiety and panic in patients diagnosed with anxiety disorders[41] (maintained at 3-year follow-up)[38] and to be effective as an adjunctive intervention in reducing psychological distress and depression[40,42-44] as well as improving health-related quality of life (QOL).[45] Reported favorable changes in distress have been found to endure at 3-month,[43] 6-month,[46] and 4-year follow-ups.[47] MBSR programs are widely available in the United States and elsewhere.

This article summarizes findings from a small nonrandomized pilot study to obtain preliminary evidence of the feasibility and efficacy of recruiting women experiencing subjectively measured moderate to severe HFs to an MBSR program. The aim of the study was to assess the women's compliance with the demands of the program and the assessment process and also to provide preliminary information on changes in the women's frequency and/or intensity of HFs, and their menopause-related QOL associated with participation in the program.

METHODS

Recruitment and eligibility

Between January and May 2004, women who reported experiencing a minimum average of seven moderate to severe HFs per day were recruited through local newspaper advertisements and flyers distributed at an exercise facility that markets to perimenopausal and postmenopausal women. Advertisements offered eligible women the opportunity to participate, at no cost, in the MBSR program as a possible means of managing their HFs. The study was approved by the University of Massachusetts Medical School Institutional Review Board. Eligible women had to report experiencing at least 7 HFs per day of moderate or severe intensity on the majority of days over the past 30 days, be between the ages of 47 and 60, have no menses in the previous 3 months, not have had a hysterectomy or oopherectomy, have no history of breast cancer, and no hormone therapy, selective serotonin reuptake inhibitor or selective estrogen-receptor modulator medications in the past 6 months. HF occurrence peaks around the final menstrual period[48-50]; thus, we recruited both late perimenopausal (3-11 months of amenorrhea) women and postmenopausal women. Women in late peri- and postmenopause were combined in the sample for two reasons. First, some women with fewer than 12 months of amenorrhea at the time of the study would have experienced their final menstrual period (FMP), but this would not be evident, as its determination (12+ consecutive months of amenorrhea) is necessarily retrospective; thus, an unknown number of women would be misclassified regarding pre- or post-FMP. Second, as noted by Burger et al[51] and Metcalf,[52] patterns of reproductive hormones in the 1 to 2 years before the FMP are similar to patterns in the 1 to 2 years after the FMP, so that separating pre- and post-FMP for this study was likely to be an artificial distinction. Reproductive hormones were not measured to assess eligibility, as a number of studies have found that hormones fluctuate markedly in the 1 to 2 years before and the 1 to 2 years after the final menstrual period, so that a single measurement is not informative regarding peri- or postmenopausal status.[51,53]

Potential subjects were interviewed by telephone to confirm eligibility and to arrange a consent interview at University of Massachusetts Medical School. At this interview, the behavioral demands of the intervention and the assessment procedures were explained to the woman, and if she chose to consent, she completed the preprogram assessment questionnaires. Women then chose one of the regular MBSR program morning or evening classes beginning the following week. Participants were asked to maintain their present dietary pattern over the period of their participation and if they were already taking soy supplements or menopausal remedies, be willing to maintain their present dose.

Intervention

The foundation and methodology of MBSR have been described in detail elsewhere.[36] Briefly, participants attended eight weekly 2½-hour classes over a 7-week time span plus an all-day class on a weekend day during the sixth week. During the sessions, participants received training in mindfulness through (a) body scan meditation, a gradual moving of attention through the body from feet to head to bring awareness of bodily sensations while lying in a supine position; (b) sitting meditation, in which attention is brought to the flow of bodily sensations (particularly the sensations of breathing), thoughts, and emotions practiced sitting upright on a chair or cushion; and (c) mindful stretching exercises intended to develop awareness (mindfulness) during movement. In-class didactic material further emphasized the systematic development of mindfulness and its application in everyday life. Additional discussion focused on the psychology and physiology of stress reactivity and suggestions for the application of mindfulness as a method for responding positively to stressful situations. A variety of informal MBSR practices were assigned between sessions and program participants received two guided meditation CDs to be practiced at home for 45 minutes, 6 days per week. Classes were conducted by highly experienced MBSR instructors and typically comprised approximately 25 participants and included people other than the participants, from varied backgrounds, referred to the program with a variety of diagnoses and stress-related conditions. Study participants did not have to reveal to others their reason for being in the class, unless they chose to do so.

Assessment

At the consent interview, participants completed measures of menopause-related QOL, the level of interference their HFs were causing in their daily lives, their sleep patterns, perceived stress, psychological distress, and their capacity for mindfulness. These measures were repeated at the end of the intervention. From the beginning of the first week of the intervention, women kept a HF log in which they recorded the time and intensity of their HFs each day as well as the number of minutes they spent on their home MBSR practice throughout the intervention and for 1 month after the program. Participants received weekly reminder calls to arrange the collection of HF and MBSR practice logs and brought their completed logs to each class and placed them in a sealed collection box in the MBSR classroom. Postprogram assessment questionnaires were distributed at the last MBSR class and returned by mail in stamped addressed envelopes. During the follow-up period, participants returned the daily logs by mail each week. After all assessments, participants were interviewed by phone by the first author (J.C.) to gain their subjective impressions of participation in the study.

Measures

Daily HF log

The HF log has been used to measure the severity of HFs in a number of clinical trials[6] and has proven feasible for women to complete. Women record the number of mild, moderate, severe, and very severe HFs each day in this log. A daily HF severity score is calculated as the sum of HFs, weighted by the severity ratings (mild = 1 through very severe = 4). Collection on a daily basis reduces recall error; however, weekly scores (averaging daily scores over 7 days) were computed to smooth out day-to-day variability.

Menopause-Related Quality of Life Questionnaire (MENQOL)

This is a validated self-administered instrument listing 29 menopause-related symptoms in four domains: vasomotor, physical, psychological, and sexual. Women report the degree of bother that they have experienced from each symptom over the past month.[54] A lower score represents better QOL.

Hot Flash-Related Daily Interference Scale (HFRDIS)

This is a 10-item measure that assesses the impact of HFs on overall QOL as well as daily activities in nine specific domains of life: work, social activities, leisure activities, sleep, mood, concentration, relations with others, sexuality, and enjoyment of life).[55] Higher scores indicate a greater degree of interference.

Women's Health Initiative Insomnia Rating Scale (WHIIRS)

This five-item scale of sleep quality assesses sleep initiation and maintenance in the past 4 weeks.[56] Higher scores are indicative of poorer sleep quality.

Hopkins Symptom Checklist (SCL-90-R)

The SCL-90-R is a 90-item self-report inventory that assesses psychological symptom status.[57] It contains nine subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. Scores for each subscale as well as a global index of psychological distress (Global Severity Index) can be calculated.

Perceived Stress Scale (PSS)

PSS is a 14-item scale that measures the degree to which situations in one's life are appraised as unpredictable, uncontrollable, and overwhelming.[58] It posits that people appraise potentially threatening or challenging events in relation to their available coping resources. A higher score indicates a greater degree of perceived stress.

Toronto Mindfulness Scale

This is a 10-item scale that assesses the capacity to evoke a state of mindfulness.[59] The Toronto Mindfulness Scale has been found to be valid, reliable, and sensitive to change.[60] A higher score indicates a more mindful state at the time of assessment.

Mindfulness Practice Daily Log

This log records the number of minutes of out-of-class mindfulness practice.

Statistical methods

Data analyses employed nonparametric procedures given the small sample sizes. Medians and interquartile

TABLE 1. *Characteristics of participants at baseline*

Characteristic	Mean (SD)	% (no.)	Range
Age (y)	53.65 (3.66)		48.54-60.65
Body mass index (kg/m^2)	25.47 (4.00)		18.34-34.75
Caffeine drinks/day[a]	1.57 (1.28)		0-4
Regular exercise (Y/N)		93.33 (14)	0-1

[a]n = 14; missing for one participant

ranges (75th percentile minus 25th percentile) were calculated for each outcome at baseline and post-intervention and for week 11 for HF outcomes from the daily logs. Statistical significance of within-woman changes over time in these outcomes was assessed using Wilcoxon signed rank tests. Spearman correlations between HF severity, mindfulness scores, and minutes of mindfulness practice were estimated.

RESULTS

Recruitment and retention

Thirty-two women called in response to the recruitment advertisements to request further information. Twenty-six of these requests came as a result of the two newspaper ads, and six came from the flyer. Seven of the 32 women were ineligible due to hysterectomy, one was ineligible because of previous MBSR experience, and one was ineligible due to current hormone therapy use. After learning more about the demands of the program, three decided not to enroll in the study due to time demands or travel, and two decided they were not interested. The 18 remaining eligible women signed a consent form. However, three did not subsequently begin the MBSR classes, two reported that after considering the matter, they were no longer interested in participating in the study and one cited family illness that had arisen. Thus, 15 of the 18 (83%) women who consented began the MBSR program and 13 of the 18 (72%) women who consented completed the intervention (defined as attendance at six or more of the eight MBSR classes). Of the two participants of 15 (13%) who dropped out during the intervention, one cited the time demands of the MBSR classes and the HF logs, and the other cited family illness and death. One of the completers did not perform the final assessment instruments. Ten of the 13 women (77%) completed all weekly HF and mindfulness practice logs, two women missed 1 week, and one woman missed 2 weeks. The characteristics of the participants are shown in Table 1.

HF frequency and intensity

Results from the daily HF logs from the 11 participants with logs at weeks 1, 7, and 11 are contained in Table 2. Although the inclusion criteria for the study were at least seven HFs per day over the past 30 days, and women's self-report of that number was accepted for entry into the study, the baseline assessment revealed that the women were reporting somewhat fewer HFs at that time. However, there was a significant reduction in the median reported overall HF frequency from the first week (5.43) to immediately post-intervention (3.57), and this reduction was maintained at follow-up (3.29). The reduction in median HF frequency was approximately 39% over the course of participation. Most of the reported frequency change was for moderate and severe HFs, with little change seen in the number of mild HFs. There was also a significant reduction in the median HF severity score (number of HFs per day times reported severity score, from week 1 [11.29] to post-intervention [6.71] and the reduction was maintained at follow-up [6.71]). This corresponds to a 40% reduction in median HF severity over the course of participation.

QOL measures

Median scores on each of the HFRDIS, MENQOL, WHI Insomnia Rating Scale, six of the SCL-90-R

TABLE 2. *Outcome from daily hot flash logs at baseline and weeks 7 and 11*

	Median (interquartile range)		
Outcome	Baseline	Week 7	Week 11
Frequency			
Overall	5.43 (4.57)	3.57 (2.57)[a]	3.29 (3.14)[a]
Mild	1.57 (1.43)	0.86 (2.86)	1.00 (2.14)
Moderate	2.71 (2.57)	1.14 (2.14)[a]	1.71 (2.14)[b]
Severe/very severe	1.71 (1.57)	0.00 (1.43)	0.57 (1.43)[a]
HF severity score	11.29 (7.86)	6.71 (3.14)[a]	6.71 (9.14)[a]

HF, hot flash.
Participants with observations at all three time points only (n = 11).
[a]Wilcoxon signed ranks test for within-woman difference statistically significant at $P < 0.01$.
[b]Wilcoxon signed rank test for within-woman difference statistically significant at $P < 0.05$.

TABLE 3. *Quality of Life outcomes at baseline and week 7 (post-intervention)*

Outcome	Median (interquartile range) Baseline	Week 7	No.
HF interference			
Activities	3.44 (2.22)	2.50 (2.44)[b]	12
Overall	4.50 (4.00)	3.00 (2.50)	12
MENQOL			
Vasomotor	6.33 (1.83)	4.67 (2.00)[a]	12
Psychosocial	2.86 (2.36)	1.93 (1.07)[b]	12
Physical	2.59 (1.47)	2.13 (0.78)	12
Sexual	2.17 (2.50)	1.33 (1.33)	12
WHI Insomnia Rating Scale	17.00 (6.00)	13.50 (7.00)[a]	12
Hopkins Symptoms Checklist			
Somatization	0.54 (0.58)	0.33 (0.17)[a]	10
Obsessive-Compulsive	0.65 (1.00)	0.40 (0.40)[b]	10
Interpersonal Sensitivity	0.56 (0.78)	0.11 (0.22)[b]	10
Depression	0.46 (1.15)	0.08 (0.17)[b]	10
Anxiety	0.25 (0.50)	0.00 (0.20)	10
Global Severity Index	0.42 (0.74)	0.19 (0.18)[a]	10
Perceived Stress Scale	22.00 (11.50)	15.50 (8.50)[b]	12
Toronto Mindfulness Scale	21.50 (9.50)	27.00 (7.50)[a]	12

HF, hot flash; MENQOL, Menopause-Related Quality of Life Questionnaire; WHI, Women's Health Initiative.
Participants with observations at both time points only.
[a]Wilcoxon signed rank test for within-woman difference statistically significant at $P < 0.01$.
[b]Wilcoxon signed rank test for within-woman difference statistically significant at $P < 0.05$.

assessment scales, Perceived Stress and Capacity for Mindfulness at baseline, and at the completion of the intervention (week 7) are contained in Table 3. Interference from HFs in everyday activities (HFRDIS) was reduced significantly. There was also a substantial improvement in ratings of the impact of HFs on overall QOL, although in this small sample, the change did not reach significance. Scores on the vasomotor symptoms questions and the psychosocial symptoms on the MENQOL also reduced significantly as did scores on the WHI Insomnia Rating Scale. Responses on the SCL-90-R showed significant reductions on the Global Severity Index, a measure of emotional distress, and scores on the Somatization, Obsessive-Compulsive, Interpersonal Sensitivity, and Depression subscales also showed significant reductions. Median scores on the PSS decreased significantly over the course of the intervention (a 29.5% overall decrease in the median), and scores on the Toronto Mindfulness Scale increased significantly (a 25.6% overall increase in the median). Results of the HFRDIS and MENQOL are shown graphically in Figure 1.

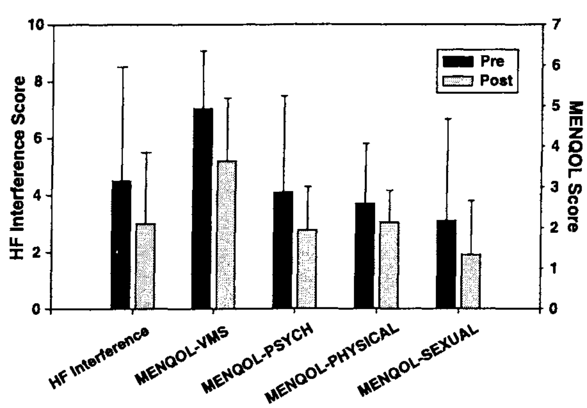

FIG. 1. Baseline versus follow-up (week 11) MENQOL (Menopause-Related Quality of Life Questionnaire) scores, median +/− interquartile range (n = 12). HF, hot flash; VMS, vasomotor scale.

Home practice compliance

Weekly compliance with formal mindfulness practice (defined as an average of at least 45 min/day for that week) was high during the intervention period, with an average of 77.8% of participants reporting at least that amount of practice. The median number of minutes of reported home practice during the intervention was 58 min/day. Compliance declined in the 4 weeks after completion of the intervention, with 42.9% of participants reporting at least 45 minutes of practice on average per day and a median of 35 min/day. Spearman correlations with HF severity at week 1 were 0.45 for the number of minutes women reported practicing, and −0.42 for Toronto Mindfulness Scale score.

Participants' postprogram reports

Twelve of the 13 women were individually interviewed over the telephone (approximately 25 minutes per call) by the first author (J.C.) at the completion of their participation to obtain subjective impressions of their participation in the MBSR program and to obtain feedback about their experience of the study protocol. The results of the interviews were consistent with the results from the daily diaries in that nine women (75%) reported that their participation in the program had resulted in a reduction in the frequency or intensity of their HFs. The reported degree of improvement ranged from slight to dramatic. Ten women (83%) reported that they were better able to cope with the HFs, and 10 (83%) reported a positive impact on their daily functioning. Eleven women (92%) thought that stress was a trigger for their HFs, especially in making the HFs more intense, and all but one felt that participation in the program had helped them deal with the stresses that seemed to trigger or intensify their HFs.

DISCUSSION

The fact that only three of the 23 eligible women gave the time demands of the program as the reason for not participating in the study, together with the relatively high degree of compliance with the daily home mindfulness practice requirements, indicates that the time demands of the MBSR program are feasible for at least this select population. Also, the high completion rate of the demands of the daily HF log through the 7 weeks of classes and for 4 weeks after the completion of the intervention indicates its feasibility for use with this population. The relatively small dropout rate (13%) during the course of the 7-week intervention is similar to levels reported in other studies of MBSR programs with other diagnostic groups.[43,61] This finding, together with the fact that this was a community sample of women who were not actively seeking medical help for their HFs indicates that the program may be appealing to a broad range of women suffering from HFs.

The 39% median reduction in HF frequency observed over the course of the women's participation is comparable to the 38% reduction in objectively recorded (sternal skin conductance) HF frequency found associated with an eight-session slow-paced breathing program by Freedman and Woodward.[62] Sternal skin conductance does not reliably assess HF intensity, and these data were not reported in their paper. HFs can be expected to improve naturally over time without intervention and have been shown to improve regardless of the type of intervention.[6] However, the 40% reduction in overall HF severity, over the course of the 11 weeks of the assessment period is greater than the approximately 20% to 30% expected from placebo.[6] It is also larger than that observed by Irvin et al,[26] who, using a self-report diary in a randomized trial, found an approximately 25% reduction in HF intensity (P = 0.05) associated with daily practice of a 20-minute relaxation response audiotape over a period of 7 weeks. Those investigators did not find a significant reduction in HF frequency (20%). In summary, the within-woman declines in HF frequency and severity are statistically significant both during and after the intervention, but the magnitude of the decline is somewhat smaller after the intervention.

There were consistent improvements in the MENQOL scores. MENQOL scores related to vasomotor symptoms and psychosocial concerns improved, as did the degree to which the women's menopause-related symptoms interfered with the activities in their daily life (HFRDIS). These improvements could be a result of either the reductions in the severity of the women's HFs or improved coping resources related to their participation in the program, or both. The observation that declines tended to be larger for severity than for frequency (at least during the intervention period) may indicate that the MBSR program had the greatest effect on the women's coping skills. The percentages of reductions in the median scores on each of the MENQOL scales (range, 17%-38%) are in excess of the 15% suggested by the authors of the instrument as the minimal clinically important change.[63] Also, using a summary MENQOL score suggested by Lewis et al,[64] the percentage of reduction in median MENQOL scores was 28%. This is a greater reduction than was found in MENQOL scores in the placebo group in a randomized, controlled trial of hormone therapy[65] and somewhat less than the 52% reduction in MENQOL in the intervention group of that trial. The median score of this group of women at baseline on the HFRDIS "activity" items (3.44) is similar to the mean found by Carpenter et al[66] (3.64) with a sample of breast cancer survivors experiencing moderate to severe HFs and considerably higher (4.5) than that sample (2.7) on the overall QOL item. The median sleep disturbance score (17.0) on the WHIIRS at baseline is at the 98% percentile for women enrolled in the WHI study[67] indicating severely disturbed sleep in this group. The significant improvements found on the WHIIRS are noteworthy because reductions in sleep quality leading to fatigue[5] occur in about 40% of women during perimenopause,[68] and sleep disturbance is an important component of the women's QOL.[69]

Improvements on the PSS are of interest because lower PSS scores are associated with better coping resources,[70] and stressful events are associated with increased risks to health when the coping resources are perceived as insufficient to meet the demand that the event represents.[58] Further, the transition through menopause has been associated with an increased risk of depression, especially in women with a lengthy perimenopause,[71] and higher PSS scores have been associated with failure to make health-promoting behavior changes[72,73] and greater vulnerability to stress-related depressive symptoms.[74]

There was a positive association between the number of minutes the women reported practicing at week 1 and the severity of their HFs. It is possible that the women were more motivated to practice by their hope for relief in response to the discomfort they were experiencing. It is also of interest that there was a negative association between the women's Toronto Mindfulness Scale scores at baseline and their HF severity scores, and improvements on the QOL measures were accompanied by a 25% increase in scores on the mindfulness scale. In exit interviews, most women reported that they used their learned mindfulness to redirect attention to help them cope with their HFs and in this way felt that they developed a greater sense of control and confidence in dealing with HFs.

This study is limited by the small sample size. Also, because it was done with limited in-house funds and the emphasis was on the feasibility of recruiting women from this population for the MBSR intervention and obtaining information about their compliance with the daily HF diary, it was not possible to support the logistics of recruiting additional women to serve as controls with whom to compare the results. The observed outcomes could thus be due entirely to group support, attention from the instructor, the passage of time, or other factors including a placebo effect. Further, the self-reported HF outcomes are from subjective recordings. The concordance between self-reported HFs and objective measures using skin conductance monitors in ambulatory monitoring studies is quite variable, ranging from a low of 36% to 50%[75] to 86%,[62] and indicates that women tend to underestimate the frequency of their HFs[75] in subjective assessments when compared to objectively recorded HFs. Also, a different intervention effect may occur for subjective and objective measures. In a recent study,[76] women's subjectively reported HFs were associated with a negative affect, whereas objectively recorded HFs (by sternal skin conductance) were associated with a positive affect. The high proportion of women (93%) in the sample who reported exercising regularly does make this group atypical of menopausal women; however, the mean BMI of this group (25.47) is only slightly lower than the median BMI found in a nationally representative sample of late perimenopausal (26.06) and postmenopausal (25.79) women.[77] Given the limitations of the pilot study, these preliminary results of MBSR for HFs show that participation in the program holds promise as a support for women in dealing with moderate to severe HFs and deserves further study. It is intended to repeat the intervention with a larger controlled trial that includes objective HF measures.

CONCLUSIONS

These results provide preliminary positive evidence of the feasibility of MBSR as a behavioral program for supporting women who are experiencing severe HFs, and the observation that participation in the program was associated with reductions in both HF frequency and HF intensity greater than has been found in the placebo group in some studies[6] warrants further investigation.

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The Toronto Mindfulness Scale: Development and Validation

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In this study, the authors both developed and validated a self-report mindfulness measure, the Toronto Mindfulness Scale (TMS). In Study 1, participants were individuals with and without meditation experience. Results showed good internal consistency and two factors, Curiosity and Decentering. Most of the expected relationships with other constructs were as expected. The TMS scores increased with increasing mindfulness meditation experience. In Study 2, criterion and incremental validity of the TMS were investigated on a group of individuals participating in 8-week mindfulness-based stress reduction programs. Results showed that TMS scores increased following treatment, and Decentering scores predicted improvements in clinical outcome. Thus, the TMS is a promising measure of the mindfulness state with good psychometric properties and predictive of treatment outcome. J Clin Psychol 62: 1445–1467, 2006.

Keywords: Toronto Mindfulness Scale; self-report assessment; mindfulness; meditation; psychometric characteristics

Mindfulness training is increasingly being used as a clinical intervention for a variety of problematic conditions. Salmon, Santorelli, and Kabat-Zinn (1998) documented that there were more than 240 programs using mindfulness-based interventions, a number that no doubt has increased. Mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1990) and mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002) are among the more widely practiced treatments designed to cultivate mindfulness skills primarily through formal meditation practices. Furthermore, dialectical behavior therapy (DBT; Linehan, 1993) and acceptance and commitment therapy (ACT; Hayes, Strosahl, & Wilson, 1999) advocate the development of mindfulness largely through the practice of behavioral skills. Finally, theoretical rationales have been proposed for integrating mindfulness training into the treatment of other clinical syndromes such as generalized anxiety disorder (e.g., Roemer & Orsillo, 2002), posttraumatic stress disorder (Wolfsdorf & Zlotnick, 2001), and substance abuse (Breslin, Zack, & McMain, 2002; Marlatt, 2002).

Although there has been considerable variability in terms of methodological rigor in clinical trials (for reviews see Baer, 2003; Bishop, 2002; Grossman, Niemann, Schmidt, & Walach, 2004), mindfulness-based interventions appear to lead to substantial reductions in a variety of medical and psychological conditions. For example, symptoms of chronic pain (Kabat-Zinn, Lipworth, & Burney, 1985), stress (Shapiro, Schwartz, & Bonner, 1998), panic disorder (Kabat-Zinn et al., 1992), depressive relapse (Teasdale et al., 2000), disordered eating (Kristeller & Hallett, 1999), and suicidal behavior (Linehan, Armstrong, Saurez, Allmon, & Heard, 1991) have all been shown to decrease following implementation of mindfulness-based interventions. Despite the encouraging outcome results, whether these treatments lead to increased mindfulness and whether increased mindfulness mediates mindfulness-based treatment outcomes has yet to be systematically investigated. Until recently, this has been due, in large part, to the lack of an operational definition of mindfulness.

Broadly conceptualized, mindfulness has been described as a non-elaborative, nonjudgmental, present-centered awareness in which each thought, feeling, or sensation that arises in the attentional field is acknowledged and accepted as it is (Kabat-Zinn, 1990; Shapiro & Schwartz, 1999; Segal et al., 2002). The goal of mindfulness in clinical settings is twofold: First, to increase insight into how automatic, habitual patterns of overidentification and cognitive reactivity to sensations, thoughts, and emotions increase stress and emotional distress; second, to reduce the vulnerability to these mind states, thereby producing lasting improvements in emotional well-being (Linehan, 1994; Teasdale, 1999). This mental training is achieved through becoming skillful in the practice of mindfulness meditation (e.g., Germer, 2005; Kabat-Zinn, 1990, 1994, 1998; Segal et al., 2002; Shapiro & Swartz, 1999, 2000). However, the insufficiently operationalized definitions have presented an important research challenge in evaluating mindfulness programs referred to above (Bishop, 2002).

Recently, a number of self-report mindfulness measures have been developed, including the Cognitive and Affective Mindfulness Scale (CAMS; Feldman, Hayes, Kumar, & Greeson, 2004), the Freiburg Mindfulness Inventory (FMI; Buchheld, Grossman, & Walach, 2001), the Kentucky Inventory of Mindfulness Skills (KIMS; Baer, Smith, & Allen, 2004), the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), and the Mindfulness Questionnaire (MQ; Chadwick, Hember, Mead, Lilley, & Dagnan, 2005). In addition, The Revised Cognitive and Affective Mindfulness Scale (CAMS-R; Feldman, Hayes, Kumar, Kamholz, Greeson, & Laurenceau, 2005) and the Philadelphia Mindfulness Scale (PHLMS; Cardaciotto & Hebert, 2005) are under development. Interestingly, all these measures were originally designed to assess mindfulness as a trait-like quality that is manifest as a general tendency to be mindful in daily life.

Alternatively, mindfulness can be viewed as a mode, or state-like quality, that is maintained only when attention to experience is intentionally cultivated with an open, nonjudgmental orientation to experience (Bishop et al., 2004). Specifically, the proposed two-component mindfulness definition was (a) the intentional self-regulation of attention to facilitate greater awareness of bodily sensations, thoughts, and emotions; and (b) a specific quality of attention characterized by endeavoring to connect with each object in one's awareness (e.g., each bodily sensation, thought, or emotion) with curiosity, acceptance, and openness to experience. Such a state involves an active process of relating openly with one's current experience by allowing current thoughts, feelings, and sensations (Hayes et al., 1999). Based on this definition, the next step was to develop a scale that could assess the subjective experience of a mindfulness state retrospectively in reference to mindfulness meditation techniques designed to evoke the mindfulness state. This retrospective method has been demonstrated to increase reliability and validity, and to minimize error attributable to memory bias (Ericsson & Simon, 1980; Klinger, 1978; Singer & Kolligian, 1987).

Furthermore, Bishop et al. (2004) proposed that mindfulness is distinct from other forms of self-focused attention such as anxious preoccupation or rumination that, contrary to the goals of mindfulness-based treatments, have been shown to exacerbate distress and maintain psychopathology (e.g., Nolen-Hoeksema, 1991; Pyszczynski & Greenberg, 1987; Trapnell & Campbell, 1999). This model defines mindfulness as an intentional, reflective style of introspection or self-observation that, in addition, differs from concentrative meditation (Smith, 1975). Concentrative practices involve maintaining one's attention on a single focus of awareness such as a single word or phrase, a candle flame, or even one's own breathing (e.g., transcendental meditation, clinically standardized meditation). Although mindfulness, or insight meditation, also includes some concentrative practices, the focus of attention is unrestricted such that the meditator develops an awareness of one's present experience, including thoughts, feelings, or physical sensations as they consciously occur on a moment-by-moment basis.

Based on this definition, we investigated relationships between the Toronto Mindfulness Scale (TMS) and several measures of attention and awareness to evaluate the construct validity of the TMS. As far as mindfulness is thought to reflect a self-regulated awareness of bodily sensations, thoughts, and feelings, the construct appears to be conceptually similar to situational self-awareness, defined as an awareness of both internal states (thoughts and feelings) and an awareness of one's surroundings (SSAS; Buss, 1980). Mindfulness appears to share some overlap with absorption, which is defined as the ability to maintain a state of attentional involvement on current experience and is typically measured using the Tellegen Absorption Scale (TAS; Tellegen & Atkinson, 1974). However, the TAS also assesses the tendency to think in images and to experience altered states of consciousness (Tellegen, 1982). Thus, mindfulness is expected to overlap to a modest degree with absorption. Mindfulness further seems to reflect the polar opposite of inattentiveness or absentmindedness that might result in cognitive failures (e.g., attention drifting while reading, forgetting why one chose to move from one part of his or her house to the other). Finally, although mindfulness involves the self-regulation of attention, it appears to be distinct from other forms of attention control, most notably dissociation, which involves altered states of consciousness such as feelings of merger or depersonalization along with a lack of awareness of one's own experience (Putnam, 1985). We thus predicted that the TMS would be positively correlated with situational self-awareness, negatively correlated with cognitive failures, and independent of dissociation.

Mindfulness is further defined by a style of self-focused, nonelaborative attention characterized by experiential openness, curiosity, and acceptance. Mindfulness thus appears to be related more to intentional states of self-reflectiveness (a curious, decentered style of introspection) than to involuntary states of rumination (RRQ; Trapnell & Campbell, 1999) or self-consciousness (SSAS-Self-Consciousness; Buss, 1980), which are distinct styles of self-focused attention. Mindfulness also appears to be related to openness to experience, which refers to receptivity to feelings, intellectual curiosity, and a willingness to have new experiences (NEO-FFI; McCrae & Costa, 1985). Mindfulness would not appear to share much overlap with psychological mindedness, which refers to the ability to reflect upon and understand the meanings and motivations for one's thoughts, feelings, and behaviors (Conte, Ratto, & Karasu, 1996). Thus, we predicted that the TMS would be positively correlated with measures of reflectiveness and openness to experience and unrelated to ruminative self-focused attention, self-consciousness, and psychological mindedness. Finally, we would expect that these qualities are also unrelated to socially desirable responding. Thus, the second goal of this study was to investigate whether mindfulness shares qualities with other constructs involving a reflective style of self-focused attention and experiential openness, and is distinct from anxiously preoccupied or ruminative forms of self-focused attention.

Furthermore, Bishop et al. (2004) proposed that mindfulness is similar to a skill that can be developed with practice; developing the skills through meditation practice is thus thought to allow one to choose a mindfulness state more often. We predicted that respondents with greater experience in mindfulness meditation would score higher on the TMS than those with less experience in mindfulness meditation. Finally, because increased mindfulness is thought to improve clinical outcomes (Kabat-Zinn, 1994), we predicted that increases in TMS scores from pre- to postparticipation in an MBSR program would be associated with reduced stress and mood disturbances.

In sum, the development of the TMS represents an initial step in a line of research evaluating mindfulness as a mechanism underlying the efficacy of mindfulness-based treatments. In this article, we describe the development of the TMS and two studies that were designed to determine the psychometric properties of the instrument. Study 1 investigates internal consistency, factor structure, relationships with other constructs, and criterion-related validity. Study 2 further examines the criterion-related, and incremental validity, of the TMS for a group of individuals who participated in an 8-week mindfulness-based treatment.

Development of the Toronto Mindfulness Scale Candidate Items

Forty-two statements were derived to reflect the operational definition of mindfulness developed by our consensus team (Bishop et al., 2004), and judged by the researchers of those meetings to be consistent with the conceptual model. These included items reflecting the subjective aspects of attentional self-regulation and a quality of nonelaborative attention characterized by curiosity, acceptance, and openness to experience with all items referring to an immediately preceding meditation session. The TMS instructions asked participants to reflect on an immediately preceding meditation session and to indicate the degree to which each of the 42 statements described what they just experienced on a 5-point scale from 0 (*not at all*) to 4 (*very much*).[1]

Study 1: Internal Consistency, Factor Structure, Construct, and Criterion Validity

Method

Participants and procedure. Three-hundred ninety participants consisting of 176 men and 214 women with a mean age of 40.8 years ($SD = 13.3$) were recruited for this study. Participants with no mindfulness meditation experience were recruited through newspaper advertisements ($n = 134$) and among a group of people registered (but not participating) in a mindfulness meditation training retreat ($n = 24$). These participants were carefully screened to ensure that they had no previous experience with any form of meditation (including yoga, tai chi, and qi-gong). Participants ($n = 232$) with various levels of experience in mindfulness meditation were recruited from a variety of settings. Experience was defined as having at least 8 weeks of experience in the daily practice of mindfulness meditation.[2] We recruited from the following settings: (a) a local Buddhist meditation center, (b) experienced practitioners registered for a mindfulness meditation retreat, (c) MBSR clinicians trained in mindfulness techniques, (d) a nonclinical sample of participants who recently completed an 8-week mindfulness-based stress reduction

[1]The instructions were as follows: "We are interested in what you just experienced. Below is a list of things that people sometimes experience. Please read each statement. Next to each statement are five choices: "not at all," "a little," "moderately," "quite a bit" and "very much." Please indicate the extent to which you agree with each statement. In other words, how well does the statement describe what you just experienced?"

[2]Because mindfulness-based treatments are typically 8 weeks in duration, we reasoned that this would be a conservative estimate of the amount of practice in the techniques required to acquire the skills to evoke mindfulness.

program offered through a local community center, and (e) newspaper advertisements asking for volunteers with experience in mindfulness meditation. The range of mindfulness meditation experience was 2–360 months (mode = 6 months). There were no significant differences in terms of age between the meditators and nonmeditators ($p > .05$), and the ratio of men to women was similar across the two inexperienced and experienced groups.

Participants, tested in groups of 5 to 25, were seated in chairs or on meditation cushions according to their preference, and given the following instructions: "For the next 15 minutes, please pay attention to your breathing and anything that might arise during your experience." No other instructions were given. Maintaining awareness on the breath and noting sensations, thoughts, and feelings that arise is a basic mindfulness meditation technique. Thus, it was expected that asking experienced meditators to be aware of their breath in this manner would be sufficient to evoke a state of mindfulness. For those inexperienced in mindfulness techniques, we would not expect a mindfulness state to be evoked. After 15 minutes, participants completed the TMS in reference to what they were aware of experiencing during that period. To assess construct validity, a subset of 165 research participants completed the battery of self-report measures described below following completion of the TMS. Participants were paid $20 for their time.

Measures

The Tellegen Absorption Scale (TAS; Tellegen, 1982) was used to measure absorption. This scale consists of 34 true–false items. Internal consistency coefficient alpha is 0.88 and it correlates with several variables such as the ability to be hypnotized and imagery (Roche & McConkey, 1990).

The Situational Self-Awareness Scale (SSAS; Govern & Marsch, 2001) was used to measure situational self-awareness. This 9-item scale yields three subscales reflecting private self-awareness or internal state awareness (e.g., "Right now, I am conscious of my inner feelings"; $\alpha = 0.70$), public self-awareness or self-consciousness (e.g., "Right now, I am self-conscious about the way I look"; $\alpha = 0.82$) and awareness of immediate surroundings (e.g., "Right now, I am keenly aware of everything in my environment"; $\alpha = 0.72$). The measure is sensitive to changes in self-awareness over time and across situations (i.e., laboratory manipulations to increase self-awareness).

The Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes 1982) was used as the measure of cognitive failures. This 25-item scale measures the propensity to experience failures in cognition and behavior due to inattention. Internal consistency coefficient alpha is 0.79.

The Dissociative Experiences Scale (DES; Bernstein & Putnam, 1986) was used to measure dissociative experiences. This 28-item instrument assesses the frequency with which individuals experience a variety symptoms of dissociation, defined as "a lack of normal integration of thoughts, feelings, and experiences into the stream of consciousness and memory" (Bernstein & Putnam, 1986, p. 727). Internal consistency coefficient alpha is 0.60 and the scale has been shown to discriminate between those with and without dissociative-spectrum disorders.

The NEO-Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992) Openness subscale was administered to evaluate openness to experience. This is a 12-item subscale that measures openness to feelings and new experiences ($\alpha = 0.87$).

The Psychological Mindedness Scale (PMS; Conte et al., 1990) was used to measure psychological mindedness, defined as a "person's ability to see relationships among thoughts, feelings, and actions, with the goal of learning the meanings and causes of his experiences and behavior" (Applebaum, 1973, p. 36). This 45-item scale measures, for example, access to one's feelings, interest in the relations between feelings and behavior and motivation for change. Internal consistency coefficient alpha is 0.84.

The Rumination-Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999) was administered to measure style of self-focused attention. This 24-item scale measures two orthogonal styles of self-observation: rumination (e.g., "I tend to "ruminate" or dwell over things that happened to me for a really long time afterward"; $\alpha = 0.90$) and reflection (e.g., "My attitudes and feelings about things fascinate me"; $\alpha = 0.91$).

The Marlow-Crowne Social Desirability Scale (Crowne & Marlowe, 1960) was used to measure socially desirable responding. This 33-item inventory assesses the tendency to present oneself in a socially desirable manner. Internal consistency coefficient alpha is .88.

Internal Consistency

Sixteen of the original 390 participants were identified and removed as multivariate outliers with endorsement patterns that could be considered markedly atypical, such as endorsing every item with either a 0 or a 4. Six of the 42 candidate items with extreme skewness and kurtosis were removed from the pool of candidate items. We proceeded to examine the correlations among the remaining 36 candidate items and computed reliability estimates based on the responses of the 374 individuals. One item was removed due to its comparatively low item-total correlation ($r = .28$). The remaining 35 items showed high internal consistency, with an alpha coefficient of .95 and an average item-total correlation of $r = .53$. The item content of the deleted items was general in scope, and there was no clear evidence of redundancy in meaning among the remaining items based on magnitude of interitem correlations or face validity.

Exploratory Factor Analysis

Participants. We used random sampling to split the remaining 374 individuals into Sample 1 ($n = 174$) for the exploratory factor analysis (EFA), and Sample 2 for the confirmatory factor analysis (CFA; $n = 200$). In Sample 1, the mean age was 41.2 years ($SD = 13.6$) and 54% were women. Meditation experience ranged from no experience to 17 years ($M = 3.4$, $SD = 4.6$). The sample size of 174 cases was considered to be sufficient for the EFA (MacCallum, Widaman, Zhang, & Hong, 1999) based on the initial pool of 35 test items with moderate-sized prior communalities ($M = 0.49$, $SE = 0.02$).

Using Sample 1, responses to the 35 candidate TMS items were subjected to EFA using squared multiple correlations for prior communalities. The method of maximum likelihood (ML) extraction method was used, followed by an oblimin (oblique) rotation to allow for correlation between the factors. No restriction was applied to the number of factors to be estimated, and the ML method was used to make use of goodness of fit indices not available with other extraction methods (Fabrigar, Duane, MacCallum, & Strahan, 1999).

Results and Discussion

The initial run resulted in a three-factor solution, but the scree plot provided evidence for a two-factor solution, and 20 items either failed to load substantially on one factor (i.e., factor loading less than .40), or loaded strongly on two or more factors. We deleted these

20 items and attempted to derive a new solution based on the remaining 15 items. The second run resulted in a clear two-factor solution based on an examination of the scree plot and preliminary eigenvalues. The first and second factors accounted for about 66% and 29%, respectively, of the explainable variance. The solution converged in four iterations with simple structure, a Kaiser's measure of sampling adequacy of .86 and a Tucker and Lewis reliability coefficient of .91, indicating that this two-factor model demonstrated a good fit to the data. The factors themselves were correlated (r = .26), and because the average interitem correlations for each factor are substantially larger than the interfactor correlation, we have some initial support for the discriminant validity of a two-factor TMS (Clark & Watson, 1995). The TMS items and their factor loadings, along with reliability estimates are presented in Table 1.

Factor 1 is labeled *Curiosity* as the items loading on this factor all reflect awareness of present moment experience with a quality of curiosity. Factor 2 is labeled *Decentering* as the items loading on this factor emphasize awareness of one's experience with some distance and disidentification rather then being carried away by one's thoughts and feelings and is conceptually similar to decentering as defined by Teasdale et al. (2002).

Table 1
Exploratory Factor Analysis (EFA) Results: Factor Loadings and Reliability Estimates

Toronto Mindfulness Scale (TMS) items: Original item number and content	Factor loadings	
	1	2
17: I was curious about my reactions to things.	**.83**	−.13
32: I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings or sensations.	**.78**	−.12
26: I was curious to see what my mind was up to from moment to moment.	**.73**	.10
06: I was curious about each of the thoughts and feelings that I was having.	**.71**	−.09
39: I remained curious about the nature of each experience as it arose.	**.70**	.23
41: I was curious about what I might learn about myself by just taking notice of what my attention gets drawn to.	**.70**	.13
29: I noticed subtle changes in my mood.	**.46**	.08
34: I was more invested in just watching my experiences as they arose, than in figuring out what they could mean.	−.09	**.82**
33: I was more concerned with being open to my experiences than controlling or changing them.	.08	**.71**
37: I was receptive to observing unpleasant thoughts and feelings without interfering with them.	−.07	**.70**
42: I approached each experience by trying to accept it, no matter whether it was pleasant or unpleasant.	.01	**.67**
20: I was open to taking notice of anything that might come up.	.10	**.55**
40: I was aware of my thoughts and feelings without over-identifying them.	−.01	**.53**
35: I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things 'really' are.	−.04	**.52**
36: I experienced myself as separate from my changing thoughts and feelings.	.09	**.49**
Scale reliability estimates	*F*1	*F*2
Coefficient alpha	.88	.84
Mean interitem correlations	.50	.39
Standard deviation of interitem correlations	.10	.10
Percentage of explained variance	66	29

Note. The factor loadings for the TMS items belonging to each factor are printed in boldfaced type.

Confirmatory Factor Analysis

Participants. We used data based on the 200 remaining cases from the second randomly sampled data set to conduct a CFA using the CALIS procedure in SAS (SAS Institute, Inc., 1989) with the maximum likelihood estimation method. A CFA with two-factors would have 31 estimated parameters, and this would require a minimum of 155 cases (5 times the number of parameters) making the sample size of 200 adequate for this procedure. The mean age of the participants in this sample was 42.5 years ($SD = 13.1$) and 56% were women. Meditation experience ranged from no experience to 17 years ($M = 3.6$, $SD = 4.7$). There were no age or sex differences between the two samples.

Results and Discussion

The CFA was used to test the fit between the EFA-derived factors and items in an independent sample. We found mixed support for the proposed two-factor model. All estimated parameters were statistically significant and at least of moderate size. Residuals were symmetrical but with a few extreme values, and this lack of fit was reflected in the modest values for fit indices. It became clear after a systematic review of residuals, covariance matrices, and modification indices that two items (i.e., TMS20 from Factor 1 and TMS29 from Factor 2) were multidimensional, loading across factors and covarying more strongly than predicted with at least half of the items from the other factor. Instead of modifying the model by adding two parameters, we reestimated a simplified version of the two-factor model by removing these two items. We acknowledge a susceptibility to chance characteristics of the CFA sample driving this decision (MacCallum, Roznowski, & Necowitz, 1992). However, given that this modification served to simplify the model rather than add to its complexity, and that the two items in question also were not strong performers in the EFA independent sample, we felt justified in refitting this simpler model, which would retain more than enough items per scale at six and seven, respectively.

The chi-square test fit criterion for the modified CFA model was significant, $\chi^2(64) = 138.24$, $p < .0001$, but with a magnitude of just over twice the number of degrees of freedom, meeting a general threshold for goodness of fit (Hatcher, 1994). Other ML fit indices provided support for the model, notably Bentler's Comparative Fit Index (CFI; Bentler, 1990) and Bentler and Bonett's Non-normed Index (NNFI; Bentler & Bonett, 1980) with values of .94 and .92, respectively. These indices reflect goodness of fit as they exceed .90, and approach a value of 1.00; hence, they are less likely to be influenced by sample size (Marsh, Balla, & McDonald, 1988).

Factor loadings were both statistically significant and at least moderately large in magnitude, ranging from .56 to .82, indicating that items converged meaningfully onto the scales as predicted. Normalized residuals were symmetric but contained extreme values. Further modification was ruled out, however, to guard against too heavy a reliance on the unique structure of this sample for conclusions about the TMS subscales.

Scale reliability was assessed in several ways. Item variance, indicated by the squared correlation between matched items and factors, ranged from .32 to .67. The proportion of item-level variance to measurement error was .57 and .27 for Curiosity and Decentering, respectively. Reliability estimates of the composites, analogous to a coefficient alpha for internal consistency for the scales, were .86 and .87.

The discriminant validity of the two-factor model was also assessed. A chi-square difference test, which compares the difference between the current two-factor model and one in which the interfactor correlation parameter is fixed to 1, was statistically significant, $\chi^2(1) = .349.74$, $p < .0001$, indicating that a unidimensional model would be clearly inferior to the current two-factor model. The 95% confidence interval for the interfactor correlation ($r = .42$) did not include a value of 1 ($.28 \leq CI_{.95} \leq .56$) providing further support for two distinct but related latent constructs. The final set of TMS items with factor loadings and reliability estimates are presented in Table 2.

Correlations Between the Toronto Mindfulness Scale and Other Constructs

Participants. The subset of 165 research participants who received the additional measures described above were part of the larger sample randomly divided into two sets for the main analyses. The mean age of the participants in this subsample was 42.1 years ($SD = 13.3$) and 52.7% were women. Meditation experience ranged from no experience to 15 years ($M = 2.9$, $SD = 5.7$). There were no age or sex differences between this and the two main samples.

Results and Discussion

In Table 3, we provide a summary of correlates with the subscale scores for Curiosity and Decentering. Both the Curiosity and Decentering subscales were significantly and positively

Table 2
Confirmatory Factor Analysis: Factor Loadings and Reliability Estimates

TMS Factors and item numbers	Standardized loading	t Test[a]	Item reliability
Curiosity			
17	.77	8.31	.59
32	.76	8.38	.58
26	.77	8.23	.60
06	.62	9.25	.38
39	.77	8.20	.60
41	.82	7.53	.67
Decentering			
34	.76	7.93	.57
33	.72	8.35	.52
37	.59	9.19	.34
42	.78	7.62	.61
40	.63	8.97	.40
35	.69	8.64	.47
36	.56	9.28	.32
		Curiosity	Decentering
Composite Reliability Index[b]		.93	.91
Variance Extracted Index[c]		.89	.59
Correlation between factors (95% CI)[d]		.42, CI(95) = .28 to .56	

Note. TMS = Toronto Mindfulness Scale.
[a]Convergent validity is demonstrated because all t tests for associated factor loadings are significant at $p < .001$ (i.e., all items are measuring same construct). [b]Measures the internal consistency by factor, analogous to a coefficient alpha. [c]Measures the amount of item variance associated with the underlying factor relative to measurement error. Discriminant validity is demonstrated because each value exceeds the square of the interfactor correlation (.18). [d]Discriminant validity is demonstrated because the value 1.0 (complete construct overlap) is outside the confidence interval.

Table 3
Relationships Between the Toronto Mindfulness Scale (TMS) and Other Measures in Sample 2 (n = 200)

Measures	Construct	Curiosity	Decentering
TAS	Absorption	.31***	.22**
SSAS	Internal State Awareness	.41***	.15
SSAS	Awareness of Surroundings	.16*	.21**
CFQ	Cognitive Failures	.06	−.16*
RRQ	Reflective Self-Awareness	.23**	.42***
NEO-PI-R	Openness to Experience	.09	.23**
PMS	Psychological Mindedness	.22**	.19*
SSAS	Self-Consciousness	.31***	−.13
DES	Dissociation	.06	−.04
RRQ	Ruminative Self-Awareness	.06	−.19
MC	Social Desirability	.04	.13

Note. TAS: Absorption = Tellegen Absorption Scale; SSAS: Internal State Awareness = Private subscale from the Situational Self-Awareness Scale; SSAS: Awareness of Surroundings = Surroundings subscale from the Situational Self-Awareness Scale; CFQ: Cognitive Failures = Cognitive Failures Questionnaire; RRQ: Reflective Self-Awareness = Reflection subscale of the Rumination-Reflection Questionnaire; NEO-PI-R: Openness to Experience = Openness subscale of the NEO-PI-R; PMS: Psychological Mindedness = Psychological Mindedness Scale; SSAS: Self-Consciousness = Public subscale from the Situational Self-Awareness Scale; DES: Dissociation = Dissociative Experience Scale; RRQ: Ruminative Self-Awareness = Rumination subscale of the Rumination-Reflection Questionnaire and MC: Social Desirability = Marlow-Crowne Social Desirability Scale.
$*p < .05$. $**p < .01$. $***p < .001$.

correlated with absorption, and awareness of one's surroundings; however, only Curiosity was significantly correlated with awareness of internal states (thoughts and feelings). The two subscales did not correlate significantly with dissociation. Cognitive failures correlated negatively with Decentering but were not significantly correlated with Curiosity. Thus, the pattern of findings generally confirms that the TMS is measuring a heightened focus of attention to internal states and to a lesser degree one's environment.

Furthermore, both Curiosity and Decentering were significantly and positively correlated with reflective self-awareness and psychological mindedness. Interestingly, only the Decentering subscale was positively correlated with openness to experience, which reflects an open attitude towards one's experience. The two subscales did not correlate significantly with ruminative self-focused attention, self-consciousness, and social desirability, although there was a significant positive correlation of Curiosity with self-consciousness. This pattern of findings suggests that the TMS is measuring a reflective, introspective self-awareness that is distinct from ruminative styles of self-focused attention or self-consciousness. Moreover, given the weakness of the significant correlations, the results of the correlation analyses support the discriminant validity of the TMS in relation to the other constructs.

Finally, to further examine the criterion validity of the TMS, we investigated whether or not the TMS scales would change with increased meditation experience. This information was available for 223 research participants, 130 and 92 men and women, respectively (one case was missing gender information), with an average age of 39.73 years ($SE = 0.90$). Meditation type was categorized as mindfulness meditation (i.e., MBSR) or meditation in the Shambhala Buddhist tradition (Trungpa, 1988), and duration of meditation experience was categorized as less versus more than one year. Of the 43 participants practicing mindfulness meditation, 20 had less than one year and 23 had more than one year of experience, and of the remaining 180 participants, 79 had less than a year and 101 had more than one year of experience. There were no significant differences in age or sex among the research participants.

We conducted a 2 × 2 between subjects MANOVA on the Curious and Decentering scores with type (MBSR, Shambhala) and experience (< 1 year, > 1 year) as independent variables, adjusting for the nonorthogonality between the TMS scales. We entered the scales in the same order as they were defined in the factor analyses (i.e., Curious then Decentering). There was a significant Type × Experience interaction effect, $F(2,218) = 3.73$, $p = .025$. To investigate the interaction effect on individual TMS scales, we performed a Roy–Bargmann stepdown analysis (Bock & Haggard, 1968). The stepdown analysis analyzed Curiosity in the first step followed by Decentering in the second step with Curiosity treated as a covariate. A unique contribution to explaining the joint differences in type and experience was made by the TMS Curiosity subscale, Stepdown $F(1,219) = 7.31$, $p = .007$, but not TMS Decentering. A simple effects analysis showed that the Type × Experience interaction for TMS Curiosity was true for mindfulness practitioners only: Those with more than 1 year of experience scored significantly higher on TMS Curiosity than those with less than 1 year of experience ($p = .027$).

A main multivariate effect was observed for experience, $F(2,218) = 12.75$, $p < .001$ and investigated using a Roy–Bargmann stepdown analysis (Bock & Haggard, 1968) on the dependent measures in priority with Curiosity followed by Decentering. The TMS Curiosity subscale was found to be unrelated to the amount of meditation experience as a main effect, but after covarying the effects of Curiosity, the TMS Decentering scores were found to be significantly higher for research participants with greater meditation experience, Stepdown $F(1,218) = 25.27$, $p < .001$. Both mindfulness and Shambhala meditators with more than one year of experience scored higher on TMS Decentering ($M = 27.10$, $SE = 0.80$) than those with less than one year of experience ($M = 21.75$, $SE = 0.71$), with means adjusted for the effects of Curiosity used as a covariate (see Table 4).

In sum, mindfulness meditation experience was related to increased Curiosity scores (see Figure 1). In addition, both mindfulness and Shambhala meditators with greater experience demonstrated increased Decentering scores (see Figure 2).

Table 4
Mean Toronto Mindfulness Scale (TMS) Curiosity and Decentering by Amount and Type of Meditation

	< 1 year experience			> 1 year experience		
Type of meditation	*M*	*SD*	*n*	*M*	*SD*	*n*
TMS Curiosity						
Mindfulness	16.42	9.42	20	23.26	8.54	23
Shambhala	19.09	9.81	79	16.67	10.68	101
TMS Decentering						
Mindfulness	23.29	7.81	20	28.70	7.74	23
Shambhala	21.43	7.77	79	26.69	8.37	101

Note. Shambhala = Shambhala Buddhist.

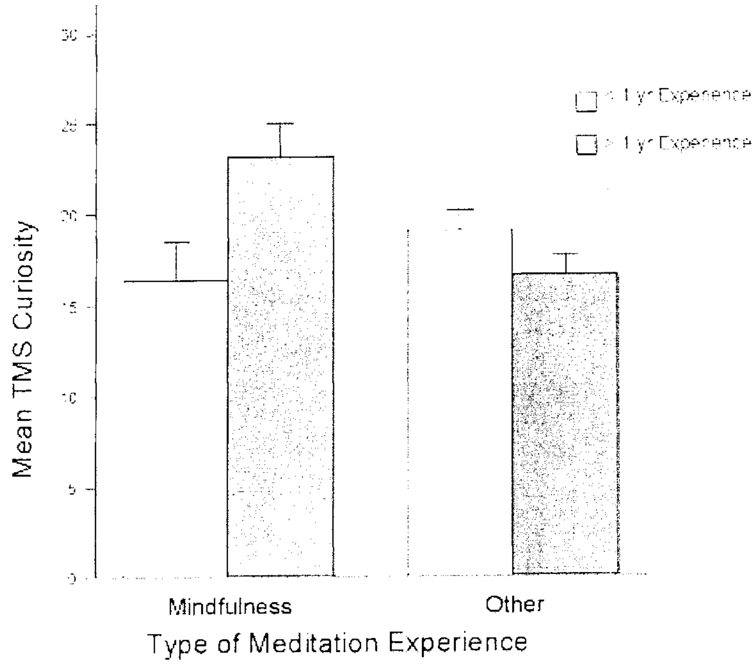

Figure 1. Mean Toronto Mindfulness Scale–Curiosity (plus standard error) by type and amount of meditation experience ($N = 223$).

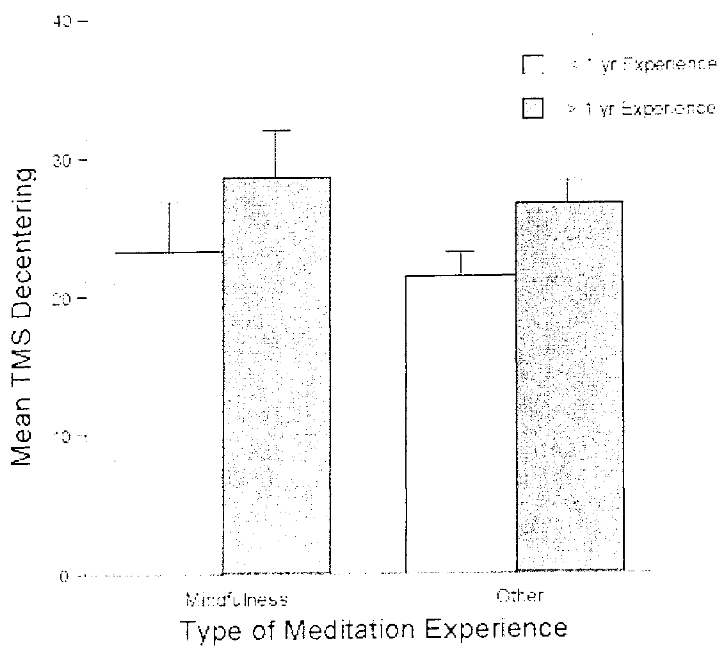

Figure 2. Mean Toronto Mindfulness Scale–Decentering (plus standard error) by amount of meditation experience ($N = 223$).

Study 2: Criterion and Incremental Validity—Sensitivity to Treatment and Prediction of Treatment Outcome

In Study 2, we examined the validity of the TMS by studying samples of patients participating in mindfulness-based stress reduction (MBSR) programs. If the measure taps mindfulness as a state as hypothesized, and if the instrument is to be useful in research, it is necessary to demonstrate that the TMS is sensitive to change. Because MBSR was developed to assist patients in developing the capacity for mindfulness, their mindfulness scores on the TMS would be expected to increase from pre- to posttreatment. Study 2 was also undertaken to evaluate the incremental validity of the TMS over pretreatment levels of stress and symptoms in the prediction of stress and symptom levels at posttreatment. Increased mindfulness is thought to improve clinical outcomes (Kabat-Zinn, 1994). Thus, we hypothesized that increases in TMS scores from pretreatment to posttreatment would be associated with reduced stress and mood disturbances.

Method

Participants. Ninety-nine participants were recruited from MBSR programs offered at the University of Massachusetts Medical School (UMMS) in Worcester, Massachusetts ($n = 75$), and the Department of Psychosocial Oncology at the Tom Baker Cancer Centre (TBCC) in Calgary, Alberta, Canada ($n = 24$). Patients at UMMS had a range of conditions including general stress, anxiety disorder or primary depression, chronic pain disorder, diabetes, and multiple sclerosis. Patients at the TBCC consisted of patients with various cancer malignancies at all stages of illness (localized to metastatic). The data sets from the two settings were combined into a single sample. The mean age of the sample was 46.68 years ($SD = 13.32$) with a range of 19 to 79 years. Women made up 67.5% of the sample.

Interventions

The 8-week MBSR program at UMMS followed the original manualized treatment developed by Kabat-Zinn (1984) and Kabat-Zinn et al. (1990). This program has been shown to be associated with general reductions in stress, anxiety, and depression in medical patients (e.g., Kabat-Zinn et al., 1985; Kabat-Zinn, Lipworth, Burney, & Sellers, 1987; Miller, Fletcher, & Kabat-Zinn, 1995). The treatment manual used at TBCC was based on the UMMS manual, but with modifications for cancer patients. The main modifications related to educational content (e.g., applying the skills to cope with cancer-related stress). A recent randomized controlled trial has demonstrated that the TBCC MBSR program significantly reduces stress and mood symptoms in cancer patients (Carlson, Ursuliak, Goodey, Angen, & Speca, 2001; Speca, Carlson, Goodey, & Angen, 2000). Both programs provided patients with training in various mindfulness meditation skills (e.g., body scan, sitting meditation, gentle yoga).

Measures

In addition to the TMS, the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) was used as a measure of subjective stress. Using the present sample, the coefficient alpha was .88.

The Brief Symptom Inventory (BSI; Derogatis, 1993) was used as a measure of psychopathology. This 53-item measure provides subscale scores of psychiatric symptoms and a composite score reflecting total level of psychological distress. The coefficient alpha for the BSI using this sample was .96.

Procedure

Participants were tested on two separate occasions, pre- and post-MBSR. Pretreatment testing occurred during an orientation session preceding the first treatment session. Post-treatment testing occurred immediately following the last session (participants stayed after the session ended). The procedures were identical at each testing period. Participants were first instructed to engage in a mindfulness meditation technique (sitting meditation), and asked to practice it for 15 minutes. Participants immediately completed the TMS and then the battery of outcome measures.

Results and Discussion

Change in clinical outcome measures and TMS scores. We examined changes in the clinical outcome measures from pre- to post-MBSR using paired t tests. All measures indicated a trend to wellness from pretreatment to posttreatment. The PSS and BSI scores decreased significantly and TMS Curiosity and Decentering subscales increased significantly (see Table 5).

TMS scores and clinical outcome. To test the incremental validity of the TMS, we used increases in Curiosity and Decentering scores as predictors for clinical outcome measures in a hierarchical linear regression analysis controlling for pretreatment clinical outcome scores.

Post-treatment BSI scores were treated as the dependent measure predicted by their associated pretreatment scores in the first step and in the second and third steps by residualized change scores for Curiosity and Decentering. After partialling out variance in posttreatment BSI associated with pretreatment BSI, the remaining variance was predictable by increases in TMS Decentering ($r_p = -.22$) but not TMS Curiosity. A similar result was found for outcome PSS scores using the same hierarchical linear regression procedure. Increases in TMS Curiosity were not associated with lowered PSS scores, but increases in TMS Decentering did in fact predict lower PSS scores at post-treatment partial $r_p = -.36$ (see Table 6).

Table 5
Pretreatment and Posttreatment BSI, PSS, TMS Curiosity and Decentering (N = 99)

	M		*SD*			
	Pre-	Post-	Pre-	Post-	*t*	*d*
PSS	31.58	23.59	8.21	6.88	−10.73***	1.05
BSI	1.11	0.61	0.66	0.51	−9.81***	0.85
TMS Curiosity	19.46	23.37	9.74	8.88	3.41**	0.42
TMS Decentering	19.15	24.01	8.41	7.91	5.07***	0.60

Note. PSS = Perceived Stress Scale. BSI = Brief Symptom Inventory.
** $p < .01$. *** $p < .001$.

Table 6
Summary of Hierarchical Regression Analysis for Toronto Mindfulness Scale (TMS) Predicting Clinical Outcome (N = 99)

Variable	B	SE β	β
Posttreatment PSS[a]			
Step 1			
Pretreatment PSS	.444	.072	.529***
Step 2			
Pretreatment PSS	.447	.072	.533***
Change in TMS Curiosity	−.081	.069	−.102
Step 3			
Pretreatment PSS	.437	.068	.521***
Change in TMS Curiosity	.132	.086	.165
Change in TMS Decentering	−.371	.098	−.404***
Posttreatment BSI[b]			
Step 1			
Pre-treatment BSI	.517	.057	.675***
Step 2			
Pre-treatment BSI	.529	.057	.691***
Change in TMS Curiosity	−.007	.004	−.123
Step 3			
Pre-treatment BSI	.517	.056	.675***
Change in TMS Curiosity	.001	.006	.021
Change in TMS Decentering	−.015	.007	−.215*

Note. PSS = Perceived Stress Scale; BSI = Brief Symptom Inventory.
[a]*For Posttreatment PSS:* R^2 = .280 for Step 1; ΔR^2 = .010 for Step 2 (p = *ns*); ΔR^2 = .092 for Step 3 ($p < .001$). [b]*For Posttreatment BSI:* R^2 = .456 for Step1 ($p < .001$); ΔR^2 = .015 for Step 2 (p = *ns*); ΔR^2 = .026 for Step 3 ($p = .03$).
*$p < .05$. ***$p < .001$.

General Discussion

The goal of this research was to develop and validate a self-report instrument measuring the capacity to invoke a mindfulness state. Results indicated that the TMS demonstrated high internal consistency. A two-factor structure (Curiosity, Decentering) was found in the initial sample and subsequently confirmed in a second sample. The relationships between the two TMS factors and other constructs were largely as expected. Mindfulness scores were positively but only weakly correlated with psychological constructs that included assessments of awareness, openness to experience, and curiosity about one's current experience. Conversely, mindfulness appears to be distinct from anxiously preoccupied or ruminative forms of self-focused attention. The criterion validity of the TMS was supported by demonstrating higher scores on both factors for participants after an 8-week MBSR group and in individuals with greater than one year versus less than one year of mindfulness meditation experience. Furthermore, Decentering showed incremental validity in the prediction of psychological distress.

At a descriptive level, the two factors of this empirically derived model are consistent with the second factor of a two-component mindfulness offered by Bishop et al. (2004), that is, an attentional quality characterized by a curious, open, accepting awareness of experience including bodily sensations, thoughts, or emotions. The items of Factor 1 (Curiosity) reflect an attitude of wanting to learn more about one's experiences. The items of Factor 2 (Decentering) reflect a shift from identifying personally with thoughts and feelings to relating to one's experience in a wider field of awareness (Teasdale et al., 2002). However, our results did not provide support for the first component of Bishop et al.'s definition, that is, the active self-regulation of attention to immediate experience. The lack of support for the first component does not appear to be due to the lack of items reflecting attentional self-regulation in the original item pool (e.g., "I was paying attention to the 'here and now'"; "I was aware of what my mind was doing from moment to moment"; "I purposefully paid attention to each experience for the sake of seeing what I could learn about myself"). One possibility is that attentional self-regulation and the quality of that attention cannot be easily separated by self-report measures in that one cannot be curious, open or accepting about experiences that one has not brought their attention to. In support of this notion, the CAMS (Feldman et al., 2004) represents four factors (Attention, Awareness, Present-Focus, and Acceptance/Nonjudgment) that load on a single mindfulness factor. Similarly, the FMI (Buchheld et al., 2001) assesses nonjudgmental, open observation of present-moment experience that is best interpreted unidimensionally.

The findings of this study support a conceptualization of mindfulness that has at least two factors. In contrast, four currently available mindfulness questionnaires (e.g., MAAS, FMI, CAMS, and MQ) are comprised of just one factor. It is important to highlight, however, that the original form of the MAAS (Brown & Ryan, 2004) initially had an acceptance factor that was dropped as it demonstrated no incremental validity in predicting criterion measures. Furthermore, both the 12-item CAMS (Feldman et al., 2004) and the 30-item FMI (Buchheld et al., 2001) had four factors that were scored as a single factor due to weak psychometric properties of the four scales for each measure. Moreover, Baer, Smith, Hopkins, Krietemeyer, and Toney (2006) support the notion of mindfulness as a multifaceted construct in a recent investigation of the factor structure of mindfulness using items from these three mindfulness questionnaires along with the KIMS (Baer et al., 2004) and the MQ (Chadwick et al., 2005). Given that the various mindfulness questionnaires have been designed from different operational definitions and have been validated on a range of student and clinical samples, further research is required to investigate how the TMS relates to other mindfulness questionnaires and to better understand the nature of the construct.

The finding that Curiosity scores were associated with greater meditation experience among individuals trained in MBSR versus those that practiced Shambhala Buddhist meditation may provide further criterion related validity for the TMS. This finding is consistent with important differences in the instructional set associated with these two meditation practices. Non-secular mindfulness practice as typically taught in a clinical context encourages one to "investigate your distractions" (Rosenberg, 1998, pp. 170–171), whereas in the Shambhala tradition one practices, in part, to gain greater degrees of concentration and attentional focus. When distractions do arise, practitioners are discouraged from taking an active investigative interest in the nature of their thoughts, feelings, or sensations, and urged to return to the primary focus of attention (Dunn, Hartigan, & Mikulas, 1999; Goldstein, 2002).

Only the Decentering subscale showed incremental validity in the prediction of perceived stress and distress. The concept of decentering has previously been recognized as playing a central role underlying the efficacy of cognitive therapy (CT; Beck, Rush, Shaw, & Emory, 1979; Ingram & Holllon, 1986). A shift in one's cognitive perspective known as *decentering* or *disidentification* is thought to lead to a change in one's relationship to negative thoughts and feelings such that one can see negative thoughts and feelings simply as passing events in the mind rather than reflections of reality. If changes in Decentering scores can be shown to precede changes in criterion measures, the TMS may prove useful in investigations of the mediating role of mindfulness in observed outcomes and in efforts to understand the psychological processes by which mindfulness reduces general stress and emotional distress levels. At 13 items, the TMS is brief (it typically requires only 3 minutes to complete the scale itself, see Appendix) and can be incorporated into mindfulness-based treatments with minimal intrusiveness or response burden.

There are a number of limitations to this study that need to be considered. First, the initial 15-item TMS was modified by deleting two items to improve the fit in the validation sample. Although we recognize that the findings that influenced our decision may have been due to the characteristics specific to the CFA sample, this one modification served to simplify the model (MacCallum et al., 1992). Although we felt justified in refitting this simpler model, evaluation with independent samples is required to further validate the 13-item TMS.

Second, although the procedure of assessing the subjective experience of mindfulness retrospectively in reference to an immediately preceding mindfulness meditation session increases the reliability of the measure, the results obtained may not be generalizable across mindfulness meditation sessions nor to mindfulness in everyday life. The TMS assesses the level of mindfulness during a single point in time and thus may not reflect a respondent's true or average capacity to evoke a state of mindfulness. Multiple testing periods should yield an indication of the ability to evoke a mindfulness state. In terms of using the TMS in evaluation research, we recommend multiple assessments of mindfulness at pre-, mid- and post-treatment to ensure reliable estimates of the respondent's ability to cultivate a state of mindfulness. This is because participants in meditation-based treatments may develop the capacity to evoke mindfulness generally, but may fail to do so effectively on a given testing session (e.g., at posttest for idiosyncratic reasons such as fatigue or extreme stress), resulting in misleading TMS scores. Further research is required to establish whether the ability to invoke a mindful state during meditation practice as measured by the TMS generalizes to the degree of mindfulness in everyday life.

Third, the frequency and duration of meditation sessions were not assessed for the experienced meditators. Thus, it is possible that there were significant variations in the practice level within this group. For example, four-year follow-up examinations of the practice behavior among individuals who completed MBSR programs at the University of Massachusetts have shown that many people who claim to formally meditate actually meditated less than once weekly for prolonged intervals or less than 3 times weekly for less than 15 minutes per session (Kabat-Zinn, Lipworth, Burney, & Sellers, 1987). Future research should include efforts to better characterize an individual's meditation practice.

In summary, our findings show that the TMS is a reliable and valid measure of mindfulness and depicts the latter as a state of curious, decentered awareness of one's experience that is operationally and conceptually distinct from anxiously preoccupied and ruminative states of self-focused attention. Thus, the TMS may be a useful instrument in investigations of the mediating role of mindful awareness in mindfulness-based interventions and observed patient outcomes.

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Appendix

Toronto Mindfulness Scale

Instructions: We are interested in what you just experienced. Below is a list of things that people sometimes experience. Please read each statement. Next to each statement are five choices: "not at all," "a little," "moderately," "quite a bit," and "very much." Please indicate the extent to which you agree with each statement. In other words, how well does the statement describe what you just experienced, just now?	**Not at all**	**A little**	**Moderately**	**Quite a bit**	**Very much**
1. I experienced myself as separate from my changing thoughts and feelings.	0	1	2	3	4
2. I was more concerned with being open to my experiences than controlling or changing them.	0	1	2	3	4
3. I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings or sensations.	0	1	2	3	4

4. I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things 'really' are.	0	1	2	3	4
5. I was curious to see what my mind was up to from moment to moment.	0	1	2	3	4
6. I was curious about each of the thoughts and feelings that I was having.	0	1	2	3	4
7. I was receptive to observing unpleasant thoughts and feelings without interfering with them.	0	1	2	3	4
8. I was more invested in just watching my experiences as they arose, than in figuring out what they could mean.	0	1	2	3	4
9. I approached each experience by trying to accept it, no matter whether it was pleasant or unpleasant.	0	1	2	3	4
10. I remained curious about the nature of each experience as it arose.	0	1	2	3	4
11. I was aware of my thoughts and feelings without overidentifying with them.	0	1	2	3	4
12. I was curious about my reactions to things.	0	1	2	3	4
13. I was curious about what I might learn about myself by just taking notice of what my attention gets drawn to.	0	1	2	3	4

Scoring:

Key: All items were written in the positively keyed direction, so no reverse scoring of items is required.

Curiosity score: The following items are summed: 3, 5, 6, 10, 12, 13
Decentering score: The following items are summed: 1, 2, 4, 7, 8, 9, 11

REGULAR ARTICLE

Mass profiling-directed isolation and identification of a stage-specific serologic protein biomarker of advanced prostate cancer

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Carcinoma of the prostate (CaP) is the second leading cause of cancer-related mortality among American men. While high cure rates are associated with localized CaP, no cure exists for advanced recurrent disease. At present there are no known serologic biomarkers specific to this stage of the disease. Several groups have used mass spectrometry (MS) based mass profiling (MP) combined with multivariate analysis to identify diagnostically predictive protein peaks for CaP in serum and tissues. Nevertheless, an appreciable level of skepticism exists for MP attributed primarily to a lack of definitive protein characterization. To address this problem, we have applied an approach that combines MP with a whole-protein based top-down separation strategy for the identification of a stage-specific marker in a group comprising 16 patients with CaP (metastatic and localized disease) and 15 healthy individuals. MP, combined with multivariate analysis, yielded 17 serum proteins specific to metastatic disease. A single protein detected at *m/z* 7771 was found to be significantly decreased in the sera of all the metastatic CaP patients but not in localized CaP or healthy individuals. This protein was therefore chosen as the primary candidate for further analysis. The complex nature of the serologic proteome necessitated an isolation strategy that included a C18 prefractionation, followed by multidimensional liquid chromatography and, finally, two-dimensional gel electrophoresis. The separation process was monitored by UV-Vis and matrix-assisted laser desorption/ionization-time of flight MS analysis. This strategy was found to greatly facilitate subsequent MS characterization of the unknown protein, which was identified as platelet factor 4, a chemokine with prothrombolytic and antiangiogenic activities. Confirmation was achieved using both Western blot analysis and enzyme-linked immunosorbent assay. With the growing interest in using MP for patient classification and diagnosis, our approach and its variations should be powerful in the separation and characterization of proteins following MP.

Keywords:
Multidimensional liquid chromatography / Platelet factor 4 / Prostate cancer / Protein profiling

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Abbreviations: BPH, benign prostatic hyperplasia; **CaP**, carcinoma of the prostate; **DE**, delayed extraction; **HMW**, high-molecular weight; **LMW**, low-molecular weight; **MP**, mass profiling; **PF4**, platelet factor 4; **PSA**, prostate-specific antigen; **SCX**, strong cation exchange

1 Introduction

Carcinoma of the prostate (CaP) is the second leading cause of death from cancer in American males, with an estimate of nearly 30 000 deaths in 2003 alone. Approximately 35% of patients diagnosed with CaP will exhibit a rise in prostate-specific antigen (PSA) levels within 10 years following definitive local therapy, indicating a biochemical recurrence of CaP [1–3]. Those patients with confirmed metastatic disease have a median actuarial time of 5 years following diagnosis [4]. While PSA is considered useful for diagnosing recurrent disease following prostatectomy, the presence of PSA is not specific to metastasis and is affected by hormonal therapy. To date, no metastatic-specific serological marker exists for the early detection of metastatic CaP.

Serum has served as a highly relevant target for the study of cancer, since cancer development is reliant upon various endocrine/paracrine effectors. From this perspective, several research groups have reported on the use of mass profiling (MP) by MALDI-TOF MS and its variant, SELDI-TOF MS, as a means of diagnosing cancer [5–12]. In addition, we have recently reported detection of CaP by MP of low-molecular weight (LMW) proteins, following enrichment with C18 nonporous beads, with a sensitivity and specificity of 94.1 and 99.0%, respectively [12]. Interestingly, in this study, hierarchical cluster analysis demonstrated that patients with advanced CaP clustered tightly within the CaP group, indicating that advanced CaP may cause a change to the serologic proteome distinct from localized disease. In order to further explore this observation, random serologic samples from eight patients with advanced CaP, together with eight patients with local CaP, and 15 healthy individuals were reanalyzed. From this reanalysis, 17 protein ions were found to be distinctly different in abundance in advanced CaP compared to the other two study groups. However, one protein ion at m/z 7771 was found to be significantly decreased in all patients with metatstatic CaP tested. We therefore chose this protein to isolate and characterize using a MP-directed top-down approach.

While MP-related techniques have begun to show potential, shortcomings of this approach have been raised [13, 14], with one of these being related to the question of subsequent isolation and characterization of the protein of interest, which is especially relevant for complex biological fluids such as serum. This shortcoming is due in part to the fact that while an m/z value is obtained from MP for those protein peaks deemed diagnostically significant, a definitive identification of the protein of interest does not accompany that value. Put simply, difficulty often arises as a result of two main points: (1) multidimensional separation strategies are required to adequately purify the protein of interest for unambiguous MS identification, and (2) each fraction "must" be monitored by MS analysis throughout the separation process to ensure that the protein of interest with an m/z value matched to that identified by MP is being isolated. In other words, one must keep the top-down approach intact, so that the protein of interest is not digested throughout the isolation processes. While this concern has been somewhat addressed relative to tissue-based MP strategies, highly complex biological fluids such as serum have proven to be challenging in this regard [15–17]. This report aims at highlighting a multidimensional separation approach, which could be adapted as needed, to tackle the arduous task of isolating and characterizing proteins identified through MP.

2 Materials and methods

2.1 Patients and serum samples

Patients were referred by a network of participating urologists from the University of Massachusetts (UMass)-Memorial Medical Center, Fallon Clinic, and private offices in central Massachusetts. Sera were collected from patients with biopsy-confirmed local CaP and metastatic disease prior to treatment with hormones, radiation, or chemotherapy. Patients with metastatic disease had PSA-confirmed early recurrence of CaP. Sera were also obtained from 15 healthy individuals from an open screening program at the University of Massachusetts Medical School. Blood samples were drawn into 10 mL red top tubes. Sera were separated, divided into aliquots, and stored at −80°C at the site of collection. After receiving the samples from the site of collection, sera were further divided into 100 μL aliquots. Each aliquot was thawed once for each experiment. All participants were between 40 and 86 years of age. This study was approved by the University Institutional Review Board, and all patients provided informed consent. Normal individuals were labeled "Norm", patients with local CaP were labeled "CaP-local", and patients with recurrent CaP "CaP-met" throughout. Patient history is summarized in Table 1.

Table 1. Patient history

	Normal individuals (Norm)	Patients with local disease (CaP-local)	Patients with advanced disease (CaP-met)
Number	15	8	8
Age range	40–83	47–86	56–74
Average age	61.3	66.6	67.4
PSA (<4.0)	15	2	n.a.
PSA (4.0–10.0)	0	4	n.a.
PSA (>10)	0	2	n.a.
PSA slope, ng/mL	n.a.	n.a.	0.016–0.256
BPH[a]	2	–	–

n.a., not applicable

a) BPH, benign prostatic hyperplasia

2.2 Sample preparation

Protein extraction was performed according to the method previously described [12]. Briefly, serum was diluted 1:50 in H_2O and further diluted 9:1 in 10% v/v TFA. Activated Corasil Bondapak C18 37–50 μ resin (Waters, Millford, MA, USA) was then added to the sample 1:10 v/v in a 0.5 mL polypropylene centrifuge tube and vortexed for 2 min at room temperature. The supernatant was discarded and the resin washed twice with 100 μL 1% TFA. Extraction of the proteins was performed by adding 50 μL of 0.25% TFA in 75% ACN and vortexing for 2 min and transferring the extract to a clean tube.

2.3 Mass profiling

MP was carried out using the Ciphergen Protein Biosystem (PBS) II, equipped with a UV nitrogen laser (337 nm) and delayed extraction (DE), in conjunction with Ciphergen 2.1 version software (Fremont, CA, USA) as previously described [12]. Freshly prepared protein extracts were mixed 1:1 with the 50% saturated matrix consisting of sinapinic acid (Fluka, St. Louis, MO, USA) in 50:50 1% TFA:ACN. The dried droplet method was used to crystallize 1 μL of the matrix/sample mixture on a gold sample probe. The mass window was set to acquire data from 0.1 to 20 kDa. External calibration was carried out before the experiment using $[M + 1]^+$ and $[M + 2]^{2+}$ ions from the following protein standards: bovine insulin (M_r 5733.6), bovine ubiquitin (M_r 8564.8), and bovine cytochrome *c* (M_r 12 230.9). Each mass spectrum was an accumulation of an average of 200 laser shots. All patient sera were analyzed in triplicate.

2.4 Data analysis

Data analysis was performed as previously described [12]. Briefly, the mass spectra were exported as text files, each containing an average of 7000 data points (*m/z*, intensity pairs). These files were imported into Peakfit 4.0 (SPSS, Chicago, IL, USA) for smoothing, background correction, and normalization. The processed text files were then imported into a single Excel spreadsheet and the data points aligned according to a *m/z* axis which was based upon the mass accuracy of the Ciphergen PBS II Instrument (~200 ppm) according to $M_i + 1 = (M_i + M_i \times 0.0002)$, where M is the integral *m/z* value from *m/z* 2000 to 13 500 and i = 1–6659. The resultant matrix was then standardized across the data set according to the equation $(S_X - S_L)/(S_H - S_L)$, where S_X is the sample intensity, and S_H, S_L are, respectively, the highest and lowest intensity of a particular *m/z* within the two groups (Norm and CaP-met). A standard weighted-means-averaging algorithm was then applied [18] to filter the highest weight, which best differentiated the normal *versus* cancer-met groups. Weight values (W) were assigned to each *m/z* based on the ratio of the differences in mean intensity between CaP-met and normal ($\mu_1 - \mu_2$), to their respective SDs ($\sigma_1 + \sigma_2$), according to the equation $W = (\mu_1 - \mu_2)/(\sigma_1 + \sigma_2)$. Top-weighted *m/z* values with a p value <0.05 (Norm *vs.* CaP-met) were selected. From this, 82 *m/z* values distinct for the CaP-met group compared to the CaP-local groups were selected. The selected *m/z* values, which were either up- or down-regulated in the advanced CaP group, were verified to be actual protein peaks, using Origin 6.0 (OriginLab, Northampton, MA, USA). Seventeen defined protein peaks were represented by these 82 *m/z* values. Hierarchical clustering analysis was performed (Ward's method and 1-Pearson r) on these 17 highest weighted protein peaks using Stastistica 6.0 (StatSoft, Tulsa, OK, USA).

2.5 Chromatographic isolation

Because the protein peak of interest (*m/z* 7771) was found to be dramatically decreased in patients with advanced CaP, sera from normal individuals were used for protein isolation and identification in the following way. LMW proteins were first enriched using a lipophilic extraction method similar to that used for MP. Specifically, 1 mL of serum equating to ~55 mg of protein was pooled from several normal individuals, diluted 1:20 in 1% TFA, and loaded onto a preactivated C18 SPE cartridge (500 mg; MAXI-CLEAN; Alltech Associates, IL, USA). The cartridge was washed with 1% TFA and subsequently eluted with 0.25% TFA/75% ACN. The eluate was mixed with 0.02 volumes of 0.5 M ammonium acetate buffer (pH 3.8) to a final concentration of 10 mM ammonium acetate. The resulting solution was then applied to a strong cation exchange (SCX) column (HiTrap SP HP, column volume 1 mL; Amersham Biosciences, Piscataway, NJ, USA) preequilibrated with 10 mM ammonium acetate (pH 3.8). Separation was carried out with five-step gradient elutions of 0.5, 0.7, 0.8, 0.9, and 1 M NaCl in 10 mM ammonium acetate, pH 3.8, using a digital metering pump (Series I; LabAlliance, PA, USA) at 1 mL/min. Protein fractions were monitored at 214 nm using a Waters 486 tunable absorbance detector, and fractions were collected and analyzed off-line by MALDI-TOF on the Ciphergen PBS II with a gold probe. The fraction containing the protein of interest was further fractionated by RP-HPLC using a 5 μm C4 column, 4.6 × 250 mm (214TP54; GraceVydac, Columbia, MD, USA). Waters 510 pumps with an automated gradient controller were used to deliver the following solvents at a flow rate of 0.8 mL/min: mobile phase A, 5% ACN/0.1% TFA and mobile phase B, 95% ACN/0.1% TFA. The solvent gradient was linear from 0 to 100% B over 45 min, followed by a hold at 100% B for 10 min. The run was monitored by absorbance at 214 nm while collecting 1.0 min fractions. Each collected fraction was subsequently monitored by MALDI-TOF on the Ciphergen PBS II with a gold probe. Fractions that contained the protein peak of interest were evaporated to dryness under vacuum using a Savant SpeedVac (Holbrook, NY, USA).

2.6 2-DE

2-DE was performed as previously described [19]. Briefly, the first dimension was carried out on an IPGphor with an Immobiline DryStrip of pH 3–10NL, 7 cm (Amersham Biosciences). The dried HPLC fraction containing the protein of interest was dissolved into 150 μL of rehydration buffer (7 M urea, 2 M thiourea, 4% CHAPS, 0.5% IPG buffer (Amersham Biosciences), 1% DTT). IEF was comprised the following steps: 30 V for 10 h as active rehydration; 500 V for 0.5 h, 1000 V for 0.5 h, and 8000 V for 3.5 h, totaling a final 25 000 Vh. The second dimension was performed using a 15% polyacrylamide gel at 100 V constant voltage for 1 h. An LMW marker set (Amersham Biosciences) was used as reference. Silver staining was performed using a Silver Stain Plus kit (Bio-Rad, Hercules, CA, USA) according to the manufacturer's protocol.

2.7 In-gel tryptic digestion

Tryptic digestion was performed as described elsewhere [20]. Briefly, gel spots were excised and destained with a 1:1 mixture of 30 mM potassium ferricyanide (Sigma, St. Louis, MO, USA) in 100 mM sodium thiosulfate (Sigma). Reduction of disulfides was then performed with 10 mM DTT in 100 mM NH_4HCO_3 for 15 min at 55°C, followed by alkylation with iodoacetaminde in 100 mM NH_4HCO_3 for 15 min. After washing with 25 mM NH_4HCO_3 in water, the gel pieces were minced, dehydrated with ACN, dried by SpeedVac, and subjected to trypsin digestion using a modified porcine trypsin (Promega, Madison, WI, USA) for 10 h at 37°C. Peptide extraction was carried out with 5% TFA in 60% ACN.

2.8 Protein identification by reflectron MALDI-TOF MS

The tryptic digest solution was analyzed using the standard dried droplet method with CHCA matrix. Subsequent protein identification was carried out on a Micromass MALDI-TOF mass spectrometer in reflectron mode. Mass spectra were acquired over m/z 600–3000. Trypsin autolysis ions (MH^+ 842.5099; MH^+ 1045.570; MH^+ 1940.9351; MH^+ 1987.0784; MH^+ 2211.1045) were used as internal calibrants. Peptide m/z values were then searched against a human subset of the Swiss-Prot database for protein identifications using the MASCOT search engine (http://www.matrixscience.com).

2.9 Western blot analysis

One hundred micrograms of total protein (2 μL of serum) obtained from randomly selected four normal individuals and four patients with metastatic disease were denatured in SDS and loaded onto an 18% precast gel (Bio-Rad) as *per* the manufacturer's instructions. Blotting was carried out using platelet factor 4 (PF4) specific polyclonal antibodies following the manufacturer's instructions (Peprotech, Rocky Hill, NJ, USA). A secondary donkey antirabbit antibody tagged with horseradish peroxidase was used in conjunction with ECL Plus (Amersham Biosciences) to visualize the protein. Blots were then analyzed on a Storm 840 instrument (Amersham Biosciences) in the blue laser mode. Proteins bands were quantified using Kodak 1-D software (Eastman Kodak, New Haven, CT, USA).

2.10 ELISA

The PF4 levels were determined using the IMUCLONE PF4 ELISA kit (American Diagnostica, Greenwich, CT, USA) according to the manufacturer's instructions, with the exception that serum samples were diluted 1:2000 with the buffers provided. All experiments were performed in duplicate.

3 Results

3.1 MP and statistical analysis of serum

An averaged spectrum was initially plotted to represent each patient group and overlaid within one graph (Fig. 1*a*). This resulted in some visible differences specific to each group such as the ion at m/z 7771 (Fig. 1*b*). Multivariate analysis was also carried out on the entire data set in order to identify additional relevant markers. This resulted in 82 m/z values distinct for the CaP-met group compared to the Norm with *p*-values well below 0.05. These 82 m/z values translated to 17 defined peaks as visualized in Origin 6.0 (Fig. 1*a*). Of these, eight were increased in the CaP-met group (m/z 2183, 2461, 3397, 3852, 3892, 6777, 6799, and 11 624), while nine were decreased (m/z 2020, 2041, 2788, 3578, 3885, 4055, 5067, 7771, and 7981) (Fig. 2*a*). Hierarchical cluster analysis was then carried out on this selected set of ions to produce an icicle plot, which illustrates complete separation between the CaP-met and the other two groups (Fig. 2*b*). As expected, the CaP-local and healthy groups did not cluster separately in this study due to the fact that the selected m/z values were chosen because they were only changed in the CaP-met group. In addition, two of the 17 peaks identified, corresponding to ions at m/z 3892 and 7771, were found to exhibit the highest statistical significance in the comparison between Norm and CaP-met groups. The ion profiles of these peaks m/z 3892 and 7771, together with m/z 3885, an adjacent peak of m/z 3892, are shown in Fig. 1*b*. The identification of a decreased peak at m/z 3885 and an increased peak at m/z 3892 in the serum from CaP-met patients demonstrates the robustness of the MP strategies used in discerning closely adjacent peaks. The ion at m/z 7771 was found to exhibit the greatest statistical significance (highest differential in abundance compared to normal and smallest intrapopulation variation), in addition to a high level of consistency throughout the entire study group with an average decrease of 3.1-fold (Fig. 3).

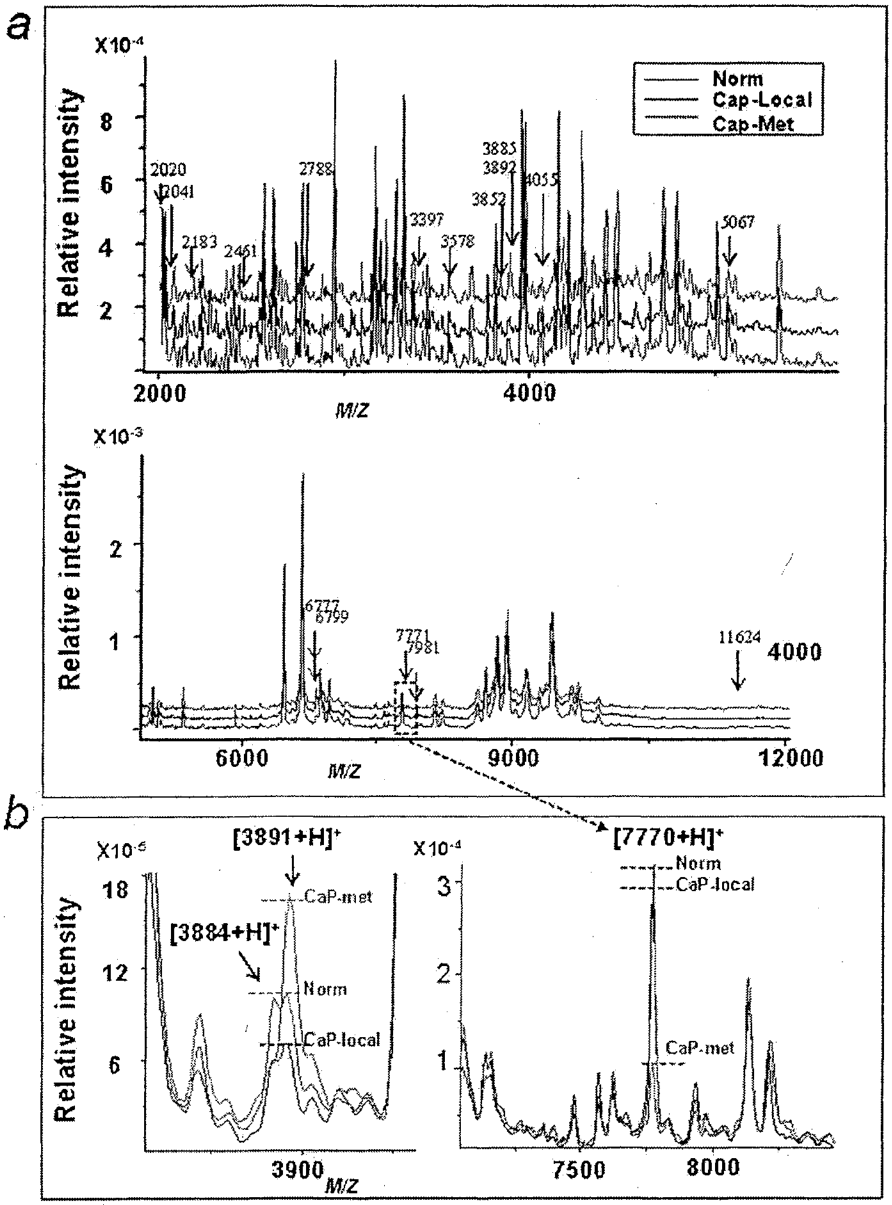

Figure 1. Averaged mass spectra for the CaP-local, CaP-met, and Norm groups. (*a*) C18 SPE extraction was performed on sera from healthy individuals, patients with local CaP, and metastatic CaP, as described in Section 2, and profiles acquired using a Ciphergen PBS II with a gold probe. Averaged mass spectra for each patient group are shown. Intensity values of CaP-local and CaP-met profiles are offset by 1×10^{-4} and 1×10^{-3} relative intensity, respectively. Very similar patterns between the three groups are demonstrated. However, differences in ion abundance between the three profiles were revealed by statistical analysis. Top-weighted protein peaks are indicated by arrows. (*b*) An expanded view showing the protein ions of interest with the highest weight values at *m/z* 3892 and 7771. The *m/z* 3392 ion is increased specifically in the CaP-met group while the *m/z* 3885 and *m/z* 7771 are decreased in the CaP-met group. For ease of comparison, the intensity values of CaP-local and CaP-met profiles are not offset. The average peak heights of protein ion *m/z* 3392 and 7771 in each group are indicated by horizontal dotted lines.

3.2 Isolation and characterization of the *m/z* 7771 protein

Sera from healthy individuals were pooled and extracted by the SPE approach as outlined above in Section 2. This step allowed enrichment of LMW proteins as demonstrated by MALDI-TOF MS (Figs. 4*b*, 5*a*). This step leads to a reduction in protein content by nearly 95% (Fig. 4*a*), with a recovery of ~1.3 mg of total protein from 1 mL of serum. SCX chromatography was then carried out on this fraction, which resulted in elution of the *m/z* 7771 protein in the 0.9 and 1.0 M salt fractions (Fig. 5*b*). Unfortunately, a number of high-abundance proteins including albumin were also found to coelute with the protein of interest in these fractions, and so RP-HPLC gradient elution chromatography was applied as a second-dimension separation step to further purify those fractions. The protein of interest at *m/z* 7771 was found to elute at ~26% ACN just prior to the albumin peak (Fig. 6*a*). MALDI-TOF MS analysis of the fraction containing the protein of interest indicated that at least three other less abundant proteins were present with *m/z* values near to that of the protein of interest (Fig. 6*b*), while a number of high-abundance proteins eluted later at higher concentrations of ACN (Fig. 6*c*). Adequate separation of the target protein from the higher abundance proteins including albumin was achieved by this approach (Fig. 6*b*).

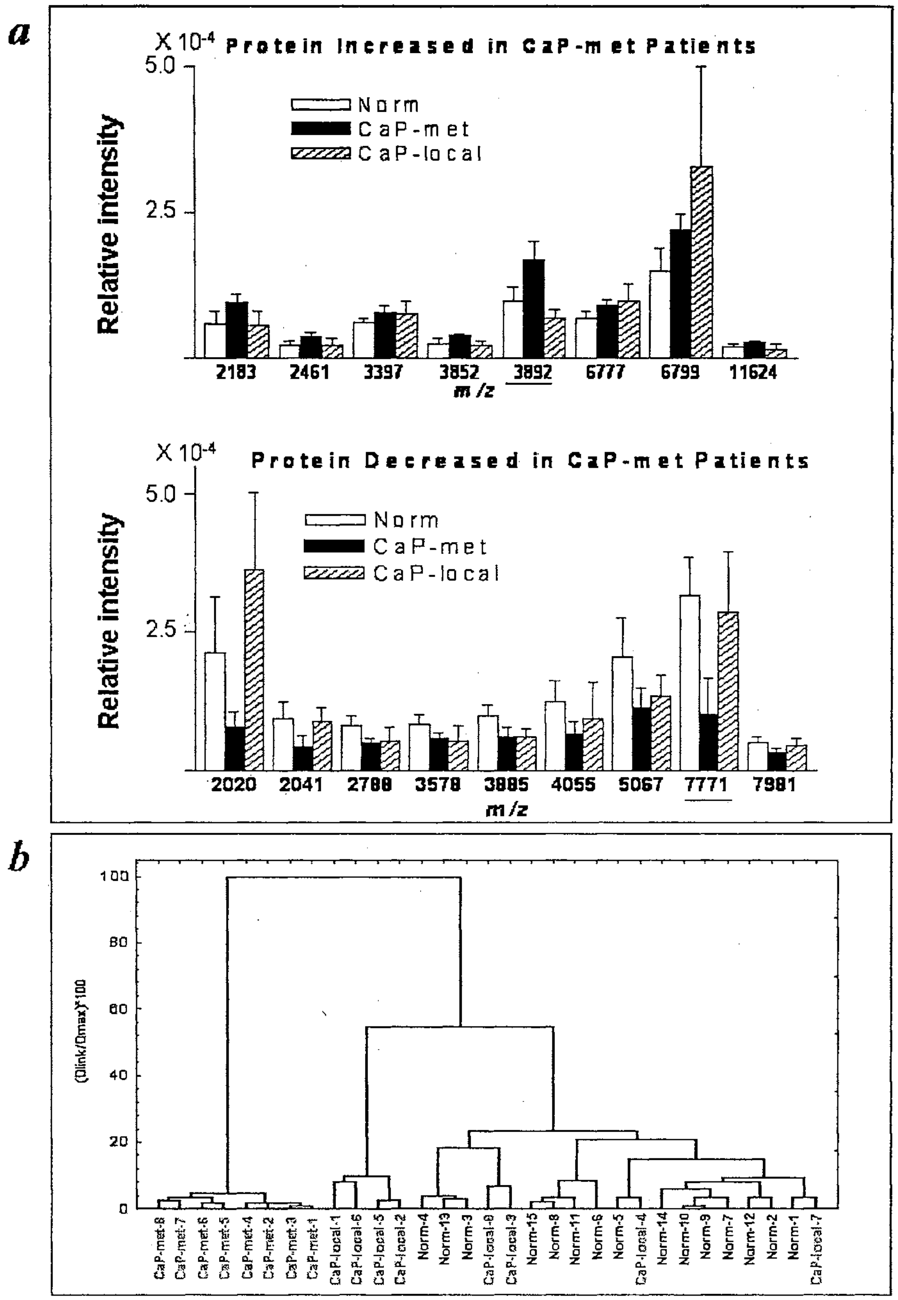

Figure 2. Protein peaks changed in patients with CaP-met disease. (*a*) Multivariate analysis was carried out on all the mass spectra obtained from each patient group as described in Section 2. From this analysis eight peaks were found to be significantly increased (upper plot) while nine were decreased (lower plot) in the CaP-met group, compared to the Norm and CaP-local groups. Average intensity and SD error bars are shown for each peak with $p < 0.05$ (Norm *vs.* CaP-met) in each case. Two ions, m/z 3892(↑) and m/z 7771(↓) with the greatest statistical significance are shown underlined. (*b*) Hierarchical clustering analysis was performed on all 17 ions with the resultant icicle plot shown. CaP-met group was found to cluster tightly and completely separated from the other two groups.

The RP-HPLC fraction containing the apparently pure target protein as determined by MALDI-TOF MS was further purified using 2-DE. This was found to be a necessary purification step, since an initial attempt of protein identification on the tryptic digest of the RP-HPLC fraction containing the protein of interest did not yield a confident identification with the predicted mass (7.7 kDa), using either LC-MS/MS or MALDI-TOF MS mass fingerprinting. While 1-D SDS-PAGE would generally be adequate at this stage for further purification, 2-DE provided additional information for protein identification including p*I*, along with the ability to further separate proteins that have similar M_r. One major spot and other defined protein spots were found to be present within a tight region following 2-DE, all with similar p*I*s of ~9 and with masses of ~7.5–8 kDa (Fig. 7). Since the protein of interest (m/z 7771) presented with the greatest intensity in the HPLC fraction (Fig. 6*b* lower panel), MALDI-TOF reflectron MS-based mass fingerprinting was carried out on the major, highest intensity silver-stained spot (Fig. 7; circled spot) following in-gel digestion. The protein in this gel spot

Table 2. Predicted and calculated mass for PF4 tryptic peptides

Measured *m/z*	Theoretical (mi[a])	Peptide sequence	Modification[b]	MC[c]	Δm [d], Da	Start	End
944.534	944.528	(K)TTSQVRPR(H)	–	0	−0.006	15	22
1039.604	1039.615	(R)HITSLEVIK(A)	–	0	0.011	23	31
1333.704	1333.719	(K)ICLDLQAPLYK(K)	CAM-C	0	0.015	51	61
1347.747	1347.735	(K)ICLDLQAPLYK(K)	Cys-am	0	−0.012	51	61
1461.803	1461.814	(R)KICLDLQAPLYK(K)	CAM-C	1	0.011	50	61
1461.803	1461.814	(K)ICLDLQAPLYKK(I)	CAM-C	1	0.011	51	62
1475.792	1475.830	(R)KICLDLQAPLYK(K)	Cys-am	1	0.038	50	61
1475.792	1475.830	(K)ICLDLQAPLYKK(I)	Cys-am	1	0.038	51	62
1577.854	1577.847	(K)AGPHCPTAQLIATLK(N)	CAM-C	0	−0.007	32	46
1591.868	1591.863	(K)AGPHCPTAQLIATLK(N)	Cys-am	0	−0.005	32	46
1665.727[e]	1665.710[e]	(–)EAEEDGDLQCLCVK(T)	2 CAM-C	0	−0.017	1	14
1679.787[e]	1679.726[e]	(–)EAEEDGDLQCLCVK(T)	1 Cys-am, CAM-C	0	0.06	1	14
1693.765[e]	1693.741[e]	(–)EAEEDGDLQCLCVK(T)	2 Cys-am	0	0.02	1	14

a) mi, monoisotopic mass
b) CAM-C, cysteine modified by carbamidomethylation; Cys-am, cysteine modified by acrylamide
c) MC, miscleavage
d) Δm, mass difference between measured and theoretical tryptic fragments of activated PF4
e) Peptide fragment identified following retrospective mapping of active form of PF4

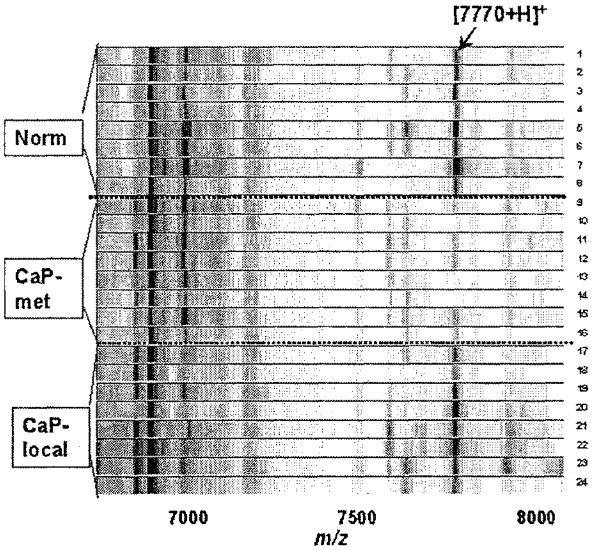

Figure 3. 'Gel view' diagram of a protein lost in the CaP-met group. A "gel view" diagram is shown with focus on the 6–8 kDa region of the MALDI-TOF mass spectra obtained using a Ciphergen PBS II. This diagram is made up of 24 separate spectra, eight of which were randomly selected from each patient group. Protein of interest, at *m/z* 7771, is shown decreased in the entire CaP-met group compared to the other two groups.

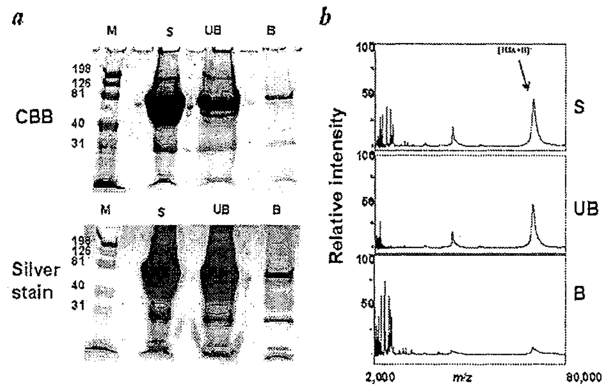

Figure 4. SPE of serum. 2 µL of serum was diluted 1:50 in 1% TFA and extracted with 10 µL of activated C18 resin. (*a*) Crude serum (S), C-18 unbound (UB), and bound (B) proteins were analyzed by SDS-PAGE. Replicate gels were stained with CBB and silver. Lane 1: S, Lane 2: UB, Lane 3: B. (*b*) MALDI-TOF analyses (on a Ciphergen PBS II) were carried out on S, UB, and B. After C18-SPE, a decrease in proportion of HMW proteins (*e.g.*, HSA) and a concomitant enrichment of LMW proteins compared to the unfractionated serum were observed. MALDI-TOF spectra were acquired using constant laser energy level and resulted from an accumulation of 200 laser shots.

was identified as PF4 by MALDI-TOF reflectron MS and MASCOT searching of the Swiss-Prot database (Fig. 8, Table 2). The predicted M_r for this protein as based on the gene sequence is greater than 10 kDa, and therefore does not generate a hit in databases which use gene-based predicted M_rs. However, the average mass of the active monomeric form of PF4 is known to be 7769.18 according to its reported primary structure [21], which is in very good agreement with the experimentally determined *m/z* value of 7771 (M_r 7770). The sequence coverage obtained was 84.3%, with all predicted tryptic peptides longer than four amino acids detected (Table 3).

Table 3. Sequence coverage for PF4

Amino acid sequence, precursor/active forms[a)]	Coverage[b)]
(1)MSSAAGFCASRPGLLFLGLLLLPLVVAFASA/(1')***EAEEDGDLQCLCV<u>K</u>TTSQV<u>R</u>P<u>R</u>HIT SLEVI<u>K</u>AGPHCPTAQLIATL<u>K</u>***NG<u>R</u>***<u>K</u>ICLDLQAPLY<u>KK</u>***I<u>KK</u>LLES(101/70')	84.3%

a) Potential cleavage sites are underlined, the identified fragments are shown in bold italic, and the number of amino acids are shown for both the precursor (1–101) and active (1'–70') forms of the protein. Theoretical average M_r for the active form of PF4 is 7769.18.

b) (%) MALDI-TOF coverage of the active form of PF4 (1'–70') is indicated.

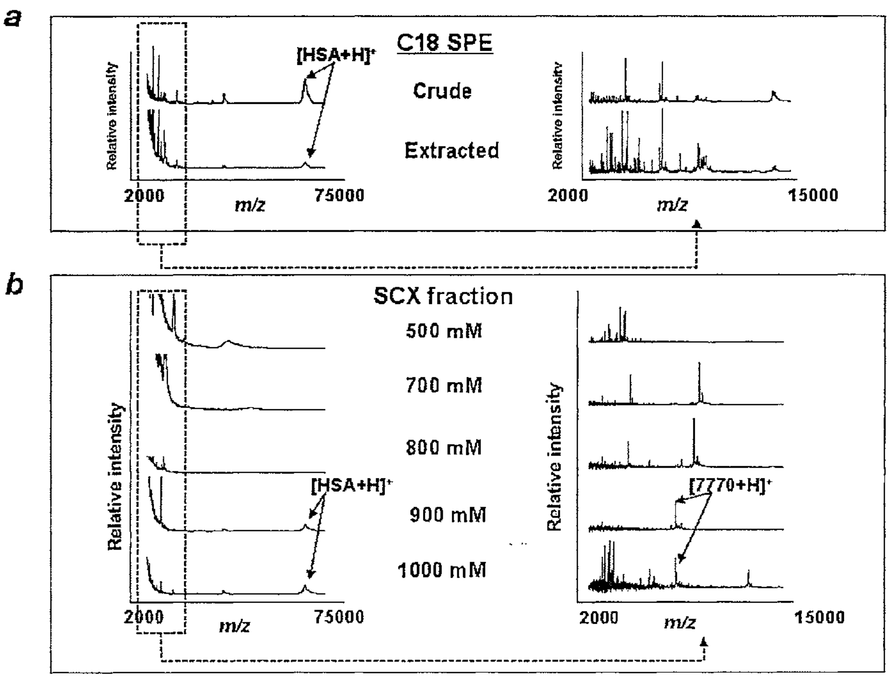

Figure 5. MALDI-TOF MS monitoring of C18 preparative and SCX fractionation. (*a*) A C18-based SPE was carried out on pooled sera from the Norm group with the resultant mass spectra shown. Profiles were obtained using a Ciphergen PBS II. Mass windows were limited to m/z 2000–75 000 (left) and m/z 2000–15 000 (right) in order to illustrate the enrichment of LMW proteins with a concurrent decrease in HMW proteins including albumin. (*b*) SCX chromatography was carried out following SPE extraction. MS analysis was carried out on each SCX fraction with increasing concentrations of NaCl as shown. Resultant spectra are shown with mass windows between m/z 2000–75 000 (left) and m/z 2000–15 000 (right). The 0.9 and 1 M salt fractions contained the peak of interest at an m/z of 7771. Unfortunately, residual HSA was also found to coelute with the protein of interest.

3.3 Western blot analysis

Western blot analysis was used to confirm the M_r and relative level of PF4 as tested by MS. The serum samples from the CaP-met patient group contained an average of 3.5-fold less PF4 as compared to that of the healthy individuals as illustrated by four sera randomly selected from each of these groups (Fig. 9). The M_r and relative abundance was found to be consistent with what was observed in the mass spectrometric analysis.

3.4 ELISA for PF4

All serum samples were assayed using a commercially available ELISA kit for PF4. The Norm, CaP-local, and CaP-met groups were found to contain, respectively, 9.1 ± 2.4, 7.9 ± 3.5, and 1.9 ± 1.6 mg/L of PF4. These results demonstrate an approximate four-fold decrease in PF4 serum levels ($p < 0.05$) for the CaP-met group compared to the healthy group, with no statistically relevant decrease for the CaP-local group (Fig. 10).

4 Discussion

In the present study, mass profiles were obtained on sera from CaP patients following the use of a C18 extraction technique, which has previously been shown to preferentially extract LMW proteins below 20 kDa [12]. We demonstrated, through the visual comparison of averaged spectra, that these profiles clearly contain protein markers with the potential for diagnostic significance specific to metastatic CaP compared to localized disease. Both univariate and multivariate analyses were used to identify 17 statistically significant diagnostic peaks specific to the CaP-met patient group. Eight of the peaks occurred in

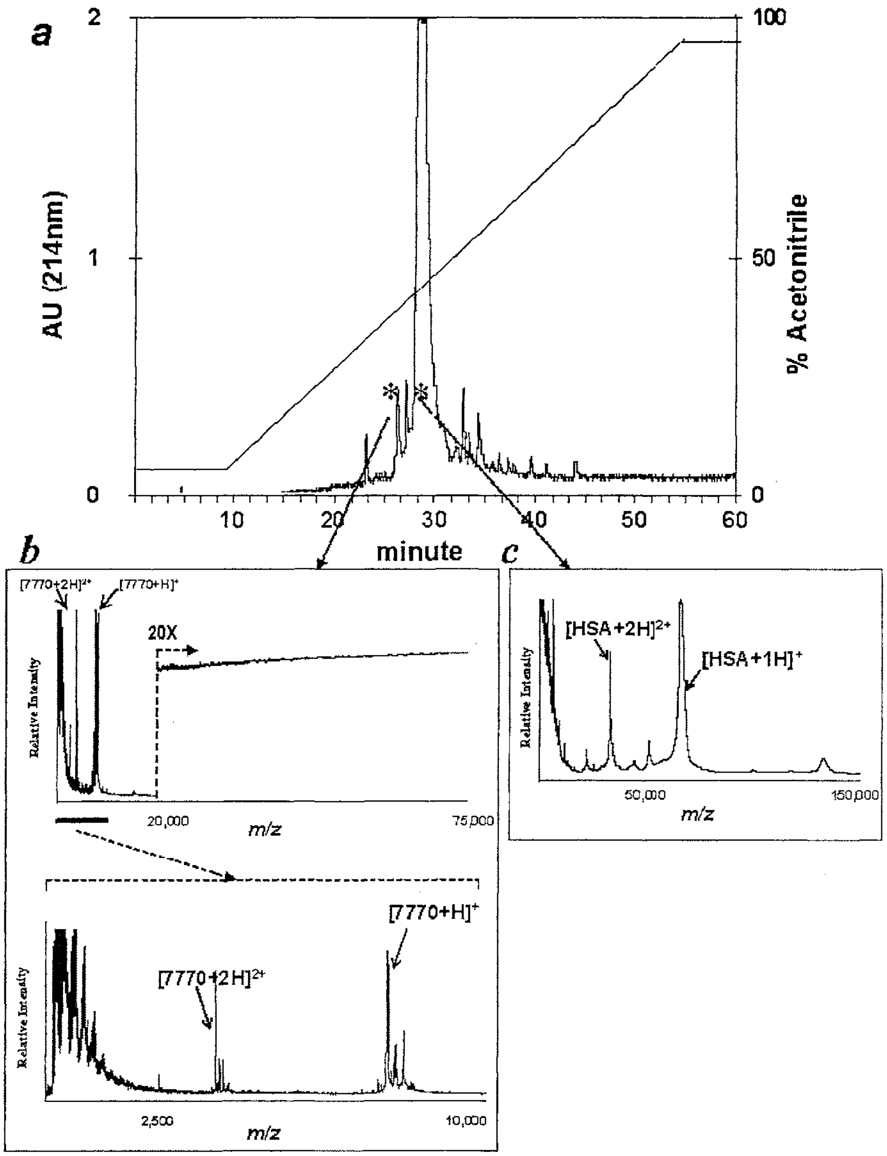

Figure 6. RP-HPLC separation. (*a*) Protein of interest was found to elute just prior to that of HSA in addition to other HMW proteins, as illustrated. (*b*) MALDI-TOF MS analysis of the collected peak elution at ~26 min was carried out on a Ciphergen PBS II with the mass windows set to *m/z* 2000–75 000 (upper panel) and *m/z* 2000–10 000 (lower panel). Upper panel: $[7770 + H]^+$ and $[7770 + 2H]^{2+}$ ions are indicated. Intensity of the two ions was off-scale. Relative intensity of *m/z* 20 000–75 000 is expanded 20-fold to demonstrate the absence of higher M_r components. Lower panel: the spectrum was normalized to the intensity of *m/z* 7771. (*c*) HMW proteins including HSA are shown to exist in significant quantities.

increased abundance, and nine peaks occurred in decreased abundance. The CaP-met group was found to cluster tightly and completely separate from the CaP-local and Norm groups in hierarchical clustering analysis using all the 17 diagnostic peaks.

The primary focus of this study was to demonstrate the utility of a multidimensional MP-directed top-down strategy to identify proteins detected solely on the basis of their relative intensities and corresponding *m/z* values pinpointed in the initial MP. We chose a single protein (*m/z* 7771) from this list to study in detail due to the fact that it is the most statistically relevant of the 17 protein ions. A number of streamlined versions of previously reported separation strategies [22–26] were initially employed to purify this protein in a fashion that would be complementary to a top-down approach. Strategies included the use of affinity-based pre-extraction of albumin and IgGs, along with SCX, RP, SEC, and 1-D and 2-D electrophoresis (data not shown). However, some of these techniques did not effectively capture the protein of interest, which is present at low abundance in serum or required extensive desalting, both of which result in some loss of the protein of interest. After much investigation, we have combined several published methodologies and applied them in a robust 4-D fractionation/separation scheme. The first is a C18 solid phase preparative extraction, followed by SCX step elution chromatography and RP-HPLC, and finally by 2-DE. The high acrylamide percentage of the second dimension of 2-DE was especially useful, since this percentage

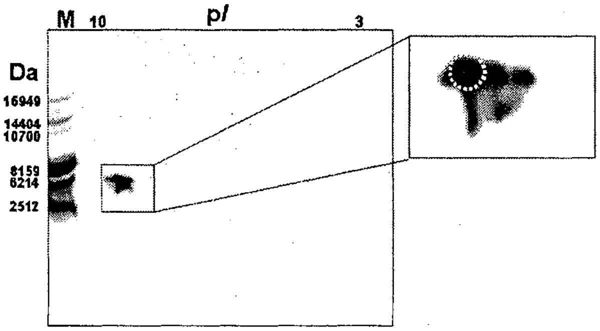

Figure 7. 2-DE served as the final purification step, carried out on the HPLC fractions containing the protein of interest. This separated four to five defined protein spots confined to a tight region with similar p*I*s at ~9 and with masses of ~7.5–8 kDa. Expanded view illustrates the presence of three more abundant proteins with similar M_rs but with slightly different p*I*s. Strongest gel spot circled with a dotted line was in-gel digested prior to protein identification by mass fingerprinting. M, molecular weight marker.

allowed the separation of very similar coeluting proteins, in addition to yielding additional information (p*I*) about the protein of interest. While this approach worked well to isolate the protein described, variations of this approach should prove useful and can be adapted to fit different experimental settings. For example, the C18 preparative step may be eliminated in the separation scheme for protein mixtures of lower complexity. In addition, 1-D SDS-PAGE could easily take the place of 2-DE in most cases, but a gel-based analysis/purification should not be eliminated entirely. The combination of RP and SCX chromatography is relatively inexpensive, easily scalable, and useful, regardless of the protein or peptide solution to be studied. In fact, other investigators have reported the use of SCX modified, together with hydrophobic modified magnetic beads as an orthogonal 2-D MP, which would be complementary to preparative purification of proteins found to be diagnostic [27].

Another point worth noting is related to the use of MALDI-TOF MS for monitoring the purity of the protein of interest throughout the whole separation scheme. In our initial analyses, the relatively pure appearing RP-HPLC fractions containing the protein ion *m/z* 7771, as assessed by MALDI-TOF MS, did not yield confident identifications with expected mass (7.7 kDa), by either LC-MS/MS analysis or MALDI-TOF MS mass fingerprinting. However, after 2-DE purification of the RP-HPLC fractions, the predominant spot was identified as PF4 with high sequence coverage (84.3%). The apparently pure RP-HPLC fraction may contain high-molecular weight (HMW) contaminants which could be missed during the MALDI-TOF MS monitored separation of the protein of interest (*m/z* 7771), because of the decreased detector sensitivity with increasing mass in the instrument used (PBS II) [12]. Caution should therefore be taken when using MALDI-TOF MS to assess purity during the purification process. A 1-D SDS-PAGE or 2-DE separation approach should complement the MALDI-TOF MS analysis in order to ensure a lack of higher M_r contaminants.

The protein ion chosen for this study, once purified, was identified by reflectron MALDI-TOF MS peptide mass mapping to be PF4. The sequence coverage was high, with all observable predicted peptides detected (longer than four amino acids). The M_r determined by MALDI-TOF MS matched that for the cleaved form of the active protein within 1 Da. This turned out to be an especially good test for this separation scheme for a number of reasons: (1) Although the fact that albumin shared similar physical properties and therefore coeluted through the second dimension of purification (SCX), it could be well separated in the third dimension (RP-HPLC); (2) other contaminating proteins of similar M_r and p*I* were found to separate well from the protein of interest following 2-DE; and (3) peptide coverage of PF4 by MALDI mass fingerprinting was considerably higher after 2-DE separation. To date, there have been very few reports of serologic proteins being definitively characterized [15, 17, 28] following initial identification by MP as diagnostically rele-

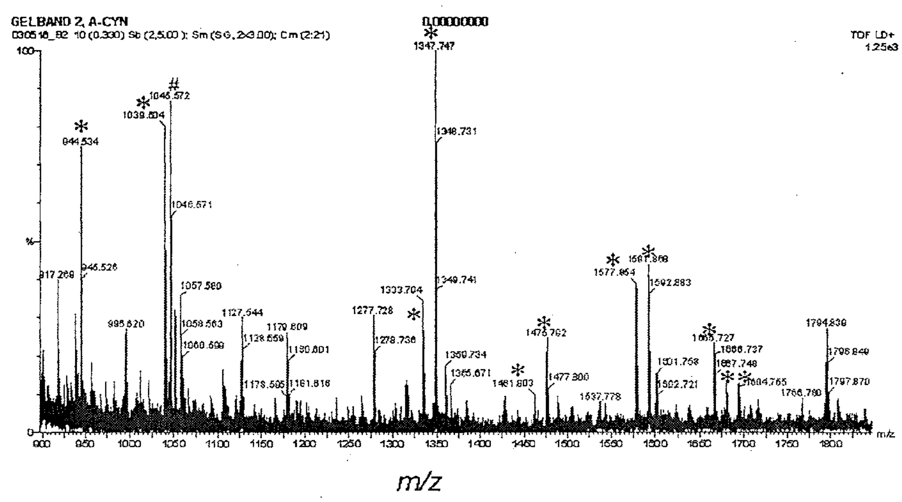

Figure 8. Mass mapping of the protein ion *m/z* 7771 by reflectron MALDI-TOF MS. Tryptic peptides obtained from the gel spot of interest were subjected to MALDI-TOF reflectron MS analyses at a mass accuracy of ~10 ppm as shown. Protein of interest was identified as PF4 with matching peptides indicated with *. A trypsin autolysis product is indicated with a #.

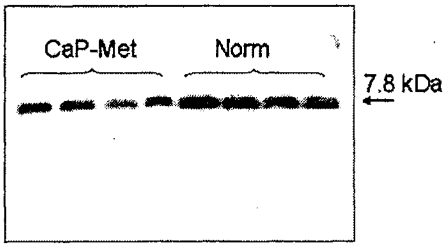

Figure 9. Western blot analysis. Four serum samples were randomly selected from each of the CaP-met and Norm patient groups and immunoblotted using an antibody specific to PF4. This resulted in a band that ran at a M_r consistent with that observed by MS analysis in addition to a decreased abundance of ~3.5-fold in the CaP-met group (left) compared to the Norm group (right).

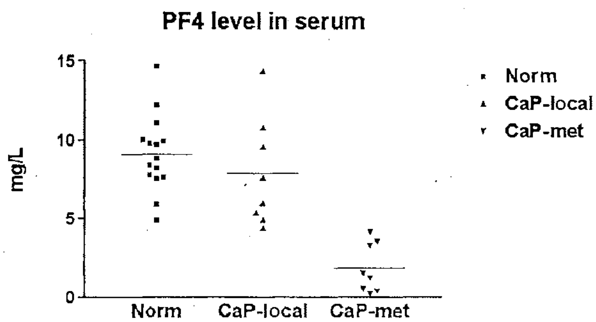

Figure 10. Serum levels of PF4 were quantified by a commercially available ELISA kit. Norm, CaP-local, and CaP-met groups were found to contain 9.1 ± 2.4, 7.9 ± 3.5, and 1.9 ± 1.6 mg/L of PF4 respectively, demonstrating an approximate four-fold decrease ($p < 0.05$) specific to the CaP-met group compared to the other two groups.

vant. As a consequence it is a very active area of research. Challenges arise not only as a result of the high level of complexity associated with the serologic proteome, as mentioned, but also as a result of the lack of information in gene-based search engines used to link peptide matches to the predicted protein M_r. In the case of PF4, the post-translationally cleaved active protein product was not listed in the common gene-based search engines. This information gap is especially problematic for proteomics analysis with partial bottom-up or shotgun-based approaches, because one of the most important identifying factors, the M_r, would be eliminated after digestion of the protein mixture. There is no doubt that with the continued development of bioinformatics for post-translational events analysis (including enzymatic cleavage and chemical conjugation, *etc.*), a definitive identification of such proteins in complex media will be made more accessible. Nevertheless, it is our view that top-down purification approaches followed by standard biologic assays (*e.g.*, Western analysis/ELISA) will be necessary to assure correct protein identification. In the present study, the identified protein was validated using both Western blot and ELISA analyses, and a three-fold to four-fold decrease of PF4 specific to patients with metastatic disease was demonstrated.

The identification of PF4 is in agreement with the notion that diagnostic profiles obtained by MALDI/SELDI profiling are likely to reveal epiphenomenon [14] or reflect the association of disease and major blood proteins [28], rather than proteins that originate from tumor cells. However, PF4 is an especially relevant marker and, while it has not previously been linked to CaP, it has been implicated as a mediator of metastatic diseases through a number of poorly defined mechanisms [29–31]. For example, PF4 is primarily localized to platelets and megakarocytes and exhibits antiangiogenic activity [29, 32]. While not completely understood, antiangiogenic properties may be ascribed to an inhibitory competition of basic fibroblast growth factor (bFGF) [33, 34]. Furthermore, it has been demonstrated that administration of recombinant PF4 inhibits the growth of murine melanoma and human colon carcinomas [35], as well as the development of murine lung metastases [36], all through the attenuation of neovascularization.

In summary, the top-down protein isolation strategy was found to greatly facilitate MS identification of the protein marker represented by the m/z 7771 ion, and identified as PF4. With the recent growing interest in the area of MP, this approach should hold promise for the separation and characterization of proteins identified by MP in complex mixtures, including serum. While the focus of this manuscript was directed toward the application of MP-directed multidimensional protein separations, it is also of significance that the protein identified herein is a chemokine with both prothrombolitic and antiangiogenic activities. It is our intention to validate the present findings through a prospective study of a large group of prostate cancer patients with various clinical histories, pathologic staging, age, and prognostic factors.

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Mindfulness: A Proposed Operational Definition

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There has been substantial interest in *mindfulness* as an approach to reduce cognitive vulnerability to stress and emotional distress in recent years. However, thus far mindfulness has not been defined operationally. This paper describes the results of recent meetings held to establish a consensus on mindfulness and to develop conjointly a testable operational definition. We propose a two-component model of mindfulness and specify each component in terms of specific behaviors, experiential manifestations, and implicated psychological processes. We then address issues regarding temporal stability and situational specificity and speculate on the conceptual and operational distinctiveness of mindfulness. We conclude this paper by discussing implications for instrument development and briefly describing our own approach to measurement.

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In the last 20 years, *mindfulness* has become the focus of considerable attention for a large community of clinicians and, to a lesser extent, empirical psychology. Mindfulness has been described as a process of bringing a certain quality of attention to moment-by-moment experience (Kabat-Zinn, 1990). The capacity to evoke mindfulness ostensibly is developed using various meditation techniques that originate from Buddhist spiritual practices (Hanh, 1976). Mindfulness in Buddhist traditions occupies a central role in a system that was developed as a path leading to the cessation of personal suffering (Thera, 1962; Silananda, 1990). Mindfulness in contemporary psychology has been adopted as an approach for increasing awareness and responding skillfully to mental processes that contribute to emotional distress and maladaptive behavior.

Much of the interest in the clinical applications of mindfulness has been sparked by the introduction of Mindfulness-Based Stress Reduction (MBSR), a

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manualized treatment program originally developed for the management of chronic pain (Kabat-Zinn, 1982; Kabat-Zinn, Lipworth, & Burney, 1985; Kabat-Zinn, Lipworth, Burney, & Sellers, 1987). MBSR is now used widely to reduce psychological morbidity associated with chronic illnesses and to treat emotional and behavioral disorders (Kabat-Zinn, 1998). Although the popularity of MBSR has grown in the absence of rigorous evaluation (Bishop, 2002), randomized controlled trials are beginning to emerge. The findings are encouraging, with recent controlled trials showing impressive reductions in psychological morbidity associated with medical illness (Reibel, Greenson, Brainard, & Rosenzweig, 2001; Speca, Carlson, Goodey, & Angen, 2000; Carlson, Ursuliak, Goodey, Angen, & Speca, 2001) and the mitigation of stress and enhanced emotional well-being in nonclinical samples (Astin, 1997; Shapiro, Schwartz, & Bonner, 1998; Williams, Kolar, Reger, & Pearson, 2001).

Recent innovations in psychological treatment have also seen an increase in the use of mindfulness approaches. Dialectical behavior therapy (Linehan, 1993), an approach that has been shown to reduce self-mutilation and suicidal behavior in chronically suicidal patients with borderline personality disorder (Linehan, Armstrong, Saurez, Allmon, & Heard, 1991), provides training in mindfulness meditation to foster improvements in affect tolerance. Mindfulness-based cognitive therapy (Segal, Williams, & Teasdale, 2002) combines training in mindfulness meditation with cognitive therapy. A large multisite randomized controlled trial has shown that this combined approach can significantly reduce the rate of relapse in recurrent major depression (Teasdale et al., 2000). Several other investigators have provided theoretical rationales for integrating mindfulness approaches into the treatment of a range of clinical syndromes, including generalized anxiety disorder (e.g., Roemer & Orsillo, 2002; Wells, 1999; 2002), posttraumatic stress disorder (Wolfsdorf & Zlotnick, 2001), substance abuse (Marlat, 2002; Breslin, Zack, & McMain, 2002), and eating disorders (Kristeller & Hallett, 1999; Telch, Agras, & Linehan, 2001).

These approaches involve a rigorous program of training in meditation to cultivate the capacity to evoke and apply mindfulness to enhance emotional well-being and mental health. Mindfulness approaches are not considered relaxation or mood management techniques, however, but rather a form of *mental training* to reduce cognitive vulnerability to reactive modes of mind that might otherwise heighten stress and emotional distress or that may otherwise perpetuate psychopathology.[1] The cultivation and practice of mindfulness through this program of mental training is thus thought to mediate observed effects on mood and behavior (Kabat-Zinn, 1990), but these speculations remain untested and thus unsubstantiated.

Although mindfulness has been described by a number of investigators (Kabat-Zinn, 1990, 1998; Shapiro & Swartz, 1999, 2000; Teasdale, 1999b; Segal, Williams, & Teasdale, 2002), the field has thus far proceeded in the absence of an operational definition (Bishop, 2002). There have been no systematic efforts to establish the defining criteria of its various components or to specify the implicated psychological processes, and general descriptions of mindfulness have not been entirely consistent across investigators. As long as fundamental questions concerning construct specificity and operational definitions remain unaddressed it is not possible to undertake important investigations into the mediating role and mechanisms of action of mindfulness or to develop instruments that allow such investigations to proceed. Thus we must move toward a definition that is more precise and that specifies testable theoretical predictions for the purpose of validation and refinement.

In response to this need for greater precision and specificity, a series of meetings were held to establish a consensus on the various components of mindfulness, to develop operational definitions conjointly, and to generate testable predictions for validation. This paper presents the consensus emerging from those meetings. The overall goal is to produce an operational definition that, as a starting point, can be adopted by the field. We propose this operational definition in the hopes that it will stimulate investigation and theoretical development so that we can have a better understanding of mindfulness and mindfulness approaches to psychological treatment.

METHODS FOR THE ELICITATION AND DESCRIPTION OF THE PHENOMENON

Although various meditation practices are taught in mindfulness approaches to treatment, they are similar in their basic procedures and goals. A description of sitting meditation will illustrate the basic approach. The client maintains an upright sitting posture, either in a chair or cross-legged on the floor and attempts to maintain attention on a particular focus, most commonly the somatic sensations of his or her own breathing. Whenever attention wanders from the breath to inevitable thoughts and feelings that arise, the client will simply take notice of them and then let them go as attention is returned to the breath. This process is repeated each time that attention wanders away from the breath. As sitting meditation is practiced, there is an emphasis on simply taking notice of whatever the mind happens to wander to and accepting each object without making judgments about it or elaborating on its implications, additional meanings, or need for action (Kabat-Zinn, 1990; Segal, Williams, & Teasdale, 2002).[2] The client is further encouraged to use the same general approach outside of his or her formal meditation practice as much as possible by bringing awareness back to the here-and-now during the course of the day, using the breath as an anchor, whenever he or she notices a general lack of awareness or that attention has become focused on streams of thoughts, worries, or ruminations.

These procedures ostensibly lead to a state of mindfulness. Broadly conceptualized, mindfulness has been described as a kind of nonelaborative, nonjudgmental, present-centered awareness in which each thought, feeling, or sensation that arises in the attentional field is acknowledged and accepted as it is (Kabat-Zinn, 1990, 1998; Shapiro & Schwartz, 1999, 2000; Teasdale, 1999b; Segal, Williams, & Teasdale, 2002). In a state of mindfulness, thoughts and feelings are observed as events in the mind, without over-identifying with them and without reacting to them in an automatic, habitual pattern of reactivity. This dispassionate state of self-observation is thought to introduce a "space" between one's perception and response. Thus mindfulness is thought to enable one to respond to situations more reflectively (as opposed to reflexively).

OUR CONSENSUS ON AN OPERATIONAL DEFINITION

We propose a two-component model of mindfulness. The first component involves the self-regulation of attention so that it is maintained on immediate experience, thereby allowing for increased recognition of mental events in the present moment. The second component involves adopting a particular orientation toward one's experiences in the present moment, an orientation that is characterized by curiosity, openness, and acceptance. We will now describe each component in terms of behavioral and experiential features and in terms of the implicated psychological processes.

Self-Regulation of Attention

Mindfulness begins by bringing awareness to current experience—observing and attending to the changing field of thoughts, feelings, and sensations from moment to moment—by regulating the focus of attention. This leads to a feeling of being very alert to what is occurring in the here-and-now. It is often described as a feeling of being fully present and alive in the moment. Skills in *sustained attention* would be required to maintain an awareness of current experience. Sustained attention refers to the ability to maintain a state of vigilance over prolonged periods of time (Parasuraman, 1998; Posner & Rothbart, 1992). Sustained attention on the breath thus keeps attention anchored in current experience so that thoughts, feelings, and sensations can be detected as they arise in the stream of consciousness. Skills in *switching* allow the student to bring attention back to the breath once a thought, feeling or sensation has been acknowledged. Switching involves flexibility of attention so that one can shift the focus from one object to another (Jersild, 1927; Posner, 1980). Thus one of the predictions of this model is that the development of mindfulness would be associated with improvements in sustained attention and switching, which can be objectively measured using standard vigilance tests (e.g., Klee & Garfinkel, 1983) and tasks that require the subject to shift mind-set (Rogers & Monsell, 1995), respectively.

The self-regulation of attention also fosters non-elaborative awareness of thoughts, feelings, and sensations as they arise. Rather than getting caught up in ruminative, elaborative thought streams *about* one's experience and its origins, implications, and associations, mindfulness involves a direct *experience of* events in the mind and body (Teasdale, Segal, Williams, & Mark, 1995). Note that mindfulness is not a practice in thought suppression; all thoughts or events are considered an object of observation, not a distraction. However, once acknowledged, attention is directed back to the breath, thereby preventing further elaboration. This is thought to *inhibit secondary elaborative processing* of the thoughts, feelings, and sensations that arise in the stream of consciousness. Thus, mindfulness practices are though to be associated with improvements in cognitive inhibition, particularly at the level of stimulus selection. This can be objectively measured using tasks that require the inhibition of semantic processing (e.g., emotional Stroop; Williams, Mathews, & MacLeod, 1996).

Furthermore, because attention has a limited capacity (Schneider & Shiffrin, 1977), when it is released from elaborative thinking, more resources are made available to process information related to current experience. This increases access to information that might otherwise remain outside awareness, resulting in a wider perspective on experience. Rather than observing experience through the filter of our beliefs, assumptions, expectations, and desires, mindfulness involves a direct observation of various objects as if for the first time, a quality that is often referred to as "beginner's mind." This ability can be measured on tasks in which successful performance depends on detecting stimuli in unexpected settings (e.g., Henderson, Weeks, & Hollingworth, 1999). The prediction is that mindfulness practice should facilitate the identification of objects in unexpected contexts because one would not bring preconceived beliefs about what should or should not be present.

In summary, we propose that mindfulness can be defined, in part, as the self-regulation of attention, which involves sustained attention, attention switching, and the inhibition of elaborative processing. In this context, mindfulness can be considered a metacognitive skill (cognition about one's cognition; Flavell, 1979). Metacognition is thought to consist of two related processes—monitoring and control (Nelson, Stuart, Howard, & Crowley, 1999; Schraw & Moshman, 1995). The notion of mindfulness as a metacognitive process is implicit in the operational definition that we are proposing since its evocation would require both control of cognitive processes (i.e., attention self-regulation) and monitoring the stream of consciousness, as is explained more fully below.

Orientation to Experience

Mindfulness is further defined by an orientation to experience that is adopted and cultivated in mindfulness meditation practices. This orientation begins with making a commitment to maintain an attitude of curiosity about where the mind wanders whenever it inevitably drifts away from the breath, as well as curiosity about the different objects within one's experience at any moment. All thoughts, feelings, and sensations that arise are initially seen as relevant and therefore subject to observation. The client thus is not trying to produce a particular state such as relaxation or to change what he or she is feeling in any way. Rather, the client is instructed to make an effort to just take notice of each thought, feeling, and sensation that arises in the stream of consciousness.

In this manner, a stance of acceptance is taken toward each moment of one's experience. Acceptance is defined as being experientially open to the reality of the present moment (Roemer & Orsillo, 2002). It involves a conscious decision to abandon one's agenda to have a different experience and an active process of "allowing" current thoughts, feelings, and sensations (Hayes, Strosahl, & Wilson, 1999). It is an active process in that the client chooses to take what is offered with an attitude of openness and receptivity to whatever happens to occur in the field of awareness. Thus mindfulness can be conceptualized as a process of relating openly with experience.

There are several predictions based on this model. First, adopting a stance of curiosity and acceptance during mindfulness practices should eventually lead to reductions in the use of cognitive and behavioral strategies to avoid aspects of experience. Measures of repressive coping style (e.g., Miller Behavioural Style Scale; Miller, 1980; Miller & Mangan, 1983), as well as more general coping measures (e.g., Ways of Coping Questionnaire; Folkman & Lazarus, 1988), may have some utility to test this prediction. Also, with time, the practice of mindfulness would likely increase dispositional openness, a trait that is characterized by curiosity and receptivity to new experiences (Costa & McCrae, 1987). Further, adopting a stance of acceptance toward painful or unpleasant thoughts and feelings would be expected to change the psychological context in which those objects are now experienced (see Hayes, Wilson, Gifford, Follette, & Strosahl, 1996; Hayes, Strosahl, & Wilson, 1999). In essence, emotional distress would be experienced as less unpleasant and threatening since the context of acceptance changes their subjective meaning.

This would likely lead to improved affect tolerance, which can be measured with proximate measures such as the Anxiety Sensitivity Index (Peterson & Reiss, 1992/1993).

Approaching one's experience with an orientation of curiosity and acceptance, regardless of valence or desirability, sets the stage for intensive self-observation. Mindfulness can thus be further conceptualized as a process of investigative awareness that involves observing the ever-changing flow of private experience. The term *investigative* refers to an intentional effort to observe and gain a greater understanding of the nature of thoughts and feelings. The client is instructed to make an effort to notice each object in the stream of consciousness (e.g., a feeling), to discriminate between different elements of experience (e.g., an emotional "feeling" sensation from a physical "touch" sensation) and observe how one experience gives rise to another (e.g., a feeling evoking a judgmental thought and then the judgmental thought heightening the unpleasantness of the feeling).

Monitoring the stream of consciousness in this manner over time would likely lead to increased cognitive complexity as reflected by an ability to generate differentiated and integrated representations of cognitive and affective experience. For example, the development of mindfulness would likely result in a greater capacity to distinguish feelings from bodily sensations unrelated to emotional arousal and to understand and describe the complex nature of emotional states. Thus, mindfulness would be correlated positively with measures of emotional awareness (e.g., Levels of Emotional Awareness Scale; Lane, Quinlan, Schwartz, Walker, & Zeitlin, 1990) and negatively correlated with measures of alexithymia (e.g., Toronto Alexithymia Scale; Bagby, Parker, & Taylor, 1994). Similarly, the development of mindfulness would likely be associated with a greater capacity to see relationships between thoughts, feelings and actions and to discern the meanings and causes of experience and behavior. Thus mindfulness would be correlated positively with measures of psychological mindedness (e.g., Psychological Mindedness Scale; Conte & Ratto, 1997).

Further, mindfulness practices provide opportunities to gain insight into the nature of thoughts and feelings as passing events in the mind rather than as inherent aspects of the self or valid reflections on reality (Teasdale et al., 1995; Teasdale, 1999a, 1999b; Segal, Williams, & Teasdale, 2002). Coding procedures used to assess the complexity of cognitive representations in self-narratives (e.g., Labouvie-Vief, Chiodo, Goguen, Diehl, & Orwoll, 1995) and autobiographical recall (e.g., Moore, Hayhurst, & Teasdale, 1996) would be useful paradigms to test these hypotheses. Mindfulness would likely be associated with more complex descriptions of one's thoughts as contextual, relativistic, transient and subjective, and there is now some evidence to support this hypothesis (Teasdale et al., 2002).

In summary, we see mindfulness as a process of regulating attention in order to bring a quality of nonelaborative awareness to current experience and a quality of relating to one's experience within an orientation of curiosity, experiential openness, and acceptance. We further see mindfulness as a process of gaining *insight* into the nature of one's mind and the adoption of a de-centered perspective (Safran & Segal, 1990) on thoughts and feelings so that they can be experienced in terms of their subjectivity (versus their necessary validity) and transient nature (versus their permanence).

TEMPORAL STABILITY AND SITUATIONAL SPECIFICITY

We propose that mindfulness is a mode of awareness that is evoked when attention is regulated in the manner described. We use the term *mode* to refer to a state-like quality. We prefer the term *mode* to *state*. The term *mode* is defined in the *Oxford English Dictionary* as "the manner or way in which a thing is done" (Simpson & Weiner, 1989). This definition captures our belief that mindfulness is a psychological process. Mindfulness is therefore similar to a skill that can be developed with practice. We see it as much closer to a state than a trait because we believe that its evocation and maintenance is dependent on the regulation of attention while cultivating an open orientation to experience. As long as attention is purposely brought to experience in the manner described, mindfulness will be maintained, and when attention is no longer regulated in this manner, mindfulness will cease.

Although mindfulness-based interventions rely on meditation techniques to teach the necessary skills for evoking mindfulness, we hypothesize that this mode of awareness is not limited to meditation. Once the skills are learned, attention can be regulated to evoke mindfulness in many situations, thus allowing the student to respond skillfully to situations that provoke emotional reactions. Further, there has been some speculation that effective psychotherapy may also enhance the capacity to evoke and utilize mindfulness to gain insight and alternate responses to subjective inner experiences (e.g., Martin, 1997, 2002; Horowitz, 2002; Muran, 2002). If mindfulness is indeed a mode of awareness that can be developed as part of the process of psychotherapy, then the theoretical and heuristic value of the operational definition that we are proposing may not be limited to meditation-based interventions but may make important contributions to the psychotherapy outcome literature as well.

ALTERNATIVE CONCEPTUALIZATIONS

While the operational definition that we propose is consistent with the general descriptions of mindfulness in the literature, there have been a number of other qualities or components discussed that we have not included in our own definition. In our view, many of the qualities or components that have been discussed are more likely *outcomes* of having learned mindfulness skills, or maintained a mindfulness practice over time, and are not implicit in the construct. Most notably, mindfulness previously has been described as embodying qualities such as patience (allowing things to unfold in their own time), trust (confidence in the ability to stay in contact with private experience), nonreactivity (calmness), wisdom (self-knowledge) and compassion (empathy for oneself; e.g., Kabat-Zinn, 1990, 1998; Shapiro & Schwartz, 1999, 2000; Reibel et al., 2001). In addition to the theoretical importance of separating the central features of mindfulness from common correlates, at a pragmatic level a definition that confounds operational features with potential benefits reduces the utility of the construct.

CONCEPTUAL AND OPERATIONAL DISTINCTIVENESS

There are a number of constructs that may be within the same general domain as mindfulness as outlined in this paper. Most notably is Ellen Langer's work in social psychology on mindfulness as a creative cognitive process. While both constructs involve attentional engagement, we agree with Langer that her construct is quite different from mindfulness as described in the context of mindfulness-meditation techniques (see Langer, 1989). Langer's mindfulness involves the active construction of new categories and meanings when one pays attention to the stimulus properties of primarily *external* situations, while our own definition emphasizes the inhibition of such elaborative processes as one pays attention to primarily *internal* stimuli (thoughts, feelings, and sensations). Other similar constructs that might fall within the same general domain of mindfulness include *flow* (Csikszentmihalyi, 1997) and *absorption* (Tellegen & Atkinson, 1974).

We also see mindfulness within the general domain of constructs that describe the ability to observe the temporal stream of thoughts and feelings including *introspection* (James, 1890), *observing self* (Deikman, 1982), *presence* (Bugenthal, 1987), *reflective functioning* (Fonagy & Target, 1996, 1997) and *deautomatization/decentering* (Safran & Segal, 1990). Although these various constructs have not always been conceptually well developed, and few have been explicitly operationalized, each has generally been described as a process of stepping outside of the automated mode of perceptual processing and attending to the minute details of mental activity that might otherwise escape awareness. These constructs are also variously described as a process of "freeing up of attention" so that it is non-biased and exploratory (see Martin, 1997). Other related constructs, variously labeled *psychological mindedness* (Conte & Ratto, 1997; McCallum & Piper, 1987), *insight* (Tolor & Reznikoff, 1960) and *self-awareness* (Fingarette, 1963), deal more with the capacity to see relationships among thoughts, feelings, and actions and to understand the meanings and causes of experiences and behavior. Although these latter constructs also involve self-observation, they emphasize the ability to construct increasingly complex mental representations of one's own (and possibly, others') mind and behavior.

Mindfulness, as we have defined it, is likely much closer conceptually and operationally to those constructs that involve a *process* of self-observation (i.e., introspection, observing self, reflective functioning) than self-knowledge per se (i.e., psychological mindedness, insight, and self-awareness). Those that involve self-knowledge likely reflect the *outcome* of practicing many forms of intensive self-observation over time, whether from a daily practice of meditation or from psychotherapy, and are therefore probably distinct from the methods used to obtain them.

Yet the definition of mindfulness that we are proposing describes a quality of self-focused attention characterized by openness and acceptance of experience that is not articulated in the descriptions of these other constructs involving self-observation. This distinction is important because there is considerable evidence that certain forms of self-focused attention can exacerbate distress and heighten or maintain psychopathology (e.g., Pyszcynski & Greenberg, 1987; Nolen-Hoeksema, 1991), while other modes of awareness lead to a more adaptive self-focused style (Trapnell & Campbell, 1999). The question of whether mindfulness is distinct from these other constructs is ultimately an empirical one. However, we do not currently see mindfulness as redundant with other constructs describing intentional self-focused attention.

BROADENING THE CONCEPTUAL MODEL

Situating mindfulness within a more elaborated conceptual model will further elucidate the central features of this construct as it is applied in clinical practice. Our conceptualization draws heavily on self-regulation models of cognition and mood (Carver & Scheier, 1981, 1990) and contemporary cognitive models of psychopathology. We feel that this kind of theorizing, although speculative, is necessary but neglected in discussions of mindfulness.

According to a self-regulation model, much of cognition occurs in the service of goals. We are constantly engaged in a process of comparing what *is* with what is *desired*, and much of our mental life and behavioral organization functions in the service of reducing any discrepancies (Miller, Galanter, & Pribaum, 1960; Powers, 1973; Carver & Scheier, 1981, 1990). When there is a discrepancy, negative affect occurs (e.g., fear, frustration) setting in motion cognitive and behavioral sequences in an attempt to move the current state of affairs closer to one's goals, desires, and preferences (Carver & Scheier, 1990). If the discrepancy is reduced, then the mind can exit this mode and a feeling of well-being will follow until another discrepancy is detected, again setting this sequence in motion.

When goals cannot be met, and especially if the goal is afforded high value, then the mind will continue to dwell on the discrepancy and search for possible ways to reduce it, giving rise to rumination (Martin & Tesser, 1996). Rumination appears to play a central role in exacerbating negative affect. For example, the tendency to worry seems to reflect attempts to plan for and develop potential strategies for avoiding anticipated future negative events, but it can lead to the maintenance or heightening of anxiety (Borkovec, Shadick, & Hopkins, 1991; Wells, 1999). Similarly, depressive rumination appears to reflect attempts to change aspects of one's assumed basic faults (Nolen-Hoeksema, 1991) or alternately to regain something that has been lost and is of central importance to the person's sense of identity or worth (Pyszcynski & Greenberg; 1987). It is now well established that these patterns of ruminative thinking can escalate a spiraling cycle of dysphoric affect that can lead eventually to a major depressive episode (Pyszcynski & Greenberg; 1987; Teasdale & Bernard, 1993; Nolen-Hoeksema, 1991). It is also assumed that rumination will continue until the person either satisfies or gives up the goal (Martin & Tesser, 1989). Thus, disengaging from one's goals should facilitate the release from ruminative thinking and thereby reduce cognitive vulnerability to certain forms of psychopathology.

As discussed, mindfulness approaches teach the client to become more aware of thoughts and feelings and to relate to them in a wider, decentered perspective as transient mental events rather than as reflections of the self or as necessarily accurate reflections on reality. Thus, if self-devaluative, hopeless thoughts are recognized simply as thoughts, the student will be better able to disengage from them since no action will be required (i.e., since the thoughts are not "real," there is no goal to obtain and thus no need to ruminate to find a solution). The reduction in ruminative thinking that is predicted to occur with the adoption of a decentered perspective might explain why mindfulness training reduces the risk of relapse in recurrent major depression (Teasdale et al., 2000). A similar model has recently been suggested for reducing cognitive vulnerability to generalized anxiety disorder (Roemer & Orsillo, 2002).

The acceptance-based component of mindfulness approaches further offer an alternative strategy for dealing with aspects of unwanted private experience, and thus an opportunity to become less prone to being drawn into dysfunction patterns of behavior that exacerbates or maintains psychopathology. As Hayes and his colleagues convincingly argue, most forms of psychopathology involve, in some way or another, the intolerance of aspects of private experience, as well as patterns of experiential avoidance in an attempt to escape private experience (see Hayes et al., 1996, for evidence supporting this view). Hayes and his colleagues further cite substantial evidence that the most effective psychological treatments tend to undermine experiential avoidance in some way by exposing patients to aspects of feared or dreaded private experience, either behaviorally (e.g., desensitization for anxiety disorders) or by encouraging them to stay in touch with painful or frightening feelings and thoughts in psychotherapy.

Mindfulness approaches encourage patients to step out of the war with their thoughts and feelings and give up ineffective experiential avoidance strategies. The approach thus focuses on altering the *impact* of, and *response* to, thoughts, feelings, and sensations. The general orientation of mindfulness approaches is on helping clients to stay in contact with private experiences so that they can behave more effectively. Mindfulness approaches may thus be particularly effective for clinical syndromes in which intolerance of negative affect and subsequent behavioral avoidance play a central role, and there is some evidence to support this assertion. For example, MBSR has been shown to reduce the frequency of panic attacks and avoidance in panic disorder (Miller, Fletcher, & Kabat-Zinn, 1995), binge-eating episodes associated with eating disorders (Kristeller & Hallett, 1999), and avoidance of activity in chronic pain, thereby reducing disability (Kabat-Zinn et al., 1985, 1987). Similarly, dialectical behavior therapy, which incorporates mindfulness training, reduces self-mutilation and suicidal behavior associated with borderline personality disorder (Linehan et al., 1991), probably by helping patients to build affect tolerance.

Mindfulness can therefore be further conceptualized as a clinical approach to foster an alternative method for responding to one's stress and emotional distress. By becoming more aware of thoughts and feelings, relating to them in a wider, decentered field of awareness, and purposefully opening fully to one's experience, clients can abandon dysfunctional change agendas and adopt more adaptive strategies. As several recent investigators have recognized (e.g., Linehan, 1993; Teasdale et al., 1995; Marlat, 2002; Roemer & Orsillo, 2002), the concept of mindfulness can be integrated theoretically with current models of psychopathology and thus can lead to new innovations in treatment.

IMPLICATIONS FOR MEASUREMENT

One of our main objectives for establishing a consensus on mindfulness is to provide a theoretical and conceptual basis for instrument development. Our own approach has been to develop an instrument in which the response to items is in reference to an immediately preceding session involving the practice of a mindfulness technique. This approach is based on our conceptualization of mindfulness as a state-like phenomenon that is evoked and maintained by regulating attention. With this kind of instrument, we can therefore test the situational specificity of mindfulness. Additionally, by anchoring responses to a proximal mindfulness technique, we can minimize memory biases and thereby increase reliability. We are relying on factor analytic procedures to establish factorial validity of the instrument (and construct), and convergent, discriminant and criterion-related validity is being established by examining the relation between our instrument and other measures as outlined in this paper.

If mindfulness is a learned skill, then an instrument must be able to demonstrate both incremental validity and sensitivity to change. Our approach has been to compare people who have been newly trained in mindfulness skills (8 weeks of mindfulness-based stress reduction) with participants who have extensive daily experience (2 years minimum) and no experience with mindfulness techniques. Incremental validity would be supported by demonstrating that experienced mindfulness practitioners score higher on the measure than less experienced practitioners, who in turn score higher than those with no experience. We are evaluating sensitivity to change by evaluating whether mindfulness scores increase in clients who are participating in mindfulness-based stress reduction, as well as in non-clinical samples of participants in intensive (10-day) mindfulness meditation training programs.

Identifying implicated psychological processes underlying attention regulation in mindfulness has allowed us to develop powerful tests for construct validity. We are currently examining whether, with training in mindfulness, an increase in mindfulness scores corresponds to improvements in performance on tasks that require skills in sustained attention, switching, inhibition of elaborative processing and adopting a wider perspective (using tasks described earlier in this paper). Thus we will be able objectively to verify self-reported improvements in attention regulation with mindfulness training. We are particularly excited about the potential utility of these tasks in addressing future questions concerning the mechanisms of action of mindfulness.

CONCLUSIONS

With a growing interest in the clinical applications of mindfulness and mindfulness-based approaches, a concomitant increase in attention directed toward rigorous research in this area is needed. Although we are encouraged by the recent appearance of randomized controlled trials in the literature and want to encourage similar future efforts, we also want to strongly impress the need for basic research investigating fundamental questions concerning this approach. At the most basic level, issues concerning the conceptual and operational aspects of mindfulness need to be addressed so that an instrument can be developed and questions concerning mediating role and mechanisms of action can be investigated. Our team is now developing such an instrument and exploring methodologies from cognitive psychology that can be used to investigate mechanisms of action.

NOTES

1. Discussions of this approach carefully discriminate between "mindfulness meditation" and "concentration" forms of meditation that induce deep states of relaxation. Concentration meditation involves restricting the focus of attention to a single stimulus such as a word, sound, or sensation. When attention wanders, it is redirected back to that single stimulus. No attention is paid to the nature of the distraction. In contrast, mindfulness meditation involves observation of constantly changing internal and external stimuli as they arise. An excellent scholarly discussion of the differences in the goals and methods of these major classes of meditation techniques can be found in Naranjo and Ornstein (1971).

2. We use the term object to refer to any stimulus with which attention might become involved, including sensations, thoughts, and feelings as well as environmental stimuli such as sounds.

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C O M M E N T A R I E S

Perils and Promise in Defining and Measuring Mindfulness: Observations From Experience

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As mindfulness research advances on a variety of fronts, it has become increasingly important to carefully define and measure the construct. In this commentary, we draw from our recent research experience on these topics in addressing four issues of primary concern to Bishop et al: The nature of mindfulness, the role of acceptance in the phenomenon, the relation between mindfulness and meditation, and the measurement of mindfulness in meditative and other contexts.

Key words:* attention, awareness, acceptance, mindfulness. *[Clin Psychol Sci Prac 11: 242–248, 2004]

Mindfulness is increasingly recognized as a phenomenon with functional import for outcomes as diverse as physical health, psychological well-being, work and sport performance, and relationships. Paralleling this recognition is an increased interest in naturally occurring variations in mindfulness and how interventions and practices that facilitate mindfulness actually work. As this research advances, the need for exacting theoretical and operational definitions of mindfulness becomes more salient. However, mindfulness is a deceptively simple concept that is difficult to characterize accurately. Intrepid scholars seeking to do so must enter the shadowy realm of consciousness, the domain from which mindfulness arises. As old as the study of consciousness is within the field of psychology, it nonetheless remains largely uncharted and mysterious territory (Chalmers, 1995). Thus, Bishop, Lau, Shapiro, Carlson, and Anderson (this issue) are to be commended for taking on the bold task of proposing a definition of mindfulness, both conceptually and operationally.

In this commentary, we share our perspectives on Bishop et al.'s theory of, and proposed measurement approach to, mindfulness, drawing upon our own recent research experiences (e.g., Brown & Ryan, 2003, in press). Specifically, we address four topics of central concern to Bishop et al.: the nature of mindfulness, the relation of acceptance to present-centered attention and awareness, the link between mindfulness and meditative practice, and the measurement of mindfulness in meditative contexts and beyond.

THE PROPOSED DEFINITION OF MINDFULNESS

Bishop et al. propose a two-component model of mindfulness, incorporating (a) attention and awareness and (b) acceptance. We will discuss each of these in turn. First, in highlighting attention and awareness as central to mindfulness, Bishop et al. are consistent with most scholarly and popular writings on the topic. However, they do not define these terms and often use them interchangeably. Although these terms are commonly used, clarity on their meaning is important, as this bears directly on an understanding of the meaning of mindfulness, its practice, and its measurement.

Awareness refers to the subjective experience of internal and external phenomena; it is the pure

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apperception and perception of the field of events that encompass our reality at any given moment.[1] *Attention* is a focusing of awareness to highlight selected aspects of that reality. In everyday awake states, awareness and attention are intertwined. Phrased in gestalt terms, awareness is the field or ground upon which perceived phenomena are expressed, and attention continually pulls "figures" out of that ground to hold them up for closer examination.

Awareness and attention are, of course, the primary features of consciousness, which several authors (e.g., Averill, 1992; Mayer, Chabot, & Carlsmith, 1997) have distinguished from the other primary mental processing modalities, namely cognition, motives, and emotions. Consciousness serves at least two key functions: monitoring events and experiences as they unfold in real time and directing or controlling the contents of consciousness (Westen, 1999). Mindfulness specifically concerns the monitoring, observing capacity of consciousness. As Bishop et al. point out, mindfulness represents a heightened or sustained attention to and awareness of current events and experience. However, the fact that mindfulness, as a quality of consciousness, can be brought to bear on thought, emotions, and other contents of consciousness means that it cannot be reduced to them. In this sense, labeling mindfulness a "metacognitive skill" (p. 233) is, we believe, misleading.

As noted above, consciousness and cognition are distinct processing modalities. As a cognitive process, metacognition operates within the realm of thought, to monitor and control cognitive activities and to ensure that cognitive goals have been met (Schwartz & Perfect, 2002). Specifically, these processes consist of planning and monitoring cognitive activities and checking or testing goal-related outcomes. Here is a common example: After reading this article, a reader may question herself about the ideas discussed, with the cognitive goal of better understanding the text. Self-testing in this way is a typical metacognitive strategy for monitoring comprehension. If the reader concludes that her comprehension is less than adequate, she can then take further action (e.g., re-reading the article and self-testing again) to ensure that she meets her goal of text comprehension.

Mindfulness differs from such metacognitive processes in that its mode of operation is perceptual, operating upon thought, as well as upon emotion and other contents of consciousness, rather than within them. Simply put, if mindfulness involves observing thought, including thoughts about thoughts, it cannot *be* thought. The observing capacity that defines mindfulness is one reason why it has been associated with "psychological freedom" (Martin, 1997). Because it provides a "bare display of what is taking place" (Shear & Jevning, 1999, p. 204) it is not subject to the distortions and biases inherent in cognition and, evidence suggests, in metacognition as well (Glenberg, Wilkinson, & Epstein, 1982).

Distinctions between attention and awareness may also prove important to the study of mindfulness-promoting practices. Bishop et al. present two views on mindfulness practice, one highlighting focused attention, the other emphasizing conscious awareness. Specifically, they note that in meditation, "the client ... attempts to maintain attention on a particular focus, most commonly the somatic sensations of his or her own breathing" (p. 232). Yet later they write that mindfulness "begins with making a commitment to maintain an attitude of curiosity about where the mind wanders whenever it inevitably drifts away from the breath. ... All thoughts, feelings and sensations that arise are initially seen as relevant and therefore subject to observation" (p. 233). Citing Hayes, Strosahl, and Willson, they write, "It involves a conscious decision to abandon one's agenda to have a different experience and an active process of 'allowing' current thoughts, feelings and sensations" (p. 233).

Bishop et al. do not make clear how these two forms of mindfulness meditation are related, and the forms appear contradictory. How can one "maintain attention on a particular focus" and at the same time be curious about where the mind wanders? If one is encouraged to "abandon one's agenda," doesn't this also include the self-imposed agenda to maintain attentional focus on the breath? The apparent contradiction here can be resolved by understanding each form of mindfulness meditation as distinct aspects of meditative practice that may play different roles in how mindfulness is realized.

A number of Buddhist scholars and teachers have described two corresponding forms of meditative practice: concentration and awareness/insight (e.g., Kapleau, 1980; Kornfield, 1993; Rahula, 1974). Concentration meditation involves focusing attention fixedly on an internal object such as the breath, a word, or a phrase (mantra), or on an external object, such as a candle or mandala. When attention strays from the object—into thought, for example—it is gently but firmly brought back to the object. Concentration can produce highly positive experiences of peacefulness, tranquillity and mental silence, and it can set the stage for awareness meditation (e.g., Rahula, 1974), as will be described shortly. In contrast, awareness or insight meditation brings consciousness to bear on the moment-to-moment flow of our present experience—sense impressions, thoughts, feelings and so on—and the need lessens for an attentional object on which to focus. In this form, attention gives way to a heightened awareness of the ongoing stream of (ap)perceptual phenomena. While concentration meditation tends to have a calming effect on the mind, awareness meditation is active and energy gathering. Many scholars believe that both forms of meditation are important: Concentration trains the attentional capacity of the mind, while active observation of the ever-changing present encourages insight into the nature of conscious experience through a clear "view" of what makes up our world of consciousness. It can also facilitate access to experiences that normally lie outside conscious awareness (Kornfield, 1993; Wilber, 2000).

Some meditative traditions—Zen for example—use a stage model of training that incorporates both forms of meditation (e.g., Kapleau, 1980). Students are first encouraged to practice concentration (by counting the breath or attending to its sensations) to strengthen the capacity to sustain attention over time before turning to awareness practice. Adherence to this sequential model comes in recognition of the fact that, in awareness meditation, the mind can become easily lost in thought, mental images, or emotions without the power of sustained attention to keep one attuned to present experience. Stage models sometimes imply a hierarchical ordering of importance, but one form of meditation is not necessarily "better" than the other; much depends on the outcome of interest. In daily life, for example, the insight gained through heightened awareness can only be translated into concrete action by bringing focused attention to bear on our behavior or on the task at hand (cf. Martin, 1997).

What role does acceptance play in mindfulness?

Bishop et al. argue for a second component of mindfulness beyond attention and awareness of the present, namely *acceptance*. When we began our own work on developing a self-report measure of dispositional mindfulness, we started from the theoretical position, as do Bishop et al., that acceptance is a primary component of mindfulness. We also hypothesized that attention/awareness and acceptance are related, as Bishop et al.'s proposed definition suggests. The first self-report scale that we developed had two factors. One was labeled "presence" and contained items assessing present-centered attention and awareness. The other factor was labeled "acceptance" and included items such as "When unpleasant thoughts arise, I don't feel I have to put my attention somewhere else" and "I don't like feelings like fear or anger, so I don't allow myself to experience them" (reverse scored). These two factors, each with satisfactory psychometric properties, were correlated (in the .20 to .35 range across different samples), and confirmatory factor analyses found that a second-order factor model, in which the two factors were nested under an overarching "mindfulness" factor, provided a satisfactory fit. However, our convergent, discriminant, and criterion validity research showed, across several large samples, that the acceptance factor provided no explanatory advantage over that shown by the presence factor alone (Brown & Ryan, 2001).

To illustrate, Table 1 provides zero-order correlations between the two factors and a number of indicators of well-being in two samples. Visual inspection suggests that the presence factor was more highly correlated with many of these indicators than was the acceptance factor. This was verified using *t*-tests to compare the sizes of the *r* values (Cohen & Cohen, 1983). For most of the well-being indicators, the presence factor correlated more strongly than the acceptance factor at $p < .01$. For pleasant affect and physical symptoms, the *r* value differences were significant at $p < .05$; the correlations of presence and acceptance with PANAS positive affect and PWB autonomy did not differ significantly from each other.

The presence factor alone also generally showed correlations with well-being equal in magnitude to those of the combined presence and acceptance factors, as represented by the total mindfulness scale score, $ps > .05$

Table 1. Correlations of presence, acceptance, and total mindfulness with psychological well-being indicators

Scale	Presence	Acceptance	Total
Traits and attributes			
NEO-PI Neuroticism[a]	−.53****	−.25****	−.52****
NEO-FFI Neuroticism[b]	−.46****	−.24****	−.45****
RRQ Rumination[b]	−.47****	−.22****	−.45****
MSEI Self esteem[b]	.38****	.21****	.37****
TMMS Emotional intelligence[a]	.50****	.18***	.47****
Emotional disturbance			
CES-D Depression[b]	−.42****	−.26****	−.43****
STAI Anxiety[b]	−.45****	−.29****	−.46****
Emotional-subjective well-being			
Pleasant affect[b]	.32****	.19***	.32****
Unpleasant affect[b]	−.38****	−.20***	−.37****
PANAS Positive affect[b]	.30****	.23****	.33****
PANAS Negative affect[b]	−.46****	−.25****	−.45****
TSWLS Life satisfaction[b]	.30****	.14**	.29****
Eudaimonic well-being			
SVS Vitality[a]	.44****	.09	.38****
MAP Self actualization[b]	.43****	.24****	.43****
PWB Autonomy[b]	.37****	.29****	.40****
PWB Competence[b]	.44****	.24****	.43****
PWB Relatedness[b]	.31****	.09	.26****
Physical well-being			
Reported physical symptoms[b]	−.26****	−.13**	−.26****
HSCL Somatization[a]	−.40****	−.23****	−.41****

Note. Superscripts *a* and *b* refer to samples with $N = 313$ and $N = 327$, respectively.
CES-D Depression = Center for Epidemiologic Studies Depression Scale (Radloff, 1977); HSCL Somatization = Hopkins Symptom Checklist (Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974); MAP Self actualization = Measure of Actualization of Potential (Lefrançois, Leclerc, Dubé, Hébert, & Gaulin, 1997); MSEI Self esteem = Multidimensional Self-Esteem Inventory (O'Brien & Epstein, 1988); NEO-PI Neuroticism = NEO Personality Inventory (Costa & McCrae, 1992); NEO-FFI Neuroticism = NEO Five Factor Inventory (Costa & McCrae, 1992); PANAS Positive affect, Negative affect = Positive and Negative Affect Scales (Watson, Clark, & Tellegen, 1988); Pleasant affect = Pleasant hedonic valence (Diener & Emmons, 1984); PWB Autonomy, Competence, Relatedness = Personal Well-Being Scales (Ryff, 1989); Reported physical symptoms = (Larsen & Kasimatis, 1991); RRQ Rumination = Rumination-Reflection Questionnaire (Trapnell & Campbell, 1999); STAI Anxiety = State Trait Anxiety Inventory (Spielberger, 1983); SVS Vitality = Subjective Vitality Scale (Ryan & Frederick, 1997); TSWLS Life satisfaction = Temporal Satisfaction With Life Scale (Pavot, Diener, & Suh, 1998); TMMS Emotional intelligence = Trait Meta-Mood Scale (Salovey, Mayer, Goldman, Turvey & Palfai, 1995); Unpleasant affect = Unpleasant hedonic valence (Diener & Emmons, 1984).
$^{**} p < .01$, $^{***} p < .001$, $^{****} p < .0001$.

(see Table 1). The correlations of presence with SVS vitality and PWB relatedness were in fact higher than those of the total scale score, *ps* < .05. These and other findings suggested to us that *as a distinct construct*, acceptance is functionally redundant in mindfulness. We then focused our efforts on the presence construct, and items from this factor were incorporated into a second-generation measure: the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003).

We continued to believe, however, that acceptance is important to mindfulness, but not in the way we first thought. We have operationally defined mindfulness as an *open* or *receptive* attention to and awareness of ongoing events and experience (e.g., Brown & Ryan, 2003), and the MAAS measures this by asking respondents to rate the frequency with which their day-to-day consciousness reflects this quality. The redundancy of the acceptance factor that we found in our preliminary work may be because mindfulness, as we define it here, subsumes an acceptance of what occurs.

Specifically, embedded within the capacity to sustain attention to and awareness of what is occurring is an openness to and acceptance of it. Such presence means "taking each moment as it comes." When an individual does not accept what is occurring at a given moment, a natural reaction is to limit awareness and redirect attention, to seek to avoid or escape from the event or experience—mentally, behaviorally, or in some other way. To turn away is to become (intentionally) inattentive and unaware—that is, to cease to be present, or to be mindless. Kornfield noted that, "*to pay attention carefully* is . . . a surrender to what is actually happening in each moment without trying to alter or change or put a conceptual framework around it. . . . This cultivates a state of mind which allows us to be open, to observe and experience fully the entire range of mental and physical reality without either suppressing it or acting it out" (1993, pp. 56–57, emphasis added). Likewise, Tolle (1999) asserts that in giving "fullest attention to whatever the moment presents . . . implies that you also completely accept what is, because you cannot give your full attention to something and at the same time resist it" (p. 56). Without regular or consistent, open, and non-judgmental observation, mindful states, as simply defined by frequent attention to and awareness to what is occurring, would be uncommon, resulting in low scores on a mindfulness scale that assesses attention and awareness, as the MAAS does.

IS MINDFULNESS SPECIFIC TO MEDITATIVE CONTEXTS?

Bishop et al. emphasize the role of meditation in cultivating mindfulness. They note, for example, the role of attentional focus on the breath as a means to experiencing internal events. In fact, in distinguishing their conceptualization of mindfulness from that of Langer (e.g., 1989), they de-emphasize mindfulness of external stimuli, stating instead that "our own definition emphasizes ... attention to primarily *internal* stimuli (thoughts, feelings and sensations)" (p. 235, emphasis in original). We have both conceptual and empirical concerns in binding mindfulness to meditation and to the consciousness of primarily internal phenomena that meditation typically involves.

Along with Bishop et al., we believe that meditative practices can be an effective route to the enhancement of mindfulness. Yet, mindfulness is not merely a product of meditation. As we have argued elsewhere (Brown & Ryan, 2003), mindfulness is an inherent, natural capacity of the human organism. Dzogchen teaching has called this inherent capacity "unfabricated mindfulness" (see Goldstein, 2002). Our research (e.g., Brown & Ryan, 2003; Carlson & Brown, 2003; Levesque & Brown, 2003) has shown that individuals in the general population, most of whom have had no formal meditation experience, reliably differ in the propensity to be mindful, measured using both a dispositional measure (the MAAS) and on a day-to-day basis using a state measure derived from the MAAS. Further, this research has shown that these natural individual differences have significant self-regulatory and psychological well-being consequences.

In accord with our theorizing that mindfulness involves a present-centered attention to and awareness of all accessible events and experiences, our measure taps mindfulness of both internal and external stimuli. By tying mindfulness primarily to the consciousness of internal stimuli, Bishop et al. imply that mindfulness mainly has relevance to situations in which there are no external demands to negotiate, such as in meditation. Yet a primary benefit of meditative practice is that it can change how individuals behave "off the cushion" in their day-to-day lives (e.g., Kabat-Zinn, 1993), bringing mindful presence to bear not only on internal events, but also on our daily social and physical worlds. In this view, the concept of mindfulness is less restricted in scope, and the practice of mindfulness can be broadly considered.

Bishop et al. emphasize that meditation can be a powerful vehicle to enhance mindfulness, and we agree. Our research with Zen practitioners has shown that meditation practice is associated with greater mindfulness (Brown & Ryan, 2003). This research also showed, however, that dispositional mindfulness is related to the extent to which individuals carried their practice over into their daily lives. In addition, we believe, as Bishop et al. also appear to, that it is important to remain open to the possibility that mindfulness may be cultivated through practices other than meditation. For example, some theorists (Epstein, 1990; Martin, 1997; Wilber, 2000) have suggested that a variety of forms of psychotherapy may facilitate open or receptive attention and awareness to psychological and/or behavioral events and experience. Personality and therapeutic traditions discussing this point have ranged from psychodynamic (Freud, 1912/963) to Gestalt (Perls, 1973) to cognitive behavioral (Safran & Segal, 1990) approaches. Research underway in our laboratory is testing whether psychotherapy can enhance clients' levels of mindfulness.

Measurement in meditative contexts. Bishop et al.'s development of a measure of mindfulness for use in meditative contexts could potentially be very useful in exploring the phenomenology and impact of mindful states (cf., Forte, Brown, & Dysart, 1987/1988). Bishop et al.'s other goals for such a measure, including the investigation of meditational processes, are laudable. We wish only to add a note of caution regarding their plan for assessing mindfulness "in reference to an immediately preceding [mindfulness] session" (p. 237) or immediately post-training in longitudinal programs. If, as can be assumed in mindfulness-training contexts, respondents are aware of the goal to enhance mindfulness, care will have to be taken to lessen the effects of social desirability and demand characteristics. Longitudinal or experimental research will also be needed to ensure that qualities assumed to follow *from* mindfulness can be distinguished from measures *of* mindfulness. This points, more generally, to the importance of showing that a new measure has predictive value, particularly, we believe, for outcomes such as mental health, equanimity, compassion, generosity, wisdom, and other human potentialities that have traditionally been associated with mindfulness and meditation (Shapiro & Walsh, 2003; Walsh, 1996).

CONCLUSION

The field of mindfulness studies is still in an early stage of development. Much of the research to date has concerned the efficacy of mindfulness training to enhance well-being in clinical contexts, and the results have been quite positive (Baer, 2003). As researchers begin to explore the applications of mindfulness in more varied contexts and populations, scientific progress will rest upon our definitions and measures of the phenomenon. In this regard we share Bishop et al.'s deep interest in basic questions concerning mindfulness: What is it? How is it expressed and how is it best measured? How does mindfulness operate to produce salutary outcomes? Given the depth and complexity of the phenomenon, debate over such basic issues is to be expected and well-conducted empirical research can help to refine both answers and questions. Equally importantly, the study of basic questions will also help to more firmly place mindfulness within a network of other, established fields of study, and thereby enhance our understanding of human nature as a whole.

NOTES

1. The term "perception" is typically used to refer to the consciousness of external stimuli received through the five senses, while philosophical discourse often refers to "apperception" as the consciousness of internal events and experience (Depraz, Varela, & Vermersch, 2000).

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Alterations in Brain and Immune Function Produced by Mindfulness Meditation

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Objective: The underlying changes in biological processes that are associated with reported changes in mental and physical health in response to meditation have not been systematically explored. We performed a randomized, controlled study on the effects on brain and immune function of a well-known and widely used 8-week clinical training program in mindfulness meditation applied in a work environment with healthy employees. **Methods:** We measured brain electrical activity before and immediately after, and then 4 months after an 8-week training program in mindfulness meditation. Twenty-five subjects were tested in the meditation group. A wait-list control group ($N = 16$) was tested at the same points in time as the meditators. At the end of the 8-week period, subjects in both groups were vaccinated with influenza vaccine. **Results:** We report for the first time significant increases in left-sided anterior activation, a pattern previously associated with positive affect, in the meditators compared with the nonmeditators. We also found significant increases in antibody titers to influenza vaccine among subjects in the meditation compared with those in the wait-list control group. Finally, the magnitude of increase in left-sided activation predicted the magnitude of antibody titer rise to the vaccine. **Conclusions:** These findings demonstrate that a short program in mindfulness meditation produces demonstrable effects on brain and immune function. These findings suggest that meditation may change brain and immune function in positive ways and underscore the need for additional research. **Key words:** meditation, mindfulness, EEG, immune function, brain asymmetry, influenza vaccine

HIV = human immunodeficiency virus; **NK** = natural killer cell; **EEG** = electroencephalography; **EOG** = electrooculography; **PANAS** = Positive and Negative Affective Scale; **MBSR** = mindfulness-based stress reduction. **MANOVA** = multivariate analysis of variance.

INTRODUCTION

With the widespread and growing use of meditative practices in hospitals and academic medical centers for outpatients presenting with a range of chronic stress and pain-related disorders and chronic diseases, under the umbrella of what has come to be called mind/body or integrative medicine, the question of possible biological mechanisms by which meditation may affect somatic, cognitive, and affective processes becomes increasingly important. Research on the biological concomitants of meditation practice is sparse and has mostly focused on changes that occur during a period of meditation compared with a resting control condition in a single experimental session (1–3). Whereas these studies have been informative, they tell us little about changes that are potentially more enduring. Moreover, virtually all forms of meditation profess to alter everyday behavior, effects that are by definition not restricted to the times during which formal meditation itself is practiced. Thus, in the current report, we focus not on the period of meditation itself, but rather on the more enduring changes that can be detected in baseline brain function as well as brain activity in response to specific emotional challenges.

We focus on emotion-related brain activity because meditation has been found in numerous studies to reduce anxiety and increase positive affect (4–8). In an extensive corpus of work on the functional neuroanatomical substrates of emotion and affective style, we have established that the frontal regions of the brain exhibit a specialization for certain forms of positive and negative emotion (9, 10). Left-sided activation in several anterior regions is observed during certain forms of positive emotion and in subjects with more dispositional positive affect (10, 11). We therefore hypothesized that because meditation decreases anxiety and increases positive affect, subjects who were practicing meditation should show increased left-sided activation in these territories compared with those in a wait-list control group.

Recent studies have established that greater relative left-sided anterior activation at baseline is associated with enhanced immune function using measures of NK activity (12, 13). There has been a paucity of serious research attention to possible immune alterations that might be produced by meditation (14). This is somewhat surprising in light of the fact that negative psychosocial influences on immunity have now been well established (15–17). Recent research indicates that relaxation and stress management procedures increase T-cytotoxic/suppressor (CD3+CD) lymphocytes in HIV-infected men (18). On the basis of recent research demonstrating the negative impact of stressful life events on antibody titers in response to influenza vaccine (19), we vaccinated all subjects at the end of the 8-week meditation program (in mid November), along with the subjects in wait-list control group at the same time. We hypothesized that the meditators would show greater antibody titers in response to the vaccine compared with the subjects in the wait-list control group. On the basis of

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the association we have previously reported between anterior activation asymmetry and NK activity, we also predicted that the magnitude of change toward greater relative left-sided activation would be associated with a larger increase in antibody titers in response to the vaccine.

METHODS

Measures of brain electrical activity were recorded before random assignment to each of the two groups (Time 1) and then again immediately after (Time 2) and four months after (Time 3) the training period ended. Brain electrical activity, or EEG, and EOG (for correcting EEG for eye movements) was recorded during both baseline conditions and in response to a positive and negative emotion induction using methods that have been extensively described in previous research (20, 21). EEG was recorded from 27 sites distributed across the scalp and referenced to linked ears during 8 1-minute baseline trials, four with eyes open and four with eyes closed, presented in counterbalanced order according to our established procedures (22). EEG was also recorded during a 1-minute period before and a 3-minute period after subjects wrote about one of three of the most positive and negative experiences in their life. These events were listed on a questionnaire administered to subjects before the start of the entire protocol. For this task, the EEG was aggregated across the 1-minute period before and the 3-minute period after the writing itself. Data were not collected during writing because of movement artifact. The EEG was parsed into 1.024-second epochs, overlapped by 50% and then processed with the use of a fast Hartley transform method to derive measures of spectral power density in the α-band (8–13 Hz), which is inversely related to activation (20, 22). Asymmetric activation was indexed using an asymmetry score that is computed by subtracting log-transformed left hemisphere α-power densities from the comparable measure derived from homologous right-sided electrodes.

After each of the writing periods, subjects were given the PANAS (23) in state form. In addition, at each assessment, they were administered the PANAS in trait form, along with the Spielberger State-Trait Anxiety Inventory (24) in trait form. In addition, subjects in the meditation group were asked to provide daily reports of the frequency and number of minutes and techniques of formal meditation practice.

Blood draws were then obtained at 3 to 5 weeks and then again at 8 to 9 weeks after vaccination to examine antibody titers in response to the vaccine using the hemagglutination inhibition assay (19).

A total of 48 right-handed subjects who were employees of a biotechnology corporation in Madison, Wisconsin, were recruited to participate. Of these, 41 subjects completed some of the measures for at least two of the assessments. The initial laboratory evaluation was conducted before random group assignment. Subjects were then randomly assigned to the meditation group ($N = 25$; 19 female) and the wait-list control group ($N = 16$; 10 female) at a ratio of approximately 3:2. There were no differences between groups in the number of subjects who failed to complete the study. Average age of subjects was 36 years and did not differ between group (range = 23 to 56 years). All but two subjects were white (one Asian-American in the treatment group; one South Asian Indian in the control group). Subjects in the wait-list control group were evaluated at each assessment period along with subjects in the meditation group. After completion of the last assessment, the wait-list control subjects were provided with an 8-week training program comparable to that provided to the subjects in the meditation group.

The meditation training (known as MBSR) was delivered by J.K.-Z., and was directly modeled on the MBSR intervention originally developed at the University of Massachusetts Medical Center (25, 26). The effects of MBSR have been reported in numerous clinical studies with diverse populations, as well as in medical students (27, 28). One study demonstrated significant effects of mindfulness on the rate of skin clearing in patients with moderate to severe psoriasis (29) Two recent reviews of MBSR research called for studies to elucidate potential mechanisms of action (30, 31).

The training consisted of a class that met weekly for 2.5 to 3 hours per class, along with a silent seven-hour retreat that was held during week 6 of the course. In addition, subjects were assigned home practice that consisted of formal and informal meditative practices that they were instructed to perform for 1 hour per day, 6 days per week, with the aid of guided audiotapes.

The statistical analysis of the data focused on the interactions between group (Meditation/Wait-list control) and time (Times 1–3, with the first assessment occurring before the intervention, Time 2 occurring immediately after the 8-week intervention and Time 3 occurring four months after the training period ended. MANOVAs were computed for each of the four anterior asymmetry measures. In addition to examining main effects and the interaction, linear trends were also tested. Follow-up ANOVAs on the separate time periods were performed.

RESULTS

Affect and Anxiety Measures

We evaluated self-report measures of positive and negative affect and anxiety before and after the training. There was a significant Group × Time interaction [$F(1,31) = 5.45$, $p < .05$] on a measure of trait anxiety, the Spielberger State-Trait Anxiety Inventory (24), accounted for by a reduction in anxiety for subjects in the meditation group from Time 1 to Time 2 [$t\,(20) = 2.86$, $p < .01$; see Figure 1). There was no significant Group × Time interaction on the Positive and Negative Affect Scale (23). However, in light of the clear a priori predictions for the meditators to show significant decreases in negative affect with treatment, we tested change over time within each group. There was a significant decrease in trait negative affect with the mediators showing less negative affect at Times 2 and 3 compared with their negative affect at Time 1 [$t\,(20) = 2.27$ and $t\,(21) = 2.45$, respectively, $p < .05$ for both; not shown]. Subjects in the control group showed no change over time in negative affect ($t < 1$).

Brain Electrical Activity Measures

Based on previous findings linking asymmetric anterior activation to positive affect, we specifically examined changes in four anterior electrode sites (F3/4, FC7/8, T3/4, and C3/4 in the International 10/20 system) during both base-line periods and in response to the emotion inductions. We computed MANOVAs with Group and Time (Times 1–3) as factors and examined main effects and interactions, as well as linear

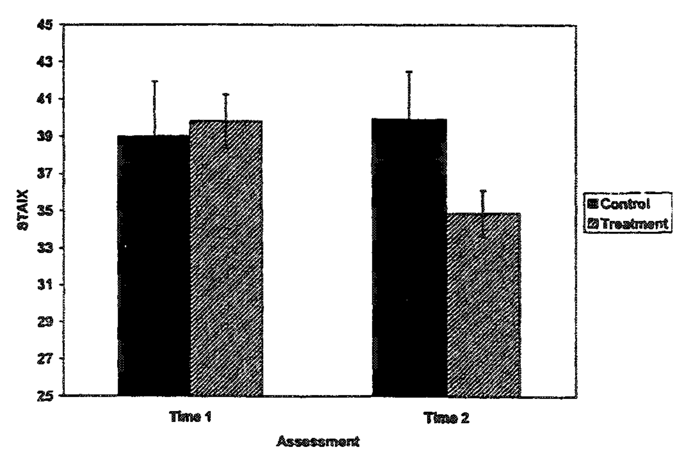

Fig. 1. Mean trait anxiety from the Spielberger State-Trait Anxiety Inventory (24) measured separately by group and time. Error bars reflect means ± SE.

trends. For the baseline period assessments, there was a marginally significant Group × Time linear trend ($F(1,33) = 3.73, p = .06$) and a significant main effect for Group (across time periods; $F(1,33) = 4.57, p = .04$). When the comparison of change from baseline for each time period was examined, there was a significant Group × Time interaction [$F(1,37) = 5.14, p < .05$] for the Time 1–3 comparison and a marginally significant Group × Time interaction [$F(1,33) = 2.82, p = .10$] for the Time 1-Time 2 comparison for the central leads (C3/4). At Time 1, no group differences were present at baseline for any region. At both Time 2 and Time 3, meditators showed significantly greater relative left-sided activation at the central sites (C3/4) compared with the wait-list control group ($p < .05$ for each; see Figure 2).

The omnibus MANOVA performed on the positive emotion induction condition revealed a marginally significant overall Group × Time interaction [$F(2,26) = 2.52, p = .10$] for the anterior temporal (T3/4) electrode leads. When the comparison of change from baseline for each time period was examined, there was a significant Group × Time interaction [$F(1,30) = 4.82, p < .05$] for the Time 1-Time 2 comparison. This same interaction for the Time 1-Time 3 comparison was marginally significant and in the same direction [$F(1,29) = 3.46, p = .07$]. In response to the positive emotion induction at Time 1, no group differences were present in any region. However, meditators showed a significant increase in left-sided anterior temporal activation from Time 1 to Time 2 ($p < .05$), whereas controls showed no change (Figure 3). There were no other significant Group × Time interactions for any other electrode site for the positive emotion induction.

In response to the negative affect induction, the omnibus MANOVA revealed a marginally significant linear trend for the Group × Time interaction [$F(1,27) = 2.94, p < .10$] for the anterior temporal leads. The Group × Time interaction for the Time 1-Time 2 comparison for the anterior temporal region (T3/4) was again in the same direction as the other interactions, but not significant [$F(1,31) = 3.16, p = .08$].

In response to the negative emotion induction for the central leads, an omnibus MANOVA revealed a marginally significant Group × Time interaction [$F(2,32) = 2.78, p < .08$], along with a marginally significant linear trend for this interaction [$F(1,33) = 3.45, p = .07$]. In addition, there was a significant main effect for Group [$F(1,33) = 6.78, p = .01$]. For the central leads, the Group × Time interaction for the Time 1-Time 2 comparison was $F(1,33) = 3.62, p = .07$, and for the Time 1-Time 3 comparison it was $F(1,37) = 5.41, p < .05$. Again, there were no group differences in any region at Time 1. At Times 2 and 3, subjects in the meditation group showed significantly greater left-sided activation (C3/C4) compared with subjects in the control group (for Time 2: $p < .05$; for Time 3: $p < .01$). The meditators evinced a significant increase in left-sided activation in this region from Time 1 to Time 2 ($p < .05$; not shown) and Time 3 ($p < .05$: Figure 4).

There were no group differences present for any of the posterior electrodes sites for any of the conditions.

Influenza Vaccine Antibody Titers

In response to the influenza vaccine, the meditators displayed a significantly greater rise in antibody titers from the 4 to the 8 week blood draw compared with the controls [$t(33) = 2.05, p < .05$; Figure 5].

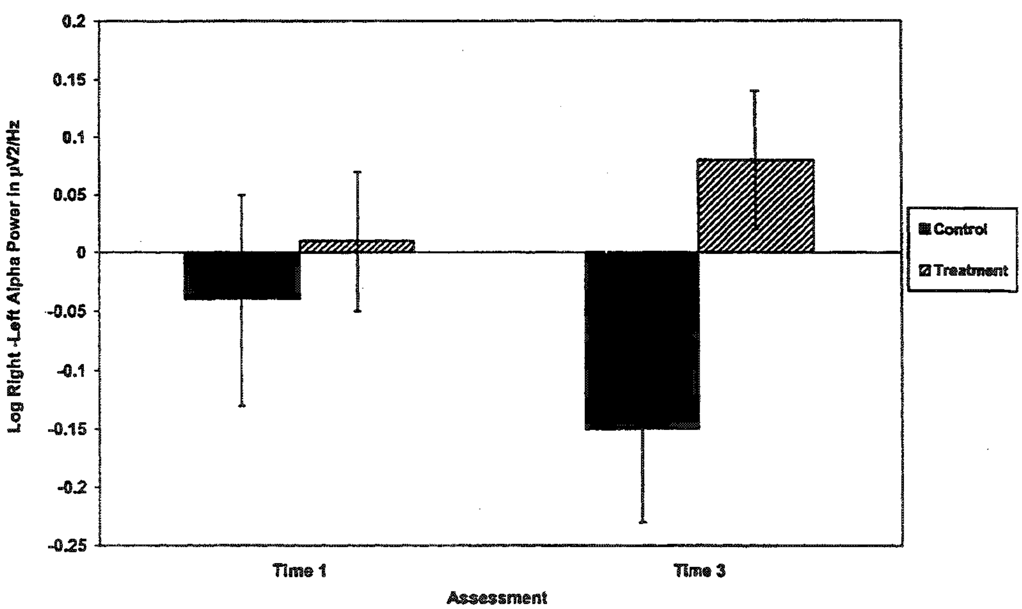

Fig. 2. Means ± SE of asymmetric activation during baseline for subjects in the Meditation group and Control group during Time 1 (before random assignment, before treatment began) and Time 3. The ordinate is an asymmetric metric that represents right minus left log-transformed α power density from the C4/C3 electrode sites. This is a standard index of asymmetric activation (20). Higher numbers on this indicate greater left-sided activation.

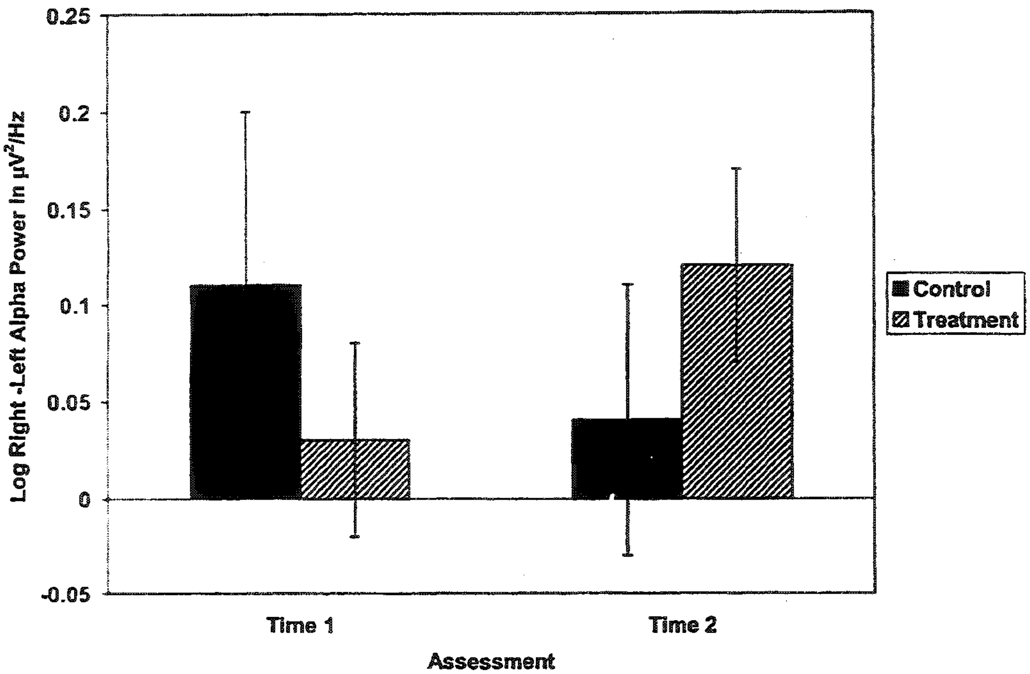

Fig. 3. Means ± SE asymmetric activation (in the T3/T4 electrode sites) in response to the positive emotion induction in the Meditation group and Control group during Times 1 and 2. The ordinate is the same metric of asymmetric activation displayed in Figure 2.

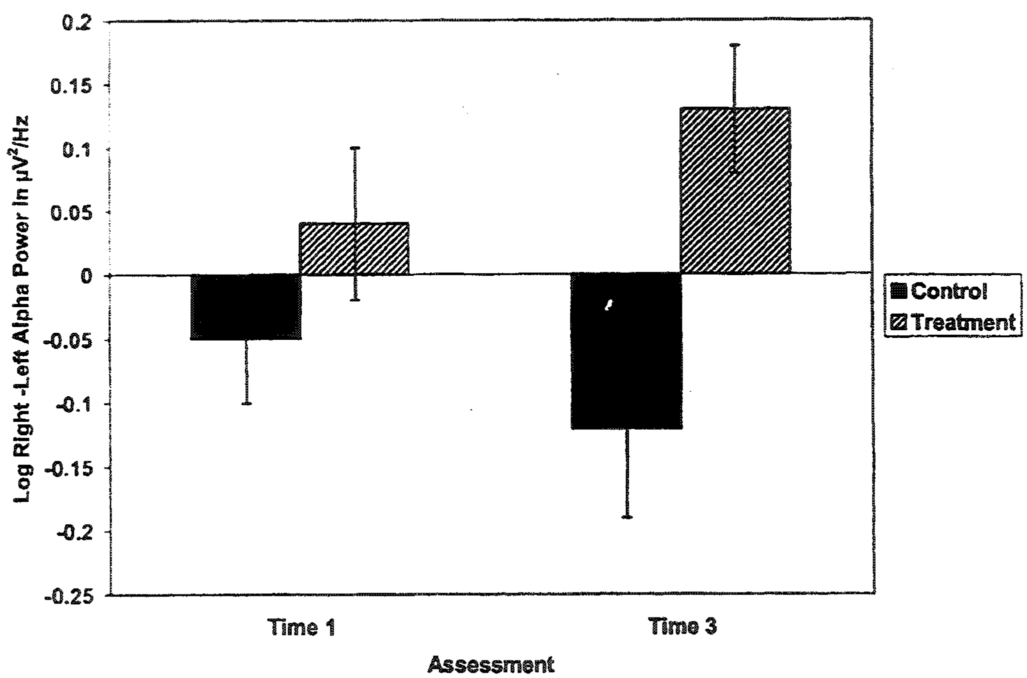

Fig. 4. Means ± SE asymmetric activation in response to the negative emotion induction in the Meditation group and Control group during Times 1 and 3. The ordinate is the same metric of asymmetric activation displayed in Figure 2 (C3/C4).

Relations Among Measures

To examine the relation between the magnitude of increase in left anterior activation and the magnitude of antibody titer rise in response to the influenza vaccine from the 4- to 8-week blood draw, we computed a change score for each subject to express the change in activation asymmetry from Time 1 to Times 2 and 3 and correlated the change in activation asymmetry with the rise in antibody titers, separately for each group. Among subjects in the meditation group, those who showed a greater increase in left-sided activation from Time 1

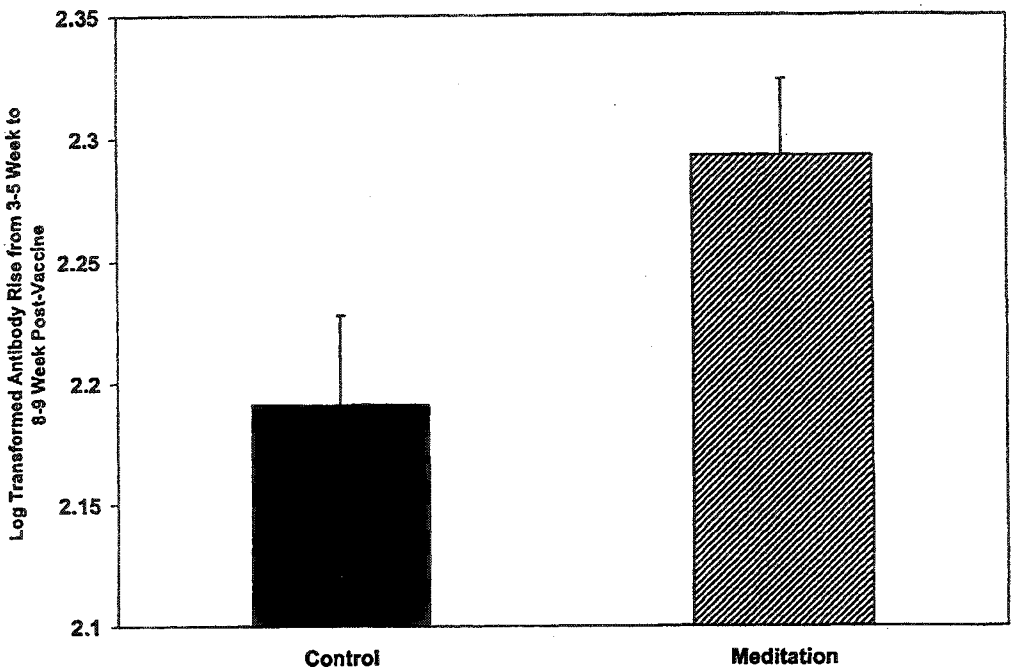

Fig. 5. Means ± SE antibody rise from the 3- to 5-week to the 8- to 9-week blood draw in the Meditation and Control groups. The ordinate displays the difference in the log-transformed antibody rise between the 3- to 5- and the 8- to 9-week blood draws derived from the hemagglutination inhibition assay.

to Time 2 displayed a larger rise in antibody titers ($r = .53$, $p < .05$; see Figure 6) while there was no significant relation between these variables for subjects in the control group ($r = .26$). These correlations were not significantly different.

We also examined correlations between the frequency and duration of reported practice and changes in the self-report and EEG measures that showed significant Group × Time interactions, as well as antibody titers to influenza vaccine. There were no significant associations between the measures of practice and any of the biological or self-report measures. Descriptive statistics on these measures of daily practice are provided in Table 1.

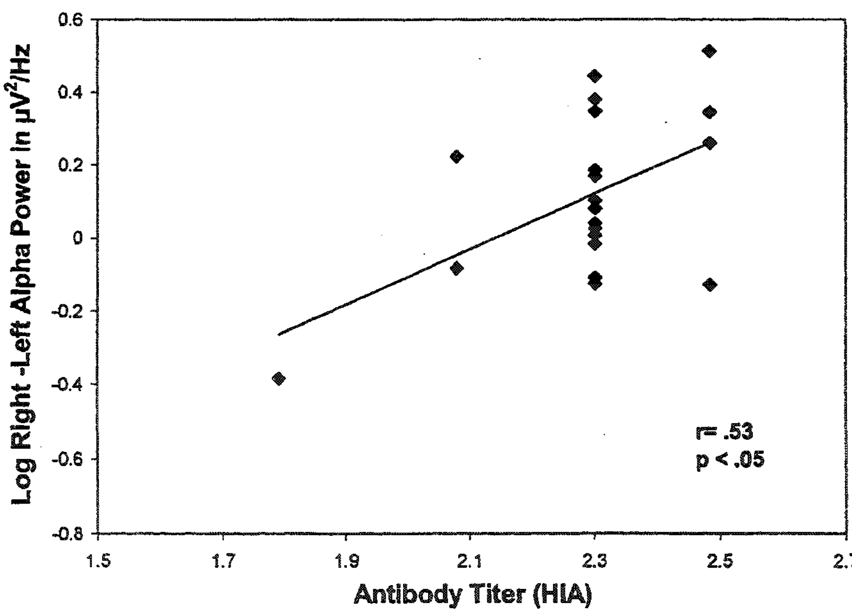

Fig. 6. Scatter plot for the meditation group only showing the relation between the change in asymmetric anterior activation at baseline from Time 1 to Time 2 in C3/C4 and the magnitude of rise in antibody titers to the influenza vaccine from the week 3 to 5 to the week 8 to 9 blood draw. The meditators that showed the largest magnitude increase in left-sided anterior activation from Time 1 to Time 2 also showed the largest rise in antibody titers from the 3- to 5- to 8- to 9-week blood draws. There was no significant relation between these variables in the control group.

TABLE 1. Self-Reported Daily Practice in the Meditation Group

	Time 2			*Time 3*		
	Means	SD	Range	Means	SD	Range
How regularly do you practice (0–6 scale)	2.48	2.14	0–6	1.70	1.66	0–6
How long do you practice (0–30 minutes/session)	16.19 min	9.74	0–30	14.21 min	13.36	0–30
How many times have you practiced in the last week?	2.52	2.56	0–7	2.15	2.03	0–7

DISCUSSION

These findings are the first to document significant changes in anterior activation asymmetry as a function of meditation training. A variety of previous research has established that activation asymmetries in anterior scalp regions are related to dispositional affect. Moreover, such asymmetries reflect both state and trait components (32, 33) with both phasic positive mood as well as dispositional positive affect associated with greater relative left-sided anterior activation. On the basis of an extensive corpus of both animal and human data, Davidson and colleagues recently suggested (33) that prefrontal activation asymmetries are plastic and could be shaped by training. The findings from this study are the first to suggest that meditation can produce increases in relative left-sided anterior activation that are associated with reductions in anxiety and negative affect and increases in positive affect.

We predicted that we would find significant changes in prefrontal as well as central electrode locations. It is unclear why our most consistent findings were observed at the central leads (C3/C4), although this is a region where we have observed reliable affect-related asymmetries in the past (11). Moreover, we have found robust asymmetric increases in left premotor activation in response to positive emotional pictures in a study that measured regional glucose metabolism with positron emission tomography (34). The fact that there was no significant increase in dispositional positive affect in the meditation group may be related to the failure to detect increases in left prefrontal activation. It may well be that if the duration and/or intensity of the intervention were increased, the increases would be observed in both positive affect and left prefrontal activation.

It is of interest that we observed reliable increases in left-sided activation with training in the meditation group in response to both the positive *and* negative affect induction. We have suggested on the basis of a growing literature on the neural bases of emotion regulation that left-sided anterior activation is associated with more adaptive responding to negative and/or stressful events. Specifically, individuals with greater left-sided anterior activation have been found to show faster recovery after a negative provocation (see Refs. 32 and 33 for reviews).

To our knowledge, this is the first demonstration of a reliable effect of meditation on an in vivo measure of immune function. The finding may reflect a relatively more rapid peak rise in antibody titers among the meditators compared with the controls. The observation that the magnitude of change in immune function was greater for those subjects showing the larger shift toward left-sided activation further supports earlier associations between these indices (12, 13).

There are several limitations of our study that are important to note. First, there was a relatively small number of subjects who participated and this limited our statistical power. A number of our hypothesized effects were in the predicted direction, but failed to reach significance. Second, the study examined the impact of a relatively brief intervention delivered in a demanding work environment during regular business hours. It will be of interest in the future to examine the changes in brain and immune function produced by MBSR or more intensive training in a more conducive learning environment. And, finally, the measures of brain function we obtained are relatively crude (see Ref. 20 for a discussion of their limitations). Future studies should examine the impact of meditation using more neuroanatomically informative measures of brain function such as functional magnetic resonance imaging.

Our findings indicate that a short training program in mindfulness meditation (MBSR) has demonstrable effects on brain and immune function and underscores the need for additional research on the biological consequences of this intervention.

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COMMENTARIES

Mindfulness-Based Interventions in Context: Past, Present, and Future

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For Francisco Varela, 1945–2001

Baer's review (2003; this issue) suggests that mindfulness-based interventions are clinically efficacious, but that better designed studies are now needed to substantiate the field and place it on a firm foundation for future growth. Her review, coupled with other lines of evidence, suggests that interest in incorporating mindfulness into clinical interventions in medicine and psychology is growing. It is thus important that professionals coming to this field understand some of the unique factors associated with the delivery of mindfulness-based interventions and the potential conceptual and practical pitfalls of not recognizing the features of this broadly unfamiliar landscape. This commentary highlights and contextualizes (1) what exactly mindfulness is, (2) where it came from, (3) how it came to be introduced into medicine and health care, (4) issues of cross-cultural sensitivity and understanding in the study of meditative practices stemming from other cultures and in applications of them in novel settings, (5) why it is important for people who are teaching mindfulness to practice themselves, (6) results from 3 recent studies from the Center for Mindfulness in Medicine, Health Care, and Society not reviewed by Baer but which raise a number of key questions about clinical applicability, study design, and mechanism of action, and (7) current opportunities for professional training and development in mindfulness and its clinical applications.

Key words: **mindfulness, meditation, mind/body medicine, mindfulness-based stress reduction (MBSR), mindfulness-based cognitive therapy (MBCT).** ***[Clin Psychol Sci Prac 10: 144–156, 2003]***

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I appreciate the opportunity to comment on Baer's (2003; this issue) review of mindfulness training as clinical intervention and to add my own reflections on the emergence of mindfulness in a clinical context, especially in a journal explicitly devoted to both science and practice. The universe of mindfulness[1] brings with it a whole new meaning and thrust to the word *practice*, one which I believe has the potential to contribute profoundly to the further development of the field of clinical psychology and its allied disciplines, behavioral medicine, psychosomatic medicine, and health psychology, through both a broadening of research approaches to mind/body interactions and the development of new classes of clinical interventions.

THE GROWING INTEREST IN MINDFULNESS

I find the Baer review to be evenhanded, cogent, and perceptive in its description and evaluation of the work that has been published through the middle of 2001, work that features mindfulness training as the primary element in various clinical interventions. It complements nicely the recent review by Bishop (2002), which to my mind ignores some of the most important, if difficult to define, features of such interventions in its emphasis on the perceived need

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to reduce to a clinical algorithm the complexity of the practice and nuanced delivery of mindfulness-based stress reduction (MBSR).

Both Baer and Bishop pose important questions that require addressing if researchers and clinicians are ultimately to understand mindfulness and its clinical utility. Both reviews agree that the scientific study of mindfulness and MBSR to date suffers from a range of methodological problems, a view with which I concur. When a field is in its infancy, it is not uncommon for the first generation of studies to be more descriptive of the phenomenon rather than definitive demonstrations of efficacy. Attempts at the latter tend to evolve over time after the potential value of a new approach has been at least tentatively established. This now appears to be the case with mindfulness-based interventions. Both Baer and Bishop conclude that enough evidence has now accumulated to warrant the development of more methodologically rigorous investigations of both the clinical efficacy of mindfulness training in various specific disorders and the possible mechanisms and pathways through which it might exert characteristic effects within those specific disorders.

The very fact that an increasing number of studies on mindfulness and its clinical applications are being funded and published and that an increasing number of doctoral theses on mindfulness are appearing in Dissertation Abstracts suggests that this is an area that is currently sparking considerable interest, perhaps driven primarily by the intuition that new dimensions of therapeutic benefit and novel insights into mind/body interactions might accrue through its exploration. Because interest in mindfulness and its applications to specific affective conditions is likely to increase even further, particularly within the cognitive therapy community with the development of mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002) and with the use of mindfulness within dilectical behavior therapy (DBT; Linehan, 1993), it becomes critically important that those persons coming to the field with professional interest and enthusiasm recognize the unique qualities and characteristics of mindfulness as a meditative practice, with all that implies, so that mindfulness is not simply seized upon as the next promising cognitive behavioral technique or exercise, decontextualized, and "plugged" into a behaviorist paradigm with the aim of driving desirable change, or of fixing what is broken.

WHAT EXACTLY IS MINDFULNESS, AND WHERE DOES IT COME FROM?

As pointed out by Baer, mindfulness has to do with particular qualities of attention and awareness that can be cultivated and developed through meditation. An operational working definition of mindfulness is: the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment. Historically, mindfulness has been called "the heart" of Buddhist meditation (Thera, 1962). It resides at the core of the teachings of the Buddha (Gunaratana, 1992; Hanh, 1999; Nanamoli & Bodhi, 1995), traditionally described by the Sanskrit word *dharma,* which carries the meaning of *lawfulness* as in "the laws of physics" or simply "the way things are," as in the Chinese notion of *Tao.* One might think of the historical Buddha as, among other things, a born scientist and physician who had nothing in the way of instrumentation other than his own mind and body and experience, yet managed to use these native resources to great effect to delve into the nature of suffering and the human condition. What emerged from this arduous and single-minded contemplative investigation was a series of profound insights, a comprehensive view of human nature, and a formal "medicine" for treating its fundamental "dis-ease," typically characterized as the three "poisons": greed, hatred (aversion), and ignorance/delusion (unawareness).

Of course, the Buddha himself was not a Buddhist. One might think of dharma as a sort of universal generative grammar (Chomsky, 1965), an innate set of empirically testable rules that govern and describe the generation of the inward, first-person experiences of suffering and happiness in human beings. In that sense, dharma is at its core truly universal, not exclusively Buddhist. It is neither a belief, an ideology, nor a philosophy. Rather, it is a coherent phenomenological description of the nature of mind, emotion, and suffering and its potential release, based on highly refined practices aimed at systematically training and cultivating various aspects of mind and heart via the faculty of mindful attention (the words for mind and heart are the same in Asian languages; thus "mindfulness" includes an affectionate, compassionate quality within the attending, a sense of openhearted, friendly presence and interest). And mindfulness, it should also be noted, being about attention, is also of necessity universal. There is nothing particularly Buddhist about it. We are all mindful to one degree or another, moment by moment. It is an inherent human capacity. The contribution of the Buddhist traditions has been in part to emphasize simple and effective ways to cultivate and refine this capacity and bring it to all aspects of life. In this regard, mindfulness certainly received its most explicit and systematic articulation and development within the Buddhist tradition over the past 2,500 years, although its essence lies at the heart of other ancient and contemporary traditions and teachings as well, approaches that can be of great value in refining one's own practice, insight, and teaching (see, for example, Chuang Tsu, 1964; Krishnamurti, 1999; Lao-tsu, 1988; Maharaj, 1973; Maharshi, 1959; Thakar, 1972; Tolle, 1999).

Mindfulness is the fundamental attentional stance underlying all streams of Buddhist meditative practice: the Theravada tradition of the countries of Southeast Asia (Thailand, Burma, Cambodia, and Vietnam); the Mahayana (Zen) schools of Vietnam, China, Japan, and Korea; and the Vajrayana tradition of Tibetan Buddhism found in Tibet itself, Mongolia, Nepal, Bhutan, Ladakh, and now large parts of India in the Tibetan community in exile. It should be noted that these traditions all have various schools, subtraditions, and particular texts that they revere more than others, so the actual practices and emphases regarding mindfulness can vary considerably, even within one tradition, such as Theravada or Zen (Goldstein, 2002). Nevertheless, mindfulness, as elucidated by the Buddha in two discourses, the Anapanasati Sutra (Rosenberg, 1999) and the Satipathana Sutra (Thera, 1962), is the core teaching and constitutes the foundation upon which all of these various forms and traditions rest. In these traditions the actual practice of mindfulness is, however, always nested within a larger conceptual and practice-based ethical framework oriented towards nonharming (an orientation it shares with the Hippocratic tradition of Western medicine). This "view" includes a skillful understanding of how unexamined behaviors and what Buddhists would call an untrained mind can significantly contribute directly to human suffering, one's own and that of others. It also includes the potential transmutation of that suffering through meditative practices that calm and clarify the mind, open the heart, and refine attention and action.

Over the past 40 years or so all of these Buddhist traditions have taken root in the West to one degree or another (Bachelor, 1994; Fields, 1992), and have by this time been taken up by several generations of Westerners, who practice these methods in their own lives on a daily basis as well as through participation in periodic teacher-led, intensive meditation retreats, which can last from a weekend to 3 months or more (see, for example, Goldstein, 1987; Goldstein, 2002; Goldstein & Kornfield, 1987; Walsh, 1977, 1978). This phenomenon represents a cultural shift that may be only in its infancy. Nevertheless, it provides a range of rich resources for personal practice and dialogue that can contribute toward the training and development of a cohort of highly competent teachers, from a wide variety of professional backgrounds, committed to the effective delivery of authentic mindfulness-based interventions in various settings.

Mindfulness is often spoken of synonymously as "insight" meditation, which means a deep, penetrative nonconceptual seeing into the nature of mind and world. This seeing requires a spirit of perpetual and persistent inquiry—as in, "What is this?"—toward whatever arises in awareness, and toward "who is attending," "who is seeing," "who is meditating." Its role in deep inquiry and the cultivation of insight have led some to argue that that mindfulness provides a unique perspective that can inform critical issues in cognitive science, neurophenomenology, and attempts to understand the cognitive underpinnings of the nature of human experience itself (Varela, Thompson, & Roach, 1991).

CROSS-CULTURAL AND PARADIGM ISSUES IN WORKING WITH THE CONSCIOUSNESS DISCIPLINES

From the perspective of the behavioral sciences, mindfulness can be thought of as a "consciousness discipline," as described by Walsh in a seminal paper (Walsh, 1980) that explicates the generic paradigm of the meditative traditions and their associated disciplines and shows how such disciplines might be approached empirically by the behavioral sciences without falling into paradigm clash or a range of category errors, which can unwittingly ignore or dismiss the deepest and most subtle features of such practices, thereby predisposing investigators to draw erroneous conclusions. Thus, in encountering the consciousness disciplines and the question of their possible adaptation and application in secular clinical or medical contexts, it is critically important to treat mindfulness and the traditions that have articulated it much as a respectful anthropologist would treat an encounter with an indigenous culture (Davis, 1998) or a different epistemology (Zajonc, 2000). This intimate sensitivity will be necessary to understand, evaluate, and preserve essential elements of the universal dharma dimension of mindfulness practice as it is analyzed by and incorporated into Western science. It in no way contradicts the call by Hayes (2002) to find ways to fit practices and knowledge from spiritual traditions into the theoretical matrix of scientific psychology. The challenge is to find a fit that honors the integrity of what may be different but complementary epistemologies.

It should be noted in this regard that, in the cross-cultural context of scientific studies of Tibetan monks practicing meditation, sensitivity to differences in orientation and motivation between neuroscientists and meditators around both the meditation practices and the set and setting in which they are investigated is essential for the investigation to have integrity and to be interpretable and valid from the perspective of both the scientists and the meditators (Houshmound, Harrington, Saron, & Davidson, 2002). In a recent "cross-cultural" development of note, EEG, fMRI, and PET studies of brain activity in the evocation of specific meditative states and positive feelings, such as compassion and devotion, in a highly trained long-term monastic practitioner (a Western Lama in the Tibetan tradition with a doctorate in molecular biology) have engaged the meditator not merely as subject but as a full collaborator in the design and interpretation of these investigations with his scientific counterparts, capitalizing as well on his highly developed ability to give a precise account of his mental activity during various practices. These investigations show a range of stable patterns of brain activity ("neural signatures of different mental states") that have never been observed in naive subjects, patterns that can be replicated by the subject at will, depending on his choice of meditative practice. Such studies have multiple implications for research in affective neuroscience, neuroplasticity, and our understanding of what might be possible through specific kinds of training regarding the ways we process and express emotion (Goleman, 2003). They assume practical relevance in light of brain changes reflecting enduring shifts in the processing of negative emotion under stress, which have been observed in novice meditators following training in MBSR in an 8-week worksite intervention (Davidson, Kabat-Zinn, Schumacher, Rosenkranz, Muller, Santorelli, et al., in press).

THE MEANING OF "PRACTICE" IN THE CONTEXT OF MINDFULNESS MEDITATION

If we hope to understand mindfulness meditation, it behooves us to examine the use of the word practice and its meaning as it refers to the meditative traditions and the consciousness disciplines that form their core. We speak of the "practice" of meditation, and the "practice" of mindfulness, meaning the actual engagement in the discipline, the inward gesture that invites and embodies it (Depraz, Varela, & Vermersch, 2000). It is not used in the common sense of "rehearsal" for some future performance. The "performance" is always this moment unfolding (Kabat-Zinn, 1994). This engagement takes a variety of forms, from a range of formal practices that are undertaken for varying periods of time on a regular basis, to informal practices that are aimed at cultivating a continuity of awareness in all activities of daily living. However, mindfulness meditation practice, whether within the various Buddhist traditions or within the context of MBSR, for instance, is not limited to the operationalization of particular techniques, which, however important and essential, which they are, are also merely launching platforms or particular kinds of scaffolding to invite cultivation and sustaining of attention in particular ways. They are the menu, so to speak, not the meal; the map, rather than the territory, the traditional admonition being not to mistake the finger pointing at the moon for the moon.

In a recent commentary in this journal on the subject of mindfulness and generalized anxiety disorder, Borkovec (2002) describes in whimsical but cogent and insightful detail the emotional consequences of living with a trust that, he says, "allows me to let go of the illusory future and past and to focus on the nonillusory present." Using examples of washing the dishes and of writing a National Institute of Mental Health (NIMH) grant, he unpacks various cognitive sets that either create anxiety about future outcomes, or keep him grounded in the process itself (the present moment) and its intrinsic meaning and pleasures. He states,

If a focus on the outcome and the extrinsic aspects of an activity are conducive to anxiety and depression, then the objective quality of my work, whether washing dishes or writing grant proposals, will likely be lowered, given what we know about the adverse effects of negative emotion on performance. So seeking the extrinsic outcome makes the failure to achieve that outcome more likely. A focus on the process and intrinsic qualities of an activity reduces the likelihood of anxiety and depression (thus eliminating their negative impact on performance), increases the pleasure of joy during the process, and thus increases the likelihood of achieving the extrinsic outcome. I have to let go of the desired outcome *in order to acquire it. What a paradoxical and strange way to live. (pp. 79–80)*

I would add only that it is perhaps a sane way to live that may not be so strange once one begins to inhabit that landscape in a more regular way. Perhaps it is only strange in a society that persists in devaluating the present moment in favor of perpetual distraction, self-absorption, and addiction to a feeling of "progress." Although Borkovec's descriptions of his inner process are compelling, it is unlikely that such process would be sustained or developed over time in most of us without some element of intentional practice (it is not enough as a rule to remind oneself to "just let go," especially when one is little aware of how attached one may be and also how blind to being caught up in habitual patterns of thinking and emotional expression). It is here that the cultivation of the inner orientation of which Borkovec speaks is important. Mindfulness is not merely a good idea such that upon hearing about it, one can immediately decide to live in the present moment, with the promise of reduced anxiety and depression and heightened performance and satisfaction, and then instantly and reliably realize that way of being. Rather, it is more akin to an art form that one develops over time, and it is greatly enhanced through regular disciplined practice, both formally and informally on a daily basis.

This challenge is posed to our patients in the Stress Reduction Clinic at the very beginning, and with the introduction of the body scan meditation, or even the process of eating one raisin mindfully: namely, to let go of their expectations, goals, and aspirations for coming, even though they are very real and valid, to let go—momentarily, at least—even of their goal to feel better or to be relaxed in the body scan, or of their ideas about what raisins taste like, and to simply "drop in" on the actuality of their lived experience and then to sustain it as best they can moment by moment, with intentional openhearted presence and suspension of judgment and distraction, to whatever degree possible. Mindfulness develops and deepens over time but invariably requires an ongoing commitment to its practice and cultivation in any and every moment.

PRACTICE WITHOUT ATTACHMENT TO OUTCOME

In fact, the term "practice" used in this way is better understood as a way of being, a way of seeing, which is embodied, inhabited, grown into through the implementation of the methods and techniques that comprise the discipline (Kabat-Zinn, 2003). There is a major role for paradox here, so Borkovec's noting of it is quite relevant. Indeed, paradox is built in, since the ultimate understanding one encounters through paying attention transcends even conventional subject-object duality. From the outset of practice we are reminded that mindfulness is not about getting anywhere else or fixing anything. Rather, it is an invitation to allow oneself to be where one already is and to know the inner and outer landscape of the direct experience in each moment. This implies waking up to the full spectrum of our experience in the present moment, which, as we engage in mindfulness practice, we rapidly discover is severely edited and often distorted through the routinized, habitual, and unexamined activity of our thoughts and emotions, often involving significant alienation from direct experience of the sensory world and the body.

In my experience, an understanding of these considerations is critical, both to the development of clinical interventions that authentically nurture mindfulness and speak with compelling, sustained relevance to the lives and needs of potential participants, and to the scientific paradigm for its study. This emphasis on nonattachment to outcome is a radical departure from most clinical interventions. Yet it can be found at the heart of Jacobson's pioneering work (1938), which emphasized learning to recognize and trust the direct proprioceptive experience of the landscape of sensation within tension rather than striving to achieve a more desirable state, such as relaxation. It was only when his method was condensed into progressive muscle relaxation (PMR) in the service of systematic desensitization (Wolpe, 1958) that the nonstriving, slow, mindful element was, ironically, abandoned—probably unwittingly—in favor of time efficiency and, with it, the primacy of the experiencing of the sensations themselves, without judgment or editing (see Woolfolk & Lehrer, 1984).

ORIGINAL VISION AND RATIONALE FOR MBSR

The intention in developing MBSR in 1979 and offering it through an outpatient stress reduction clinic at the University of Massachusetts Medical Center was twofold, as explained below.

MBSR as a training vehicle for the relief of suffering. The primary intention was to see if it were possible to create a vehicle for the effective training of medical patients in relatively intensive mindfulness meditation (including mindful hatha yoga) and its immediate applications to the stress, pain, and illness people were grappling with in their lives. The intervention needed to be free of the cultural, religious, and ideological factors associated with the Buddhist origins of mindfulness, because the objective was not to teach Buddhism or even "to make great meditators" out of people, but to offer an environment within which to experiment with a range of novel and potentially effective methods for facing, exploring, and relieving suffering at the levels of both body and mind, and understanding the potential power inherent in the mind/body connection itself in doing so. At the same time, the program needed to remain faithful in both spirit and substance to the universal dharma dimension alluded to, which, as noted, lies at the very core of the gesture of mindfulness. The task, which is always ongoing and immediate for the MBSR instructor, is to translate the meditative challenges and context into a vernacular idiom, vocabulary, methods, and forms which are relevant and compelling in the lives of the participants, yet without denaturing the dharma dimension. This requires some degree of understanding of that dimension, which can come about only through exposure and personal engagement in practice—learned or deepened either though meditation retreats at Buddhist centers or through professional training programs in MBSR with teachers who have themselves trained in that way, or, ideally, both.[2] The Stress Reduction Clinic requires extensive grounding in mindfulness practice as one criterion in hiring new teachers. The standards we employ are outlined in a series of recommendations for assessing teaching readiness and competency in MBSR instructors in general (Santorelli, 2001).

The Stress Reduction Clinic, embedded within a department of medicine and a division of preventive and behavioral medicine, was originally designed to serve as a referral service for physicians and other health providers, to which they could send medical patients with a wide range of diagnoses and conditions who were not responding completely to more traditional treatments, or who were "falling through the cracks" in the health care system altogether and not feeling satisfied with their medical treatments and outcomes. MBSR was thus framed from the beginning as a generic challenge to each patient to train in ancient and potentially transformative meditative practices *as a complement* to his or her medical treatments (Kabat-Zinn, 1993). The clinic, in the form of an 8-week course for outpatients, was meant to serve as an educational (in the sense of inviting what is already present to come forth) vehicle through which people could assume a degree of responsibility for their own well-being and participate more fully in their own unique movement towards greater levels of health by cultivating and refining our innate capacity for paying attention and for a deep, penetrative seeing/sensing of the interconnectedness of apparently separate aspects of experience, many of which tend to hover beneath our ordinary level of awareness regarding both inner and outer experience (Kabat-Zinn, 1990; Santorelli, 1999).

MBSR as a model. If the experience was "successful" in terms of acceptability of the process to the participants and the referring physicians, and in terms of attaining measurable outcomes of clinical significance, the second intention in developing MBSR was that the program might serve as a model for other hospitals and medical centers, which indeed has proved to be the case, and would be adaptable to other contexts in which stress, emotional and physical pain, or illness and disease were primary concerns. To this end, the clinic eventually developed a range of professional training programs in MBSR.[3] Mindfulness-based programs are now offered in hospitals and clinics around the world, as well as in schools, workplaces, corporate offices, law schools, adult and juvenile prisons, inner city health centers, and a range of other settings.

SOME CHALLENGES ASSOCIATED WITH TEACHING MINDFULNESS-BASED INTERVENTIONS

It should be clear from what has been said that mindfulness, from our point of view, cannot be taught to others in an authentic way without the instructor's practicing it in his or her own life. Mindfulness meditation is not simply a method that one encounters for a brief time at a professional seminar and then passes on to others for use as needed when they find themselves tense or stressed. It is a way of being that takes ongoing effort to develop and refine, in T. S. Eliot's apt phrase, "A condition of complete simplicity / (Costing not less than everything)" (Eliot, 1943). It is both the work of a lifetime and, paradoxically, the work of no time at all—because its field is always this present moment in its fullness. This paradox can be understood and embodied only through sustained personal practice over days, weeks, months, and years.

Recall that practice as we have been using the word is not a mechanical self-repetition of meditation instructions (although it can sometimes subtly feel that way), but a commitment to reside as best one can from moment to moment in awareness with an open heart, a spacious, nonjudging, nonreactive mind, and without trying to get anywhere, achieve anything, reject anything, or fall into either the stream of conceptual thought or what the Dalai Lama calls "afflictive" or "unwholesome" emotions (Goleman, 1997, 2003). Since it is virtually inevitable that people will fall into both the stream of conceptual thought and afflictive emotions (and potentially unwise actions) over and over again, the practice involves working intimately and compassionately with whatever arises in the field of awareness, so that whatever arises is seen and known (recognized) in the field of awareness as it arises (or as soon as one can). Thus, mindfulness can always be large enough to include whatever arises if it can be seen, felt, and known nonconceptually, directly apprehended through the five senses (including proprioception) and through the mind, which in Buddhism is considered another sense door. However, it takes personal commitment and perseverance in formal practice gradually to establish a degree of stability in one's capacity to attend, especially to stressful or aversive objects, including severe emotional turbulence or enduring dysphoria, and to see beneath the surface of the phenomena themselves as they arise in the field of experience. Classes and periodic retreats form a supportive group environment within which practice can develop and deepen over time for both teachers and students of mindfulness. A working principle for MBSR teachers is that we never ask more of our patients in terms of practice than we ask of ourselves on a daily basis. Another is that we are all students and the learning and growing are a lifelong engagement.

The decision to teach mindfulness, even among those teachers with many years of personal meditation practice, whether they be trained as psychologists, physicians, surgeons, or other health professionals, can at times be intimidating and humbling, and understandably so. One needs to be well prepared to take on such a challenge, and that usually includes feeling that one is nowhere near ready to begin teaching. In our experience, unless the instructor's relationship to mindfulness is grounded in extensive personal practice, the teaching and guidance one might bring to the clinical context will have little in the way of appropriate energy, authenticity, or ultimate relevance, and that deficit will soon be felt by program participants. For how can one ask someone else to look deeply into his or her own mind and body and the nature of who he or she is in a systematic and disciplined way if one is unwilling (or too busy or not interested enough) to engage in this great and challenging adventure oneself, at least to the degree that one is asking it of one's patients or clients? How will one know how to respond appropriately and specifically to their questions if one cannot draw on one's own lived experience, not just on book knowledge and concepts, when the practice itself is all about seeing clearly and transcending (not getting caught up in and blinded by) the limitations of the conceptual mind while, of course, not rejecting the conceptual mind or the power and utility of thought within the larger context of awareness?

Since people with stress, pain, and medical conditions of all sorts invariably and quite naturally come to stress reduction or to various forms of therapy with agendas and goals (and, in fact, are encouraged to define realistic goals for themselves in MBSR), how will a teacher skillfully reconcile their motivation to achieve these perfectly sensible goals with the orientation of nonstriving, nondoing, and letting go that must inform the meditation practice and the entire program if it is to be mindfulness? It can be done only if one feels a deep experience-based confidence in the practice and an equally deep humility in offering it to others, developed through one's own intimate engagement and struggles with it. Ultimately, one teaches out of one's own passion for the practice itself, keeping things grounded in the actuality of present-moment experience. Of course, a skillful teacher will bring in any number of things as appropriate to inform and round out the teaching, dialogue, and practice itself, drawing on his or her extensive professional and personal knowledge base, temperament, and skills. However, without the foundation of personal practice and the embodying (a preferable term to "modeling," which carries the unfortunate connotation of intentionally acting in a particular way for the sake of appearances) of what it is one is teaching, attempts at mindfulness-based intervention run the risk of becoming caricatures of mindfulness, missing the radical, transformational essence and becoming caught perhaps by important but not necessarily fundamental and often only superficial similarities between mindfulness practices and relaxation strategies, cognitive-behavioral exercises, and self-monitoring tasks.

Over the past 10 years numerous health professionals have taken on the teaching of mindfulness-based stress reduction and have developed well-established clinical and research programs. Although there is no formal vehicle for assessing competency of MBSR teachers at this time, nor a professional credentialing mechanism,[4] the feedback from the people coming out of these programs, when we have occasion to meet them, tends to be highly enthusiastic and positive. They themselves tend to speak of the experience as transformative. There is a sense among those of us teaching mindfulness that we continue to be nurtured personally and professionally by the work itself and by the practice. This, and a sense of connectedness with local and global communities of colleagues who do this work are constant reminders of the importance of staying true to the spirit of mindfulness practice.

RECENT RESULTS FROM THE CENTER FOR MINDFULNESS AND THEIR IMPLICATIONS FOR THE SCIENCE OF THE MIND/BODY CONNECTION AND FURTHER STUDIES

From a research perspective, work at the Center for Mindfulness and the Stress Reduction Clinic has attempted to provide various platforms upon which increasingly rigorous explorations of aspects of mindfulness and its clinical and social applications could ultimately be built. A number of early descriptive studies, reviewed by Baer (2003), attempted to investigate the validity and short- and long-term clinical effectiveness of the MBSR intervention in patients with a wide range of medical conditions (Kabat-Zinn, 1982; Kabat-Zinn, Chapman, & Salmon, 1997; Kabat-Zinn & Chapman-Waldrop, 1988; Kabat-Zinn, Lipworth, & Burney, 1985; Kabat-Zinn, Lipworth, Burney, & Sellers, 1986; Kabat-Zinn et al., 1992; Salmon, Santorelli, & Kabat-Zinn, 1998; Miller, Fletcher, & Kabat-Zinn, 1995;). This work eventually led us to undertake several small randomized trials, one with patients with moderate to severe psoriasis undergoing ultraviolet phototherapy treatments (Kabat-Zinn et al., 1998), the other a worksite intervention in which we delivered the 8-week MBSR program to company employees and monitored quantitative EEG and immune responsivity at various times, as well as a range of psychosocial measures (Davidson et al., in press). These studies demonstrated clinical effectiveness with two very different mindfulness-based interventions: one delivered in isolation solely by audiotaped instructions; the other, in the group context of MBSR. Their designs may serve as models in the design of further and larger studies of the potential healing and restorative effects of mindfulness and MBSR for different classes of individuals with different life situations in different environments. These studies are described below in some detail.

Skin Clearing in Psoriasis

In the psoriasis study we asked if mindfulness could influence a healing process that we could see and photograph in people with a skin disease that has a strong relationship with psychological stress, namely, psoriasis. Thirty-seven patients with moderate to severe psoriasis who were candidates for treatment with phototherapy (UVB) or photochemotherapy (PUVA) were randomized into two groups. One group (meditators) followed guided mindfulness meditation instructions delivered by audiotape during their ultraviolet (UV) treatments (either PUVA or UVB) on a 3-times-per-week protocol. (For full study design and methods, see Kabat-Zinn et al., 1998). This tape included a guided visualization in which the subject visualized the ultraviolet light slowing down and then stopping the rapidly growing cells in the epidermis. The other group (usual care) received the light treatments (either PUVA or UVB) without listening to a tape. The skin status of each patient was monitored by clinic nurses at each treatment session and documented periodically by photography. The photographs were rated in terms of skin status by dermatologists blind to the identity and group assignment of the patients. These ratings were then used to validate or invalidate the nurses' necessarily unblinded ratings. A Cox proportional hazards analysis of the photographically validated data showed that the meditators' skin cleared at about 4 times the rate of the nonmeditators' (usual care group) during the 12-week study period (p = .033). An earlier and smaller study (Bernhard, Kristeller, & Kabat-Zinn, 1988) also found that the meditators' skin cleared more rapidly than that of the nonmeditators.

Although both studies suffer from a small sample size, the replicability of the finding suggests that the effect is real and merits further research. We cannot conclude from these observations that it is the mindfulness practice per se that is responsible for the fourfold rate of skin-clearing in the meditation cohort, although that is our hypothesis. However, the finding does lead to a number of potentially important, if currently tentative conclusions: (1) that some factor or combination of factors having to do with the activity of mind can positively influence a healing process in a specific disease; (2) that psychological participation of this sort on the part of the patient during the light treatments can lead to reduced time to clearing in at least some patients, and thus to fewer treatments, and thus to potential cost savings; (3) that the need for fewer light treatments also reduces the risk of basal cell carcinoma associated with ultraviolet light treatment; (4) that social support—minimal in this intervention because the patient is isolated in the light box, there is no group experience, and all the instruction in the meditation is by audiotape—cannot be a major factor in the observed outcome; (5) that the experimental design itself is well suited for studying the role of the mind (intention, attention, belief, expectation, psychological conditioning, meditation, visualization) in a readily observable healing process for a specific disease down to the level of gene expression, including concurrent investigation of appropriate biological mediators associated with psoriasis, such as cytokines, transforming growth factor (TGF-α), and Bcl-x protein; (7) that, since psoriasis is an uncontrolled cell proliferation, although not oncogenic, such investigations may shed light on the potential for positive psychological involvement in oncogenic processes, such as basal cell carcinoma, which shares some molecular characteristics with psoriasis; and (8) that this design is an example of both integrative (Snyderman & Weil, 2002) and participatory (Kabat-Zinn, 2000) medicine: integrative because the meditative (unconventional) intervention is coextensive in time and place with the allopathic treatment, and participatory because the full engagement of the patient's mind and body is a critical part of the psychological intervention. All of these areas suggest further studies that might illuminate critical issues in mind/body medicine and adjunctive psychological approaches to patient care and treatment, including mindfulness-based approaches with specific diseases.

Our 1998 study was criticized by Relman on various methodological grounds, including the small sample size, the way we accounted for dropouts, the effectiveness of the blinding of physician-evaluators, and our statistical treatment of the data. He also took umbrage at our conclusions. While recognizing the validity of some of his criticisms, we were able to respond to each one, refuting their criticality either to the basic observation or to our conclusions (see Relman, Riley, Kabat-Zinn & Hosmer, 2001). I cite this interchange because it highlights the degree of controversy that occasionally arises, particularly regarding the quality of the evidence in studies investigating mind/body phenomena. Such controversy extends beyond the psoriasis study. Relman also challenged the validity of the findings and conclusions of much larger clinical trials and epidemiological studies that are widely accepted in behavioral medicine (see "The Great Debate": Relman & Angell, 2002; Williams and Schneiderman, 2002).

Debates of this kind are welcome and healthy for any field of research. They certainly underscore the importance of larger and better designed studies to further establish or dispute findings in the nascent field of mindfulness-based clinical interventions and their potential therapeutic effects in people with specific medical and psychological conditions, as called for by Baer (2003) and Bishop (2002). They also illuminate the degree to which well-trained scientists can and should disagree about the evidentiary status underpinning even widely accepted of phenomena in the behavioral and human sciences.

Brain, Immune Changes, and Emotional Processing in a Work Site MBSR Program

In another study (Davidson et al., in press) 41 employees of a biotechnology company were randomized to either an MBSR condition ($n = 25$) or a wait-list condition ($n = 16$). The MBSR subjects participated in an 8-week program during working hours. All subjects underwent extensive laboratory testing on three occasions, pre and post the 8-week intervention period and at 4-month follow-up, including EEG to measure brain electrical activity in response to various emotional challenges. All subjects were also vaccinated with influenza vaccine at the end of the 8-week intervention period and subsequently tested for antibody titer.

As originally hypothesized, we found significant increases in left-sided activation in the anterior cortical area in the subjects who had undergone MBSR training as compared to the wait-list controls. Left-sided activation in several anterior regions has been observed during certain forms of positive emotional expression and in subjects with more dispositional positive affect (Davidson, 1992; Davidson, Ekman, Saron, Senulis, & Friesen, 1990), as well as in studies of the highly trained Tibetan monk cited earlier, in whom the effect was of remarkable magnitude (Goleman, 2003). Right-sided activation is usually associated with negative emotional expression such as anger, anxiety and depression (Davidson, 2000; Davidson & Irwin, 1999).

We also found that the meditators displayed a significantly greater rise in antibody titers from the 4-week post-vaccination to the 8-week blood draw as compared to control subjects. Moreover, among the subjects in the MBSR group, those who showed the greatest pre-to-post increase in left-sided activation displayed a significantly larger rise in antibody titers, whereas there was no significant relationship for control subjects. This study suggests that MBSR training can lead to brain changes consistent with more effective handling of negative emotion under stress. These changes endured for at least 4 months after the intervention.

To our knowledge, this study is the first to demonstrate a reliable effect of meditation on an in vivo measure of immune function and on anterior activation asymmetry in the brain. The results suggest that there may be multiple biological consequences of mindfulness training relevant to emotional and physical health, and that such an intervention can be delivered effectively in a work setting to a broad spectrum of employees and influence psychological and emotional health under stressful conditions. In light of the findings of Teasdale et al. (2000) and the development of MBCT for relapse prevention in the treatment of depression (Segal et al., 2001), mindfulness/acceptance-based treatments for generalized anxiety disorder (Roemer & Orsillo, 2002), DBT for borderline personality disorder (Linehan, 1993), and mindfulness-based therapy for obsessive-compulsive disorder (Schwartz, 1996), these results suggest that it would be fruitful to explore mindfulness-based interventions in various affective disorders, using an approach that maps potentially relevant underlying neurobiological mechanisms and pathways together with affective behavior change measures, taking advantage in the study design of the intrinsic adaptability of mindfulness-based approaches to different life circumstances and conditions.

A New Prostate Cancer Intervention Combining MBSR and Dietary Intervention

In addition to these studies, a recent uncontrolled pilot study (Saxe et al., 2001) combined and expanded MBSR training with a low-fat vegetarian dietary intervention to explore the effectiveness of this new 12-week intervention, which included spouses and significant others, in slowing, arresting, or reversing prostate-specific antigen (PSA) velocity in men with prostate cancer who had previously undergone prostatectomies and who subsequently proved to have rising PSA levels, indicating metastatic spread. In a series of 10 patients, we found that the rate of PSA increase decreased in 8 of the 10 patients, while 3 had a decrease in absolute PSA (signed rank test $p = .01$). Estimated median PSA doubling time increased from 6.5 months before the intervention to 17.7 months after the intervention. This study demonstrates the potential feasibility and utility of using the cultivation of mindfulness within the context of MBSR to achieve behavior changes, such as dietary compliance, that are frequently difficult to attain and maintain with use of strictly behavioral motivators. In this case the mindfulness training and application was extended to include bringing mindfulness to shopping and food selection, cooking, and eating in ways that can enhance dietary adherence. This remains an area of ongoing investigation.

CONCLUSION

Baer's conceptual and empirical review of mindfulness-based interventions points toward the potential promise of further and increasingly methodologically rigorous studies of mindfulness-based clinical interventions. This commentary highlights and contextualizes some of the fundamental issues, opportunities, and challenges facing both clinicians and researchers alike, in the design, delivery, and evaluation of such a deceptively simple yet highly complex intervention approach and its effective integration, at the level of theory as well as treatment, with other therapies and practices in medicine and psychology. It necessarily glosses over or leaves undescribed the nature, spirit, and substance of the curriculum of mindfulness-based interventions; the inherent flexibility of the curriculum in terms of both content and delivery and yet its reliance on essential core meditative practices grounded in silence, stillness, self-inquiry, embodiment, emotional sensitivity, and acceptance of the full gamut of emotional expression held in awareness (all practices that shape and inform the intervention and its unfolding at every level); and, finally, its acknowledgment of the universal longing in people for happiness, well-being, resilience, and peace of mind, body, and soul, and how that longing might be effectively met, honored, and mobilized for transformation among program participants (Kabat-Zinn, 1990; Santorelli, 1999). This commentary has perforce also ignored the poetry of mindfulness, and the appropriate uses of the poetic imagination within mindfulness-based interventions.

NOTES

1. Following Baer, I will not discuss the social-psychological construct that Langer (1989) has termed "mindfulness," but focus on the traditional usage stemming from Buddhist meditation practices that have been adapted to one degree or another and

integrated within the mainstream of medicine over the past 20-plus years.

2. Note that while this perspective may seem commonsensical, if not axiomatic—just as surgeons who want to perform an unfamiliar complex procedure would first need to acquire, from those who developed it or their designees, first-person, hands-on experience through specialized postgraduate training before becoming competent in performing it—this proposition has not been subject to empirical testing in the case of mindfulness. Hayes (2002) has emphasized that methods involving acceptance and mindfulness must be separated from their religious and spiritual traditions so they can be conceptualized and studied from a scientific perspective and integrated into Western psychological understanding. Of course, any true integration of a new and fundamental element into psychology is likely to contribute to a broadening of the field itself and its perspective on alternative epistemologies, in this case those epistemologies lying at the interface of meditative experience itself, influenced in some measure by cultural and contextual considerations, and empirical science, as suggested by Walsh (1980). This area is one for fruitful research and deserving of rich debate and dialogue, which can only deepen the profession's ultimate understanding of what works, for whom, and why. I am merely delineating in this article the bare outlines of a perspective that my colleagues and I have developed from both our own firsthand experience of meditation practice and teaching, and our clinical experience with medical patients undergoing training in MBSR in the context of mainstream medicine and health care. Of course, it is important to point out that research has yet to probe systematically the relationship between specific outcomes of MBSR and the degree and depth (difficult to measure) of formal practices engaged in by participants, either in the classes themselves or between sessions, to achieve optimal clinical effects.

3. Further information on MBSR and its professional training opportunities, standards of practice, guidelines for providers, background bibliographies on mindfulness, and ongoing projects can be obtained by contacting the Center for Mindfulness in Medicine, Health Care, and Society at University of Massachusetts Memorial Medical Center, Shaw Building, Worcester, MA 01655-0267, or accessing the Web site: http://www.umassmed.edu/cfm. There are also training opportunities in MBCT. Information for these can be obtained by contacting Zindel Segal, Center for Addiction and Mental Health, Clarke Division, University of Toronto, Toronto, Ontario M5T 1R8, Canada, for training programs in North America; and John Teasdale, Medical Research Council, Cognition and Brain Sciences Unit, 15 Chaucer Road, Cambridge CB2 2EF, U.K., for training programs in Europe. For mindfulness meditation retreats in the Buddhist Theravada tradition (vipassana), see the Web site: http://www.dharma.org. The Center for Mindfulness requires that prospective interns have experienced at least one and preferably two teacher-led 10-day vipassana retreats (or an equivalent) before enrollment.

4. *Note added in proof:* The Center for Mindfulness in Medicine, Health Care, and Society has recently initiated a multistage credentialing process, teacher certification in MBSR. See www.umassmed.edu/cfm for details.

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CAN DIET IN CONJUNCTION WITH STRESS REDUCTION AFFECT THE RATE OF INCREASE IN PROSTATE SPECIFIC ANTIGEN AFTER BIOCHEMICAL RECURRENCE OF PROSTATE CANCER?

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ABSTRACT

Purpose: Epidemiological and laboratory evidence indicates that a Western diet is associated with an increased incidence of prostate cancer. Specific components of the diet, such as high saturated fat, low fiber and high meat content, may have greatest clinical significance in the later stages of tumor promotion and progression. However, departure from the conventional diet is difficult to initiate and maintain. Therefore, we combined the well-known Mindfulness-Based Stress Reduction (MBSR) program with a low saturated fat, high-fiber, plant-based diet to determine the effect on the rate of change in prostate specific antigen (PSA) in patients with biochemical recurrence after prostatectomy.

Materials and Methods: We enrolled 10 men and their partners in a 4-month group-based diet and MBSR intervention. A pre-study post-study design in which each subject served as his own control was used to compare the rate of increase in and doubling time of PSA before and after intervention.

Results: The rate of PSA increase decreased in 8 of 10 men, while 3 had a decrease in absolute PSA. Results of the signed rank test indicated a significant decrease in the rate of increase in the intervention period ($p = 0.01$). Estimated median doubling time increased from 6.5 months (95% confidence interval 3.7 to 10.1) before to 17.7 months (95% confidence interval 7.8 to infinity) after the intervention.

Conclusions: Our small study provides evidence that a plant-based diet delivered in the context of MBSR decreases the rate of PSA increase and may slow the rate of tumor progression in cases of biochemically recurrent prostate cancer. Larger-scale randomized studies are warranted to explore further the preventive and therapeutic potential of diet and lifestyle modification in men with prostate cancer.

KEY WORDS: prostate, prostatic neoplasms, prostate-specific antigen, diet, disease progression

Approximately 35% of men initially treated for prostate cancer have biochemically defined recurrence marked by detectable prostate specific antigen (PSA) elevation within 10 years of definitive local therapy. In more than a third of these men metastatic disease develops within the subsequent 5 years.[1] To our knowledge no curative therapy exists for metastatic prostate cancer. Medical and surgical androgen ablation can produce responses in most patients but with side effects, including osteoporosis, decreased muscle mass and impotence.[2] This finding has motivated a search for novel adjunctive strategies that may retard tumor progression and postpone hormone therapy.

Dramatic international variations in age adjusted incidence and mortality rates, such as an incidence in Qidong County, China of 0.5/100,000 men versus the incidence in the United States of 102.1/100,000[3,4] and approximate host country rates in the grandchildren of Japanese migrants, point to the dominant influence of environmental factors.[3,5,6] Of environmental influences diet may be the most important modifiable risk factor. Total fat and meat consumption is associated with overall incidence of prostate cancer[7–9] as well as with an incidence of more aggressive tumors.[8,9] Saturated fat from meat and dairy intake is the most strongly associated fat subtype.[10,11] Conversely the intake of whole grains and soy products is associated with decreased mortality.[12]

Results from laboratory animal experiments are consistent with these findings. Fat restriction has inhibited the growth of transplanted prostate cancer cells in rodents.[13,14] Fat restriction[5] and the feeding of the soy isolate genestein[15] inhibit growth of the LNCaP human prostate cancer cell line.

Preliminary evidence also indicates that prostate cancer may be sensitive to diet even after metastasis develops. Plant-based diets may be associated with prolonged survival and instances of remission of bone metastasis in men with advanced disease.[16] These findings may be partially explained by the demonstrated ability of low-fat, high-fiber diets to modulate circulating androgen levels.[17,18]

A number of psychosocial factors reinforce dietary habits and must be addressed if a new healthier pattern is to be

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The contents are solely the responsibility of the authors and do not necessarily represent the official views of either funding agency.

established. Mindfulness Based Stress Reduction (MBSR), an outpatient program developed at University of Massachusetts Medical School, aims through intensive training in mindfulness meditation and its applications in everyday life to enhance healthy attitudinal and behavioral changes in patients with a wide range of stress and pain disorders, and chronic diseases.[19] It has been shown to be effective for decreasing panic disorder and anxiety,[20] and for helping patients to cope with the inevitable personal, family and social conflicts that accompany difficult life style changes.[21] Stress management training generally has been shown to modulate neuroendocrine and neuroimmune pathways,[22,23] and it may have salutary effects on chronic prostatitis,[24] a condition often exacerbated by stress.[25] Furthermore, social support has been associated with increased survival in cases of metastatic breast cancer and malignant melanoma.[26,27] We tested the effect on PSA of an intensive intervention combining dietary change with MBSR after prostatectomy in men after biochemical recurrence of prostate cancer. Each patient served as his own control since the PSA rate of change and doubling time from the end of the nadir period to the beginning of intervention (pre-study period) were compared with those from the beginning to the end of the 4-month intervention (post-study period).

PATIENTS AND METHODS

The study protocol was approved by the University of Massachusetts Medical School Institutional Review Board for use of human subjects in medical research. All participants provided informed consent before being enrolled in the study.

Patients had biopsy confirmed adenocarcinoma of the prostate, underwent radical prostatectomy as primary therapy and subsequently had increasing PSA on at least 2 sequential tests not more than 6 months apart after achieving a posttreatment nadir. They were referred by a network of participating urologists from the University of Massachusetts-Memorial Medical Center, Fallon Clinic and private offices in central Massachusetts. Study exclusion criteria were primary high dose radiation or brachytherapy, postoperative radiation therapy to the prostatic fossa or hormone therapy within 6 months of intervention, more than 1 leuprolide injection during the year before intervention to ensure further against any lingering effect of hormonal therapy on the pre-study PSA rates and co-morbidities that would limit study participation.

This study was a nonrandomized clinical trial providing an intensive intervention integrating dietary change with MBSR. The plant-based diet was nutritionally balanced, low in saturated fat and high in fiber. It focused on whole grains, legumes, fresh green and yellow vegetables, seeds and legumes, soy food and fruit. Processed and refined products, caffeine and foods of animal origin were strictly limited. MBSR was taught as an integral part of the dietary intervention. It included mindfulness meditation training, gentle exercise in the form of yoga and social support.

Each participant received individual dietary counseling and MBSR orientation before the intensive group intervention, which consisted of a series of 12 weekly classes of 3 to 4 hours each. They were required to be accompanied to the classes by a support person, preferably someone with whom they shared food. For 7 of the 10 participants this person was the spouse.

Classes were held in the University of Massachusetts Division of Preventive and Behavioral Medicine demonstration kitchen and adjacent conference room. Each class included a presentation on nutrition information by a trained nutritionist (P. H. R.), instruction and practice in preparing interesting and representative dishes by a vegetarian chef (D. J.), and elements of MBSR training by an instructor (J. F. C.) from the UMass Stress Reduction Clinic. Each class included opportunities for in-depth discussion of any challenges and difficulties that may have arisen in making the recommended changes. Classes were concluded by a shared meal prepared by the participants under the direction of the chef.

Diets were assessed at the beginning and end of the 4-month intervention period for total and saturated fat, carbohydrate, protein, fiber and total caloric intake using the 7-Day Dietary Recall, an instrument that assesses diet with a high level of accuracy.[28] Physical activity assessment was based on responses to ancillary questions on the instrument. Body weight also was assessed at the beginning and end of the intervention period. Height was measured at baseline only.

As the primary study end point, the rate of change in PSA before (pre-study) and during the course of intervention (post-study) were determined and compared. Post-study rates of PSA change were based on serum samples obtained at the beginning and end of intervention using the Immulite 2000 PSA test (Diagnostic Products Corp., Los Angeles, California), a completely automated, ultrasensitive chemiluminescence assay with a sensitivity limit of 0.04 ng./ml. PSA measurements used to determine pre-study comparison rates of PSA change began with the last nadir point after the completion of primary treatment, defined as that point after which there were 2 or more consecutive increases in PSA. They included all subsequent measurements up to the beginning of intervention. PSA measurements from the end of the nadir period to the beginning of intervention, as part of routine patient clinical care, were obtained by reviewing medical records.

Some patient pre-study measurements were made elsewhere using test kits with slightly different performance characteristics than the Immulite PSA test (M. Snyder, personal communication, July 2000). Only a single laboratory was used per patient for determining pre-study slope. When there were pre-study measurements from more than 1 laboratory, values from the most frequently used laboratory were used for analysis. We assumed that rates of change in PSA but not absolute PSA levels were comparable among laboratories.

Linear regression was used to calculate pre-study and

TABLE 1. *Patient age and tumor characteristics*

Pt. No.—Age	TNM Tumor Stage	Gleason Score	Pre-Study Adjunctive Therapy	Pre-Study PSA (ng./ml.)	Mos. Doubling Time	
					Pre-Study	Post-Study*
1—70	T2b	6	Radiation	1.95	7.3	22.4
2—64	T2a	7		0.11	3.5	−13.4
3—70	T2c	6	Hormone	0.84	2.7	6.2
4—56	T4	7		0.07	6.5	6.0
5—65	T2c	9		0.74	3.9	13.1
6—74	TX	6		22.9	7.9	−18.4
7—61	T2b	7		0.40	5.4	12.1
8—69	T2c	5		0.13	6.4	−16.2
9—67	T2b	6		1.56	24.7	11.3
10—78	T3	6		1.43	11.2	44.3

* Negative values indicate decreasing slope and absolute values can be interpreted as halving time.

post-study rates of PSA increase in all men. During periods of rapid proliferation cancer shows log linear, and not simply linear, growth.[29] Therefore, PSA data were log transformed to meet the normality and linearity assumptions of linear regression and these log transformed data form the basis of all results presented. Slopes of log PSA versus time were compared in each subject for pre-study and post-study periods using the signed rank test. Slopes were translated into PSA doubling time using the formula, doubling time = log 2/slope. We calculated median doubling time and the corresponding 95% confidence interval (CI). The association of the change in slope with the change in dietary and life-style factors was estimated using Spearman's rank correlation. Multiple regression analysis was performed to estimate associations after adjusting for pre-slope values.

Additional analysis was also performed to evaluate the possibility of regression to the mean, that is the tendency of high values to be lower on repeat measurement. In 5 men with sufficient PSA values the initial PSA values used for determining selection were not used to estimate pre-study slope. Thus, the effect of regression to the mean was damped. The distribution of slope was simulated using a correlation of 0.6 estimated from the data. Thus, the effect of possible regression to the mean on PSA doubling time was estimated and subtracted from the estimated change in slope.

RESULTS

Table 1 lists ages and disease status of the 10 participants. Two men underwent adjunctive therapy after radical prostatectomy and before study entry, including postoperative radiation to the prostatic fossa and leuprolide administration 2 years and 11 months before intervention. The Gleason score was determined by pathological evaluation of biopsy specimens. In 9 of the 10 patients there was no clinical evidence of local recurrence, while in the remaining patient there was no clinical evidence of recurrence after completing postoperative radiation to the prostatic fossa. Mean time from the last nadir PSA to the beginning of intervention plus or minus standard deviation (SD) was 35.5 ± 35.8 months. The SD was relatively large because intervention began in 1 man 122 months after PSA began to increase. In almost all cases nadir values were identical to the sensitivity threshold of the PSA test (0.04 ng./dl.).

The slope of PSA change decreased in 8 men, including a change to a negative value in 3, indicating an absolute PSA decrease and not only a decreased rate of change. In 2 men it increased when comparing the pre-study and post-study periods (table 2). The signed rank test showed a statistically significant decrease in the slope of the group overall (p = 0.01). Analysis accounting for possible regression to the mean provided an upper estimate of any possible effect, which was subtracted from the overall change in the pre-study PSA rate. This adjustment did not affect the number of men with a decreasing slope but it resulted in a slight increase in the p value derived from the signed rank test (adjusted p = 0.04). Figure 1 shows paired pre-study versus post-study slope by patient in order of increasing pre-study slope. The post-study slope was negative in 3 men, indicating decreased PSA. For the group overall estimated median doubling time based on slope was 6.5 months during the pre-study period (95% CI 3.7 to 10.1) and 17.7 months during the post-study period (95% CI 7.8 to infinity). The upper limit of the latter CI would be equivalent to a slope of 0 or less, indicating no doubling time, which was the expected result in the 3 men with decreases in PSA.

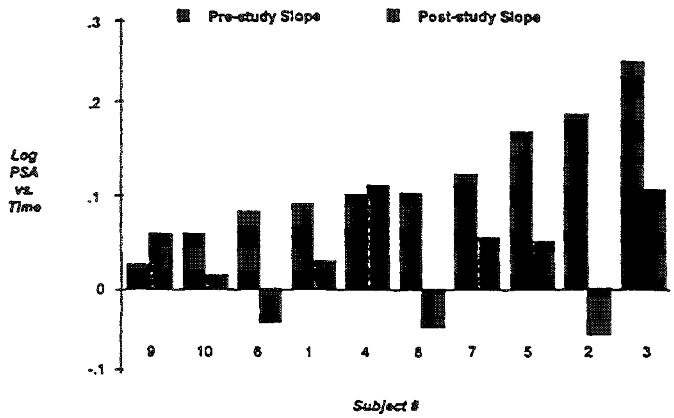

FIG. 1. Pre-study versus post-study PSA slope by patient, ordered according to increasing pre-study slope.

Total fat intake decreased in 6 of the 10 participants. The mean reduction was of 6 gm. daily (table 3). Nine men decreased the saturated fat intake a mean of 4.14 gm. daily. The reduction in saturated fat accounted for 69% of the mean decrease in total fat. Mean caloric intake decreased in 8 cases representing an average of 530 kcal. daily for the group. Mean fiber intake increased by 5.5 gm. daily, representing a 40% increase from baseline, but only 4 of the 10 men increased the fiber intake. In the 2 men in whom caloric intake increased fiber intake increased by 28.6 gm./1,000 kcal. daily. In the remaining 8 men there was an increase per unit decrease in caloric intake of 4.3 gm./1,000 kcal. daily. That is, although absolute fiber intake decreased, the fiber concentration of the diet increased.

The 2 men who increased energy intake also greatly increased the exercise level from 19 to 51 and 18 to 122 daily, respectively. Eight of the 10 patients increased the time spent in intentional physical activity. The average duration increased by 57% from 21 to 33 minutes daily. Body mass index (BMI) was calculated according to the formula, BMI = weight in kg./height in m.^{2} All 10 men lost weight. The mean decrease in body mass index was 7% from 30.3 to 28.2 kg./m.^{2}, corresponding to an average weight loss of about 6.3 kg.

TABLE 2. *Estimated PSA slope during pre-study and post-study intervention period*

Pt. No.	Slope		Mos. Doubling Time	
	Pre-Study	Post-Study	Pre-Study	Post-Study*
1	0.095	0.031	7.3	22.4
2	0.196	−0.051	3.5	
3	0.256	0.112	2.7	6.2
4	0.105	0.116	6.6	6.0
5	0.176	0.053	3.9	13.1
6	0.065	−0.038	7.9	
7	0.128	0.057	5.4	12.1
8	0.107	−0.043	6.5	
9	0.028	0.061	24.7	11.3
10	0.062	0.016	11.2	44.3
Mean (95% CI)	0.124 (0.076–0.173)	0.031 (0.012–0.075)	6.5 (3.7–10.1)	17.7 (7.8–infinity)

* In 3 patients absolute PSA levels decreased, not just the rate PSA doubling time. A negative post-study slope indicates that if the levels decrease continued, PSA would eventually reach zero.

TABLE 3. *Changes in dietary intake, exercise level and body mass index according to changes in PSA slope*

Pt. No.	PSA Slope*	Fiber Intake (gm./day)	Total Fat Intake (gm./day)	Saturated Fat Intake (gm./day)	Energy Intake (kcal./day)	Exercise Level (min./day)	Body Mass Index (kg./m.^{2})
2	−0.25	39.6	−7.04	0.10	1,179	32	−2.59
8	−0.15	−2.0	−14.23	−4.60	−2,333	24	−2.20
3	−0.14	24.1	0.05	−1.38	1,027	104	−3.95
6	−0.13	3.7	6.78	−2.92	−166	4	−3.91
5	−0.12	−2.1	−2.95	−4.27	−640	39	−1.88
7	−0.07	6.8	−14.16	−5.37	−263	25	−0.92
1	−0.06	−4.4	−33.57	−13.89	−1,190	−6	−0.74
10	−0.05	−1.2	5.46	−0.68	−569	13	−2.59
4	0.01	−2.3	1.68	−1.93	−777	7	−0.89
9	0.03	−7.6	−2.29	−6.43	−1,566	−12	−1.49

* Log PSA versus time.

TABLE 4. *Pre-study and post-study values of significant predictors of changes in PSA slope*

Pt. No.	Fiber Intake (gm./day)		Exercise Level (mins./day)		Body Mass Index (kg./m.^{2})	
	Pre-Study	Post-Study	Pre-Study	Post-Study	Pre-Study	Post-Study
1	6.9	2.5	32	26	29.61	28.87
2	14.1	53.8	19	51	31.30	28.71
3	19.2	43.3	18	122	34.08	30.13
4	12.8	10.6	0	7	29.25	28.36
5	14.9	12.8	19	58	28.82	26.94
6	13.9	17.7	15	19	29.93	26.02
7	6.5	13.3	25	50	31.00	30.08
8	21.6	19.6	18	42	31.16	28.96
9	14.6	7.0	51	39	29.67	28.18
10	12.7	11.5	13	26	28.65	26.06

PSA slope showed that 3 measured changes in dietary and life-style factors were statistically significantly associated with the change in the rate of increase in PSA during the course of intervention (table 4). The strongest relationship, which was an inverse association, was with dietary fiber intake (Spearman's $\rho = -0.73$, $p = 0.02$). The change in the rate of increase also was inversely related to the change in the number of minutes of exercise (Spearman's $\rho = -0.60$, $p = 0.04$). The change in the rate of increase was positively associated with the change in body mass index (Spearman's $\rho = 0.60$, $p = 0.04$). Figure 2 shows dietary fiber, exercise level and body mass index versus the change in PSA slope, respectively. The change in PSA slope also was related to the pre-slope (Spearman's $\rho = -0.71$, $p = 0.02$), as were the life style factors. When adjusted for pre-slope values, none of the dietary and lifestyle factors showed a statistically significant association.

DISCUSSION

We observed that in men with increasing PSA after radical prostatectomy a program of structured dietary change integrated with MBSR training resulted in a significantly decreased rate of PSA increase, an almost 3-fold increase in PSA doubling time (although the CI was large because of small sample size) and an absolute decrease in PSA in 3 men. Moreover, changes produced by the intervention, including increased dietary fiber intake and exercise level, and decreased body weight, were specific predictors of these outcomes. Unlike most existing or proposed treatment strategies this intervention directly addresses risk factors that can be modified by patients and has no known adverse side effects. Moreover, it uses a novel integration of a meditative mind/body orientation based on the cultivation of mindfulness and encompassing all aspects of the dietary change intervention, such as shopping, food preparation, eating, and experiencing emotions after eating. These elements may increase motivation and intervention compliance. The potential health benefits of this approach include enhanced quality of life and simultaneous decrease in risk factors for co-morbidities that are common in older men, such as cardiovascular disease and diabetes. Furthermore, because the intervention involved other members of each patient support group, most notably the spouse, its effect would be expected to be more durable than one aimed only at the study participant.

What is the mechanism of a possible effect of this intervention on prostate cancer progression? The dietary fiber, exercise, and body weight relationships with PSA doubling time indicate a common endocrine mechanism. Vegetarians consume more dietary fiber and have lower serum testosterone and 17β-estradiol than nonvegetarians.[30] A low-fat, high-fiber diet combined with exercise and weight loss also has been shown to increase sex hormone-binding globulin and, therefore, would decrease the ratio of free-to-bound testosterone.[18] Decreased availability of biologically active free testosterone for binding by testosterone receptors may lead to decreased prostate cancer cell proliferation.

While dietary and lifestyle changes may make theoretical sense, it is often argued that they are impractical and patients may not comply with the changes they are asked to make. Not all participants complied with the diet and lifestyle recommendations to the same degree and we cannot be certain that the changes that they made are enduring. Nevertheless, most men made significant behavioral changes and all attained significant weight loss in a relatively short period. The combined effect of the changes in dietary factors and exercise levels was consistent with reported decreases in caloric intake and increases in exercise levels.

According to the Health Belief Model people modify behavior when they believe that there may be serious consequences if behavior is not modified, they are capable of taking action to change behavior, changing behavior decreases risk and the potential cost of taking action are outweighed by the benefits. All study participants knew that they were in the early stages of recurrent prostate cancer, a condition with no known cure and limited treatment options. A number had co-morbidities, such as heart disease and diabetes, demanding commitment to the same set of dietary and lifestyle changes. Participation was encouraged by their urologists and supported by their partners. In addition, MBSR may have helped them to recognize and work through feelings of loss and helplessness. It also may have assisted them to identify and address self-defeating behavioral patterns and

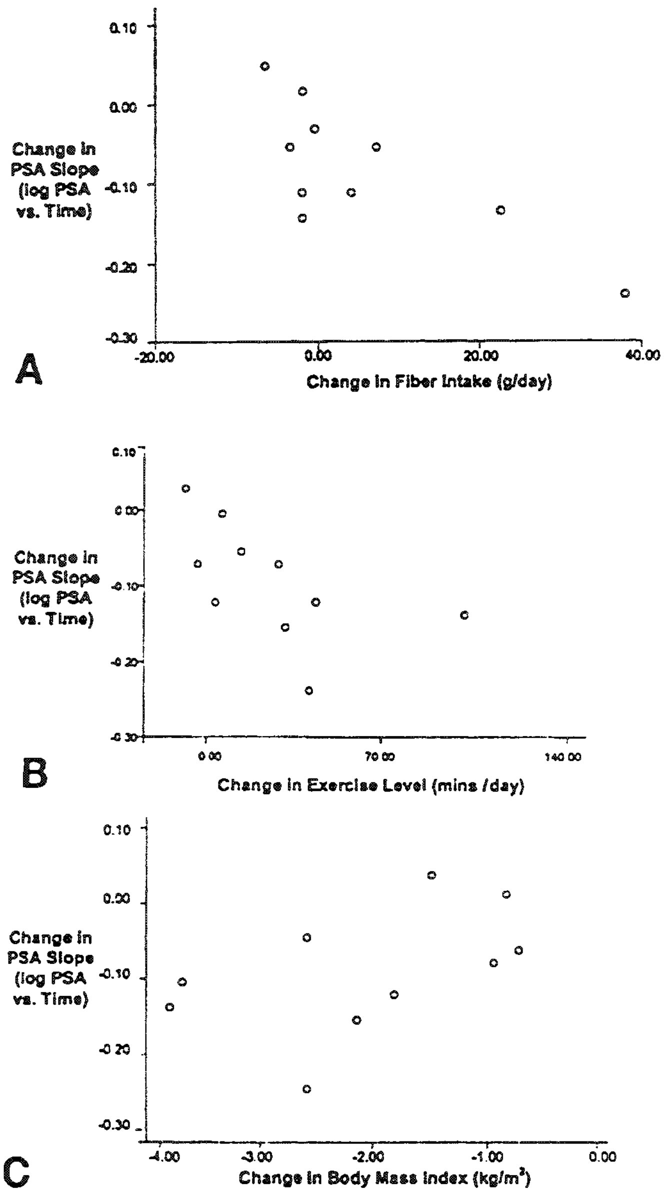

FIG. 2. Changes as predictor of change in PSA slope. *A*, fiber intake. *B*, exercise level. *C*, body mass index.

mobilize the innate capacity for self-healing. They made these changes in the context of a group with a common health concern and a difficult lifestyle transition. They were supported and encouraged by a dedicated, compassionate and highly trained staff. Furthermore, positive reinforcement for change was provided by nonprostate cancer related health benefits that they reported, such as improved blood pressure, serum glucose and cholesterol, decreased medication requirements, increased energy levels, decreased pain and enhanced well-being.

Our study had several important limitations. The most obvious of these was the small sample size of 10 participants and the lack of randomization. Partially because of small sample size we did not completely differentiate the effects of dietary factors from each other or from other aspects of intervention. Thus, it was difficult to gauge the possible specific effects of these components or assess possible interactions with dietary factors. These questions should be the focus of future inquiry.

The 4-month period may have been too short for some patients to achieve and maintain for a prolonged time the desired level of dietary and lifestyle change. A longer interval of sustained adherence may be required to maximize the biological impact of intervention on PSA. Because of the relationships of pre-slope PSA with PSA change and lifestyle factors associated with the PSA change, adjusting for pre-slope values may have represented inappropriate over control for these factors. While regression to the mean does not appear to have biased results to a large extent in these data, future work must focus on the need to control background PSA or some other indicator of disease progression in the study design, perhaps by blocking randomization on this variable.

While it is biologically feasible that this intervention may decrease disease progression, this interpretation must be made cautiously because we did not assess tumor progression directly, relying instead on the surrogate marker PSA. When the recurrent prostate cancer diagnosis is based only on a PSA increase, the extent of spread is often unclear. However, a post-prostatectomy PSA increase usually signifies recurrent prostate cancer and the rate of the PSA increase correlates closely with the rate of prostate cancer growth.[31] Also, in patients with hormone refractory disease undergoing chemotherapy or other nonhormonal therapy a decrease of greater than 50% from baseline PSA is associated with increased survival.[32] Although it is likely that most, if not all, men had recurrence, none had clinical, bone scan or magnetic resonance imaging evidence of metastasis. As a result, we did not ascertain whether or in whom these presumed recurrences represented local, regional or distant disease. We did not compare absolute PSA among laboratories. It is difficult to estimate whether or in what way it may have biased our findings. Furthermore, 1 man underwent radiation therapy and 1 received leuprolide postoperatively. While we did not enroll in our study men who had recently (within 6 months of intervention) undergone these therapies, it also is not clear whether or how these followup treatments may have affected the subsequent rate of PSA change.

CONCLUSIONS

Dietary change combined with mindfulness training significantly slowed the rate of increase in PSA in men with biochemical or PSA recurrence after radical prostatectomy. Doubling time increased from a median of 6.5 months before to 17.7 after the study. All 10 men lost weight, averaging 7% in the whole group. PSA decreased in 3 men. Furthermore, changes associated with the intervention, including increased dietary fiber intake and exercise level, and decreased body weight, were specific predictors of these outcomes. Small sample size and the lack of randomization limited our study. Although findings in self-selection trials have great clinical relevance, future randomized large-scale studies are warranted to explore possible biological mechanisms and, using direct assess the effectiveness and clinical applicability of diet and lifestyle intervention using direct prostate cancer end points.

Drs. Douglas Dahl and Yunsheng Ma, Barbara Olendzki and Elana Rosenbaum contributed to this study.

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Parsing the data: An examination of a study on meditation and the treatment of psoriasis

Readers will notice an imbalance in the early pages of this interchange about a study by Jon Kabat-Zinn and colleagues exploring the use of meditation as an adjunct to the standard treatment for psoriasis ("Influence of mindfulness meditation-based stress reduction intervention on rates of skin clearing in patients with moderate to severe psoriasis undergoing phototherapy (UVB) and photochemotherapy (PUVA)," Psychosomatic Medicine 1998). The initial comment critiquing the study is considerably longer and more detailed than the companion comment applauding the study. Under normal conditions, editorial fairness would have sought a better balance. Under the conditions that applied in this situation, however, editorial fairness demanded that the comments be accepted as they were and not in any way supplemented.

The background is this:

The original stimulus for the exchange came from a comment by Kabat-Zinn, Professor of Medicine at the University of Massachusetts Medical School, at the panel discussion on complementary and alternative therapies published in the previous issue of Advances *("Complementary and alternative therapies and the question of evidence," Fall 2000). The panel consisted of two critics and two advocates of complementary and alternative therapies, and the heart of their disagreement centered on the value of the evidence supporting such therapies. The critics thought that the evidence was poor and sparse, and the advocates thought there was considerably more good evidence than the critics acknowledged and that the evidence was growing. During the audience discussion following the main presentations, Kabat-Zinn, in some comments about mind–body studies, remarked that the study he and his colleagues had recently published on using meditation as an aid in clearing psoriasis seemed to him the type of research that could help build the evidence needed to validate unestablished therapies.*

Kabat-Zinn's comment sparked the editorial idea of asking the four panelists to write their assessments of his research. The assessments potentially could serve as a case study of the possibly divergent ways that critics and advocates approached the data supporting complementary and alternative therapies. Their side-by-side assessments might show that critics and advocates were applying different standards to the data or were approaching the task of scientific assessment with different presumptions.

Kabat-Zinn thought the idea interesting and said, in effect, that he looked forward to the results and hoped he would be kept informed. Invitations went out to the four panelists. Two declined. In retrospect it is here that the trouble began, though it did not seem so at the time. Of course, two assessments were not as good as four, but of the two acceptances, one came from a critic—Arnold Relman, former editor of the New England Journal of Medicine*—and one came from an advocate—David Riley, then the editor-in-chief of* Alternative Therapies in Health and Medicine. *The match and the project still seemed good ones.*

When the assessments arrived, the trouble was obvious. Relman's assessment was thoroughly critical, carefully argued, and very detailed. Riley's assessment was enthusiastically positive but barely looked at the data and was quite short; it essentially was a bite-sized critique of biomedicine for not appreciating the value to patients of findings like those of Kabat-Zinn et al.

Editorially, the imbalance between the assessments was distressing. Also distressing was the realization that in this situation editorial fairness precluded any change.

I could not in good conscience inform David Riley that Arnold Relman had written a severe critique and that Riley's comments on the study—which, I believed, raised substantial issues—did not speak to the points raised by Relman. Nor could I fairly find some reason not to print an exchange whose imbalance might upset mind–body *advocates. If I ever had a reason to call the project to a halt, it was when two of the four panelists declined my invitation to write about the study. I had let that opportunity go by, and now it seemed to me I could not reasonably and fairly do anything but print the comments that I had invited, introducing them with some sort of explanatory comment.*

In my considerations, I did not give much thought to Kabat-Zinn or to on the reputation of the study and perhaps the researchers themselves. I assumed that Kabat-Zinn would be unhappy but that he would respond in the next issue, and that would be that. But once he read the proofs, he persuaded me (after several exchanges) that publishing Relman's critique without a rejoinder in the same issue would be a disservice to the study, its authors, and to the discussion itself. The arguments of the critique would win by default; counter-arguments, coming three months later, would have no weight.

This meant changing the rules of the game. I spoke with Relman, explaining my reasons for wanting to change the format midway through, and he understood.

The much-expanded result follows: a comment by Relman and a comment by Riley, then a response by Kabat-Zinn and David Hosmer (the statistician on the study) with a reply by Relman, and finally one more response by Kabat-Zinn and Hosmer and one more reply by Relman. Let us hope that the effort produces some light.

Since Relman's initial comments presume that readers are aware of Kabat-Zinn's remarks at the panel discussion (originally, the four assessments of the Kabat-Zinn et al. study were scheduled to appear in the same issue as the discussion), here are the relevant portions of his comments:

> I don't think this is a situation in which one study is going to weigh the balance. . . . Evidence-based medicine will virtually take a generation of studies to understand what the mechanisms are and what the reality is of the new therapies. . . .
> I say just in passing that we did a study at the University of Massachusetts Medical Center, looking at people with psoriasis, and without going into any of the details, found in a replication study—we did it twice before publishing the result—found that people who meditated while receiving the ultraviolent light therapy healed at approximately 4 times the rate of people who were just getting the the ultraviolent light by itself. Although there were only 37 subjects in the study, the difference in the rate of skin clearing was highly significant statistically. Now that's the kind of study that I'd like to see a lot more of, and then looking underneath it, underneath the skin if you will, to what's actually going on in terms of uncontrolled cell-proliferation.

Finally, for readers unfamiliar with Kabat-Zinn et al.'s study, here is the abstract of that investigation:

Objective This study tests the hypothesis that stress reduction methods based on mindfulness meditation can positively influence the rate at which psoriasis clears in patients undergoing phototherapy or photochemotherapy treatment.

Methods Thirty-seven patients with psoriasis about to undergo ultraviolent phototherapy (UVB) or photochemotherapy (PUVA) were randomly assigned to one of two conditions: a mindfulness meditation-based stress reduction intervention guided by audiotaped instructions during light treatments, or a control condition consisting of the light treatments alone with no taped instructions. Psoriasis status was assessed in three ways: direct inspection by unblinded clinic nurses; direct inspection by physicians blinded to the patient's study condition (tape or no-tape); and blinded physician evaluation of photographs of psoriasis lesions. Four sequential indicators of skin status were monitored during the study: a First Response Point, a Turning Point, a Halfway Point, and a Clearing Point.

Results: Cox-proportional hazards regression analysis showed that subjects in the tape groups reached the Halfway Point (P = 013) and the Clearing Point (P = 033) significantly more rapidly than those in the no-tape condition, for both UVB and PUVA treatments.

Conclusions: A brief mindfulness meditation-based stress reduction intervention delivered by audiotape during ultraviolet light therapy can increase the rate of resolution of psoriatic lesions in patients with psoriasis.

A critical view

Arnold Relman

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I have been asked by the editor of *Advances in Mind–Body Medicine* to comment on the paper by Kabat-Zinn and his colleagues about the effects of a stress-reduction intervention on the rate of skin clearing in patients with psoriasis who are undergoing two types of phototherapy, which was published two years ago in *Psychosomatic Medicine*. I am happy to do so, because it gives me an opportunity to clarify some misunderstandings and to illustrate many of the problems with the claims of evidence-based support for the clinical effectiveness of psychological interventions.

First, let me comment on Dr Kabat-Zinn's remark [during the panel discussion on complementary and alternative medicine] that he sent the paper to me "before [he] sent it to anybody else." Did he mail the manuscript to me directly? I confess that I have no recollection of personally receiving his paper, and if he did send it to me, I apologize for my lapse. On the other hand, if Kabat-Zinn simply meant to imply that the paper was initially submitted to *The New England Journal of Medicine* before it was sent to other journals, I would have had no knowledge of the manuscript because I retired as the editor of *New England Journal of Medicine* nearly 9 years ago. In any case, I did not read it until I recently received a copy from Harris Dienstfrey.

None of this is particularly important here, however. What is important is whether Kabat-Zinn's characterization of his paper is correct. According to him, "Although there were only 37 subjects in the study, the difference in the rate of skin clearing was highly significant statistically." After carefully studying the paper, my opinion is that the data are even more meager than he implies, and the statistical analysis quite unconvincing. Indeed, in the Discussion section of his paper, Kabat-Zinn seems to be agreeing with my assessment of his evidence. Here are some quotes from the paper: "These results must be interpreted cautiously, however, in light of the small numbers." Again, a few paragraphs later on the same page of the Discussion, he says that attribution of his results to the stress reduction intervention "should be considered preliminary and tentative." And, a little farther on, he says that any conclusive attribution to psychological factors "awaits further research." I agree with those cautious words, and therefore am puzzled by his comment in the panel discussion about his "highly significant" effects, and also by his rather flat-footed assertion in the Conclusions part of the Abstract that the stress-reduction intervention he used "can increase the rate of resolution of psoriatic lesions . . ." This inflation of language is an example of how data, even when initially admitted by their authors to be "preliminary and tentative," acquire exaggerated significance in subsequent discussion and get to be cited in secondary sources as "highly significant" evidence of propositions for which the empirical evidence is really quite unconvincing. More about this point at the end of my commentary.

But my criticism goes far beyond Kabat-Zinn's inconsistent language. My study of his paper leads me to the regrettable conclusion that the design and analysis of his study are seriously flawed and that it is not at all clear that even "preliminary and tentative" conclusions can be drawn. Let me explain why.

First, with respect to *design and analysis*, there are a number of serious problems:

1. Thirty-seven patients started on trial, and 14 (or 15?) of these dropped out because their treatment was changed by their dermatologist—in ways that we are not told about in any detail. Did the dropouts get more or less phototherapy than those who didn't drop out? What other treatment did they get,

and why? The authors say that there were equal numbers of dropouts from each group, implying that therefore we need not worry about the dropout effect, particularly since the authors included *all* starters in the final statistical analysis. But unless we know the reason for dropping out and exactly what treatment was given to each of the dropouts from all arms of the study, we can't interpret the results.

2. As shown in Table 2, a diminishing number of the original 37 starters reached each therapeutic end point (33 reached the First Response; 29 the Turning Point; and 28 the Half-Way Point). Since we are told that all patients "were kept in the study until they cleared up or until they dropped out," we must conclude that this decline in the number of subjects (from 37 starters to 28 at the half-way point) was due to dropouts. But according to the Table, only 19 patients reached the final Clearing Point. If there were only 14 or 15 dropouts, as stated, what happened to the missing 3 or 4 patients?
3. The nurses, who followed the patients closely and collected most of the data, were *not* blinded. This is a serious weakness, since the assessment of extent of change in lesions is largely subjective. The authors say that patients were also followed by blinded physicians who checked the nurses' judgment about complete clearing. But there is no test of the effectiveness of blinding the physicians. How do we know that the physicians didn't learn in the course of this study which of their patients were getting the audiotape stress reduction intervention? There are many ways they might have learned about this and thus might have become unblinded and biased, like the nurses. In any rigorously conducted blinded trial, the investigators are expected to give some information on the effectiveness of blinding. And, without effective blinding, a study of this kind, that is so dependent on clinical assessment of lesions, cannot be trusted.
4. The time to "complete" healing was the most reliable observation because it can be assessed most objectively, and because it was the only end point that was presumably checked by independent, blinded physicians. However, according to Table 2, only 10 experimental and 9 control patients reached the final outcome of complete clearing. This is much too small a number to allow firm conclusions—unless the difference in results between the two groups had been very large. But they are not. Hence the "unadjusted" statistics on time to complete healing are not statistically significant (Table 2); even the "adjusted" statistics on complete healing in Table 3 are of borderline significance.
5. The adjustments in Table 3 take account only of pre-treatment duration of illness and the severity of illness at the start of treatment. Other possible confounders were not considered (for example, previous courses of treatment and response to previous treatment). More sophisticated adjustments might have increased or decreased the statistical difference between the treated and control patients. So, the most reliable data are the unadjusted results, and these are too few to permit any firm conclusions.

In summary, then, I take strong issue with Kabat-Zinn's characterization of his study as providing "highly significant" statistical evidence that people who meditate while receiving ultraviolet light therapy heal at approximately four times the rate of people who are just getting the ultraviolet light by itself. To the contrary, I believe that most trained epidemiologists would consider this to be a weak and flawed study that simply doesn't allow any definite interpretation. At the most, it might be considered as a possible hint at such an effect—a study that would have to be repeated with a much larger number of subjects and a much more robust, randomized, double-blinded design before any conclusion could be drawn.

This is a good illustration of why therapeutic claims need to be backed by strong evidence. Here is a study much cited by proponents of the curative powers of meditation as "scientific proof" of effectiveness. And yet, close examination of the design and the data reveals serious flaws that make it highly suspect. I am *not* saying that this study shows meditation to be ineffective. What I do maintain, however, is that this study is uninterpretable and does not even come close to proving a positive effect. Even Kabat-Zinn acknowledged this in the text of his paper, although he seems to have forgotten his reservations in the comments he made at the panel discussion in May '99.

But, even if we could legitimately conclude from Kabat-Zinn's data that there had indeed been an effect of meditation on the rate of response to phototherapy in one short-term clinical trial, what would we know about the ability of meditation to cure or significantly affect the clinical course of psoriasis over time? The answer unfortunately is: "Very little." There is no evidence that the natural history of the disease can be changed, that relapses can be prevented, or that patients would continue to have any benefit from repeated use of the meditation tapes. Psoriasis is a chronic, relapsing disease, which flares up from time to time. Any conclusions about the role of meditation in the treatment of this disease would require well-designed long-term studies of many more patients.

There are no shortcuts and no easy way to find reliable answers in this field or in most other fields in clinical therapeutics. Advocates of meditation and all other "alternative" methods of healing have the same obligation to support their claims with objective data that bind all clinical investigators. Without reliable and objective data there is simply no way to separate fact from fiction or self-delusion. If Kabat-Zinn's paper had been submitted to me when I was editor of the *New England Journal of Medicine*, and if it were a trial of some other, more conventional form of medical treatment, I am quite certain that I and my editorial colleagues would have rejected it because of its weak experimental design and relative paucity of data. We would have recommended that he try again with a larger study and a better design. And that is what I would recommend to him now. Why should we have different standards for trials of "alternative" and conventional therapy?

A positive assessment

David Riley

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My only minor criticism of the psoriasis study is that I would have liked to see a larger sample size in order to control better for other variables. In addition, 12 subjects dropped out of the study before completing their treatments.

Nonetheless, here we have an intervention that is essentially nontoxic, is used as an adjunctive therapy to conventional medicine, and empowers patients. The facts that the rate of clearing is accelerated by the therapy and that this acceleration reduces the necessity for additional sessions of phototherapy and photochemotherapy, with their attendant risks for cancer, are both very important. Despite its small numbers, I believe that this sort of therapy should be encouraged for all psoriasis patients when appropriate. I would go further: Is it ethical to withhold this information from patients or, put conversely, is it malpractice not to include it as part of the treatment options for patients?

The implications of the study are far reaching. The self-healing component of medicine is profound and at the heart of all successful medical therapies.

Response to the comments of Drs Relman and Riley

Jon Kabat-Zinn and David Hosmer

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The point that I (JKZ) was making when I rose to speak at the debate that was held at Spaulding Hospital in May of 1999 was that there are many different levels of evidence that must be arrived at sequentially in a complex scientific exploration to establish ultimate bedrock confidence in an observed phenomenon and its underlying explanation according to known laws and principles. Usually, this happens over a period of years, and involves multiple investigations and investigators, early descriptive studies, small clinical trials, and finally large clinical trials when the phenomenon observed has been shown to have enough merit to be investigated at such a high level of energy and expense. It was within this scientific framework that we undertook and ultimately published 2 years ago the small study in question (Kabat-Zinn et al. 1998). Dr Relman's critique of our paper gives us the opportunity to engage together in a useful dialogue which may lead to a deeper understanding of the question we wished to explore in the first place, even if it does not lead to agreement between us regarding the evidence presented in this particular study and its interpretation. In our summary remarks, we also comment briefly on the supportive statement offered by Dr Riley.

I (JKZ) had joined the discussion about the need for effective studies simply to remark that we had attempted to contribute evidence about the degree to which the mind might influence skin clearing in psoriasis and to appeal for more studies along the same lines, and by inference, better and larger studies. Very few studies of this kind have been undertaken, and I was suggesting that the field would benefit from more attention to such protocols to determine whether an influence of the mind on a healing process in a specific disease could be detected and further investigated in terms of mechanism if it were shown to be replicable. I specifically stated that our study was small and that we didn't publish our findings as a full report until we had seen the phenomenon on 2 separate occasions.

We clearly stated in the paper that the results of our study "must be interpreted cautiously" and the attribution "to elements of the stress reduction intervention . . . [be] considered tentative and preliminary." At the same time, the difference in rates of skin clearing between the 2 groups constitutes what we consider to be a real and potentially important observation, with a range of clinical and theoretical implications that we also outlined in the paper (see below). In any nascent field such as mind–body medicine, progress is made incrementally, small step by small step. Our study was meant to be one such contribution. We submitted it first to the *New England Journal of Medicine* (not to Dr Relman), which returned the manuscript unreviewed. It then underwent a stringent review process at *Psychosomatic Medicine*. What is important at this juncture is not to inflame debate about the merits and shortcomings of one particular study, but to have others attempt to replicate or refute the findings independently, perhaps benefitting from Dr Relman's critique and our rebuttal to improve the design and analysis of any future study. This is the way progress unfolds in science, and this was always the way we have seen our contribution.

In my (JKZ) impromptu remarks, I erroneously characterized our finding as "highly statistically significant" instead of "statistically significant," in part, I imagine, because I was trying briefly to convey two thoughts at once: one, that the results were significant statistically at 2 different clinical end points and in spite of the small sample size, and two, that to my mind, the results are both clinically and theoretically interesting and potentially important. As a rule, I try to be conservative and mindful in my use of language, and to guard against the kind of excesses and inflation of language Dr Relman is rightly worried about. Nevertheless, experts often disagree heatedly about the merits and flaws of particular studies, and we feel we were appropriately balanced in our paper in presenting our positive but measured interpretation of the results we obtained through our analysis of the data, explicitly voicing the study's limitations and the need for further studies to confirm and extend the findings. The fact that we saw the same phenomenon of a statistically significant increased rate of skin clearing in the meditation cohort in an earlier pilot study with an even smaller sample size bolsters our confidence that this is a real effect. We take strong issue with many of Dr Relman's specific readings of our design and analysis, which we address sequentially below, and with the overall tone of his remarks, which implicitly suggest that we might have done better not to have published our study at all. We would see that as highly irresponsible, given what we consider to be the robustness of the phenomenon and its potential importance (see below).

While Dr Relman's concerns about the inflation of discourse in secondary sources are laudable, they cut both ways. He himself speaks of our study being "much cited by proponents of the 'curative powers' of meditation as 'scientific proof' of effectiveness." Who are these unnamed proponents he is speaking of? Are "they" really claiming curative powers for meditation and claiming the existence of *proof*? In my own (JKZ) writings and presentations, I make a clear distinction between curing and healing, and have never spoken of this study as suggesting that the intervention described could *cure* psoriasis but simply that it appears to have an accelerating effect on the rate of healing (skin clearing). Moreover, it would be highly inappropriate to speak of this study *proving* anything. We see it as providing suggestive evidence that something in the meditation group is affecting the rate of skin clearing (healing) and that while we cannot be certain it is the meditation practice itself, this is our working hypothesis, although other factors such as expectations might be involved, as we have stated.

It is an inevitable, if lamentable, occurrence that the fine details and qualifiers of scientific papers will often be lost in their descriptions in secondary sources and in the lay press. Nevertheless, we all have a responsibility to speak judiciously about both the implications and the limits of particular studies, and to be aware of our individual biases regarding the evidence in question so that we do not get caught either in inflationary or deflationary patterns of thought and discourse. What is called for is an open-minded skepticism as the evidence comes in over time.

There have been many accusations in the past that advocates of so-called "alternate medicine" are not interested in having their interventions held to the same standards of rigorous scientific testing as is the case for mainstream medicine. Obviously, we would not have undertaken the study nor published it had we not been interested in adhering to the highest professional standards for evidence in the field. Indeed, we do not see ourselves as advocates of an "alternative" medicine. Our work is within mainstream medicine, and we see our study as a novel attempt to find an appropriate experimental system for addressing the question: Can the mind effect a healing process that we can see and photograph? Hence the choice of psoriasis and an intervention that seamlessly integrated the allopathic treatment (the UV light) with the psychological approach (the meditation/visualization) in real time. Dr Relman is known for speaking to the need for convincing experimental evidence to support claims of effectiveness for nontraditional treatments. Our study is a step in that direction. We differ strongly on whether it is flawed or not and on whether it is convincing or not. No one study, especially one with such a small sample size, is capable of addressing a phenomenon in its fullness. Many studies are required to either refute or confirm and expand upon a specific finding, and this usually takes many years. I (JKZ) said "a generation" at the debate.

A little background to our study: We made our original observation that people who were using a guided meditation tape while in an ultraviolet lightbox undergoing phototherapy treatments showed an increased rate of skin clearing back in the mid-1980s. Because the study involved only 12 subjects, we wrote up the observation as a "Letter to the Editor" in the *Journal of the American Academy of Dermatology* (Bernhard, Kristeller & Kabat-Zinn 1988). Group differences in both the turning point and the clearing point were statistically significant. We continued the study until we had data on 23 subjects (unpublished), which only increased the statistical significance of the finding. We did not publish the results of this small randomized trial as a full paper, however, because the skin assessment of the patients was performed visually by nurses who could not be blinded to the status of the patient, and because of the sample size.

We elected instead to conduct a larger study with a more stringent study design, one that would include photographing the patients at specific intervals during their treatments (2 target lesions were used per patient), and then having 2 dermatologists blinded to the identity and cohort membership of the subjects (no faces were included and all photographs were coded to insure blindedness) independently assess the status of the skin from the photographs alone to determine whether the patient had achieved clearing or not, and by what time. This method, as described in our paper (more on this below), was used to confirm, deny, or modify the necessarily unblinded and therefore potentially biased assessments of the clinic nurses. The analysis of the time to clearing (the clearing point) was based entirely on these blinded assessments, which were also confirmed independently by checking the physician clinic notes for each subject.

We had hoped to recruit at least 80 subjects into our study to balance the inevitable dropout rate for phototherapy treatment, which tends to be high due to the frustration subjects experience when they do not clear in the early weeks of treatment. However, recruitment into the study proved more difficult than we had anticipated, perhaps because of the changes in reimbursement due to HMO penetration during this time period. Attempts to expand the recruitment base to include local HMOs failed. With a tailing off of subjects being recruited into the study, we decided to look at the data for the 37 subjects who were already enrolled. We were quite surprised to see the significant results reported in Table 3 of our paper and cited in the abstract. In particular, for the halfway (to clearing) end point (assessed by unblinded nurses assessment only) the Hazard Ratio comparing tape to no-tape group was 3.88 ($P = 0.013$). For the clearing point (data confirmed by blinded photographic assessment) the Hazard Ratio for group was 3.75 ($P = 0.033$) (more on these findings in point 5 below). This outcome suggests to us that the finding that the meditation group cleared faster than the control group is a robust one, in spite of the limitations of the study. We believe we have reported on these findings in as responsible and conservative a way as we could, and were explicit about the preliminary and tentative nature of the conclusions that could or could not be drawn from this study, and from the fact that it replicated an earlier observation.

As we discussed in our paper, the observation has potential importance, both clinically and methodologically. If the observation is true, it suggests the following: (1) that the time and therefore the cost of conventional phototherapy treatment could be reduced at least in some cases by engaging the patient's participation through meditative and visualization strategies; (2) that an increased rate of skin clearing through patient participation during treatments means less exposure to UV and therefore reduced risk of basal cell carcinoma; (3) that the isolation of the subject in the lightbox means that social support as an explanation of the effect is highly unlikely; and (4) that this experimental design affords a model system and many obvious controls (including placebo light) for studying a healing phenomenon, from the level of what is going on in the patient's mind (expectations, beliefs, thoughts, and specific attentional practices, including mindfulness of sensory experience and the intentional use of healing imagery) down to the level of the expression and activity of different lymphocyte populations and the regulation of apoptotic factors and growth factors in the epidermis, all of which have been implicated in psoriasis.

Dr Relman's specific criticisms of our design and analysis merit a point-by-point response. To begin with, it appears from his comments that he may not fully appreciate the method of analysis we employed and its validity in this particular context. We chose to analyze the time to response using the well-known and broadly accepted Cox proportional hazards model. The fine points of this statistical approach were not included in the paper, as we felt that this level of statistical detail would not be of interest to a clinical readership. However, we do feel it is necessary to elaborate on the details of our analysis here in order to respond to Dr Relman's specific objections.

In our study, subjects were followed from the time they were randomized to treatment group (tape or no tape) until they either were judged as cleared, dropped out, were withdrawn from the study by their physician, or the study ended. The measured response was the number of weeks a subject was followed. As noted above, we monitored 4 different clinical end points: a first response point, a turning point, a halfway point (1/2 clearance of the index lesions), and a clearing point (>95% clearance of the index lesions). Observations for subjects who did not achieve an end point were treated as right censored for that end point. It is obvious that a subject could not have attained full clearance without first having reached a halfway point. Likewise, the halfway point could not have been attained unless a first response was observed. Thus our analysis is more complicated than one in a setting where there is a single response, for example "death." A number of variations of the proportional hazards model have been proposed for use when multiple or related events are possible. These models are discussed in detail with examples in Hosmer and Lemeshow (1999). We choose to use the model proposed by Wei, Lin and Weissfeld (1989) where subjects are considered to be at risk for all events. With this model all subjects are followed for the occurrence of each particular event. In each case the analysis began with $n = 37$.

Regarding Dr Relman's specific objections in his points 1 through 5:

1. As noted in our Results section, 12 patients dropped out of the study at various points and 2 were dropped from the study when their doctors changed the treatment to include steroids. Dr Relman questions the reasons subjects dropped out. Our statistical analysis has as a key assumption that dropouts (any censored observation) are noninformative with respect to treatment. This means that subjects did not drop out for reasons related to the particular treatment (tape or no tape) they were receiving. In our study we observed approximately an equal number of censored observations in each treatment group. For the most part, those subjects who discontinued their 3-times-per-week treatment schedule did so, as is often the case in phototherapy, due to treatment fatigue or for personal reasons. In those cases, subjects were followed until the time they discontinued the treatment protocol and were then treated as right censored. The particular reasons for discontinuing treatment are not germane to this study as long as they are effectively independent of the tape/no-tape condition. In our view, the data support the noninformative censoring assumption.
2. We specifically state in the second paragraph of the Results section that 4 subjects did not attain clearing. So there are no missing subjects, as Dr Relman suggests.
3. It is unclear what Dr Relman means about testing for the effectiveness of the blinding of the physician–evaluators. As noted, the photographs of all skin lesions were coded numerically. No faces of patients were included. There was no way of knowing through inspection of the photographs which treatment group a given subject was in. Moreover, both subjects and physicians were counseled not to speak about the study during regularly scheduled dermatology clinic visits nor to convey or inquire about information regarding group (tape or no-tape) assignment. Physician assessment of all photographs was done at the end of the entire study period and was not a part of the week-to-week data collection in the phototherapy clinic. Considering the nature of the treatment, blinding of nurses and patients would have been impossible. The agreement between the evaluation of the physicians, who were blinded, and the nurses, who were not, of the clearing point times supports a conclusion that the effect due to bias was at most minimal. Also, regarding the assessment of the photographs by the physicians, we clearly state in our paper that "several training sessions were held to ensure uniform evaluation standards." In the section on "Clinical Assessment of Skin Status," we described how the blinded evaluation of the photographs was carried out, how many

disagreements there were between the physicians (2) and how they were resolved. We also describe the number of instances of disagreement (2) between the nurses' (unblinded) assessments and the physician assessments and how they were treated. It is unlikely that the physicians learned who was in which group during the course of treatment, and in any event, the possibility that such knowledge could have influenced their evaluation of the coded photographs is extremely remote.

4. We did not assess significance of effect via a test of proportions. At least this is what we think Dr Relman is suggesting here with his remark about an inadequate number of events. As described above, we used a time-to-event analysis. Without knowing what alpha level he would insist upon, we cannot comment on his term "borderline significant" except to observe that such a characterization suggests dismissiveness. We feel it is entirely appropriate to have referred to results with $P < 0.05$ as significant.
5. The model-building process that was used to obtain the results presented in Table 3 in our paper considered all measured covariates as possible confounders and effect modifiers. The published model contains only covariates that were either significant in their own right or that confounded treatment effect. There were no significant interactions (effect modifiers). The covariate "years with psoriasis" is an indirect measure of disease history. One often encounters results that tend toward significance univariately such as in Table 2 but when appropriately adjusted for confounders, become statistically significant. Hence, we feel that the model in Table 3 presents the best estimate of the effect of treatment, and that it is not appropriate to characterize the adjusted data as less reliable than those in Table 2 nor to suggest that the data are too few to permit modest conclusions. As noted above, significance at the halfway point ($HR = 3.88$, $P = 0.013$) and at the clearing point ($HR = 3.75$, $P = 0.033$) between the tape and no-tape groups supports the conclusion that the skin lesions in the meditation cohort are clearing at a rate that is approximately 4 times faster than the skin lesions of the nonmediators.

Clearly a larger follow-up study with a more elaborate design could include a more detailed treatment history and explore the important question of relapse rates.

Summary

We strongly disagree with Dr Relman's characterization of our study and his assessment that the data do not allow even preliminary and tentative conclusions to be drawn. We believe our data speak for themselves within our stated limitations of the study. On issues of experimental and methodological detail, differing views and opinions are always a matter of degree, and experts practically by definition will often see problems very differently. Science is an historical process, and certainty in our knowledge base accretes for the most part slowly over time, with key contributions, even major breakthroughs, often in severe dispute until settled by further researches and the passage of time. Perhaps Dr Relman would be open to using his critical expertise and influence to help design and carry out the next generation of studies in this field, which might answer more definitively some of the questions that have been raised in his debates with proponents of integrative medicine. We are certainly happy to make our meditation tapes available to any serious research group in dermatology interested in attempting to replicate our findings.

We pursued our study and published it precisely as an attempt to contribute responsibly to the growth of knowledge regarding the degree to which psychological factors might influence a disease process. While we are strong advocates of further research, we also believe that our interpretation of our data is valid, with the qualifiers that we clearly stated, and that the study makes an important contribution to the field at this point in time.

As for the brief and somewhat cursory comments of Dr Riley about the far-reaching implications of our study, his enthusiasm carries him to a realm where we would not go ourselves based solely on our small study, when he suggests that it might be "unethical" or even "malpractice" to withhold our intervention as part of the treatment options of psoriasis patients when appropriate. His points that our approach is nontoxic, an "adjunctive therapy" to the conventional treatment, and is empowering of patients are all well taken and clinically important, and we agree that "this sort of therapy should be encouraged when appropriate" or at least made an option for motivated patients if it is explained to them that there is suggestive evidence from a small study that it might be instrumental in increasing clearing times and therefore shortening total UV exposure. Once again, only further studies will produce the kind of confidence we all desire to know the extent to which this mind-body intervention merits integration into the clinical treatment for psoriasis on a normative basis.*

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Relman's reply

Statistical analysis, no matter how sophisticated, cannot overcome fundamental weaknesses in the design and methodology of a clinical study, and this is a case in point.

Whenever possible, the data in clinical studies should be objective, and those who record the data should be blinded to the treatment. The only data in this study that allegedly met these criteria are the determinations of time to complete healing made by two physicians who studied photos of skin lesions. There were only 19 subjects whose lesions were said to have completely cleared (10 using tapes; 9 not); this is much too small a number to give results that could be reliably and widely applied.

In any case, using the statistical model they chose, the authors found that the "unadjusted" difference between the tape and no-tape groups was not statistically significant. The difference only became significant after "adjusting" for the two confounding variables (duration and severity of disease) about which they had any information. The authors "feel" that these "adjusted" results are persuasive, but that is simply their opinion. The fact is that the authors simply don't know whether adjustment for other possible confounders might have changed the results—one way or the other. Unidentified confounders often invalidate, in retrospect, conclusions of a clinical trial. The only way to avoid this problem is to randomize a large number of subjects so that confounding factors are equally distributed. This study, however, is so small that randomization is no protection against the possible effect of confounders.

Moreover, I am not convinced that the two physicians who interpreted the photos were truly blinded. Did they see any of the patients during the course of treatment? If so, they could easily have connected the photographed lesions with particular patients, and they might also have learned about which treatment group (meditation or not) a given patient was in. Simply admonishing patients and doctors not to talk is not enough. So how could the authors have checked on the blinding of the doctors? Quite simply, by asking them at the end of the study (and before the data are analyzed) what they knew—a common method of validating blinding.

Also, it is specious to argue that the clearing point data are "confirmed" by the other data on the timing of earlier changes in the lesions, and by

** For readers of the original paper, there is a typographic mistake that was not caught in editing on page 628, column one, paragraph one, last sentence. The end of the sentence should read: "... whereas for the PUVA clearing point, the difference between the medians of the no-tape (95 days) and tape (45.5 days) subjects (49.5 days) was nearly significant (P = .06)."*

the results of a previous study (which was published only as a letter to the editor). None of these other data were objective or blinded. They were merely the subjective interpretations of nurses who knew whether the patients were using meditation or not, and could well have been biased by that knowledge. All these data are fatally flawed. You can't bolster a conclusion simply by accumulating flawed data.

In short, the reply by Drs Kabat-Zinn and Hosmer does not resolve most of my basic criticisms. At most, their study merely hints at the possibility of an effect of meditation on healing of skin lesions and suggests the need for a larger and better designed trial. The fact that the treatment being tested is in the realm of "mind–body medicine" should not justify any lowering of the usual standards of proof that are applied to any carefully conducted clinical trial.

Response of Drs Kabat-Zinn and Hosmer to Dr Relman's second critique

Two dermatologists did the photographic evaluations independently, and their assessments had to agree, as described in our paper and in our earlier response to Dr Relman. This makes his objection about possible bias in the blinding untenable, as at most, only one dermatologist would be familiar with the lesions of a particular patient. We remain mystified by his persistence in attributing to us a desire to lower and/or justify "lowering the usual standards of proof that are applied to any carefully conducted clinical trial." We have already stated very clearly in the paper and in our first response how we see our contribution.

Relman's reply

I do not know whether my concern about the "blinding" of the dermatologists who interpreted the photographs is "untenable" or not, because I cannot fathom how and by whom these photographs were read. I have gone back to the methods section of the original paper and still cannot be sure. Judging from the last comments of Drs Kabat-Zinn and Hosmer ("at most, only one dermatologist would be familiar with the lesions of the patient"), the dermatologists who were said to have read the photographs blindly also saw at least some of the patients clinically. If that is the case, my suggestion that the dermatologists might have been able to connect the patients with the photos is not "untenable." The requirement that both dermatologists agree on the interpretation of the photographs offers no assurance to me that the blinding was complete.

Furthermore, on rereading the original paper I note that lesions considered to be "probably clear" were lumped together with those considered "clear without a shadow of doubt." That fact hardly instills confidence in the total objectivity of the readings.

In any case, my concerns about blinding represent just one among several criticisms of the study design, which I detailed in my first commentary. As Kabat-Zinn seems to recognize, this is by no means a definitive study. Unfortunately, it is often being cited as such.

Seeing what we can see: On the coming exchange* between Jon Kabat-Zinn and Arnold S. Relman

Larry Dossey

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Sometimes medicine seems an Alice-in-Wonderland scenario in which physicians occupy different realities. For example, the same day I read Arnold S. Relman's broad dismissal of mind–body studies in *Advances*, in which Relman claimed that "there is no credible evidence that you can think or image or hope your way out of progressive major illness" (Delbanco et al. 2000), I came across an article by David S. Sobel in the *Journal of the American Medical Association* that presented such a contrast that it seemed to have come from a different world. In an article entitled "Mind Matters, Money Matters: The Cost-Effectiveness of Mind/Body Medicine," Sobel (2000) stated:

> What if there was a new medical treatment that had been shown in clinical trials to improve health outcomes in a number of illnesses, speed postsurgical recovery, reduce unnecessary procedures, decrease medical costs, and improve patient satisfaction? . . . These benefits (and many others) result from a variety of nonpharmacologic mind/body and behavioral medicine treatments.
>
> An increasing number of studies, including randomized clinical trials, point to safe and relatively inexpensive interventions that can improve health outcomes and reduce the need for more expensive medical treatments.

Sobel cites randomized clinical trials supporting his contentions in four areas—heart disease (Blumenthal et al. 1997), chronic illness (Lorig et al. 1999), surgical preparation (Dreher 1998), and the care of premature infants (Scafidi 1990).

Why doesn't this evidence persuade healthcare professionals like Relman? Why hasn't it been integrated into mainstream healthcare? "One reason," Sobel explains, "is that the data are incomplete." This statement could be applied to every area of medical research. "However," he continues, "even when there are good data, providers of medical and mental health services are often unaware of them. Mind–body medical interventions are often held to a higher standard of evidence than are traditional interventions, and must justify themselves not only by improved health outcomes and quality of care, but also on the basis of cost alone. Both medical and mind–body health interventions should be judged by a similar set of criteria, and the beliefs and biases that delay the use of psychosocial interventions need to be challenged" (Williamson et al. 1981).

How is it that when Sobel scans the medical horizon, he sees abundant evidence that mind–body interventions profoundly affect health outcomes while Relman sees none? Do they live in different worlds? Is Sobel guillible? Is Relman blind?

David J. Hufford, professor of humanities and behavioral science and director of the Doctors Kienle Center for Humanistic Medicine at Penn State College of Medicine and Hershey Medical Center, related an event to me that may shed light on these differences. The incident took place at a conference on complementary and alternative medicine in Philadelphia, 10 November 1999. Dr Marcia Angell, of the *New England Journal of Medicine*, on which Dr Relman served as editor for many years, presented her views about publishing

* Dossey wrote this speculative commentary after reading in the previous issue of *Advances* that Kabat-Zinn and Relman were to have an exchange. He had not read the proposed exchange, then still to be written, and he signed off on his proofs still without reading it. —HD

studies in complementary and alternative medicine. While disclaiming any bias against good scientific studies in these areas, Angell said that to be good a study must offer a plausible biological mechanism for any effects that are reported. Otherwise the study could not be believed. This means, she explained, that therapeutic touch, homeopathy, moxibustion, and intercessory prayer are "preposterous" and "impossible" because they lack a plausible biological mechanism, and that studies of these practices are only being published for social and political reasons. (See Angell and Kassirer 1998, in which these points are also made.)

To say that something is implausible means that it doesn't fit with currently accepted theories. But how can science grow if the only studies that are published are those that confirm ideas already in place? Moreover, scientific puzzles do not solve themselves spontaneously. How are the great mysteries to be understood unless researchers take a stab at them, plausibility be damned?

When Newton proposed the existence of universal gravity in the 1600s, it was not a plausible concept, and his contemporaries accused him of selling out to mysticism (Mills 1996), yet history proved Newton's highly implausible theory correct. When British ship surgeon James Lind proved in 1753 aboard the *HMS Salisbury* that lemons and limes cured scurvy, his discovery was considered implausible. It was many years before the British Navy made the use of citrus fruits routine, and many sailors died because of the Navy's reluctance to adopt this implausible measure in spite of its proven benefit.

There is nothing plausible about an array of phenomena in modern physics, such as the tunneling activity of electrons and the nonlocal, correlated behaviors of distant subatomic particles. Plausibility is a luxury in science that often does not exist. Plausibility can become a prison and a barrier to progress in all fields of science—including the utilization of mind–body therapies in modern medicine (Dossey 2000).

In his 1998 attack in *The New Republic* on physician Andrew Weil, a leader in the field of complementary and alternative medicine, Relman issued a black-and-white image of modern medicine: "There are not two kinds of medicine, one conventional and the other unconventional, that can be practiced jointly in a new kind of 'integrative medicine.' Nor, as Weil and his friends also would have us believe, are there two kinds of thinking, or two ways to find out which treatments work and which do not. In the best kind of medical practice, all proposed treatments must be tested objectively. In the end, there will only be treatments that pass that test and those that do not, those that are proven worthwhile and those that are not. Can there be any reasonable 'alternative'?"

As a practicing internist, I used to agree with Relman's idealized vision and noble sentiments about modern medicine. But I have come 'round to the view that conventional medicine is not now, nor has it ever been, as objective and scientific as he would have us believe. This is hardly a secret these days. On every hand, respected medical insiders have begun to acknowledge the cracks in medicine's scientific foundation. Yale surgeon and author Sherwin B. Nuland (1995) states, "Unlike other areas in which fads come and go, medical styles [of practice] are meant to be supported by irrefutable evidence. That assumption is so far off the mark that the term 'medical science' is practically an oxymoron." Referring to a 1978 report by the Congressional Office of Technology Assessment (1978), Nuland states, "[N]o more than 15 percent of medical interventions are supported by reliable scientific evidence." Richard Smith, editor of the *British Medical Journal*, agrees, stating, "[O]nly about 15% of medical interventions are supported by solid scientific evidence... This is partly because only 1% of the articles in medical journals are scientifically sound and partly because many treatments have not been assessed at all" (Smith 1991). And University of California–San Francisco School of Medicine's David A. Grimes states, "[M]uch, if not most, of contemporary medical practice still lacks a scientific foundation" (Grimes 1993). These observations suggest, as Sobel stated above, that a double standard is perhaps being applied to complementary and alternative medicine in general and mind–body research in particular, in which levels of proof are demanded that may not be required of conventional therapies—the "rubber ruler," the raising of the bar, the ever-lengthening playing field. So, in spite of Relman's contention that there are not "two kinds of thinking" in medicine, there obviously are—those who, like him, think that modern medicine is overwhelmingly scientific, and the increasing number of experts who think otherwise.

Don't get me wrong. I'm not suggesting that we lower the standards of medical research so that anything goes, but that we admit the obvious—that all areas of contemporary medicine, including mind–body, complementary and alternative medicine, *and* conventional medicine, have far to go in achieving precision.

Let's return to Relman's question: "Can there be any reasonable 'alternative' [to scientific medicine]?" We had better hope so, in view of data beginning to emerge. Currently, according to statistics appearing in the *Journal of the American Medical Association* (Starfield 2000), 225,000 deaths occur annually in US hospitals because of errors and non-error side-effects of drugs. This makes hospital care the third leading cause of death in the United States, behind heart disease and cancer. In addition, an estimated 199,000 deaths occur annually in outpatient settings (Weingart et al. 2000). These data indicate that modern medicine can be highly lethal. These statististics refer to deaths only; they do not deal with the suffering and morbidity experienced by harmed patients who do not die.

Is it possible to develop a medicine that does not bump off a quarter-million people each year and which works? Certain lines of evidence are hopeful. In coronary artery disease, which remains the major killer in our society, a behavioral, mind–body approach has been shown to cause "markedly decreased angina, improved perfusion, continued regression of coronary atherosclerosis, and reductions in cardiac events from changes in diet and lifestyle alone" (Ornish 1999, Ornish et al. 1998). This is not a temporary fix. Five-year follow-up studies show that "more regression of coronary atherosclerosis occurred after 5 years than after 1 year in the experimental group. In contrast, in the control group, coronary atheroscleros is continued to progress and more than twice as many cardiac events occurred" (Ornish 1998).

Relman also is apparently unaware of the dramatic case reports in which mind–body interventions have dramatically altered the course of a severe genetic disease, congenital ichthyosis (Barber 1984, Bennett 1985, Dienstfrey 1999, Mason 1952). These cases should count as a breakthrough observation of the first order because they illustrate the potential of the psyche to influence the expressions of the genes. In principle, these cases provide a yes answer to the question Relman asks of mind–body therapies: "Will it change the downhill course of the disease?"

I asked above whether Relman on the one hand and investigators such as Kabat-Zinn and Sobel on the other live in different worlds. I believe the answer is essentially yes. They literally do not see the same things.

We see what we *can* see. When Darwin's ship *Beagle* anchored off the coast of Tierra del Fuego during his famous voyage, the native Fuegians wondered at the small boats, but paid no attention to the big ship lying at anchor in front of them. They had no experience of huge craft but were familiar with small boats, and were therefore oblivious to the larger object (Dossey 1982; Polyani 1958, 1982). Thus William James was led to observe, "We feel neither curiosity nor wonder concerning things so far beyond us that we have no concepts to refer them to or standards by which to measure them" (James 1890).

An assumption running through the brief exchange between Relman and Kabat-Zinn is that their differences of opinion can eventually be resolved by pursuing proper science. They need only agree on a mutally acceptable methodology, do studies, and see how the data shake out. This is a quite wonderful prospect, but I doubt whether Relman and Kabat-Zinn could agree on the value of mind–body therapies under any circumstance.

"We like to believe," observed the eminent evolutionary biologist Theodosius Dobzhansky, "that if we secure adequate data bearing on a scientific problem, then anybody with normal intelligence who takes the trouble to become acquainted with these data will necessarily arrive at the same conclusion regarding the problem in question. We like to speak of conclusions demonstrated, settled, proved, and established. It appears, however, that no evidence is powerful enough to force acceptance of a conclusion that is emotionally distasteful" (Marsh 1945). Or, as Bishop Berkeley made the point two centuries earlier, "Truth is the cry of all, but the game of the few" (see Nichols 2000).

So I wish Relman and Kabat-Zinn good luck. I hope they can hammer out their differences, but I'm not holding my breath. Their disagreements transcend data and involve radically different lived experiences and world views. In the face of such powerful forces, *P* values are often helpless.

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COMMENTARY

Participatory medicine

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A recent study of ours[1] showed that patients with moderate to severe psoriasis who were meditating, guided by meditation tapes, while they were undergoing UVB or PUVA treatments, cleared at about four times the rate of subjects who received the UVB or PUVA by itself in a small ($N = 37$) randomized clinical trial. We had observed a positive effect in an earlier and even smaller pilot[2] and did the more elaborate replication study to determine whether this was a real result.

But one question we now wish we had thought to ask the patients before they agreed to participate and again when the study was over is: 'On a scale of one to 10, how onerous do you find your phototherapy treatments?' For it was only after completing the study, when we knew who was in which group, and interviewed patients in the tape group, that we heard them say how much more positively they regarded their phototherapy treatments, in spite of the inconvenience (one patient described it as having a 'second job') because they felt empowered, felt they were participating in the process, and could perhaps contribute to making a difference in their outcomes. In fact, some felt their psoriasis was milder as a result of learning to bring their mind to their skin in the ways they learned from the tapes.

We began thinking about the project in the first place simply to see if we could make the experience of being in the light booth somewhat less stressful by actually guiding the person in meditative relaxation exercises while he or she was inside. There is no doubt that the overall felt experience of phototherapy from the point of view of the patient is a little unusual, if not outright alienating, in that one is naked, with eyes covered, often with a pillowcase over the head and therefore somewhat suffocated, under the heat of the lights, enclosed in a small space with the whirring of blowers.

But beyond the potential to make the experience more relaxing and engaging, we quickly saw the potential for using meditation coupled with delivery of phototherapy in the light booth as an experimental system for a rigorous scientific exploration of certain aspects of the mind/body connection and its relationship to healing. We therefore designed and carried out a randomized clinical trial, looking not just at how relaxing people found the experience, but also at whether there was an effect on the rate of skin clearing itself. We found this to be the case. This results suggest that participation on the part of the patients through a meditative harnessing of their capacity to pay attention in an intentional and focused way has the potential to reduce the number of treatments and thus the cost, as well as the risk of skin cancer associated with UV exposure, in at least some patients.

Following the study, our subjects often spoke enthusiastically of the opportunity to become active participants in their own treatments, and so we regretted not having asked them to rate the degree of onerousness of the whole process pre- and post-intervention.

In spite of our oversight, there are common sense lines of thought and evidence suggesting that the medicine of the 21st century will be and ought to be far more *participatory* than what we have experienced so far. Indeed, in some studies, various participatory approaches have been shown to influence regression of coronary artery disease[3] and survival in breast cancer[4] and in malignant melanoma.[5] As care-givers, we have to remind ourselves of what we of course already know, namely that all human beings, including ourselves and our patients have, to varying degrees but almost always far more than we suspect, deep and life-long inner resources for learning, growing, healing, and personal transformation. Part of our job will be to make available appropriate opportunities and effective vehicles for mobilizing those resources in our patients so that they can put them to work in the service of their own health, where *health* is seen as the health of mind, body, heart and soul, one seamless, unfragmented whole.

The methods available to us now are not particularly mysterious, and a great deal of work in the fields of behavioural medicine, mind/body medicine, and what is now coming to be called *integrative medicine* suggest that many if not most patients like to be invited to participate in their own health care if the invitation reflects a genuine partnership which truly honours the patient as a unique individual with a unique universe of felt experience, relationships, and meaning. Indeed, participatory medicine would go a long way toward making our health care system, which is far more aptly described at this point in time as a disease care system, into a true health care partnership, one which would of course include disease care but which would also re-integrate the patient as person into the caring in profound ways.

For the past 20 years, the Stress Reduction Clinic at the University of Massachusetts Medical Center (now UMass Memorial Health Care) has been serving this participatory role in our hospital, and this mindfulness-based stress reduction (MBSR) approach[6–9] has now spread to over 240 medical centres and clinics in the US and abroad. The clinic, in the form of an 8-week outpatient course, is designed to catch people falling through the cracks of the health care system or not receiving full satisfaction in terms of their expectations for results of treatment. It challenges them to experiment with the possibility of doing something for themselves as a complement to what their physician and health care team are doing for them. The clinic is a service which requires a physician referral, and thus serves the needs of physicians to have a welcoming place right in the hospital where they can send their patients. Not only do the patients learn and hone the skills of self-regulation, awareness, and relaxation, but they also tap those aspects of being and attitude that shape one's appreciation for one's own life and the potential for its full expression across the lifespan, while facing and using any and all circumstances of the present moment, no matter how onerous or difficult, as the raw material for this particular inner work. There is a lot of uplift here, and we have found that most people we see, regardless of their disease or their particular circumstances, are happy to hear that, 'as long as you are breathing, from our point of view there is more right with you than wrong with you, no matter what is wrong, and that everything is "workable" if you are willing to do a certain kind of inner work in partnership with us.'

Nowadays, there is much debate in the lay press and even in medical journal editorials[10–12] of what has come to be called alternative medicine,[13,14] complementary medicine, mind/body medicine, and now, integrative medicine. Ultimately, I think what we are really talking about is *good medicine*. The patients often seem to be way ahead of the practitioners in terms of their breadth of knowledge and interest in this domain. As are we, they are most interested in positive outcomes. But they are also interested in being treated with respect, and in trying sensible alternatives when other avenues do not bring full satisfaction. A lot of good science is necessary both on the more traditional biomedical side and the more, from the biomedical perspective, unconventional side. But a good deal of work has already been done in behavioural and mind/body medicine, and it is only common sense to afford our patients the opportunity to participate more fully in their own health care in imaginative ways. Would we want any less for our own family members or for ourselves?

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Influence of a Mindfulness Meditation-Based Stress Reduction Intervention on Rates of Skin Clearing in Patients With Moderate to Severe Psoriasis Undergoing Phototherapy (UVB) and Photochemotherapy (PUVA)

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Objective: This study tests the hypothesis that stress reduction methods based on mindfulness meditation can positively influence the rate at which psoriasis clears in patients undergoing phototherapy or photochemotherapy treatment. **Methods:** Thirty-seven patients with psoriasis about to undergo ultraviolet phototherapy (UVB) or photochemotherapy (PUVA) were randomly assigned to one of two conditions: a mindfulness meditation-based stress reduction intervention guided by audiotaped instructions during light treatments, or a control condition consisting of the light treatments alone with no taped instructions. Psoriasis status was assessed in three ways: direct inspection by unblinded clinic nurses; direct inspection by physicians blinded to the patient's study condition (tape or no-tape); and blinded physician evaluation of photographs of psoriasis lesions. Four sequential indicators of skin status were monitored during the study: a First Response Point, a Turning Point, a Halfway Point, and a Clearing Point. **Results:** Cox-proportional hazards regression analysis showed that subjects in the tape groups reached the Halfway Point ($p = .013$) and the Clearing Point ($p = .033$) significantly more rapidly than those in the no-tape condition, for both UVB and PUVA treatments. **Conclusions:** A brief mindfulness meditation-based stress reduction intervention delivered by audiotape during ultraviolet light therapy can increase the rate of resolution of psoriatic lesions in patients with psoriasis. **Key words:** psoriasis, phototherapy, photochemotherapy, meditation, mindfulness, relaxation.

PROC PHREG = SAS package procedure to fit the proportional hazards model.

INTRODUCTION

The skin has long been known as an organ system that responds to emotional stress and to psychological influences with both short- and long-lasting effects (1, 2). Over the years, occasional observational and experimental studies (3) have reported a range of skin responses to hypnotic suggestion and other psychological interventions, including the disappearance of warts. Although the elucidation of psychological and biological mediating pathways by which the skin might respond to such interventions and to stress and other emotional factors has remained obscure, there is recent evidence connecting psychological stress (in caregivers of relatives with Alzheimer's Disease), rates of wound healing, and levels of the cytokine, interleukin 1β, a potential immunological mediator of wound healing (4). The present study sought to investigate the possible effect of a stress reduction intervention on rates of skin clearing in patients with psoriasis undergoing phototherapy as a potential model system for the study of psychological factors related to an observable healing process.

Psoriasis vulgaris is a common skin disease with an estimated prevalence of between 1% and 3% of the world's population (5). In moderate to severe cases, psoriatic lesions can be uncomfortable, itchy, and disfiguring. Although the precise pathophysiology of psoriasis is unknown, an abnormal cutaneous immunologic/inflammatory response, associated with epidermal hyperproliferation and abnormal differentiation seems to be involved (6). Over-expression of the gene for the keratinocyte mitogen, transforming growth factor-α, has been implicated in psoriatic epidermis (7, 8), as has overexpression of the Bcl-x gene product (9), the latter suggesting that dysregulation of normal apoptotic processes in the terminal differentiation of epidermal keratinocytes may play a role in the disease. Other studies have noted changes in neuropeptides such as substance P and vasointestinal peptide (VIP) in psoriatic skin cells (10), and some investigators (11) have suggested that the former may play a significant role, through effects on lymphocytes, mast cells, neutrophils, and macrophages, on the early inflammatory events giving rise to psoriatic lesions. Neuropeptides are known to be affected by emotional stress (12). However, to date, there is no clear evidence for a specific pathophysiological mechanism linking psychological factors with the appearance of psoriatic lesions (10).

Treatment of psoriasis is directed toward alteration of epidermal differentiation, reducing the inflammatory response, and/or slowing the growth of involved skin cells. The extent and severity of the disease typically determine the therapeutic approach. Patients with extensive disease or who have proven resistant to topical agents may be candidates for *phototherapy*, which uses ultraviolet B irradiation (UVB), or *photochemotherapy*, which uses psoralen (methoxsalen) in combination with ultraviolet A irradiation (PUVA) (13). Both procedures are palliative rather than curative, aimed at retarding proliferative growth (14, 15). Other light-sensitive mechanisms may also play a role (16).

Psychological stress has long been implicated in the onset and severity of psoriatic flare-ups (10, 17, 18). Positive correlations between psychological distress and severity of psoriasis have been reported in 32–70% of patients in retrospective (19–21) and prospective studies (22, 23). Case reports have described positive responses with hypnosis (24), thermal biofeedback (25), meditation coupled with imagery (25a), and psychotherapy (26), and some investigators (20, 27, 28) have recommended relaxation and stress reduction methods as treatment adjuncts. However, few prospective randomized clinical trials have studied the efficacy of such treatments for psoriasis (22, 29, 30) and none has explored a psycholog-

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ical intervention delivered while the patient is undergoing phototherapy sessions. Yet, the readily observable extent and severity of this disease, its association with psychological stress, and the controlled environment of the light booth in which phototherapy is delivered combine to present a unique opportunity to investigate the possible additive therapeutic effect of a psychological stress reduction exercise employed by the patient in conjunction with a traditional medical treatment. We hypothesized that the focused attention characteristic of a mindfulness meditation-based stress reduction exercise (see Methods) would enhance relaxation and a sense of participatory agency on the part of the patients during their treatments, and might result in the reduction or reversal of possible stress-related emotional and cognitive factors contributing to the exacerbation of the subject's condition.

We were encouraged by the results of a small preliminary study in which patients who practiced mindfulness meditation while receiving either phototherapy or photochemotherapy demonstrated a significantly faster mean rate of skin clearing than did subjects receiving standard phototherapy or photochemotherapy treatment alone (31). On the basis of that preliminary finding, we initiated the trial reported here.

METHODS

Subjects

Subjects were 37 patients (20 women, 17 men) presenting with moderate to severe psoriasis and scheduled to begin phototherapy (N = 21) or photochemotherapy (N = 16). Moderate to severe psoriasis was defined as involving 15% or more of the body surface area, and sufficiently severe to warrant treatment with UVB or PUVA rather than topical agents. The determination of mode of treatment (UVB or PUVA) was made by the patient's dermatologist in each case. UVB is typically employed first: PUVA is used when subjects have not responded to UVB or in cases where the disease is extremely severe. Patients were excluded if they had had phototherapy treatment during the previous month, systemic treatments such as corticosteroids, methotrexate, or retinoids during the previous 2 weeks, or were under 18 years of age. While in the study, patients were instructed to avoid any oral or topical psoriasis treatments not specifically prescribed by the physician, except emollients and 1% hydrocortisone cream for skinfold areas not exposed to the light, and this was reinforced by the clinic nurses throughout the study period. Study subjects were permitted to use antipsoriatic shampoos and topical steroid preparations for the scalp.

The study was described to prospective subjects as a test of the efficacy of relaxation tapes in making the experience of treatment more pleasant. Nothing was said to create expectations of a therapeutic effect from use of the tapes. After informed consent was obtained, subjects were assigned randomly to a stress-reduction audiotape condition or to a usual treatment (no-tape) condition. UVB and PUVA cohorts were randomized separately. The study included subjects undergoing both forms of treatment because patients in both conditions responded positively in the preliminary study (31).

Seventy patients were recruited by referring dermatologists between October 1991 and October 1994. Thirty declined participation, citing reluctance to be part of a research protocol. Two subjects were dropped from the study because they received treatment at another site, and another because she had enrolled in the study twice. The remaining 37 subjects averaged 43 ± 15 years of age, and had had psoriasis for an average of 11.2 ± 8.9 years.

Baseline descriptive data obtained on all subjects included age, gender, education, years with psoriasis, degree of body surface involvement, and prior experience with formal meditation and relaxation methods. Psychological status was assessed pre-intervention and post-intervention using the SCL-90-R (32) and the State-Trait Anxiety Inventory (STAI) (33). Other questionnaires assessing psychological response to the intervention were administered periodically to monitor indicators such as how relaxed subjects felt in the past week, how stressed they felt in the past week, how "positive" they felt about today's session, how relaxed they felt after today's session, how tense they felt at the start of today's session, and to what extent they felt that the treatment was helping them. Responses were rated on a 1 to 10 scale.

Phototherapy and Photochemotherapy Protocols

Subjects were treated three times per week according to standard phototherapy and photochemotherapy treatment protocols (5, 6). During treatment sessions, the patient stood naked, with eyes shielded, in a cylindrical light booth (diameter approximately 4 feet). UV dosage (in millijoules for UVB and joules for PUVA) was increased linearly from session to session (by approximately 15% increments for UVB and one-half joule increments for PUVA). Increasing dosage resulted in corresponding increases in exposure times. Dosage increases were delayed only if there were signs of burning. Exposure times increased from approximately 30 seconds in the first treatment session to approximately 10 minutes (UVB) and 13.5 minutes (PUVA) as maximal exposure times by the later stages of treatment.

The study period was open-ended, although it was typically completed by 40 treatment sessions (approximately 13 weeks, ie, 91 days). Patients were kept in the study until they cleared or until they dropped out. The protocol called for dropping patients from the study if the dermatologist radically changed the phototherapy prescription. Skin status throughout the study was assessed both by clinic nurses and by dermatologists, as described below.

All 37 subjects who began treatment were included in the analysis, including 12 dropouts and 2 subjects who were dropped from the study (at 26 and 80 days respectively) because their treatment protocol was changed at those times to include steroids.

Psychological Intervention

Mindfulness-based stress reduction (34–36) was employed as the principal psychological intervention because: a) it is effective in reducing symptoms and enhancing relaxation in patients with chronic pain (37–39) and with generalized anxiety (40, 41); b) its unique attentional stance can readily direct sustained awareness to the envelope of the skin and to sensations associated with light treatment; c) it can be practiced standing; d) it can be effectively delivered through audiotapes; and e) it allows readily for the inclusion of situation-appropriate imagery.

Three audiotapes were used to guide patients in the meditation technique. For the first three treatment sessions, all subjects in the tape groups (UVB and PUVA) listened to the same introductory tape (approximately 5 minutes in length) sitting on a chair *before* entering the light booth. Once in the light booth, they listened to a tape made specifically for their treatment condition (UVB or PUVA). They listened to the same tape in every treatment session but heard more of it with increased time in the light booth.

The meditation tapes were designed to accommodate increasing light exposure through longer listening times as the phototherapy treatments progressed. The sound of a bell punctuated the meditation instructions at 1.5- to 3.5-minute intervals to signal appropriate stopping points. The patients were instructed to remain in the light booth after the lights turned off and continue to practice the meditation according to the instructions they were hearing until the next bell was heard. Thus, with increasing length of light exposure, subjects were exposed to increasingly longer segments of the tapes.

The UVB and PUVA tapes differed slightly in the rate at which the different components of the meditation instructions were introduced. Due to the higher energy and biological efficacy of UVB radiation, UVB treatments tended to be shorter than PUVA treatments.

Meditation instructions on the tapes included guidance in mindfulness (moment-to-moment, non-judgmental awareness) of breathing, followed by mindfulness of body sensations (including warmth from the lights and air currents on the skin), ambient sounds, thoughts, and feelings. At later stages of the tapes, subjects were instructed to visualize the UV light (and the orally consumed psoralen in the case of patients undergoing PUVA) slowing down the growth and division of skin cells.

After subjects in the tape groups had completed 20 treatment sessions with their guided meditation tape, they were given the option in each subsequent session either to use the meditation tape or to practice the meditation and visualization on their own while listening to a tape of harp music.[1] The music was intended to support subjects' attempts to practice the meditation and visualization without guidance to reduce possible fatigue and resistance from over-utilization of the instructional tapes. Most subjects in the tape condition opted to use the music tape at least once. Music was not offered to the regular treatment (no-tape) groups.

Subjects in the tape groups were not asked to meditate outside of the light therapy sessions, and were not permitted to take the tapes home. No data were gathered on whether subjects in the tape groups practiced the meditation outside of treatment sessions.

Clinical Assessment of Skin Status:

Two target lesions (the most extensive and severe plaques, one on the trunk and one on an extremity when possible) were identified by the clinic nurses at the initial clinic visit. Polaroid photographs were then taken of each target lesion on each subject at that visit, and every five treatment sessions after until the patient cleared, dropped out of the study, or was dropped from the study due to a change in treatment prescription. A dermatological Polaroid camera (Lester Dine Corp. Palm Beach Gardens, FL) with a fixed focal length of one foot was used.

Skin status was also assessed by visual inspection, using a measure designed specifically for this study. Trained clinic nurses observed the overall skin status of each patient before each treatment session and recorded if and when each patient, treated as a single unit, had attained each of four clinical end points: a "First Response Point" (FRP), a "Turning Point" (TP), a "Halfway Point" (HP), and a "Clearing Point" (CP). The terms were defined as follows: FRP: the point at which morphological changes in scaling, erythema, or thickness were first noted in the target lesions; TP: the point at which psoriasis plaques began to decrease in area; HP: the point at which it was estimated that the patient had half the original amount of skin surface area involvement; and CP: the point at which less than about 5% of the original amount of psoriasis remained. Visual inspection was global and included assessment of all body lesions including the two target lesions used for the subsequent photographic analysis. As the nurses were not blinded to the study condition of the patients, their assessments of the most well-defined end point, the CP, were independently checked in two ways: first, by reviewing the blinded physicians' standardized clinic progress notes written at the time of direct examination of the patient. These clinical examinations took place every 4 weeks during the study and within 1 week of when the nurses judged the patient as having cleared; second, by blinded analysis of the photographs of the target lesions. An independent photographic confirmation of the TP was included as well.

After the data collection period for the entire study, all photographs were assessed independently by two dermatologists blinded to the subjects' identity and intervention status (tape or no-tape). Several training sessions were held to ensure uniform evaluation standards. The photographs for each subject were given to each evaluator in chronological order. Two tasks were required: first, to identify the Turning Point, and second, to rate the final photograph of each target lesion in terms of extent of clearing. Ratings were based on a 0 to 3 scale, where 0 signified "definitely not clear," 1 "possibly clear but doubtful," 2 "probably clear," and 3 "clear without a shadow of doubt." If the rating was a 2 or a 3, the subject was considered to have cleared. If it was a 0 or 1, the subject was rated as not having cleared.

A total of 19 subjects achieved clearing. In 17 cases, there was complete agreement between the nurses' assessments of clearing and the physician assessments (through clinic progress notes and blinded photographic ratings). In two subjects, there was disagreement between nurse and physician assessment of the clearing point. In these two cases, the physician-determined clearing times, which extended 25 and 45 days beyond when the nurses had rated them as cleared, were used in the analysis.

In 17 of the 18 subjects assessed by the nurses as not having cleared by the end of the study, both physician assessment methods confirmed the "not clear" status. In the remaining case, no physician progress note was available and the patient was counted as "not clear." In a single anomalous case, the final photographs of one subject were taken of non-target lesions and no physician note was available. In accordance with standard statistical convention, the subject was treated as "not clear." In two instances, the two physicians' photographic assessments of the CP were not in agreement. A third dermatologist made an independent assessment to resolve the disagreement. In both cases, the third physician's judgment was found post hoc to be consistent with physician progress notes.

Statistical Analysis

Univariate comparisons of each patient characteristic across the four treatment groups (tape, no-tape, PUVA, UVB) were done with one-way analyses of variance. Gender frequencies were compared with a chi square contingency table analysis (Table 1).

Each of the four end points (FRP, TP, HP, CP) was determined (in days) for each patient if and when they attained that end point. For subjects not attaining a given end point, their maximum follow-up time was used and considered as a right-censored value. Kaplan-Meier estimates of unadjusted response time distribution were used to obtain estimated quartiles for each of the various end points (see Table 2). The log-rank test was used to compare the response time distribution for each end point.

The Cox-proportional hazards regression model (PROC PHREG) was used to identify and adjust for confounding factors (Table 3). As noted above, data from all 37 starting subjects were included in the proportional hazards analysis. The dropouts were evenly distributed between the four comparison groups. No significant differences in dropout/censoring times between groups were observed (Kruskal-Wallace One Way ANOVA, $p = 0.14$).

Estimated response time-to-clearance curves (Figure 1, *A* and *B*) were computed from the fitted Cox-proportional hazards regression model for each of the four treatment groups (42, 43) to provide a graphical representation of the probability of clearing as a function of time. Median values of 0.2 for the initial SCL-90-R score and 11 for years with psoriasis were used.

RESULTS

Patient Characteristics

There were no statistically significant differences in baseline patient characteristics between subjects either in light treatment group or in the groups with or without guided meditation tapes (Table 1).

Of the 37 subjects in the study, 19 attained clearing (Table 2). Four subjects did not attain clearing, and 14 subjects prematurely discontinued treatment.

Table 2 shows the unadjusted estimates of the response time distribution for each end point. The log-rank test used to compare tape vs. no-tape within light groups was significant or marginally significant for FRP, TP, and HP within UVB ($p = .08$, .005, and .002, respectively) and marginally signif-

[1] *Birds of Paradise*, composed and played by Georgia Kelly. 211 1980 Heru Records, Sonoma, CA 95476.

TABLE 1. Patient Characteristics within the Four Treatment Conditions

Variable	PUVA		UVB		All Subjects $N = 37$	p from ANOVA
	No Tape Group $N = 8$ Mean ± SD	Tape Group $N = 8$ Mean ± SD	No Tape Group $N = 10$ Mean ± SD	Tape Group $N = 11$ Mean ± SD		
Age	38.3 ± 16.6	40.8 ± 19.0	49.4 ± 13.0	42.1 ± 12.5	42.9 ± 15.1	0.44
Education	13.0 ± 2.7	13.1 ± 2.6	12.7 ± 2.6	13.8 ± 1.9	13.2 ± 2.4	0.76
Years with psoriasis	14.4 ± 11.0	9.4 ± 5.5	6.3 ± 5.7	14.4 ± 10.3	11.2 ± 8.9	0.17
Body surface involvement	3.4 ± 1.1	3.2 ± 1.1	3.3 ± 0.8	3.3 ± 0.9	3.3 ± .9	0.98
SCL-90-R score	0.56 ± 0.85	0.50 ± 0.62	0.73 ± 1.0	0.43 ± 0.39	0.55 ± 0.72	0.82
STAI score	36.0 ± 13.9	37.0 ± 9.6	44.8 ± 16.6	32.0 ± 9.5	37.4 ± 13.2	0.16
% Female	50%	25%	70%	64%	54%	.28*

Body surface involvement scores ranged from 0–6. Zero corresponded to <1% of estimated body surface involved; 6 corresponded to >76% of estimated body surface area involved. * Chi-square test p value.

TABLE 2. Unadjusted Estimates of the Response Time Distribution for Each End Point

Group				First Response		Turning Point		Half-Way Point		Clearing Point	
Light	(N)	Tape	Quartile	Days	# of Events	Days	# of Events	Days	# of Events	Days	# of Events
			25	18.0		40.0		51.0		97.0	
UVB	10	NO	50	23.0	9	56.0	6	68.0	5	98.0	4
			75	30.0		60.0		100.0		121.0	
			25	10.0		19.0		42.0		82.0	
UVB	11	YES	50	12.0	11	33.0	10	47.0	10	84.0	5
			75	23.0		39.0		51.0			
			25	4.5		11.5		19.5		51.0	
PUVA	8	NO	50	8.0	7	20.5	7	37.0	7	95.0	5
			75	11.5		26.0		58.0		112.0	
			25	7.0		21.0		23.0		35.0	
PUVA	8	YES	50	9.0	6	21.5	6	30.0	6	45.5	5
			75	9.0		23.0		37.0		78.0	
Log Rank Test (p values)			UVB	0.08		0.005		0.002		0.83	
Tape vs. no-tape			PUVA	0.98		0.36		0.24		0.06	

Unadjusted estimates of the quartiles of the response time distribution for each end point are shown, along with p values for the log-rank tests of tape vs. no-tape conditions within light treatment type. The number of events represents the number of subjects who achieved the indicated end points in each of the four study conditions.

icant for CP within PUVA ($p = .06$). The median values as well as first and third quartiles shown in Table 2 support these results. In general, the UVB no-tape cohort took the longest time to respond, whereas the PUVA tape group responded most rapidly. Because the log-rank test was not statistically significant ($p = 0.83$) for the UVB clearing point, the difference between the medians of the tape (98 days) versus no-tape (84 days) subjects receiving UVB treatment (14 days) was not significant, whereas for the PUVA clearing point, the difference between the medians of the no tape (95 days) and tape (45.5 days) subjects (49.5 days) was nearly significant ($p = .06$).

Table 3 presents the adjusted estimated hazards ratios obtained from proportional hazards regression analysis of time to the four end points. All models included years with psoriasis and initial SCL-90-R score. Hazard ratios and confidence intervals are shown for group (tape or no-tape) and light (UVB or PUVA). At both the HP and the CP, there is a statistically significant difference between the tape group and the no-tape group, the rate of attainment being about 3.8 times more likely in the tape group at both time points. There also is a trend toward an increased rate of attainment at the First Response Point with a hazard ratio of about 2. Strong differences due to light are also in evidence at all four time points, due to the well-known difference in potency between UVB and PUVA, with hazard ratios ranging from 4.4 to 6.2.

The differences in the estimated adjusted time-to-clearance distribution response between tape and no-tape groups are seen in Figure 1, *A* and *B*. These curves were obtained from SAS using the estimated Cox proportional hazards model and median values for years with psoriasis and SCL-90-R score. They represent the estimated probability of clearing for each

TABLE 3. Estimated Cox Proportional Hazard Ratios and 95% Confidence Intervals for the Effect of Tape Group and Light in the Treatment of Psoriasis

Outcome	Variables	Estimated Hazard Ratio	95% Confidence Interval	p
First response	Group	2.16	(0.90, 5.17)	0.083
	Light	5.53	(2.08, 14.69)	0.001
Turning point	Group	2.02	(0.80, 5.12)	0.139
	Light	6.21	(2.18, 17.64)	0.001
Halfway point	Group	3.88	(1.34, 11.25)	0.013
	Light	4.71	(1.73, 12.81)	0.002
Clearing point	Group	3.75	(1.11, 12.65)	0.033
	Light	4.42	(1.37, 14.21)	0.013

p Values are given for the effect of Group (tape or no tape) and Light (UVB or PUVA) on the four treatment response end points. Estimates are adjusted for number of years with psoriasis and SCL-90-R score.

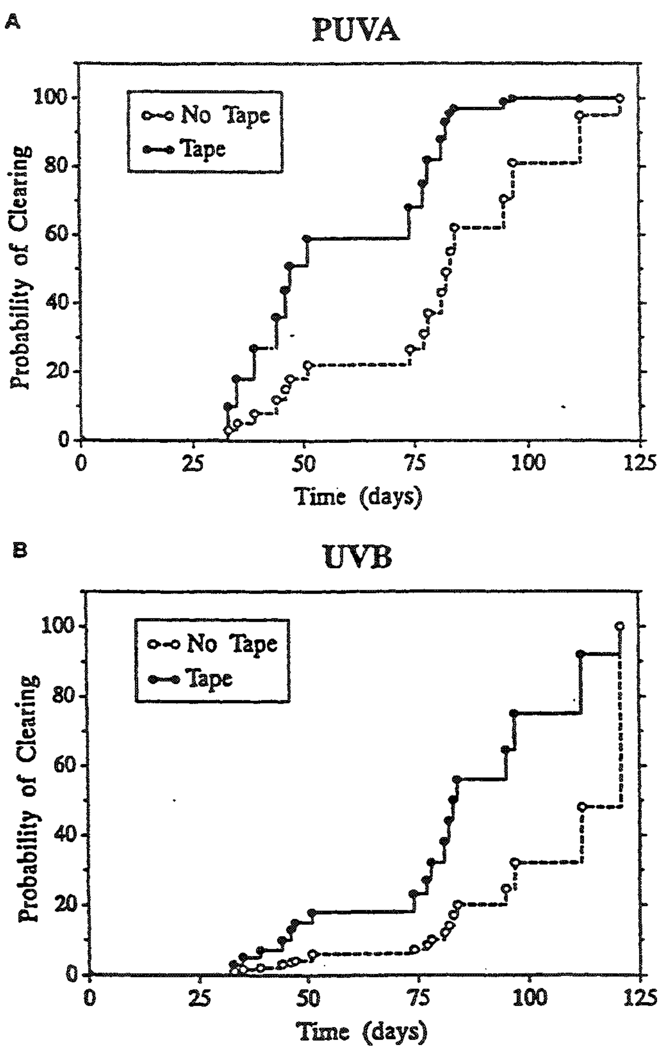

Figure 1. Estimated probability of clearing as a function of time for subjects in the tape (guided stress reduction/meditation condition) and no tape (conventional UVB or PUVA treatment) conditions. *A*, PUVA; *B*, UVB. The curves are based on the estimated proportional hazards model in Table 3 and are adjusted to median values for years with psoriasis and SCL-90-R score.

value of time used in the analysis of the CP, regardless of whether it was a censored or non-censored value.

As can be seen in Figure 1, *A* and *B*, there is a strong separation between the curves describing the tape and no-tape conditions. For UVB, the estimated time to achieve a 50% probability of clearing is 83 days for the tape group and 113 days for the no-tape group. For PUVA, the results are 48.5 days for the tape group and 85 days for the no-tape group respectively. The estimated adjusted time differences for achieving 50% probability of clearing in the tape versus no-tape conditions are 30 and 40 days respectively for UVB and PUVA. These values differ from the unadjusted differences of 14 days and 49.5 days shown in Table 2, and reflect the averaging over patients that takes place in the modeling process.

Similar statistically significant separations in the kinetics of clearing in the comparison groups were seen when the data were subjected to a Kaplan-Meier analysis, and when the analyses were performed as a function of increasing energy exposure (in millijoules for UVB and joules for PUVA) rather than as a function of time (data not shown).

Psychological Outcomes:

Data acquired on the 22 subjects who completed the entire protocol, who were assessed before treatment and at the conclusion of the protocol on the General Severity Index of the SCL-90-R showed no change in mean GSI (0.296 pre; 0.290 post) for those subjects in the no-tape condition (N = 11) and a 35% reduction in the mean GSI for those subjects with complete pre/post data (N = 11) in the tape group (0.360 pre; 0.233 post). Although the latter finding did not reach statistical significance in the univariate t test ($p = 0.18$), it is similar in magnitude to reductions routinely observed on this index in the stress reduction clinic and reported in a number of studies (37–39). No change in STAI was observed in either cohort.

Data from periodically administered rating scales of subjective response to treatment showed nonstatistically significant trends suggesting that subjects in the tape groups: a) increased in "positivity about today's session" compared with no tape subjects (14% mean percent increase from the start of treatment to the midpoint (N = 14), compared with −3% (N = 14)); b) increased in "degree of relaxation after today's session" compared with no tape subjects (6% (N = 14) vs. 1% (N = 14)); and c) increased in "the extent to which you think the treatment is helping" (29% (N = 12) vs. 14% (N = 11)).

DISCUSSION

The results suggest that the rate of skin clearing in patients with moderate to severe psoriasis can be accelerated when subjects engage in an audiotape-guided, meditative stress reduction exercise during their UVB or PUVA treatment sessions. This phenomenon has now been observed in two separate studies – the original pilot (31), and the present study, which includes two blinded, independent confirmations of each subject's skin status. In both studies, a pronounced effect was observed in spite of a small study size, suggesting that the effect is robust and attainable in a significant number of psoriasis patients practicing the stress reduction exercises. These results must be interpreted cautiously, however, in light of the small numbers of patients. This finding is, however, consistent with anecdotal reports (25a, 45) and other studies suggesting that stress reduction methods including relaxation, hypnosis, and imagery may positively affect symptoms in psoriasis in the absence of phototherapy (46, 47) or as a complement to it (48). Moreover, as noted in Methods, the present results cannot be explained by a differential dropout rate between groups.

The psychological outcome data, taken as a whole, suggest that the tape intervention resulted in reduced distress and increased well-being. With small numbers of subjects, it is difficult to achieve statistical significance with outcome measures like the SCL-90-R, which typically show high variability. We saw no change in state anxiety on the STAI between preintervention and postintervention in either the controls or the experimental subjects. A comprehensive assessment of the type and degree of psychological change resulting under these study conditions requires further investigation.

The increased rate of skin clearing and the concomitant reduction in number of sessions necessary to achieve clearing in patients who made use of the psychological intervention during treatment may have two important clinical implications: a) a possible reduction in the risk of skin cancers associated with exposure to phototherapy and photochemotherapy (49–51); b) the potential to significantly reduce the cost of treatment by reducing the total number of treatments necessary to achieve clearing.

It should be noted that, although it seems from Figure 1, *A* and *B* that 100% of patients cleared by the end of the study, this is not the case. As noted in Methods, 12 subjects dropped out of the study before their treatments were completed and 2 were censored due to prescription changes. The curves show only that, had all subjects remained in the protocol for 121 days, the *probability* of their clearing would have approached 100%. The figures represent predictions from the estimated model using the observed data and are not plots of the observational data themselves.

The attribution of the results of this study to elements of the stress reduction intervention should be considered preliminary and tentative. Until further studies are performed to control for additional variables, we cannot rule out the possibility that expectancy effects (ie, enthusiasm and/or disappointment about tape group assignment) may have played a role in the observed differences, inasmuch as the control group did not make use of placebo instructional or music audiotapes. Nevertheless, the findings of this study suggest an important psychological influence on the rate of skin clearing related to assignment to the meditation tape or no-tape condition. A conclusive attribution of the observed acceleration in rate of skin clearing to specific psychological factors, such as elements of the meditation practice and the guided imagery awaits further research.

Our present findings suggest that this experimental design is well-suited for studying the role of belief, expectation, and psychological conditioning in the resolution of a specific and readily observable disease process that psoriasis represents. Placebo (non-therapeutic) wavelengths of light could be used to differentiate effects due to light from effects due to psychological factors. The system could also be used in future studies to differentiate between therapeutic effects attributable to the meditation versus those attributable to the visualization component of the present intervention, to investigate the specificity of the meditation instructions through use of "pseudo-meditation" instructions, to study the interaction between individual patient characteristics and response to specific psychological interventions, and to assess the long-term efficacy of such interventions in preventing or slowing recurrence after treatment.

It is interesting to note that the dimension of social support, thought to be highly important in other studies of psychological interventions exerting a potentially mitigating effect on disease progression (52–54), is minimal in this experimental design because each subject undergoes the combined light treatment and psychological intervention in isolation.

The experimental design used in the present study also might prove useful in investigating the role of potential biological mediating variables in skin clearing and their interaction with a range of psychological factors and practices. One candidate for study is the cellular titer and activity of different lymphocyte populations and cytokines involved in the dermal inflammatory response and wound healing (4) as well as in psoriasis (7). Other important areas of investigation include possible differential gene expression in the case of transforming growth factor (TGF-α), as well as the reported over-expression of the Bcl-x protein in keratinocytes. As noted in the Introduction, both of these factors have been implicated in psoriasis (8, 9). Such investigations have the potential to inform our understanding of how psychological factors might interact with disruptions of apoptosis, giving rise to uncontrolled cellular proliferation. This process may be relevant to malignancies in which anti-apoptotic factors are expressed, such as basal cell carcinoma (9), as well as to psoriasis itself.

Thus, the experimental design described in the present study may provide an opportunity to investigate elements of an observable healing process ranging from gene expression and cell proliferation to attitudes, expectations, and the use of specific psychological methods such as meditation and visualization.

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ORIGINAL ARTICLES

Relationship of Cognitive and Somatic Components of Anxiety to Patient Preference for Different Relaxation Techniques

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Abstract

Background: The relationship between cognitive/somatic response pattern for anxiety and preference for different relaxation techniques was evaluated in an exploratory study of 135 medical patients referred for mindfulness-based stress reduction training, in which they practiced three major stress-reduction techniques.
Method: Following intervention, patients rated on visual analogue scales, how much they liked each of three techniques: sitting meditation, a body scan meditation, and Hatha Yoga, which differed in primary cognitive/somatic orientation but shared the unifying attentional stance characteristic of mindfulness meditation.
Results: Of the 74 patients who showed pre-treatment levels of anxiety above the mean for the entire group, 29 (39%) showed a pattern in which either the cognitive or the somatic component of anxiety predominated. The high cognitive/low somatic anxiety subgroup (n = 9) showed a significant preference for the most somatic technique (Hatha Yoga) and liked least the most cognitive technique (sitting meditation). The high somatic/low cognitive anxiety subgroup (n = 20) showed the inverse response. The body scan, with both cognitive and somatic qualities, was preferred to an intermediate degree by both groups. Irrespective of an individual's mode of anxiety expression or technique preference, participation in the mindfulness-based stress reduction program appeared to be effective in reducing overall anxiety levels.
Conclusions: These findings differ from several previous studies of anxiety modality (cognitive or somatic) and relaxation technique preference that used nonclinical populations, and appear inconsistent with Davidson and Schwartz' hypothesis that treatment of anxiety is best oriented toward the mode in which it is expressed.

Relatively little is known about psychological factors that may predispose an individual to prefer one type of relaxation technique over others. To date there are relatively few systematic studies of preferences for particular relaxation techniques, although more generally, there is increasing interest in how individuals seek out forms of psychological intervention best suited to their needs.[1] Moreover, treatment compliance is likely to depend, at least in part, on how useful patients find a particular technique. Knowledge of psychological factors that may influence a particular patient to like a specific method and prefer it over others, or to benefit differentially from use of a particular relaxation technique, might help optimize adherence in practicing relaxation techniques. The present study was conducted to investigate the relationship between the mode of anxiety expression in medical patients (cognitive or somatic) and how much they liked different relaxation techniques as a function of the mix of cognitive and somatic elements in each technique.

In 1976, Davidson and Schwartz presented a psychobiologic model of relaxation and its relationship to anxiety.[2] They proposed that there are two relatively independent components of anxiety (one cognitive and the other somatic), and that different relaxation techniques should differ in the degree to which they affect one or the

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other of these two components. Their model gave rise to the hypothesis that treatment is most effective when directed toward the predominant mode of anxiety expression (i.e., cognitive or somatic). Subsequently, Schwartz et al developed the Cognitive Somatic Anxiety Questionnaire (CSAQ) to differentiate the cognitive and somatic components of trait anxiety, then used it to explore anxiety response patterns in individuals who either exercised or practiced meditation, using a retrospective study design.[3] They found that individuals participating in an exercise class reported higher levels of cognitive anxiety than somatic anxiety, whereas those practicing meditation (primarily transcendental meditation) on a daily basis had approximately equal levels of cognitive and somatic anxiety at an intermediate level. The authors concluded that "different techniques employed for the elicitation of relaxation may be associated with specific consequences" in terms of anxiety reduction. They proposed that relaxation consists of a generalized relaxation response component, as suggested by Benson,[4] and a more specific pattern of changes superimposed upon it "which is elicited by the particular technique employed."[3]

The CSAQ and SCL-90-R have both been used to differentiate groups of individuals who experience anxiety in a predominantly cognitive or a predominantly somatic mode.[3,5,6-8] In one study stimulated by the Davidson and Schwartz model, Norton and Johnson compared the effectiveness of progressive muscle relaxation (PMR), a somatic relaxation procedure, with Agni Yoga, a more cognitively based form of relaxation, in reducing anxiety in a snake approach test.[6] Participants in the study were college students selected on the basis of having predominantly either a cognitive or somatic response pattern as assessed by the CSAQ. Those students who were characterized as high in somatic anxiety showed less anxiety in a snake approach test following training in PMR than did other subjects with a similar high somatic anxiety profile trained in Agni Yoga. Results for subjects high in the cognitive component of anxiety were less clear-cut, but nonetheless were interpreted by the authors as suggesting that students with high cognitive anxiety who were taught cognitively oriented anxiety reduction techniques (Agni Yoga) performed better in the snake approach test than did those trained in PMR. The authors suggested that their findings supported the hypothesis of Davidson and Schwartz that somatic anxiety is more effectively reduced by a somatic relaxation procedure, and cognitive anxiety by a cognitive relaxation procedure.[2]

The purpose of the present study was to determine whether medical patients being exposed to a range of stress reduction skills prefer relaxation techniques consistent with the predominant mode in which their anxiety is expressed. It was based on observations that among patients in an 8-week, outpatient mindfulness-based stress reduction (MBSR) program, strong preferences for specific meditation techniques that emphasize varying degrees of somatic or cognitive elements were often reported.

To assess such preferences systematically, patients were identified on the basis of their mode of anxiety expression (cognitive vs. somatic) at the outset of the intervention, and then evaluated to determine whether those with predominantly cognitive or somatic anxiety response patterns would prefer relaxation techniques consistent with their mode of anxiety expression. Both the Davidson and Schwartz model and the findings of Norton and Johnson predict that cognitively expressed anxiety would be most responsive to cognitive interventions, whereas somatic anxiety would respond best to somatically oriented techniques.[2,6] Presumably, preferences for such techniques, the focus of this study, should follow the same pattern.

Methods

SUBJECTS

Subjects were 150 medical outpatients participating in an ongoing 8-week MBSR program known as the Stress Reduction and Relaxation Program (SR&RP). Of these, 15 individuals were excluded from the study because of missing data, leaving 135 study subjects (58 males and 77 females), all of whom had been referred to the program for a broad range of chronic medical problems (Table 1). Three program instructors worked with groups of approximately 30 patients each.

STRESS REDUCTION AND RELAXATION PROGRAM

The SR&RP is a well-documented MBSR program.[9] Previous studies have shown high rates of adherence to

Table 1. Distribution of Diagnoses among Subjects

	n = 135	Percentage
Chronic pain	33	24.4
Hypertension	20	14.8
Heart attack or coronary artery disease	5	3.7
Anxiety with functional somatic complaints	45	33.3
Gastrointestinal disorders	14	10.4
Cancer	3	2.2
Other	15	11.1

the program and its components, and significant anxiety reduction across a range of medical and psychiatric diagnoses.[10-13] Individuals with well-characterized anxiety disorders also respond favorably to MBSR.[14] In a study of patients meeting DSM-III diagnostic criteria for either Generalized Anxiety Disorder or Panic Disorder, a significant overall reduction in anxiety was maintained at a 3-month follow-up, at which time 91 percent of the patients (20 of 22 subjects) reported continuing to practice the stress reduction techniques learned during the course. A subsequent 3-year follow-up study found persisting beneficial effects of the initial intervention.[15]

All patients enrolled in the SR&RP received the same intervention, irrespective of admitting medical or psychiatric diagnosis. This included training in three major relaxation techniques taught in a group format: sitting meditation (SM), a body scan meditation (BSM), and Hatha Yoga (Y). Mindfulness-based stress reduction training included practicing these techniques in weekly classes as well as home practice for 45 minutes per day, 6 days per week over the 8-week intervention,[9] using audio tapes for guidance.

Although these techniques differed considerably in terms of what practitioners were asked to do, they were all taught with an equal primary emphasis on maintaining nonjudgmental moment-to-moment awareness. For this reason they can all be described as different forms of mindfulness meditation.[16,17] Training in all three techniques in the SR&RP was embedded in a context of health behavior change, stressing the development of adaptive relaxation and stress coping strategies based on the mindfulness perspective. In this approach, relaxation is not treated so much as a goal of practice, but rather as a potential beneficial by-product of the attentional stance characteristic of mindfulness.

Sitting Meditation

Sitting meditation is practiced on a straight-backed chair or on floor cushions in sitting postures that support minimal physical movement. Moment-to-moment attention was focused on a succession of objects, beginning with sensations associated with breathing and expanding, over several weeks, to encompass physical sensations, sounds, emotions, and thoughts. In its emphasis on remaining still, with primary attention directed to the breath and to other aspects of moment-to-moment experience, it is the least somatic and most cognitive of the three relaxation techniques. Patients are instructed to respond to lapses of attention by returning to the breath to re-establish mindfulness.

Body Scan Meditation

Body scan meditation is practiced in a supine position. In this technique, a great deal of emphasis is placed on coupling an awareness of one's breathing with a highly refined and directed awareness of body sensations, as patients progressively direct attention throughout the body from feet to head. Unlike progressive muscle relaxation methods,[18,19] BSM does not involve alternate tensing and relaxing of muscle groups. Rather, it involves systematically directing attention to sensations in different regions of the body with the intention of simply noticing whatever sensations are present. This technique has a greater somatic focus than the sitting meditation, but less of a somatic focus than is present in the yoga, due to the absence of actual movement. Body scan meditation also is less cognitively focused than SM, because attention is primarily focused on the observing of direct proprioceptive experience within the body, region by region, rather than observations of thoughts or other potential objects of attention, such as sounds or emotions.

Hatha Yoga

In this study, the Hatha Yoga involved sequences of body postures (*asanas*) accomplished through slow, gentle movement and stretching, executed primarily from a resting supine or prone position. With its high degree of movement of the body and positioning of it in different configurations, and with its orientation toward musculoskeletal recruitment involving strength, stretching, balance, and a degree of endurance, as well as a strong emphasis on on-going diaphragmatic breathing,[20] it is the most somatically oriented of the three relaxation techniques.

Practice Schedule

Subjects received 23 hours of group instruction and practice time during the SR&RP (eight 2-hour classes and one 7-hour mostly silent retreat). In addition, they were required to practice the techniques at home for 45-minutes per session, at least 6 days per week during the 8-week program (a total of 36 hours). Two audiocassettes (45 minutes per side) were provided to guide home practice, according to the following schedule: weeks 1 and 2: BSM (45-minute tape), supplemented in week 2 with 5 to 10 minutes per day of SM (no tape); weeks 3 and 4: Yoga (45-minute tape), alternating with BSM, plus ongoing SM 5 to 10 minutes per day (no tape); weeks 5 and 6: SM (45-minute tape), alternating with Yoga or BSM according to personal preference; week 7: any or all techniques, no tapes, 45-minute sessions; week 8: any or all techniques, with tapes, according to preference.

During the weekly classes, BSM was practiced in sessions 1, 2, and 8; Yoga in session 3; and SM in every session beginning with session 2. Each week, the time spent practicing SM in the classes was increased until, by week 8, subjects were sitting as a group for periods of up to 45 minutes at a time. During the 7-hour retreat session, approximately 90 minutes were devoted to Yoga, 60 minutes to BSM, and 100 minutes to SM (in sessions of between 10 and 30 minutes in length). In each class, the techniques practiced in the preceding week were discussed and suggestions made for deepening concentration and relaxation.

In all, a total of approximately 36 hours of formal home practice was required of the patients in addition to classroom practice and the all-day session. Practice time for each of the three techniques was approximately equal.

INDEPENDENT VARIABLES

The SCL-90-R is a 90-item clinical symptom checklist covering a range of common psychological symptoms.[5] It was used to determine pre-intervention levels of cognitive anxiety (CANX) and somatic anxiety (SANX), as described by Buckelew et al.[7] Cognitive and somatic measures of depression, using the same instrument, were also obtained for another study. The CSAQ was also used in this study but is excluded from the presentation because it gave similar results. Group mean values for the CANX (0.779) and SANX (1.379) components were used to categorically define four patient groups, in which 'high' means above the mean and 'low' signifies below the mean: (1) high cognitive/high somatic (n = 45); (2) high cognitive/low somatic (n = 9); (3)low cognitive/high somatic (n = 20); and (4) low cognitive/low somatic (n = 61). Thus 74 patients (55%) had above average anxiety scores with respect to either somatic, cognitive, or both components. Of these, 29 (39%) had a dominant somatic or cognitive mode of anxiety expression.

The SCL-90-R was also used as an outcome measure, following intervention, to determine change in overall anxiety status as well as in cognitive and somatic components.

OUTCOME MEASURES

The degree to which patients liked the three relaxation techniques was measured following intervention, using visual analogue scale (VAS) ratings. Visual analogue scales have been used in pain research as a measure of pain severity, and in other settings to establish the relative value to a single patient of different treatments.[21] Each patient rated the three relaxation techniques on three VASs. Subjects were instructed to place a mark on a 100-mm line between the extremes of "not at all" and "a great deal" to indicate how much they liked each technique. The length of the line in millimeters, from the "not at all" end to the mark, comprised the VAS rating, and this in turn defined the *degree of liking* each technique for each patient. Technique preference was defined by the size of the difference between VAS scores for pairs of relaxation techniques for each individual. A difference in VAS scores of greater than 10 mm between one technique and the other two was categorically defined as a preference for the most highly rated technique. A difference of 20 mm or more between one technique and the other two was defined as a strong preference.

Results

CONTRASTING ANXIETY EXPRESSION SUBGROUPS AND VISUAL ANALOGUE SCALE RATINGS

Of central interest to this study was the relationship between the degree to which patients reported liking a particular technique and their mode of anxiety expression (cognitive or somatic). Of the 74 patients with anxiety levels above the mean, 29 (39%) were dominant in one mode (i.e., they were high in CANX and low in SANX [n = 9] or vice versa [n = 20]), while having approximately equivalent levels of overall anxiety, as measured by the SCL-90-R anxiety subscale (Table 2). As can be seen in Table 3 and Figure 1, those in the high cognitive/low somatic subgroup (n = 9) rated Yoga an average of 16.9 VAS units greater than BSM, and an average of 28.1 VAS units greater than SM. In contrast, the high somatic/low cognitive subjects (n = 20) showed the inverse relationship, rating SM 6.5 VAS units greater than the BSM and 18.6 VAS units greater than Yoga. A repeated measures analysis of variance (ANOVA) showed a significant interaction between CANX/SANX dominance and the pattern of VAS scores for the three techniques [$F(2.54) = 3.35, p < .05$]. Thus, for patients at the extreme ends of the anxiety response dominance spectrum (the high CANX/low SANX and high SANX/low CANX groups) there was a statistically significant inverse relationship between VAS ratings for the three techniques. On average, the high CANX/low SANX subgroup liked the Yoga (the least cognitive technique) the most. They liked the BSM technique to an intermediate degree, and liked SM (the most cognitive technique) least of all. By contrast, the high SANX/low CANX cohort liked best the least somatic technique (SM), liked the BSM to an intermediate degree, and liked least the most somatic technique (Yoga). This finding suggests that patients with either a dominant CANX or a dominant SANX response pattern liked best the technique the most nearly *opposite* to their dominant mode of anxiety expression.

To place this selective finding within a broader context of other relationships between CANX and SANX components (i.e., low/low and high/high as well as high/low and low/high), two-way ANOVAs were conducted, using

Table 2. Distribution of Subjects by Cognitive/Somatic Response Pattern for Anxiety on the SCL-90-R

Subgroup	*n*	*Percentage of Total Population*	*Mean Anxiety Score*
HC/LS	09	06.7	0.97
HS/LC	20	14.8	1.06
LC/LS	61	45.2	0.39
HC/HS	45	33.3	2.04

HC/LS = high CANX/low SANX; HS/LC = high SANX/low CANX; LC/LS = low CANX/low SANX; HC/HS = high CANX/high SANX expression

Table 3. Relationship between Cognitive and Somatic Anxiety and Visual Analogue Scale Ratings for Three Relaxation Techniques: Analyses of Variance

	Mean VAS Rating (n)	
	Low SANX	*High SANX*
Sitting Meditation*		
Low CANX	67.5 (n = 61)	72.5 (n = 20)
High CANX	44.6 (n = 9)	61.0 (n = 45)
Body Scan Meditation†		
Low CANX	55.2 (n = 61)	66.0 (n = 20)
High CANX	55.8 (n = 9)	53.9 (n = 45)
Hatha Yoga‡		
Low CANX	62.3 (n = 61)	53.9 (n = 20)
High CANX	72.7 (n = 9)	64.3 (n = 45)

*CANX: $F = 6.30, p = .013$; SANX: $F = 2.11, p = .149$; interaction: $F = .784, p = .378$
†CANX: $F = 1.11, p = .294$; SANX: $F = 0.88, p = .351$; interaction: $F = .729, p = .395$
‡CANX: $F = 2.61, p = .109$; SANX: $F = 1.77, p = .186$; interaction: $F = .000, p = .992$

VAS scores for all cognitive/somatic groupings for each of the three relaxation techniques (see Table 3). Of the three ANOVAs calculated, only that for SM resulted in a significant grouping effect. In this instance, cognitive/somatic grouping was found to influence VAS scores significantly [$F(2,131) = 3.15, p < .05$]. Patients with below average CANX expression scores preferred SM (a highly cognitive technique) more than did patients with above average CANX expression scores, independent of SANX expression level.

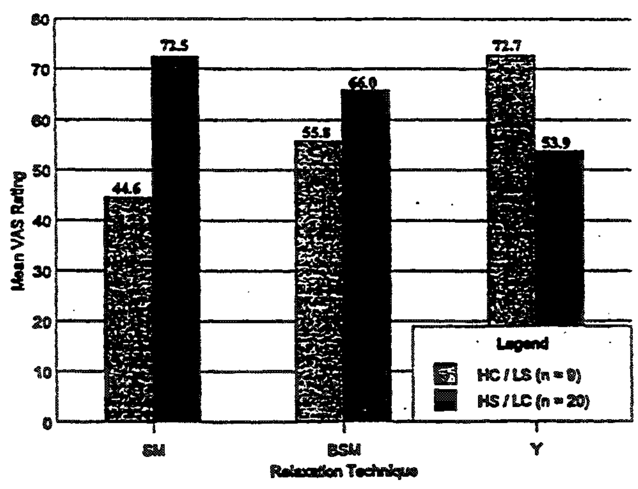

Figure 1. VAS ratings of three relaxation techniques by individuals expressing dominant cognitive (HC/LS) or somatic (HS/LC) response patterns. SM = sitting meditation; BSM = body scan meditation; Y = Hatha Yoga. A repeated measures ANOVA showed a statistically significant interaction between group (high CANX/low SANX vs high SANX/low CANX expression) and VAS ratings across the three techniques [$F = 3.35, p = .043$, df = 2]. There was no significant difference between the two groups across VAS ratings [$F = 1.09, p = .31$, df = 1], nor between the three VAS ratings across groups [$F = 0.13, p = .875$, df = 2].

OVERALL ANXIETY EXPRESSION SUBGROUPS AND VISUAL ANALOGUE SCALE RATINGS

Mean VAS ratings for the three stress reduction techniques for the total population of patients (n = 135) were: SM, 64.5 (SD = 29.4); BSM, 56.4 (SD = 33.1); and Yoga, 62.4 (SD = 30.1). These ratings did not differ significantly from each other (t-test). Sixty-four percent of all subjects (86 of 135) preferred one technique over the other two (≥10 mm difference on the VAS scale), and 44 percent (59 of 135) strongly preferred one technique (≥20 mm difference).

To examine the overall relationship among cognitive and somatic components of the SCL-90-R anxiety subscale score and VAS ratings for the three relaxation techniques, correlation coefficients were calculated for the following three groups: (1) the entire sample (n = 135); (2) subjects who showed a preference for any technique (ΔVAS ≥10 mm); and (3) those who indicated a strong preference (ΔVAS ≥20mm). In no instance were any statistically significant relationships found (Table 4). Taken together with results of the first analysis, this finding suggests that relaxation technique preferences, at least in the MBSR context, are related to the mode in which anxiety is experienced only when subjects show mode dominance (i.e., high cognitive/low somatic or high somatic/low cognitive).

Table 4. Correlation Coefficients between Visual Analogue Scale Ratings and Cognitive and Somatic Scores for Anxiety on the SCL-90-R

	VAS Rating		
	n	*CANX*	*SANX*
All Subjects			
SM	135	−.128	.006
BSM	135	−.084	−.039
Yoga	135	.085	−.021
Subjects with a preference (ΔVAS ≥10 mm)			
SM	86	−.090	.004
BSM	86	−.047	−.144
Yoga	86	.075	.039
Subjects with a strong preference (ΔVAS ≥20 mm)			
SM	59	−.078	−.046
BSM	59	−.075	−.084
Yoga	59	.005	−.087

Note: No R values reached statistical significance at $p \leq .05$
CANX = cognitive anxiety; SANX = somatic anxiety; SM = sitting meditation; BSM = body scan meditation; Δ = difference between pairs of VAS ratings

INTERVENTION OUTCOME

Participation in the treatment program resulted in significant mean pre- and post-intervention reductions in both CANX (42%) and SANX (48%), for the total study sample ($p < .0005$, 2-tailed t-test). Substantial reductions in overall anxiety and in both the cognitive and somatic components of anxiety were obtained by all cognitive/somatic subgroups in the study, although the low initial values for those with a low anxiety component (i.e., low cognitive or low somatic) and the small number for the high cognitive/low somatic subgroup probably limited statistical significance in some cases. The high CANX/low SANX cohort showed a 60 percent reduction in CANX ($p = .029$, 2-tailed, df = 7) and a 35 percent reduction in SANX as well ($p = .149$). The high SANX/low CANX anxiety cohort achieved a 54 percent reduction in SANX ($p = .0005$, 2-tailed, df = 19) and a 14 percent reduction in CANX ($p = .76$). The high CANX/high SANX cohort showed a 43 percent reduction in CANX ($p < .0005$, 2-tailed, df = 37) and a 45 percent reduction in SANX ($p < .0005$, 2-tailed, df = 37).

To further probe the relevance of the above findings, the frequency of individuals with a calculated preference for each technique and of those showing no technique preference was determined for each anxiety modality subgroup. In the high cognitive/low somatic subgroup (n = 9), five individuals (56%) preferred Yoga, two preferred BSM, one preferred SM, and one had no preference. In the high somatic/low cognitive cohort (n = 20), five individuals (25%) preferred the Yoga, four (20%) preferred the BSM, 5 (25%) preferred the SM, and six (30%) had no preference. Thus, although the overall patterns for the two cohorts in terms of their VAS ratings of the three relaxation techniques showed an inverse relationship consistent with liking most the technique opposite one's dominant mode of anxiety expression, both subgroups contained individual patients who had calculated technique preferences inconsistent with the overall group trend.

Discussion

Patients with both elevated and markedly contrasting CANX and SANX response patterns showed degrees of liking each of the techniques that depended on the direction of contrast: each subgroup, taken as a whole, (high cognitive/low somatic; and low cognitive/high somatic) liked most the technique that focused primarily on objects of attention that differed most from their dominant mode of anxiety expression (see Figure 1). Thus an inverse relationship in VAS scores was found for the two cohorts, across the gradient of most cognitive method (SM) to most somatic method (Yoga) with BSM in between. These findings run counter to predictions of the Davidson and Schwartz model,[2] to the extent that the degree of liking particular techniques is related to their efficacy for the person in reducing anxiety.

Previous research supporting the Davidson and Schwartz model differed in several key respects from the present study.[3,6] First, these studies utilized relaxation techniques that emphasized either the somatic or the cognitive process to the virtual exclusion of the other, and compared the responses of different groups of individuals who were exposed to only one of the two relaxation techniques. Second, they employed nonclinical populations of relatively young healthy adults, who may, as noted by one author,[6] respond differently to behavioral procedures than older and more distressed medical patients.

The present analysis is based on the assumption that the three techniques used in this study can be validly scaled on gradients of cognitive and somatic attentional focus and thereby reveal differences in "mode" of relaxation as described by Davidson and Schwartz.[2] The fact that the vast majority of subjects in the present study did not show a marked dominance of cognitive or somatic expression in their anxiety indicates that differentiation between these modes of anxiety expression may not be particularly relevant to the experience of these patients, all of whom were encouraged during the intervention to be aware of the full range of physical and mental processes experienced within the context of each of the techniques, and who, as a group, showed large mean reductions in anxiety. Individuals with strong cognitive or somatic dominance in the experience of anxiety may be in the minority in many populations, thus limiting predictions about technique preference or efficacy based on CANX/SANX dominance to instances where such contrasts occur.

The apparent contradiction between the results of the present study and the Schwartz et al model[3] may be understandable through consideration of the inward experience of chronic and intense anxiety. People who experience high levels of chronic anxiety, as was the case for many of the patients in the clinical population reported on in the present study, tend to avoid situations and cues that are likely to initiate or increase this aversive experience, even within a therapeutic context. This can result in conditioned avoidance behavior, described by Linehan and others as a pattern routinely observed in medical patients facing anxiety-provoking diagnostic or treatment procedures.[22] For example, Ewert et al studied heart surgery patients undergoing cardiac rehabilitation.[23] Patients who did not learn to identify as normal the usual somatic sensations associated with strenuous exercise on a treadmill were likely to (a) mistake those sensations for signs of cardiac distress; (b) express dislike for the exercise training; and (c) withdraw from (i.e., avoid) the program. Similarly, avoidance behaviors have been observed in patients with chronic obstructive pulmonary disease (COPD) undergoing pulmonary rehabilitation.[24] Such individuals often avoid potentially therapeutic interventions, which they fear may trigger dyspnea, until they learn that any resultant dyspnea can not only be tolerated but actively controlled by cultivating decreased cognitive reactivity.[20,25] This observation suggests that cognitive strategies can be instrumental in reducing somatic distress when a somatic approach by itself might lead to avoidance and rejection of therapy. Similarly, somatic strategies, such as exercise, may reduce cognitive symptoms of both anxiety and depression and can be effective for some individuals when a purely cognitive approach might engender resistance and avoidance.

In the authors' opinion, a likely explanation of the finding of an inverse gradient of liking the three techniques in question among the high cognitive/low somatic and high somatic/low cognitive cohorts is that the former may have liked the most cognitive technique (SM) the least because it occasioned the most direct attending to thought, including fearful thoughts, in a condition of relative physical immobility, and because the additive effect of that attention intensified their discomfort to an unacceptable degree. Such individuals in fact appeared to like most the technique that most emphasized attending to the somatic aspects of relaxation and that provided fewer cognitive cues (mindful Hatha Yoga). Conversely, the latter (high somatic/low cognitive) cohort may have liked SM the most because it provided the greatest occasion for attending to ambient thoughts and feelings in a condition of physical stillness, with a relatively low level of somatic involvement compared to BSM and Yoga. For both cohorts, the BSM technique, which directs attention successively to different regions of the body in a condition of physical stillness lying down, occupies a middle ground in terms of the degree of liking expressed for it by patients in both of these cohorts.

It should be noted, however, that the results for the entire study population of medical patients, and in subpopulations showing a preference or a strong preference for one technique, show no simple relationship between the degree to which individuals liked the three techniques and their levels of CANX or SANX expression (see Table 4). Only SM was significantly differentiated by VAS score in all patients reporting low CANX, regardless of SANX level (see Table 3). In large measure, this may simply be attributable to this cohort's relative lack of anxiety expression dominance. Most patients in the study (64%) preferred (by 10 or more VAS units) one technique over the other two, and many (44.4%) strongly preferred (by 20 or more VAS units) one technique over the other two, even though for the majority, neither CANX nor SANX expression modes predominated.

The analysis of treatment outcome suggests that the MBSR intervention as a whole was effective in reducing both cognitive and somatic components of anxiety for the majority of patients irrespective of expressed preferences for different techniques. Thus, the apparently beneficial effects of this program for the majority of patients may be attributable to a generalized rather than a technique-specific effect of mindfulness practice, one emphasizing cultivation of relaxed attentiveness in a predominantly nonverbal context, regardless of technique. This orientation has been described by Marlatt[26]:

> If anxiety is allowed while the mind is in a state of passive attention, the agitation may arise and then subside again in the absence of verbal labels and mental judgments that might otherwise maintain or even increase the level of arousal. While relaxed, the individual can learn to simply *observe* the comings and goings of various feelings, thoughts and images without 'identifying' with them and acting on them in the usual manner.

Thus, it may be that exposing patients to a range of relaxation techniques that are grounded in the moment-to-moment, nonreactive, nonjudgmental attentional stance characteristic of mindfulness meditation, as is done in MBSR programs, may be more therapeutically beneficial and cost effective in heterogeneous populations of medical patients than matching individual patients to specific relaxation techniques on the basis of their anxiety response modes. An exception may be individuals who show clear-cut dominance of anxiety expression in either the cognitive or somatic mode, and results of the present study suggest that clinicians using relation techniques as part of their therapy should keep in mind the potential value of starting with a technique in the opposite mode of that in which such a patient is showing dominance.

The significance of the findings presented here should be evaluated in light of the strengths and limitations of the present study. The large sample size and heterogeneous medical population make the overall lack of a significant relationship between CANX and SANX expression and preference patterns for specific relaxation techniques a compelling finding. Conversely, the significance of findings for the subgroups in which significant preference patterns did emerge is somewhat tempered by the relatively small sample size; it is hoped that other investigators will attempt similar studies. Nevertheless, the significant inverse relationship between the two dominance groups suggests that this observation may be robust and of potential clinical importance.

The distinction between CANX and SANX may also warrant refinement, both with respect to choice of measuring instrument (SCL-90-R vs CSAQ) and the method of Buckelew et al for making the distinction.[7] Finally, the relaxation techniques employed here (BSM, Yoga, and SM) may not have been as clearly distinctive with respect to cognitive and somatic components as those used in previous studies.

Overall, the results of this study support three conclusions. First, medical patients with high levels of either CANX or SANX and a low level of the other response prefer a relaxation technique that emphasizes attending to percepts in the opposite domain. Second, many patients with high or low levels of both CANX and SANX also show preferences for different relaxation techniques which, however, are predicted neither by their cognitive/somatic response pattern to anxiety nor by their overall level of anxiety. Third, whatever an individual's mode of anxiety expression, participation in this time-limited mindfulness-based stress reduction intervention effectively reduced overall levels of anxiety to a significant degree.

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Three-Year Follow-up and Clinical Implications of a Mindfulness Meditation-Based Stress Reduction Intervention in the Treatment of Anxiety Disorders

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Abstract: *A previous study of 22 medical patients with DSM-III-R-defined anxiety disorders showed clinically and statistically significant improvements in subjective and objective symptoms of anxiety and panic following an 8-week outpatient physician-referred group stress reduction intervention based on mindfulness meditation. Twenty subjects demonstrated significant reductions in Hamilton and Beck Anxiety and Depression scores postintervention and at 3-month follow-up. In this study, 3-year follow-up data were obtained and analyzed on 18 of the original 22 subjects to probe long-term effects. Repeated measures analysis showed maintenance of the gains obtained in the original study on the Hamilton [$F(2,32) = 13.22$; $p < 0.001$] and Beck [$F(2,32) = 9.83$; $p < 0.001$] anxiety scales as well as on their respective depression scales, on the Hamilton panic score, the number and severity of panic attacks, and on the Mobility Index-Accompanied and the Fear Survey. A 3-year follow-up comparison of this cohort with a larger group of subjects from the intervention who had met criteria for screening for the original study suggests generalizability of the results obtained with the smaller, more intensively studied cohort. Ongoing compliance with the meditation practice was also demonstrated in the majority of subjects at 3 years. We conclude that an intensive but time-limited group stress reduction intervention based on mindfulness meditation can have long-term beneficial effects in the treatment of people diagnosed with anxiety disorders.*

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Introduction

The lifetime prevalence of anxiety disorders in the United States is estimated to be between 15% and 25%. Symptoms of anxiety are often associated with and/or exacerbate many common medical conditions. Current treatment strategies for the various anxiety disorders include psychopharmacology, cognitive therapy, cognitive/behavioral therapy, relaxation training, self-hypnosis, biofeedback, meditation, supportive psychotherapy, psychodynamic psychotherapy, and other forms of psychotherapy. In the current climate of cost containment, effective time-limited group interventions may serve an important clinical and cost-reducing complementary role to more traditional, time-consuming, and expensive forms of therapy.

Several studies have suggested the effectiveness of various meditation techniques in reducing symptoms of anxiety in individuals with non-DSM-III-R-defined anxiety [1–4]. A previously reported study from our clinic of 22 medical outpatients who met DSM-III-R criteria for generalized anxiety disorder or panic disorder with or without agoraphobia demonstrated clinically and statistically significant improvements in subjective and objective symptoms of anxiety following an 8-week intensive outpatient group stress reduction and relaxation intervention based on mindfulness meditation [5]. The improvements were shown to persist at 3-month follow-up. The current study was designed to follow up on the 22 subjects in the original study at 3 years to investigate the long-term effectiveness of this brief, intensive group intervention in the treatment of individuals with anxiety disorders.

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The Stress Reduction and Relaxation Program (SR&RP) at the University of Massachusetts Medical Center is an outpatient clinic in the form of a one-session-per-week, 8-week-long course which serves a diverse, physician-referred, medical patient population with a wide range of diagnoses. The structure of the program has been previously described [6–11]. The SR&RP can be thought of as an educational intervention for medical patients based on relatively intensive training in mindfulness meditation and its applications in daily living. During the program, participants learn a range of both formal and informal mindfulness-based stress reduction techniques which they are required to practice daily during the intervention period. The formal meditation techniques (body scan, sitting meditation, and mindful hatha yoga) require devoting a special time of at least 45 minutes duration per day, 6 days per week during the 8 weeks of the program, during which the participants practiced these methods using audiotapes for guidance. The informal mindfulness techniques (such as mindfulness of eating, routine activities, stress reactivity, difficult communications) were assigned in different weeks to be practiced during the conduct of everyday living. The details of certain informal mindfulness exercises were recorded daily by each participant in a workbook each received along with the audiotapes. For further description of the formal and informal mindfulness methods, see [6,12].

The systematic cultivation of mindfulness, or nonjudgmental moment-to-moment awareness [6], is most frequently associated with Buddhist meditative practices, where it is known as the "heart of Buddhist meditation" and is extensively described in the traditional Buddhist literature and psychological texts [see 15]. However, the roots of mindfulness can be found in yogic practices described in the Upanishads, dating back thousands of years before the advent of Buddhism. Though its earliest origins stem from Asian meditative traditions, mindfulness can be conceptualized as a universal human attribute in that it has to do with a particular way of paying attention.

The term *mindfulness* is synonymous with awareness. Mindfulness meditation can be defined as the effort to intentionally pay attention, nonjudgmentally, to present-moment experience and sustain this attention over time. The aim is to cultivate a stable and nonreactive present moment awareness. This is usually accomplished through a regular daily discipline involving both formal and informal mindfulness practices.

Epstein [13] notes that there is a remarkable similarity between mindfulness as described by the Buddhist literature and Freud's characterization of the ideal mind state of the psychoanalyst during therapy. Freud described the latter as one of "evenly suspended attention" [14] which he defined operationally as to "suspend . . . judgment and give . . . impartial attention to everything there is to observe." Epstein notes: "Thus, Freud proposed an optimal attentional stance or state of mind [for the analyst] characterized by two fundamental properties: the absence of critical judgment or deliberate attempts to select, concentrate, or understand; and [an] even, equal, and impartial attention to all that occurs within the field of awareness" [13]. This attentional stance is remarkably similar in many respects to the quality of mind which is the aim and method of mindfulness meditation practice [13,15,16].

Training in mindfulness meditation in the context of the SR&RP has been shown to be effective in the self-regulation of chronic pain [8–10], in reducing physical and emotional symptoms in non-pain-related stress disorders and medical problems (J. Kabat-Zinn et al., unpublished manuscript), and as an adjunct to psychotherapy [17,18].

Methods

The study design for the original intervention period has been described in detail elsewhere [5]. Briefly, 44 medical patients who had been referred to the SR&RP by their physicians and who met preliminary identifying criteria were invited to participate in the original study and undergo further screening for generalized anxiety disorder and panic disorder. Screening was performed by psychologists and psychiatrists trained in administering the Structured Clinical Interview for DSM-III-R (SCID). Thirty-two of these individuals completed the evaluation process and twenty-four met the DSM-III-R criteria for generalized anxiety disorder or panic disorder with or without agoraphobia. These subjects were assessed at four times (recruitment; preintervention; postintervention; 3-month follow-up) with an extensive battery of interviewer-administered measures (see below), and weekly from time of recruitment through the intervention period and monthly up to 3 months postintervention by telephone using the Beck Anxiety Inventory, the Beck Depression Inventory, and ratings of the frequency and severity of panic attacks. Results were analyzed using a repeated measures analysis of variance. Twenty-two of the twenty-four subjects completed the intervention (92%). The original study reported clinically and statistically significant reductions on all measures during the intervention period which were maintained at 3-month follow-up. Improvements were independent of whether subjects were taking anxiolytic medications or not. The therapeutic effect was reflected in reductions in frequency and severity of panic attacks in the panic attack cohort.

Eighteen of the original 22 subjects participated in this 3-year follow-up study. Of the remaining four subjects, one declined to participate, one was unreachable, and two were noncompliant with several attempts to schedule interviews. Ten subjects were interviewed in person, and eight subjects were interviewed over the telephone. The assessment battery included Hamilton Rating Scale for Anxiety [19], Hamilton Rating Scale for Panic Attacks [20], Hamilton Rating Scale for Depression [21], Beck Anxiety Inventory (used by special permission of Jeffrey Seugerman, Ph.D., Psychological Corp., personal communication), Beck Depression Inventory [22], Mobility Inventory for Agoraphobia—Accompanied and Alone [23], Fear Survey Schedule [24], number of panic attacks in the preceding week, and the severity of these panic attacks. As in the original study, a repeated measured analysis of variance (ANOVA) was employed to compare relevant time points. Matched t-tests were used in all cases to confirm that the significant change occurred between pretreatment and posttreatment with maintenance of posttreatment levels at 3-year follow-up.

Other data obtained included current medications, amount of current practice of the various formal mindfulness, techniques, amount of current practice of the informal mindfulness technique termed "awareness of breathing in daily life," the rating of the subjective importance in their life of the SR&RP, rating scale of the degree of lasting value of what was learned in the SR&RP, treatment in addition to the SR&RP, whether any additional treatment began before or after the SR&RP, whether additional treatment was still ongoing, and the type(s) of treatment. Each subject interviewed was also evaluated for current psychosocial stressors, current psychiatric and medical disorders, and their reflections on whether and how the techniques learned in the SR&RP influenced their life.

To support the potential generalizability of the results of this follow-up study, the 58 "nonstudy" subjects reported on in the original study who had met the screening criteria for study and who received identical treatment in the SR&RP along with "study" subjects, and who collectively showed reductions in anxiety comparable to the study subjects [5] on the Symptom Check List-90-Revised (SCL-90-R) [25], were contacted and retested on this measure and on compliance measures. Data were available for 39 of these 58 nonstudy subjects at all three time points (pretreatment, posttreatment, and 3-year follow-up). The General Severity Index (GSI) scores of the SCL-90-R as well as the Anxiety Sub-Scale scores of the SCL-90-R were compared at these three times. Here too, repeated measures ANOVA was used to compare the pretreatment, posttreatment, and 3-year follow-up scores of the subjects for whom all the data points were available.

Results

Table 1 shows the mean scores of the various rating scales for study subjects for whom data were available at all three time points (pretreatment, posttreatment, and 3-year follow-up). Repeated measures ANOVA clearly showed that the clinically and statistically significant improvements in subjective and objective symptoms of anxiety and depression demonstrated at posttreatment in the original study persisted at 3-year follow-up on the Hamilton Rating Scales For Anxiety and Depression and the Beck Anxiety and Depression Inventories. Moreover, posttreatment improvements in the Hamilton Panic Score and in the number and severity of panic attacks were also shown to be maintained at 3-year follow-up, as were improvements in the Fear Survey Schedule and in the Mobility Inventory For Agoraphobia—Accompanied. Statistically nonsignificant improvement also persisted in the Mobility Inventory for Agoraphobia—Unaccompanied.

Table 2 shows maintenance at 3-year follow-up of the statistically significant improvements observed in the posttreatment SCL-90-R General Severity Index scores and Anxiety Sub-Scale scores, respectively, among subjects in the larger nonstudy comparison cohort (see Methods) using repeated measures ANOVA.

At 3-year follow-up, 8 of the 18 subjects had participated in no other treatment intervention following completion of the SR&RP. Follow-up data were not available on one subject. Of the remaining nine subjects who used some form of treatment (medi-

Table 1. Scores on outcome measures over time of patients with anxiety disorders in a study of a meditation-based stress reduction program

Measure	N	Pre-treatment Mean	Pre-treatment SD	Post-treatment Mean	Post-treatment SD	3-Year follow-up Mean	3-Year follow-up SD	Repeated measures ANOVA[a] F	df	p
Hamilton Rating Scale for Anxiety	17	25.65	11.19	17.29	9.14	17.24	9.73	13.22	2,32	<0.001
Hamilton Rating Scale for Depression	16	30.06	8.37	24.25	5.60	22.50	6.80	13.63	2,30	<0.001
Beck Anxiety Inventory	17	21.41	12.61	8.29	8.80	11.35	10.30	9.83	2,32	<0.001
Beck Depression Inventory	17	15.18	9.32	9.00	9.47	7.29	7.47	13.28	2,32	<0.001
Fear survey schedule	14	97.14	35.01	75.57	39.58	61.64	28.16	15.79	2,26	<0.001
Mobility inventory for agoraphobia										
Accompanied	13	38.00	15.81	33.15	11.35	32.46	9.70	4.00	2,24	0.032
Unaccompanied	13	47.85	22.26	43.54	17.55	41.23	15.47	1.47	2,24	0.249
Hamilton panic score	17	15.12	13.51	6.47	11.15	5.06	11.81	3.33	2,32	0.048
Hamilton number of panic attacks	16	0.94	0.77	0.31	0.48	0.31	0.60	5.00	2,30	0.013
Hamilton severity of panic attacks	16	1.31	1.20	0.50	0.82	0.50	0.73	4.02	2,30	0.028

[a] All significant changes occurred between pretreatment and posttreatment as determined by paired *t*-tests. There were no significant differences between postintervention and 3-year follow-up values for any measure.

cation and/or psychotherapy) post-SR&RP, seven had been in treatment prior to taking the SR&RP. At 3-year follow-up, four had discontinued these treatments. Two subjects had begun some additional form of treatment after completing the SR&RP. At 3-year follow-up, one remained in treatment. *t*-tests on subjects who were taking benzodiazepines ($N = 3$) at time of entry into the original study as compared to subjects who were not taking benzodiazepines ($N = 15$) at time of entry showed no significant differences in outcomes at 3-year follow-up on any outcome measure. Nor were significant differences found on any outcome measure at 3-year follow-up between subjects who were taking antidepressants at time of entry into the study ($N = 5$) compared to those not on antidepressants at time of entry ($N = 15$).

Of the 18 subjects in the main follow-up cohort, 10 continued to practice a formal mindfulness technique at 3 years posttreatment. Four were practicing at a combined frequency and duration which we described as "high"; an additional three subjects were practicing in a "moderate" range (see [9] for details of these ratings). Sixteen of the subjects continued to practice the informal technique of Awareness of Breathing in Daily Life. Of these 16 subjects, 4 reported using this technique "often," 11 "sometimes," and one subject used it "rarely."

The subjects in the main follow-up cohort were asked to rate the degree of importance they attributed to the SR&RP in terms of their life on a scale of 1–10, where 1 signified "of no importance" and 10 signified "very important." Twelve of the 18 responders rated the SR&RP a 7 or greater, and 5

Table 2. Pretreatment, posttreatment, and 3-year follow-up SCL-90-R GSI and anxiety subscale scores of a comparison cohort of non-study participants ($N = 39$) in the program who met initial screening criteria for the study

Measure	Pretreatment Mean	Pretreatment SD	Posttreatment Mean	Posttreatment SD	3-year-follow-up Mean	3-year-follow-up SD	Repeated measures ANOVA F	df	P
General severity index	0.82	0.55	0.45	0.36	0.49	0.29	13.04	2,76	<0.0001
Anxiety subscale	1.05	0.84	0.45	0.37	0.48	0.35	17.55	2,76	<0.0001

of these rated it a 10. One subject rated it "of no importance."

When subjects were asked at the time of follow-up whether they felt the SR&RP had had a "lasting value" for them, 16 of the 18 responders reported in the affirmative. One subject was "not sure" and one did not respond to this question.

Discussion

The results recorded in Table 1 demonstrate maintenance of the originally observed clinical improvements at 3-year follow-up in this cohort of patients on every outcome measure of the original study. This finding provides strong evidence that an intensive mindfulness-based stress reduction intervention such as the SR&RP can provide a clinically effective treatment for medical patients who also have anxiety disorders as defined by the DSM-III-R. The average duration of the subjects' anxiety disorders at the time of induction into the study was 6.5 years, and half of them ($N = 11$) were receiving pharmacotherapy for anxiety at that time [5]. As noted in the Results section, at 3-year follow-up, 8 of the 18 subjects had received no further treatment of any kind for anxiety. Of those undergoing some other form of treatment (medication and/or psychotherapy) post-SR&RP, seven had been in treatment prior to taking the SR&RP. By 3-year follow-up, four of these seven subjects had discontinued treatment, two other subjects had begun treatment, and of these, one had subsequently discontinued treatment. These facts, together with the finding that there were no significant differences at 3-year follow-up between subjects taking either benzodiazepines or antidepressants at the time of entry into the study and those who were not, and the finding that the majority of subjects continued to use both the formal and informal mindfulness practices learned 3 years earlier in their daily lives to one extent or another (see Results) strongly suggest that individuals with long-term chronic anxiety, whether undergoing other forms of treatment for anxiety or not, can make substantial and long-lasting positive changes in their lives to reduce anxiety and panic by participating in a once a week, outpatient mindfulness-based group stress reduction program in the form of an 8-week course.

Maintenance of reductions in anxiety and in general psychological distress was demonstrated using the SCL-90-R at 3-year follow-up (Table 2) for the 39 responders to follow-up of the original 58 nonstudy subjects (see Methods) who met criteria for being invited to participate in the original study but were not included in it, and whose anxiety outcomes postintervention, as measured on the SCL-90-R, were comparable to those of the study subjects [5]. This demonstrates that the clinical improvements in anxiety observed in the intensively studied cohort generalized to the much larger majority of participants in the SR&RP presenting with high levels of anxiety and from whom much less data were gathered. It is thus unlikely that the more intensive data gathering procedures of the original study used with the study subjects (including weekly telephone reports during the intervention and face-to-face evaluation in the SCID protocol with a psychiatrist or clinical psychologist and in obtaining data pre- and postintervention on the Hamilton anxiety and depression rating scales) played a significant "quasi-therapeutic" role in the outcomes reported either postintervention [5] or at 3-year follow-up.

A noteworthy feature of the SR&RP intervention which may be an important factor in obtaining the positive results reported here is its orientation towards stress *per se*, rather than towards a particular diagnostic entity. This hospital-based, outpatient, behavioral medicine stress reduction clinic serves a highly heterogeneous population of medical patients who are referred to it by their physicians. Its focus is *not* on treating panic or anxiety or for that matter, any diagnostic entity, but rather on learning to deal more effectively with stress, pain and chronic illness through self-observation and the self-regulation of intrapsychic and external behaviors. The subjects in the present study were referred to the stress reduction clinic with a wide range of primary medical diagnoses including hypertension, chronic pain, cancer, heart disease, and many others, in addition to their anxiety disorder.

The nonspecific orientation of the mindfulness-based stress reduction approach differs paradigmatically from standard biomedical, psychiatric, and even behavioral medicine treatment models, which advocate as specific a treatment as possible for a specific diagnostic entity, based on as precise a diagnosis as possible. The paradigm of the SR&RP, on the other hand, reflects Hans Selye's seminal observation that there is a significant nonspecific component to "stress," which he defined as "the non-specific response of the organism to any demand" [26]. The SR&RP orients itself primarily toward those characteristics that are held in common by the highly heterogeneous population of medical patients referred to the clinic: 1) they are all suffering and feel *something* is out of control in their lives; 2) they are all referred by their doctors; 3) they have all contracted one on one with a clinic staff interviewer to enroll in the SR&RP, with the explicit understanding that it is being offered as a challenge to them to try to do something *for themselves* as a complement to what the more traditional medical and psychiatric approaches can do for them, and with the understanding that the program requires an immediate lifestyle change in the form of a daily, disciplined meditation practice; and 4) they are all, at least in principle, capable of developing and deepening what we believe to be the most important elements for achieving voluntary self-regulation of physiological and mental states, namely, attention regulation, concentration, relaxation, and insight. We have found that the nonjudgmental, moment-to-moment attentional stance directed towards various immediately observable objects of attention such as one's breathing and one's body sensations, thoughts and feelings which is characteristic of mindfulness meditation practices, is something that virtually all participants are capable of if sufficiently motivated. Moreover, cultivating this kind of attentional stance appears to be of direct relevance to the immediate inner experience of the majority of participants, independent of diagnosis or personal circumstances. Mindfulness thus serves to unify the diverse experiences and backgrounds of the program participants.

The intervention is oriented toward what is "right" with people rather than toward what is "wrong" with them and aims to nurture and strengthen innate capacities for relaxation, awareness, insight, and behavior change. The emphasis in the program is to encourage each individual to explore his or her own "inner resources" for growth and learning and healing, and to systematically cultivate mindfulness in all areas of daily life, including those times in which they find themselves confronting distressing symptoms and problems.

In the above ways, the mindfulness-based stress reduction paradigm suggests a therapeutic value in orienting nonpharmacological treatment approaches towards nonspecific attentional self-regulation. Attention and its regulation lie at the core of perception, appraisal, insight, behavior change, and coping [27], and thus are relevant for dealing with the specific and nonspecific aspects of stress reactivity in human beings, including generalized anxiety and panic.

Elsewhere [28] we have hypothesized, based on our own clinical experiences and the work of others in the field of stress reactivity, that the approach to present-moment experience characterized by mindfulness can abate or short-circuit the fight or flight reaction characteristic of the sympathetic nervous system, particularly in stressful or anxiety-producing social situations where it is nonadaptive. Mindfulness and the associated calmness, clarity, and stability of mind which are associated with it allow one to "respond" to potentially anxiety-producing situations with greater effectiveness rather than to "react" with escalating panic or fear, which invariably feeds feelings of loss of control. Many of our patients in the present study described their new-found control over feelings of panic and anxiety in such terms during their exit and follow-up interviews, and this was frequently connected with continued use of awareness of breathing in daily life situations and with the overall high ratings of importance and lasting value accorded the SR&RP (see Results).

It should be noted that the formal and informal meditation instructions themselves serve as a continuing source of reminders to practitioners of the possibility of not identifying with and getting caught up in the stress of thoughts and other mental activity that usually color present-moment experience. They encourage the practitioner to adopt a more dispassionate, witness-like observing and self-reporting of the moment by moment unfolding of one's experience. Anecdotal reports from thousands of patients in the SR&RP over the past 16 years suggest that the more one practices formally at home in times of low stress, the more likely the transfer to other in vivo situations of high stress. Mindfulness appears to give the individual a practical way to disentangle from reflexive behaviors and reactions that often have their roots in past experience.

In contrast to mindfulness training, cognitive therapy aims to restructure thought content to achieve a more accurate and adaptive relationship between thought, feeling state, and action once one becomes more aware of the inaccuracy or selfnegation of certain thoughts. Mindfulness shares with cognitive therapy the perspective that perception and thought drive emoti n and behavior and that if one changes one's relationship to thought, one can change deeply ingrained self-destructive or maladaptive patterns of behavior.

However, the mindfulness approach does not try to substitute one thought pattern for another, but is based on the direct perception of the inaccuracy, limited nature, and intrinsic impermanence of thoughts in general and anxiety-related thoughts in particular. Moreover, it is grounded as much in somatic awareness as in cognitive sensitivity, through the use of practices such as the body scan and mindful hatha yoga. In addition, the meditative approach in the SR&RP is taken up by participants as a daily discipline. It is meant to be practiced independent of one's present-moment state of anxiety. The mindfulness approach emphasizes meditation as an alternative way of relating to moment-to-moment experience, and thus, more as a "way of being" rather than as a "technique" in the narrow and usual therapeutic sense for coping with a specific problem such as panic. Other differences include that it takes place in a nonpsychiatric setting, that there is no attempt at systematic desensitization, and that the observational skills required to develop awareness of the process of thinking are themselves systematically cultivated.

A further discussion of similarities as well as salient differences between the cognitive approach and mindfulness can be found in the report of the original study [5]. For a discussion of the theoretical relationship of mindfulness meditation to cognitive science in general, see Varela et al. [29]; for its clinical as well as theoretical relationship to psychotherapy and psychoanalysis, see Epstein [30], and for its relationship to cognitive therapy and depressive relapse prevention, see Teasdale et al. [31].

In summary, within the limitations of the original study (see below) this 3-year follow-up strongly suggests the long-term effectiveness of an outpatient, time-limited, group-delivered stress reduction program based on mindfulness meditation in the treatment of DSM-III-R anxiety disorders [generalized anxiety disorder (GAD) and panic disorder with and without agoraphobia]. Mindfulness training in the context of a generic stress reduction group format may thus be able to provide medical patients suffering from anxiety and panic with a set of tools for achieving effective long-term nonpharmacological self-regulation and self-control, to be used as a complement to and/or ev tual long-term substitute for more conventio medical interventions as appropriate in the treatment of anxiety disorders.

As noted in the original report [5], the study design lacked a randomized control group for comparison and a control for concomitant treatment. These limitations do not allow us to answer definitively the question of a differential response between those undergoing the intervention in question and appropriate controls. However, the cohort of patients receiving medication showed symptom reduction equivalent to the cohort not receiving any medication and this was true at follow-up as well. As noted in [5], this suggests that the mindfulness approach may be equally useful for patients receiving pharmacotherapy and those who do not. As with treatment studies comparing imipramine and alprazolam [32,33] and a study comparing three nonpharmacological therapies [34], both GAD and panic disorder patients responded equally well to the SR&RP intervention.

However, the number of patients in these two diagnostic categories was small, and a larger, randomized study would be required to determine if the SR&RP were equally effective in each case. It does appear that patients receiving pharmacotherapy received comparable benefit to those who did not. A larger randomized study would further substantiate this preliminary observation and might also compare the relative efficacies of the mindfulness-based intervention with other cognitive and cognitive-behavioral therapies. The small number of subjects in the present study also prohibits conclusions about the relationship of outcome with frequency of meditation practice among participants at follow-up. Almost all subjects had strong positive outcomes and the large majority used either formal or informal meditative practices at follow-up. A much larger sample would be required to analyze the role of frequency of meditation practice on anxiety outcomes.

We observed parallel reductions in both anxiety and depression scales over the course of the intervention period. These changes were similar to those noted by Borkovec et al. [35]. However, the presence of comorbidity for depression in eight subjects in our study was not associated with a statistically significant difference in outcome, as it was in an early report [36]. Our finding could mean that the intervention was helpful in alleviating depressive as well as anxiety symptoms. Alternatively, it could be an artifact of the small sample size.

A Note on Cost-Effectiveness

The finding that the initial improvements in anxiety and panic were maintained at 3-year follow-up in the majority of patients in this study suggests that the mindfulness-based stress reduction intervention has the potential to be significantly cost-effective. The total cost of the SR&RP was $465 at the time the subjects went through it. As noted, the average duration of their anxiety symptoms prior to entry into the program was 6.5 years. Treatments over that time period were presumably associated with significant health care costs for those individuals receiving psychotherapy and/or medication treatments ($N = 8$). Five of these individuals discontinued treatment or sought it at reduced levels in the ensuant 3 years (see Results). These changes in health-care-seeking behavior for anxiety due to improved status (reduced anxiety, panic, and depression, and a greater sense of self-control) presumably resulted in cost savings in terms of psychotherapy, emergency visits, medication, and lost productivity. Further studies are required to explore this domain systematically.

An earlier unpublished pilot study of patients in the SR&RP suggested that it is a cost-reducing intervention for patients with chronic medical problems [37]. There is a growing body of evidence that many cognitive/behavioral, time-limited therapeutic interventions have a significant cost-effectiveness compared with more traditional medical and psychiatric interventions [38]. A larger, well-controlled study by Orme-Johnson [39] reported decreased hospital admissions, inpatient hospital days, and outpatient visits over a 5-year time period in a population of 2000 practitioners of Transcendental Meditation as compared to 600,000 members of the same insurance carrier who did not practice meditation.

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Effectiveness of a Meditation-Based Stress Reduction Program in the Treatment of Anxiety Disorders

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Objective: This study was designed to determine the effectiveness of a group stress reduction program based on mindfulness meditation for patients with anxiety disorders. Method: The 22 study participants were screened with a structured clinical interview and found to meet the DSM-III-R *criteria for generalized anxiety disorder or panic disorder with or without agoraphobia. Assessments, including self-ratings and therapists' ratings, were obtained weekly before and during the meditation-based stress reduction and relaxation program and monthly during the 3-month follow-up period. Results: Repeated measures analyses of variance documented significant reductions in anxiety and depression scores after treatment for 20 of the subjects—changes that were maintained at follow-up. The number of subjects experiencing panic symptoms was also substantially reduced. A comparison of the study subjects with a group of nonstudy participants in the program who met the initial screening criteria for entry into the study showed that both groups achieved similiar reductions in anxiety scores on the SCL-90-R and on the Medical Symptom Checklist, suggesting generalizability of the study findings. Conclusions: A group mindfulness meditation training program can effectively reduce symptoms of anxiety and panic and can help maintain these reductions in patients with generalized anxiety disorder, panic disorder, or panic disorder with agoraphobia.*

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Self-regulatory behavioral strategies, used alone or as adjuncts to other behavioral or medication regimens, may offer a unique approach to treating anxiety disorders. Three major self-regulatory strategies—meditation, relaxation, and biofeedback—are currently used in clinical practice for the treatment of anxiety. Research suggests that all three play a role in reducing both physiological and psychological components of anxiety in normal populations and that the latter two techniques are effective in anxious populations, although with variable efficacy (1–6).

The research on meditation techniques has been largely limited to nonpsychiatric populations (7). To our knowledge, there are no studies of the effectiveness of meditation for patients with anxiety disorders as delineated by *DSM-III* or *DSM-III-R* criteria (8). Two controlled studies (9, 10) used meditation for patients with anxiety neurosis as defined by *DSM-II* criteria, but both lacked standardized diagnostic procedures. There was one uncontrolled study of patients diagnosed as having anxiety neurosis (11). None of these studies used a structured clinical interview for diagnosis. All of them investigated variants of one particular type of meditation, namely, transcendental meditation, in which the practitioner focuses on a mantra—a word or phrase repeated silently to achieve a meditative state.

In general, these studies suggested that transcendental meditation may be as effective as other behavioral techniques, such as biofeedback or relaxation, in the treatment of anxiety. Another uncontrolled study (12) investigated mindfulness meditation as an adjunct to psychotherapy for patients with a wide range of psychiatric disorders, excluding schizophrenia and other psy

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choses. In that study, Kutz et al. found that according to both the patients' self-assessments and the therapists' assessments, there was moderate to marked improvement in a variety of psychological symptoms, including anxiety, from before to after treatment.

The lack of diagnostic assessment according to standardized diagnostic criteria in previous studies and the widespread practice of studying nonclinical populations (e.g., college students) limit the applicability of research findings regarding the clinical effectiveness of meditation. Moreover, the majority of the studies of the effects of meditation on anxiety have relied solely on measures of state-trait anxiety to determine outcome. Such measures do not adequately assess the presence of panic attacks or avoidance behavior and may fail to capture the complexity of clinically significant anxiety symptoms.

The present pilot study was devised to address some of the shortcomings of previous research that investigated the relation between meditation training and anxiety reduction. The study was conducted in conjunction with a well-established outpatient program for stress reduction and relaxation that involves intensive training in mindfulness meditation (13, 14), with emphasis on its practical applications in coping with stress and in enhancing adaptive health behaviors. Like other forms of meditation such as transcendental meditation, mindfulness meditation helps practitioners to cultivate greater concentration and relaxation (15). It differs specifically from transcendental meditation by training practitioners to attend to a wide range of changing objects of attention while maintaining moment-to-moment awareness (mindfulness), rather than restricting one's focus to a single object such as a mantra (16) (see the Method section for an operational definition). The choice of mindfulness as the primary meditative approach was due to its immediate applicability to a great variety of present-moment experiences. This orientation lends a quality of "ordinariness" to the intervention that makes it more acceptable and accessible to a wide range of people with different life stressors and different medical disorders (17).

The stress reduction and relaxation program serves a broad spectrum of patients with both physical and psychological disturbances (18). Previous studies have shown that participation in the program results in reductions in both physical and psychological symptoms of patients in many diagnostic categories. Chronic pain patients participating in the program reported markedly reduced levels of state anxiety (as measured with the Symptom Checklist-90-Revised) during the intervention period—levels that were maintained over a 4-year follow-up period (17, 19, 20). Similar changes were reported over a 2-year follow-up period by patients with stress-related medical disorders (Kabat-Zinn, unpublished manuscript).

The specific objectives of the present investigation were 1) to conduct a prospective outcome study, with a repeated measures design, to test the efficacy of treating patients diagnosed with anxiety disorders according to *DSM-III-R* criteria in a well-established, meditation-based outpatient stress reduction program and 2) to examine whether variables at intake were predictive of outcome at follow-up.

METHOD

Potential subjects were selected from among all patients referred to the stress reduction and relaxation program in two consecutive cycles (spring and fall of 1988). The Symptom Checklist-90-Revised (SCL-90-R) (21) and the Medical Symptom Checklist (17) were administered to all patients referred to the program, as part of the intake evaluation. Those who scored above the 70th percentile on the anxiety subscale of the SCL-90-R and reported more than 10 anxiety-related symptoms (out of 37 possible symptoms) on the Medical Symptom Checklist were invited to take part in a formal screening interview to assess their appropriateness for inclusion in the study. A referral diagnosis of panic attacks or anxiety also qualified an individual to be invited to participate in the screening procedure for the study. Patients who met the study criteria and who agreed to participate were then interviewed by either a psychologist or a psychiatrist trained in administering the Structured Clinical Interview for DSM-III-R (SCID) (22). Diagnoses were determined after review of the SCID data by the two psychologists (J.K. and L.P.) and two psychiatrists (A.O.M. and L.G.P.) who conducted the individual screening evaluations. Only the patients who met the formal diagnostic criteria for generalized anxiety disorder or panic disorder with or without agoraphobia were included in the study. Individuals were excluded if they had other primary psychiatric diagnoses, any disorder with psychotic symptoms, any endocrine disorder, or significant current alcohol or substance abuse. Because of the small sample size and the pilot nature of the study, patients taking anxiolytic or other medications (N=12) were not excluded. Medication type and usage were assessed for all patients during the study.

In the two cycles of the program from which patients were recruited for this study, 192 (60%) of 321 patients satisfied the initial screening criteria of the SCL-90-R and the Medical Symptom Checklist. However, for logistical reasons and because this was a pilot study, only 44 patients were invited to undergo further screening, of whom 32 completed the evaluation. Of these, 24 met the *DSM-III-R* criteria for generalized anxiety disorder or panic disorder with or without agoraphobia according to the SCID. Of the eight excluded patients, four had other primary psychiatric diagnoses and four had no psychiatric disorder. Two of the 24 subjects did not complete the program and were not included in the analysis of outcome. Both of these individuals had psychiatric diagnoses of generalized anxiety disorder.

Because of the exploratory nature of the study, we used a repeated measures design with patients serving as their own controls on multiple pretreatment and posttreatment measures. In addition, study participants were compared on the SCL-90-R and Medical Symptom Checklist with other patients who met the initial screening criteria and were enrolled in the stress reduction and relaxation program during the same time period but who were not invited to take part in the study. This second group of patients (termed "nonstudy participants") received the same meditation intervention but did not undergo screening or the weekly assessments that the study subjects underwent.

Subjects who met the diagnostic criteria and agreed to participate in the study were evaluated with both self-rating scales and ratings of trained interviewers. Data on the following measures were gathered by telephone interview at weekly intervals from the time of recruitment through the end of treatment and at monthly intervals for 3 months after treatment: the Beck Anxiety Inventory (used by special permission of Jeffrey Sugerman, Ph.D., Psychological Corp., personal communication), the Beck Depression Inventory (23), and ratings of the frequency and severity of panic attacks. The length of time between recruitment and the start of treatment in which data were collected varied according to when subjects were recruited into the study relative to the beginning of the program (range=1–8 weeks).

In addition to these assessments, a more extensive assessment battery was administered four times: at recruitment into the study, at the start of the program (pretreatment), at completion of the program (posttreatment), and at 3-month follow-up. This battery consisted of the Hamilton Rating Scale for Anxiety (24) (as modified by DiNardo and Barlow [25] to include a separate rating scale for symptoms present during panic attacks, yielding the Hamilton panic score), the Hamilton Rating Scale for Depression (26), the Fear Survey Schedule (27), and the Mobility Inventory for Agoraphobia (28). At recruitment patients were also asked to rate on a 5-point scale their expectancy of improvement due to the treatment. A compliance questionnaire was administered at the end of treatment and at follow-up. Eight subjects entered the study so close to the beginning of the treatment intervention that only pretreatment, posttreatment, and follow-up measures were obtained.

The Hamilton anxiety and depression rating scales were administered at recruitment by the same clinicians who administered the SCID. Subsequent Hamilton assessments were administered to all subjects by one trained interviewer. To minimize bias in data collection related to expectancy of change, scoring was done after all data were collected.

The stress reduction and relaxation program is a highly structured training program in mindfulness meditation and its applications, described in detail elsewhere (14, 17–20). It takes the form of an 8-week-long course in which participants attend weekly 2-hour classes and, in addition, a 7.5-hour intensive and mostly silent "meditation retreat" session in the sixth week. During each 8-week cycle, five separate but parallel classes are offered. Each is led by one instructor who stays with that group for the duration of the course. Each class has approximately 30 participants with a wide range of medical and psychological disorders. During classes and for homework, participants practice a range of different formal and informal meditation techniques (14, 17). These experiences are discussed weekly in the classes. The 22 subjects in this study were distributed among five of the 10 classes held during that period. The exposure of these subjects differed from that of the remainder of the program participants only in their involvement in the additional assessment protocol required for the study. Four program instructors conducted classes in this study. The instructors did not know which patients were in the study, nor did they know the patients' *DSM-III-R* diagnoses.

We used repeated measures analysis of variance (ANOVA) to compare the recruitment, pretreatment, posttreatment, and 3-month follow-up scores of the subjects for whom all data points were available, with computation of appropriate contrasts. Matched t tests were used to calculate intervention effects between the pretreatment and posttreatment assessments for the entire sample. Intergroup comparisons of compliance and expectancy measures were done with standard t tests. Variables expected to predict outcome were studied with ANOVA. We plotted the weekly scores of all subjects to examine the course of change, but formal single-subject analyses are not included in this report because of the consistency and strength of the group effects. In addition, after accounting for pretreatment scores with the regression technique described by Cohen and Cohen (29), we compared posttreatment scores of the subjects receiving medication with those of the subjects taking no medication. Finally, we used t tests to compare the study participants and nonstudy participants in the program on pretreatment and posttreatment SCL-90-R scores, Medical Symptom Checklist scores, and change scores.

RESULTS

Of the 22 study participants who completed the program, 10 had panic disorder with agoraphobia, four had panic disorder without agoraphobia, and eight had generalized anxiety disorder as the primary psychiatric diagnosis. Seventeen subjects had more than one psychiatric diagnosis; 14 had other anxiety disorders and eight had diagnoses of major depressive episode (six concurrent). The average duration of their anxiety disorders was 6.5 years (range=3 months to 28 years). Eleven patients were taking medication for their anxiety disorders at intake, and 11 were taking no medication for anxiety.

The subjects' ages ranged from 26 to 64 years, with an average of 38 years. There were five men and 17 women. Eighteen of the subjects were married, two were single, and one was separated (data on one subject were missing).

The recruitment and pretreatment scores on the Ham-

TABLE 1. Scores on Outcome Measures Over Time of Patients With Anxiety Disorders in a Study of a Meditation-Based Stress Reduction Program

		Initial Recruitment		Pretreatment		Posttreatment		3-Month Follow-Up		Repeated Measures ANOVA		
Measure	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	df	p
Hamilton Rating Scale for Anxiety	14	30.36	8.53	26.93	11.13	17.86	9.18	15.86	8.65	21.1	3, 39	<0.001[a]
Hamilton Rating Scale for Depression	14	33.07	7.98	31.07	8.43	23.71	5.59	25.14	7.01	8.87	3, 39	<0.001[a]
Beck Anxiety Inventory	15	24.13	13.49	20.53	13.24	9.00	9.14	7.93	7.29	15.36	3, 42	<0.001[a]
Beck Depression Inventory	15	18.87	10.37	16.47	10.97	10.00	9.58	7.53	8.77	9.96	3, 42	<0.001[a,b]
Fear Survey Schedule	11	118.73	41.31	93.55	34.09	78.46	44.28	66.82	38.68	9.79	3, 30	<0.001[c,d]
Mobility Inventory for Agoraphobia												
Accompanied	10	45.80	16.22	41.30	16.81	36.40	12.02	36.70	13.52	4.05	3, 27	<0.05[e]
Unaccompanied	10	61.80	24.40	53.50	24.09	45.50	17.19	46.20	18.87	6.62	3, 27	<0.01[c,e]

[a]Significant change from pretreatment to posttreatment ($p<0.01$).
[b]Trend for significant change from posttreatment to follow-up ($p<0.10$).
[c]Significant change from recruitment to pretreatment ($p<0.05$).
[d]Significant change from posttreatment to follow-up ($p<0.05$).
[e]Trend for significant change from pretreatment to posttreatment ($p<0.10$).

ilton Rating Scale for Anxiety, the Hamilton Rating Scale for Depression, the Beck Anxiety Inventory, the Beck Depression Inventory, the Fear Survey Schedule, and the Mobility Inventory for Agoraphobia of the subjects with complete data at the four primary assessment points are shown in table 1. They were in the moderate to severe range on both the Beck and the Hamilton anxiety scales and in the mild to moderate range on the Beck and Hamilton depression scales.

At recruitment, nine individuals reported one or more panic attacks in the previous week (range=1–3), with a mean Hamilton panic score of 26.11 (SD=11.25, range=6–40). At pretreatment assessment, 13 individuals reported at least one panic attack in the previous week (range=1–2), with a mean Hamilton panic score of 24.46 (SD=8.71, range=11–34). At pretreatment the mean SCL-90-R general severity index score of the 22 subjects was 1.10 (SD=0.70, range=0–3) and the mean SCL-90-R anxiety score was 1.61 (SD=1.05, range=0–3).

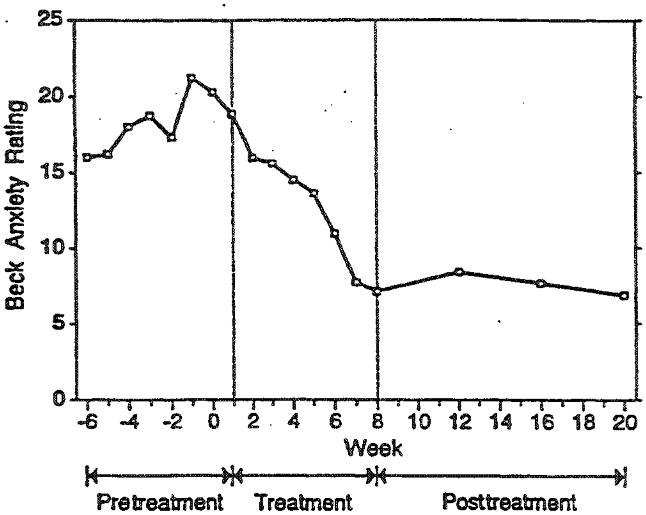
Repeated measures ANOVA indicated that among subjects for whom scores at all four primary assessment points were available, the Hamilton and Beck anxiety and depression scale scores showed small, statistically nonsignificant reductions from baseline to pretreatment, highly significant decreases over the course of the intervention (pretreatment to posttreatment), and maintenance of these changes from posttreatment to follow-up (table 1). Comparisons with matched t tests at pretreatment and posttreatment time points for all subjects, not just those with complete data at all time points, showed comparable results, with mean pretreatment and posttreatment scores, respectively, of 25.86 (SD=10.56) and 17.10 (SD=9.31) on the Hamilton anxiety scale ($t=5.18$, $df=20$, $p<0.001$) and 30.85 (SD=8.81) and 23.85 (SD=6.65) on the Hamilton depression scale ($t=4.88$, $df=19$, $p<0.001$). Mean pretreatment and posttreatment scores, respectively, were 20.32 (SD=12.05) and 7.09 (SD=8.20) on the Beck Anxiety Inventory ($t=6.14$, $df=21$, $p<0.001$) and 16.18 (SD=10.33) and 8.18 (SD=8.53) on the Beck Depression Inventory ($t=4.65$, $df=21$, $p<0.001$). These represented mean reductions of 34%, 23%, 65%, and 49%, respectively, on the four scales. Twenty of the 22 subjects showed marked improvement in scores on the Beck and Hamilton anxiety and depression scales.

The means of the subjects' weekly ratings of anxiety and depression on the respective Beck scales are presented in figures 1 and 2. These show elevated levels before treatment, a significant decline during treatment to a relatively low level by the end of treatment, and maintenance of the lower posttreatment level over 3 months of follow-up. Scores for "accompanied" on the Mobility Inventory for Agoraphobia showed a similar pattern of improvement. However, scores for "unaccompanied" on that inventory and scores on the Fear Survey Schedule improved as much from recruitment to pretreatment assessment as from pretreatment to posttreatment assessment (table 1).

Of the 13 patients who reported at least one panic attack in the preceding week at pretreatment assessment, five reported one panic attack in the previous week at posttreatment assessment (mean Hamilton panic score=22.0, SD=8.40, range=13–34). At 3-month follow-up, three of the original 13 patients reported one attack in the previous week (mean Hamilton panic score=18.0, SD=6.24, range=11–23). This was a statistically significant decrease in the number of individuals reporting panic attacks from pretreatment to posttreatment to follow-up assessment (Cochran's $Q=14.60$, $df=2$, $p<0.001$, $N=20$). Within this group, the individuals whose primary psychiatric diagnosis was panic disorder with or without agoraphobia also showed a statistically significant linear decrease from pretreatment to posttreatment to follow-up (Cochran's $Q=12.67$, $df=2$, $p<0.005$, $N=13$).

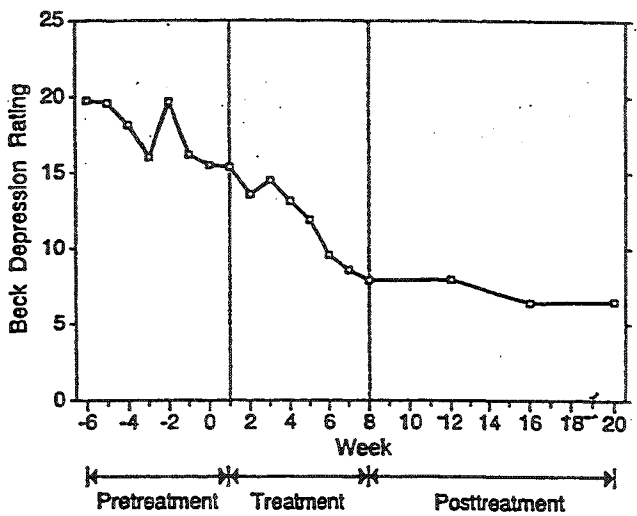
In both groups there was a significant decline in Hamilton panic scores between pretreatment and posttreatment assessments. For the subjects who reported at least one panic attack at pretreatment assessment (N=13), the mean pretreatment Hamilton panic score was 24.46 (SD=8.71) and the mean posttreatment Hamilton panic score was 8.46 (SD=12.15) ($t=4.75$, $df=12$, $p<0.001$). For the panic disorder subset (N=11), the mean pretreatment Hamilton panic score was 24.64

FIGURE 1. Mean Beck Anxiety Inventory Ratings Before, During, and After Treatment of Patients in a Meditation-Based Stress Reduction Program[a]



[a]The numbers of subjects for successive assessments were as follows: pretreatment, 4, 5, 7, 11, 12, 16, 21; treatment, 20, 22, 22, 21, 22, 21, 21, 19; posttreatment, 21, 19, 21.

FIGURE 2. Mean Beck Depression Inventory Ratings Before, During, and After Treatment of Patients in a Meditation-Based Stress Reduction Program[a]



[a]The numbers of subjects for successive assessments were as follows: pretreatment, 4, 5, 7, 11, 12, 17, 21; treatment, 20, 22, 21, 21, 22, 21, 22, 19; posttreatment, 21, 20, 21.

(SD=8.30) and the mean posttreatment Hamilton panic score was 8.36 (SD=12.68) ($t=4.07$, $df=10$, $p<0.005$). The mean number of panic attacks registered on the Hamilton anxiety scale and their severity also declined significantly between pretreatment and posttreatment assessments in both groups, and these declines were maintained at 3-month follow-up (data not shown).

The pretreatment and posttreatment scores of the subjects receiving psychotropic medication did not differ significantly from those of the subjects not receiving medication during the study. Twelve patients were taking medication for anxiety before treatment and 13 after treatment; 11 were taking medication at follow-up. Two patients were able to decrease their use of medication between the posttreatment and follow-up assessments, and one increased the use of medication during the same period.

The pretreatment and posttreatment scores on the SCL-90-R and the Medical Symptom Checklist of the study participants in the stress reduction and relaxation program were compared with the scores on these scales of the nonstudy participants in the program who had met the initial screening criteria for the study to assess possible biasing effects from the more intense assessment protocol on the study participants. As can be seen in table 2, the mean pretreatment and posttreatment scores on the total Medical Symptom Checklist, the anxiety items of the Medical Symptom Checklist, the general severity index of the SCL-90-R, and the anxiety subscale of the SCL-90-R for the 22 subjects in the study were comparable to those of the nonstudy participants in the program. The two groups showed statistically significant and equivalent symptom reduction on these measures over the intervention period.

When changes from before to after treatment in anxiety scores and in the number of panic attacks were examined on an individual basis, 20 of the 22 study subjects showed marked improvement (only one patient still had a score over 20 on the Beck Anxiety Inventory after treatment), making it difficult to examine predictors of differential outcome. Consistent with this uniformity of response, no demographic or baseline variables were significantly predictive of outcome. Expectancy ratings also failed to serve as a meaningful predictor of outcome. Self-reported amount of practice (compliance) was also not significantly correlated with any outcome measure. Furthermore, there were no statistically significant differences in outcome between patients with generalized anxiety disorder and those with panic disorder with or without agoraphobia, nor was the diagnosis of major depressive episode associated with outcome.

Adherence to the meditation practices taught in the stress reduction and relaxation program was assessed at 3-month follow-up. In response to the question "Have you been keeping up practice of the stress reduction techniques?" 91% (20 of the 22 subjects) replied in the affirmative, with a relatively homogeneous distribution between single meditation techniques and combinations of methods. Eighty-four percent (N=16) of the 19 who responded to this item were practicing formally three or more times per week; 42% (N=8) were practicing for 45 minutes or more at a time, 16% (N=3) for between 30 and 45 minutes at a time, and 37% (N=7) for between 15 and 30 minutes at a time. Twenty-one subjects reported continued use of mindfulness of breathing (an informal mindfulness practice) in their daily lives, with 77% (N=17) using it "often" and 18% (N=4) using it "sometimes."

DISCUSSION

The rate of completion of the program among the study subjects was high (22 of 24 subjects, or 92%), consistent with previous studies of the stress reduction and relaxation program (18). Twenty of 22 subjects showed marked improvement in both anxiety and depression after the intervention. This improvement was maintained at 3-month follow-up. Improvement was observed both in patients' self-ratings (Beck anxiety and depression scales) and in interviewers' ratings (Hamilton anxiety and depression scales).

Of considerable importance is the statistically significant reduction from pretreatment assessment to posttreatment assessment in the number of subjects reporting one or more panic attacks, an improvement that was maintained at follow-up. There was a statistically nonsignificant tendency for the Hamilton panic scores to decrease between pretreatment and follow-up, suggesting that for the subjects who continued to have panic attacks during and after the intervention, the severity of those attacks declined.

Fear survey and mobility inventory scores also improved significantly, but these changes began during the pretreatment period, suggesting both an effect of the general expectancy of participation and an effect of the exposure to a therapeutic milieu during the evaluation visits.

The uniformly positive response to treatment among the subjects in this small study precluded a successful analysis of predictors of outcome. Compliance was also uniformly reported as moderate to high, indicative of the subjects' positive response to the intervention approach and the successful adoption of a range of new behaviors, including both formal and informal meditation practice.

A major strength of this study was the careful diagnostic assessment procedure we used to obtain *DSM-III-R* diagnoses. Previous studies investigated the use of meditation with normal populations or populations identified by using only nondiagnostic criteria. Such studies may therefore have included patients who would not have met the *DSM-III-R* criteria for generalized anxiety disorder or panic disorders. The results of this study, which focused specifically on patients with generalized anxiety disorder or panic with or without agoraphobia, suggest that mindfulness meditation used in a group format may be a useful treatment approach for these diagnostic groups.

It is also clear that the improvements in panic and anxiety which we observed cannot be attributed solely to participation in the study itself. This is established by the comparison showing that the subjects who participated in the study and the patients in the stress reduction program who met the screening criteria but were not subjected to the intensive research protocol achieved similar reductions in anxiety scores on the SCL-90-R and the Medical Symptom Checklist. This comparison also demonstrates that the results obtained with the study subjects are very likely generalizable to the much larger group of patients who met the initial criteria for the study.

Pretreatment and Posttreatment Scores of Patients With Anxiety Disorders in a Study of a Meditation-Based Stress Reduction Program Compared With Scores of Nonstudy Participants in the Program Who Met Initial Screening Criteria for the Study[a]

Measure	Study Participants in Program: N	Mean	SD	Nonstudy Participants in Program: N	Mean	SD
Medical Symptom Checklist	21			99		
Total score						
Pretreatment		32.05	13.33		30.97	11.55
Posttreatment		23.10	17.75		19.59	12.66
Anxiety score[b]						
Pretreatment		16.95	0.51		15.96	4.67
Posttreatment		11.10	8.50		10.17	5.53
SCL-90-R	20			97		
General severity index score						
Pretreatment		1.08	0.73		1.03	0.56
Posttreatment		0.60	0.54		0.62	0.45
Anxiety subscale score						
Pretreatment		1.56	1.08		1.27	0.79
Posttreatment		0.69	0.68		0.70	0.62

[a]All within-group differences between pretreatment and posttreatment scores were significant ($p<0.05$) in the two-tailed paired t tests. None of the pretreatment scores differed significantly between study participants and nonstudy participants in the unpaired t tests, except on the anxiety subscale of the SCL-90-R, for which $p=0.05$.

[b]Mean number of symptoms out of the 37 identified as characteristic of patients with anxiety disorders.

The strong reductions in panic symptoms and frequency of panic attacks observed in this study are consistent with the cognitive model of panic (30) and with clinical outcomes from studies of panic disorder in which well-established cognitive (31) and cognitive-behavioral (32) intervention approaches were used. The meditative approach used in the stress reduction and relaxation program shares some attributes with both cognitive and behavioral therapeutic approaches used to treat anxiety and panic. It also differs structurally and theoretically from them in a number of noteworthy respects, as has been noted in a different context by others (33, 34).

In particular, the meditative, cognitive, and cognitive-behavioral approaches share an emphasis on noting sensations and thoughts without viewing them as catastrophic and the use of stress-inducing situations as cues to engage in new behaviors. They also have in common the use of homework assignments to reinforce what was learned in the group sessions. However, the stress reduction and relaxation program differs from cognitive and cognitive-behavioral models in the following important respects.

1. Emphasis is not placed on distinguishing thoughts as positive, negative, or faulty, as in cognitive therapy. Rather, the emphasis is on identifying thoughts as "just" thoughts and acknowledging the potential inaccuracy and limits of all thought, not just thoughts that produce anxiety. This attitude is cultivated in the peri-

ods of formal meditation practice, as well as in informal mindfulness practiced in the course of daily activity.

2. The formal meditation is taught as a daily discipline to be practiced regularly, independent of one's state of anxiety. The emphasis is on meditation as a way of being, as a way of living one's life, and as a way to develop alternative "generic" strategies for coping with stress and pain, rather than as a technique for coping with a specific problem such as panic.

3. The intervention takes place in a nonpsychiatric medical setting with a heterogeneous group of patients who have a wide range of medical and psychological problems. This is a significant departure from the model of cognitive-behavioral therapy, which is typically provided to individuals or groups of patients with a single disorder. Moreover, the focus of the intervention is on the meditation practice itself rather than on a specific disorder or diagnosis or constellation of symptoms.

4. Unlike Barlow's cognitive-behavioral approach, in which subjects are systematically exposed through specific induction exercises to feared internal sensations associated with panic, such as cardiovascular symptoms, hyperventilation, dizziness, and chest muscle tightness (35), there is no attempt at systematic desensitization through the induction of symptoms of any kind during the stress reduction and relaxation program. Although stressful or anxiety-related symptoms are not intentionally evoked, when these experiences arise, either during formal meditation or in the course of daily living, patients are encouraged to see them as opportunities to engage in mindful coping strategies as an alternative to more habitual patterns of emotional reactivity. In this respect, the program utilizes a cognitive restructuring that overlaps with other cognitive and cognitive-behavioral approaches.

5. The observational skills cultivated through mindfulness training differ substantially from those developed by behavioral monitoring techniques. Participants in the program are trained initially to develop concentration (one-pointed attention) through systematic and continued focusing on a restricted field of observation such as breathing or proprioception. Concentration lends stability to one's capacity to observe fearful thoughts and feelings in a nonreactive way. Coupled with mindfulness, concentration gives rise to a nondiscursive, nonanalytical, direct experiencing of the object of attention. This is in contrast to the external data gathering involved in behavioral analysis of antecedents and consequences.

Patients who are able to identify anxious thoughts as *thoughts,* rather than as "reality," report that this alone helps reduce their anxiety and increases their ability to encounter anxiety-producing situations more effectively. The insight that one is not one's thoughts means that one has a potential range of responses to a given thought if one is able to identify it as such. This increased range of options is associated with a feeling of control. It might be hypothesized that this is a feature of a cognitive pathway explaining the clinical observations in this study.

With regard to treatment validation, it should be noted that the duration of meditation practice in the weekly classes becomes incrementally longer over the course of the intervention. By the eighth week, most patients sit in silence in class, with little overt movement for periods of up to 45 minutes. This is a profound behavior change for most patients with panic disorder or anxiety. Such extended periods of stillness serve as an observable behavioral indicator of an individual's increasing ability to concentrate and achieve a degree of calmness over the intervention period. The all-day silent intensive session in the sixth week of the program, involving over 150 patients in one large room, is also an empirical indicator of the development of new behavior. It can be a substantial challenge for patients with panic disorder to sit still for long periods of time, attempting to observe anxious thoughts and impulses as they arise and working with them mindfully rather than succumbing to impulses of reactivity and panic.

A salient limitation of this pilot study is that it did not have a randomly selected comparison group. It also lacked a control for concomitant treatment. However, the group of patients receiving medication showed symptom reduction equivalent to that of the group not receiving any medication, a finding which suggests that the mindfulness approach may be equally useful for patients who receive pharmacotherapy and those who do not. As in treatment studies comparing imipramine and alprazolam (36, 37) and a study of nonpharmacological therapies (6), patients with generalized anxiety disorder and patients with panic disorder responded equally well to the program intervention. However, the number of patients in these two diagnostic categories was small, and a larger, randomized study would be required to determine whether the stress reduction and relaxation program is equally effective in each case or in the case of patients who are receiving pharmacotherapy compared with those who are not. A larger randomized study would also be valuable for comparing the mindfulness-based intervention with other cognitive and cognitive-behavioral therapies.

We observed parallel changes in anxiety and depression scale scores after the meditation program that were similar to those noted by Borkovec et al. (5). However, the presence of comorbid depression in eight subjects in our study was not associated with a statistically significant difference in outcome, as was previously reported (38). This result could mean that the intervention was helpful in alleviating depressive as well as anxiety symptoms. Alternatively, it could have been an artifact of the small size of the study group.

In summary, this pilot study of the efficacy of training in mindfulness meditation in the context of a group stress reduction clinic for medical outpatients showed statistically and clinically significant reductions in symptoms of anxiety and depression in patients with the three core anxiety disorders (generalized anxiety disorder, panic disorder, and panic disorder with agoraphobia) diagnosed according to the *DSM-III-R* criteria. These changes appeared to be independent of participation in the research protocol and were maintained at 3-month follow-up.

ADDENDUM

A recently completed long-term follow-up conducted with 18 of the 22 subjects in this study found that after 3 years, the 3-month follow-up levels of anxiety and depression reported here had been maintained.

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Compliance with an Outpatient Stress Reduction Program: Rates and Predictors of Program Completion

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The rate at which medical patients physician-referred to an 8-week stress reduction program completed the prescribed intervention was measured and predictors of compliance sought. Seven hundred eighty-four consecutive patients who enrolled in the program over a 2-year period were studied. Of these, 598 (76%) completed the program and 186 (24%) did not. Multiple regression analysis showed that (1) among chronic pain patients, only sex discriminated between completers and noncompleters, with females more than twice as likely to complete the program as males (odds ratio = 2.4; 95% CI = 1.2, 4.4); (2) among patients with stress-related disorders, only the OC scores of the SCL-90-R discriminated between completers and noncompleters (odds ratio = 2.0; 95% CI = 1.2, 3.4). Completion rates for specific diagnoses are reported and discussed. The high rate of completion observed for this intensive program in health behavior change is discussed in terms of the design features and therapeutic modalities of the intervention.

KEY WORDS: compliance; stress; pain; meditation.

INTRODUCTION

Medical patients are now routinely referred by their physicians to behavioral medicine clinics for modification of maladaptive health behaviors

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and training in relaxation techniques and coping skills. Yet to date there is little information in the literature about the success of such clinics in keeping their clients engaged in the therapeutic intervention from beginning to end. The present study sought to remedy this dearth of information by determining the program completion rate for a hospital-based outpatient Stress Reduction and Relaxation Program (SR&RP) over a 2-year period. In this study, completion of the 8-week-long group intervention served as the operational definition of compliance.[3]

The study was carried out because information about patient compliance with physician referral to clinical programs for cognitive and behavioral change can be important in evaluating the acceptability of such programs as well as their clinical effectiveness. This study also sought to identify possible predictors of program completion for this behavioral intervention.

The study population was a largely unselected sample of medical patients routinely referred by their physicians for stress reduction training. While many programs oriented toward achieving health behavior change include an elaborate selection of subjects prior to intervention, the SR&RP does not. Stringent patient selection may significantly reduce problems with high dropout rates in behavioral group interventions and may also contribute to a higher proportion of individuals who achieve a successful outcome. However, stringent selection for behavioral interventions may also exclude just those individuals who are most in need of intervention. Therefore, it is important from a clinical standpoint to report completion rates for a behavioral intervention that has a large base of referring physicians and relatively nonselective criteria for enrollment.

In addition to determining the rate at which all enrolled patients completed the SR&RP over a 2-year period, this study also analyzed the rates of program completion for two major groupings of the patients into stress-related and pain-related referrals and by specific diagnosis. It then compared the noncompleters with the program completers to identify possible predictors of program completion based on demographic information and measures of physical and psychological status.

The SR&RP is a well-documented intervention which has been shown in a number of studies to lead to clinically significant symptom reduction and improved coping in the large majority of the patients who complete it (Kabat-Zinn and Burney, 1981; Kabat-Zinn, 1982; Kabat-Zinn *et al.*, 1985, 1986a,b). It has also been shown that the clinical improvements obtained during the intervention were maintained by the patients with chronic pain

[3]Strictly speaking, "adherence" is the preferred term in the context of this work since "compliance" connotes a degree of coercion. Some authors use compliance to describe only the initial behavioral response to a clinical prescription (see Kristeller and Rodin, 1984). However, compliance has become so much the dominant term in the literature that its use in the present context appears warranted (Haynes, 1979).

conditions for up to 4 years following the intervention (Kabat-Zinn *et al.*, 1986a) and by the patients with stress-related medical disorders for up to 2 years (Kabat-Zinn *et al.*, 1986b). Previous studies also suggested that among the patients who completed the intervention, those who continued to use the techniques they had learned during the intervention period with the greatest regularity had the best outcomes in terms of overall improvement at follow-up (Kabat-Zinn *et al.*, 1986a).

The present study is of additional interest because the intervention involved rigorous training in mindfulness meditation techniques as the major self-regulatory modality. Mindfulness is a form of meditation which derives primarily from Buddhist traditions (Thera, 1962; Goleman, 1977; Hanh, 1975; Kabat-Zinn, 1982) in which the practitioner intentionally regulates attention to achieve a state of detached moment-to-moment awareness. The field of awareness may include at various times proprioceptive input, sense perceptions, cognitions, emotions, and situational factors. The practitioner attempts to maintain (1) stability of attention as the objects of attention change over time and (2) a nonjudgmental awareness of present-moment experience.

The practice of mindfulness meditation involves a formal meditative discipline and an informal practice of moment to moment awareness in daily life. Both aspects were emphasized in the training of patients in the SR&RP. Mindfulness differs from the more familiar transcendential meditation (TM) and from the more generic "relaxation response" as described by Benson (1975) by emphasizing flexibility as well as stability of attention. Thus, a disturbing thought, which be considered a distraction from the central focus of attention (the mantra) in TM could itself become the object of meditative attention in mindfulness meditation. Yet mindfulness practice satisfies the criteria described by Benson (1975) for inducing the relaxation response.

In the context of cognitive-behavioral interventions for stress reduction, mindfulness may be a particularly appropriate and effective strategy to apply to the management of stress in daily-life situations because of its emphasis on incorporating any event or experience one may have into the field of present moment awareness (Kabat-Zinn, 1982). The present study is thus of additional interest as a measure of the acceptability to patients of an intervention based on training in mindfulness meditation in the context of a routine medical referral for stress reduction.

METHODS

Program

The SR&RP is an outpatient behavioral medicine clinic in the form of an 8-week course. Patients were required to attend a 2-hr class once a week with approximately 30 other patients. The course actively involved patients in learning and practicing meditation-based cognitive and behavioral methods to improve their health and their ability to cope effectively with stress. The program involved relatively intensive training in mindfulness meditation and yoga (requirements for participation listed below) within an overall context of self-awareness and health promotion (Kabat-Zinn, 1982; Kabat-Zinn *et al.*, 1985). All prospective participants were first evaluated in an hour-long individual session prior to enrollment in the program. In these sessions relevant medical and psychosocial histories were obtained, as well as baseline measures of physical and psychological symptoms. The patients were also given the opportunity to discuss their individual situations and life stresses in detail. The program was then described to them. Patients who decided to enroll in the program explicitly agreed to the following course requirements.

(1) To attend weekly classes at the hospital for 8 consecutive weeks.

(2) To practice as "homework" the meditation and the yoga for 45 min per day, 6 days per week, during the 8 weeks of the program. Three major formal meditation techniques were employed, a body scan, sitting meditation, and Hatha Yoga. The yoga was explicitly practiced as a form of mindfulness meditation (for details see Kabat-Zinn, 1982; Kabat-Zinn *et al.*, 1986c). The meditation and yoga homework assignments were practiced for an uninterrupted 45-min period. Patients were told that they would be given two audiocassette tapes for use at home to asist them with the techniques during most of the course and that they would be asked to practice the techniques on their won without the tapes in the later weeks of the program. Subjects who were physically unable to do the yoga because of pain or disability were instructed to practice just the meditation techniques.

(3) To record the results of simple awareness exercises in a workbook (15 min/day).

(4) To attend an 8-hr intensive session on a Saturday in the sixth week of the program. This session took the form of a meditation "retreat" in which over 100 SR&RP participants practiced the meditation and the yoga in silence for 7 hr under the direction of the SR&RP instructors.

Subject Selection

Ninety-two percent of the subjects in this study were referred to the SR&RP by physicians. Eight percent were referred by other providers, primarily clinical psychologists. The degree to which patients were selected by the providers for referral to the SR&RP is unknown in this study and is under current investigation (see Discussion). However, the intake evaluation interview conducted by the SR&RP staff seldom resulted in exclusion of a referred subject. Patients were not enrolled if they were actively suicidal or psychotic. Such presentations occurred at a frequency of less than 1% of the subjects interviewed. In general, referred individuals were encouraged by the SR&RP staff to decide for themselves whether they wished to pursue the program once they understood the degree of personal commitment and involvement the program required as described to them during the evaluation session. No attempt was made by the staff to "sell" the program to the patients or to convince them that they should enroll. At this stage, 9.8% of those interviewed did not enroll in the program, usually because they decided it was not appropriate.

Subjects

The attendance behavior of every patient referred to eight consecutive "cycles" of the SR&RP conducted between January 1982 and June 1984 was documented so that an absolute rate of program completion for the entire population of referrals and not just those who subsequently enrolled could be obtained. During this time period, a total of 1155 patients was referred to the SR&RP by 476 physicians and 25 other providers.[4] Patients were contacted by telephone following receipt of the referral, sometimes with a lag time of 2 to 3 months.[5] Interested individuals were scheduled for an intake evaluation interview. When an individual declined to come in for the evaluation, the reason given was recorded.

Fifty-four percent of the patients who enrolled in the SR&RP were referred from within the University of Massachusetts Medical Center by physicians from a broad range of clinical specialty areas: 18% were referred from the primary care clinic, 7% from the pain clinic, 6% from cardiology, 10% from other medical specialties clinics, 2% from orthopedics, 8% from neurology, and 3% from psychiatry. Thirty-eight percent of the patients were referred by physicians in private practice or from other hospitals.

The enrolled patients had a wide range of medical diagnoses (Table I). They all underwent the intervention in classes which were heterogeneous in terms of diagnosis. However, in the data analysis, subjects were grouped by diagnosis into two major cohorts, those with chronic pain conditions and

[4]A small number of patients (estimated at 10%) requested the referral to the SR&RP from their physicians. These individuals may have differed from the majority in terms of motivation to complete the program. This aspect of patient behavior is under current investigation.

[5]This delay was due to the organization of the intervention process into cycles. Thus a patient referred once an 8-week cycle had begun may have waited up to 4 months to begin in the next cycle. They were usually informed by their physicians about this lag between being referred and being contacted by the program staff to set up an appointment.

Table I. Frequency Distribution of Patients Among Pain and Stress Cohorts and Individual Diagnostic Categories

	N	%
Pain cohort	215	27.4
Lower back pain	66	8.4
Headache/face pain	81	10.3
Neck/shoulder	17	2.2
Chest	9	1.1
Abdominal	12	1.5
Upper extremity pain	3	0.4
Lower extremity pain	9	1.1
Total body pain	11	1.4
Upper back pain	7	.9
Stress cohort	569	72.6
Hypertension	70	8.9
Heart attack/CAD[a]	35	4.5
Anxiety with functional somatic complaints[b]	314	40.1
GI disorders	47	6.0
Sleep disorders	9	1.1
Headache < 6 months	9	1.1
Cancer	20	2.6
Diabetes	2	.3
Other[c]	63	8.0

[a]Cardiac patients referred because of a heart attack or coronary artery disease (CAD) documented by angiography.

[b]Included a range of disorders and complaints including hyperventilation syndrome, palpitations, and anxiety accompanied by physical symptoms.

[c]Included skin eruptions, allergy, voice problems, premenstrual syndrome, Parkinsonism, epilepsy, narcolepsy, lupus, and depression.

those with other presenting complaints. The latter consisted of a wide range of medical problems and disorders which were grouped together under a "stress" classification since the major intention for referral to the SR&RP in these cases was for relaxation training and help with developing appropriate stress coping strategies. The chronic pain cohort was defined by a referral for a pain problem of greater than 6 months' duration. Thus, subjects with a headache history of greater than 6 months were included in this cohort, but those referred for headaches of recent onset (i.e., less than 6 months) were included in the stress cohort. The 20 patients with cancer in this study were included in the stress cohort as well because adjustment to illness rather than pain was the major reason for the referral in these cases.

Table II. Distribution of Diagnostic Groupings by Gender[a]

	Males		Females	
Diagnostic category	N	%	N	%
Low back pain	26	39.4	40	60.6
Headache/face pain	17	21.0	64	79.0
Other pain[a]	26	38.2	42	61.8
Hypertension	31	44.3	39	55.7
Heart attack/CAD	30	85.7	5	14.3
Anxiety with FSC[b]	97	30.9	217	69.1
GI disorders	14	29.8	33	70.2
Other stress[c]	28	27.2	75	72.8

[a]Consisted of subjects with neck/shoulder pain or a number of different conditions; see Table I for complete listing.
[b]Functional somatic complaints.
[c]Consisted of sleep disturbance, headaches of <6 months' duration, cancer, diabetes, or a range of other conditions; see Table I for complete listing.
[a]$\chi^2 = 56.1, p < .00005$.

As shown in Table I, patients with chronic pain diagnoses comprised 27% of the enrolled subjects ($N = 215$), and those with stress-related medical disorders 73% of the subjects ($N = 569$). Certain individual diagnostic categories were later grouped together in subclasses such as "other pain" and "other stress" to facilitate statistical analysis when specific diagnostic categories contained small numbers of subjects.

The overall ratio of males to females among the patients who enrolled in the intervention was 1:2. However, the ratio varied significantly across diagnostic categories (Table II) ($\chi^2 = 56.1, p < .00005$). Males were most strongly represented among patients with hypertension and heart disease (heart attack/CAD).

Symptom Measures

Baseline measures of physical and psychological status were obtained at the time of the initial interview. Pain status was assessed using the McGill-Melzack Pain Rating Index (PRI) (Melzack, 1975) and the Body Parts Problem Assessment Scale (BPPA) (Kabat-Zinn, 1983). The PRI is a widely used and validated measure of pain intensity which makes use of a ranked order of verbal descriptors of the pain experience. The BPPA is a measure of negative body image arrived at by summing across problem ratings for 53 body parts. A Medical Symptom Checklist (MSCL) (Kabat-Zinn, 1982) was used to define the number of symptom complaints reported in the preceding month. The SCL-90-R (Derogatis, 1983) was used to measure psychological distress. The SCL-90-R is a widely used and validated instrument which includes three global measures of distress and nine subdimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. The SCL-90-R data are reported in this study using the General Severity Index (GSI), a global measure of distress symptomatology, and the OC (obsessive-compulsive) subscale.

Statistical Analyses

Statistical tests were performed using the SPSS and BMDP. Univariate analyses were performed using the t test for continuous variables corrected for multiple tests by applying the Bonferroni adjustment (Ingelfinger *et al.*, 1983) and the χ^2 test of independence for categorical variables. Multiple logistical regression analyses were performed to identify combinations of variables significantly associated with program completion. The results are reported as an odds ratio (OR) with 95% confidence intervals (CI). All analyses were performed separately on the pain and stress cohorts as well as on the entire study population.

RESULTS

Overall Rate of Program Completion

Figure 1 shows the outcome distribution for all referrals to the SR&RP during the study period. Of 1155 patients referred, 869 (75.2%) were seen in an evaluation interview and 784 (67.9% of the original referrals and 90.2% of those interviewed) enrolled in the program. The subjects who were not seen in the evaluation interview (25% of the referrals) gave as major reasons for not complying with the referral lack of interest, change in personal situation, or a desire to enroll at a later date. In approximately 5% of the cases, we were unable to reach the subject to schedule an appointment.

The resulting completion outcomes for the 784 subjects who enrolled in the intervention are presented in Table III. Five hundred ninety-eight subjects completed the intervention (76% of those who enrolled) and 186 (24%) were noncompleters. The noncompleters were of two types: 68 subjects (9%) were no-shows (i.e., did not attend at all) and 118 (15%) dropped out after beginning the program. There were no significant differences between males and females in no-show or dropout rate among the total population (χ^2 = 3.19, $p > .2$).

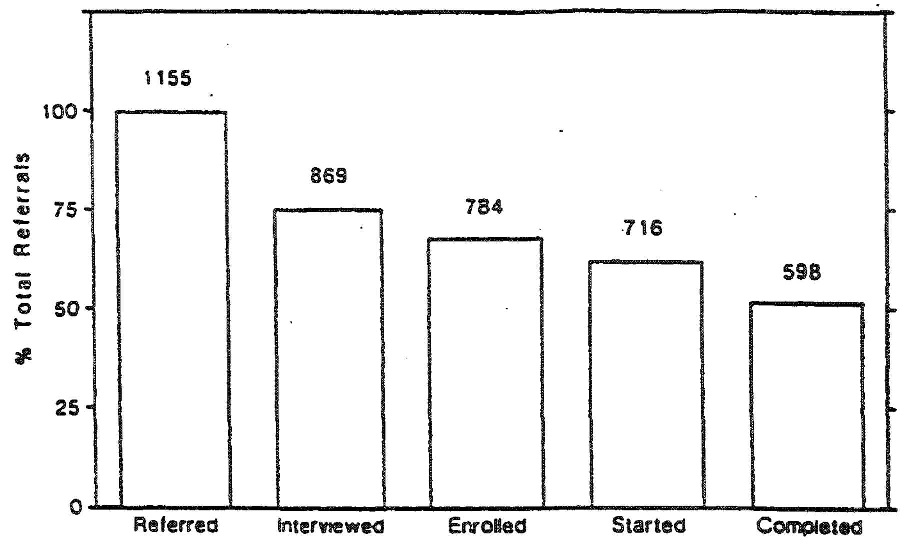

Fig. 1. The population in compliance with each stage of the intervention process is displayed as a percentage of the total referred population.

Factors Determining Program Completion

Diagnostic Class and Gender

A multiple logistic regression analysis performed on the entire population showed that the patients in the stress cohort were significantly more likely (odds ratio = 2.1; 95% CI = 1.3, 3.3) to be completers than the pain patients. The overall rate of program completion for the stress cohort was 79% and that of the chronic pain cohort 70%.

Table III. Completion Outcomes for the Total Enrolled Population*

		Males		Females		Total	
		N	%	*N*	%	*N*	%
No. subjects enrolled		269	100	515	100	784	100
No. completers		199	74.0	399	77.5	598	76.3
No. no-shows	Noncompleters	30	11.2	38	7.4	68	8.7
No. dropouts	Noncompleters	40	14.9	78	15.1	118	15.1
Total noncompleters		70	26.0	116	22.5	186	23.7

*χ^2 = 3.19, p > .2.

Table IV. Completion Outcomes for the Chronic Pain Cohort[a]

	Total	Males		Females	
	N	*N*	%	*N*	%
Total subjects enrolled	215	69	32.1	146	67.9
Completers	151	39	25.8	112	74.2
No-shows	21	11	52.4	10	47.6
Dropouts	43	19	44.2	24	55.8
Noncompleters (total)	64	30	46.9	34	53.1
% completers	70		57		77

[a] $\chi^2 = 9.14$, $p < .003$.

Table V. Completion Outcomes for the Stress Cohort[a]

	Total	Males		Females	
	N	*N*	%	*N*	%
Total subjects enrolled	569	200	35.1	369	64.9
Completers	447	160	35.8	287	64.2
No-shows	47	19	40.4	28	59.6
Dropouts	75	21	28.0	54	72.0
Noncompleters (total)	122	40	32.8	82	67.2
% completers	79		80		78

[a] $\chi^2 = 0.38$, $p > .5$.

Although the rates of program completion for males and females in the population as a whole were similar (Table III), univariate analysis of the chronic pain data showed that, for this cohort, the males had a significantly lower completion rate than the females ($\chi^2 = 9.14$, $p < .003$). Only 57% of the enrolled male pain patients completed the intervention, while 77% of the females completed it (Table IV). Multiple logistic regression analysis performed on the chronic pain cohort confirmed that females were more than twice as likely as males to complete the SR&RP (odds ratio = 2.4; 95% CI = 1.2, 4.4).

As noted above, the stress cohort showed an overall completion rate of 79%. The rate of completion for males and for females was approximately the same (Table V). Thus females with chronic pain showed a program completion rate comparable to the rate for the patients with stress-related disorders.

A statistically significant effect of diagnostic category on the rate of noncompletion was found for the total population ($\chi^2 = 15.2$, $p = .05$). This effect was due entirely to the males ($\chi^2 = 24.6$, $p < .001$) (Table VI).

Table VI. Rates of Noncompletion by Diagnostic Grouping and Gender

	Rate of noncompletion (%)				
Diagnostic Category	Males*	N^a	Females**	N^a	Overall***
Low back pain	50.0	26	20.0	40	31.8
Headache/face pain	35.3	17	20.3	64	23.5
Other pain	42.3	26	31.0	42	35.3
Hypertension	19.4	31	20.5	39	20.0
Heart attack/CAD	33.3	30	40.0	5	34.3
Anxiety with FSC	21.6	97	23.5	217	22.9
GI disorders	21.4	14	15.2	33	17.0
Other stress	0	28	21.3	75	15.5

$^a N$ = total number of males or females in each diagnostic category.
$^*\chi^2 = 24.6$ $p = .001$.
$^{**}\chi^2 = 4.2$, $p = .76$ (NS).
$^{***}\chi^2 = 15.2$, $p = .033$.

Symptom Measures

A two-way ANOVA (group by measure) of the total population (stress and pain patients combined) showed that the GSI score of the SCL-90-R was the only symptom measure that differed significantly between completers ($m = .87$) and noncompleters ($m = .76$) ($p < .05$). A similar analysis conducted on each subscale of the SCL-90-R showed a significant group (completer/noncompleter) effect ($p < .002$) only for the obsessive-compulsive (OC) subscale. Multiple logistic regression analysis confirmed the OC effect in the total population (odds ratio = 1.9; 95% CI = 1.2, 2.9). Thus, the higher the OC score, the greater the likelihood of the patient completing the intervention. The difference in mean OC scores was particularly marked in the males ($m = .96$ for completers, $m = .63$ for noncompleters) and smaller in the females (Table VII). The potential clinical relevance of this observation is discussed below (see Discussion).

Pain Patients. As noted above, females in the chronic pain cohort were significantly more likely to complete the program than were the males. There were no other statistically significant differences detected between the demographic characteristics of the completers and those of the noncompleters among the chronic pain patients (Table VIII). The completers tended to be older than noncompleters (mean age of 42.0 vs 38.4 years) and tended to have a longer pain history (mean chronicity of 8.0 vs 5.4 years). However, these differences did not reach statistical significance. There were also no significant differences detected between program completers and noncompleters on any of the baseline symptom measures, including the GSI (Table VIII) and its subscales using univariate and multivariate analyses. This finding suggests that the severity of pain condition as measured by the PRI or

Table VII. Obessive-Compulsive Subdimension Scores on the SCL-90-R

	Mean OC scores				
	Completers	N	Noncompleters	N	$p <$ [a]
All subjects					
Males	.96	179	.63	52	.05
Females	1.09	370	.91	97	NS
Stress patients					
Males (all)	.903	148	.572	29	.020
Females (all)	1.088	274	.937	68	NS
Females in "other stress" category	1.194	56	.560	12	.005

[a] Corrected for multiple t tests.

Table VIII. Mean Values of Demographic Variables and Symptom Measures for the Chronic Pain Cohort[a,b]

	Completers	N	Noncompleters	N
Age	42.0	146	38.4	63
Years with pain	8.0	142	5.4	64
PRI	21.1	96	26.0	30
BPPA	46.1	148	38.3	64
MSCL	24.4	148	22.7	64
GSI	.88	128	.71	50

[a] PRI, Pain Rating Index; BPPA, Body Parts Problem Assessment Scale; MSCL, Medical Symptom Checklist; GSI, General Severity Index of the SCL-90-R.
[b] t tests showed no statistically significant differences between completers and noncompleters.

Table IX. Mean Values of Demographic Variables and Symptom Measures for the Stress Cohort[a,b]

	Completers	N	Noncompleters	N
Age	42.6	441	42.7	122
Years with chief complaint	6.7	368	6.9	102
BPPA	24.9	435	25.7	119
MSCL	21.7	439	22.4	119
GSI	.86	426	.78	95

[a] BPPA, Body Parts Problem Assessment Scale; MSCL, Medical Symptom Checklist; GSI, General Severity Index of the SCL-90-R.
[b] t tests showed no statistically significant differences between completers and noncompleters.

other symptom measures in this study was not a factor in the determination of program completion among the pain patients, nor was the OC score a factor in distinguishing between completers and noncompleters among the pain patients.

Stress Patients. Among stress patients, no significant differences in mean age, number of years with the chief complaint, BPPA, MSCL, or GSI scores were observed between completers and noncompleters (Table IX). As in the case of the chronic pain patients, there was no indication that severity of symptoms or illness affected outcome in terms of program completion. Univariate analysis showed that male completers had a significantly higher mean OC score than male noncompleters (Table VII). This was not observed in the females as a group, but female completers in the "other stress" diagnostic grouping did show a similar and highly significant difference in mean OC scores compared to noncompleters (Table VII). A multiple logistic regression analysis performed on the stress patients as a cohort showed that only the OC score significantly differentiated completers from noncompleters (odds ratio = 2.0; 95% CI = 1.2, 3.4). The higher the OC score, the greater the likelihood of program completion.

Interestingly, among the male stress patients, heart disease was the only diagnostic category in which the GSI scores for completers and noncompleters were statistically significantly different. In this case, male cardiac patients who were completers had a significantly higher mean GSI score than noncompleters, whose mean scores were unusually low for such a population (m = .747 for completers, m = .229 for noncompleters, p = .002, two tailed, df = 22.98). OC scores were also high for the completers and low for the noncompleters among male cardiac patients but failed to reach statistical significance.

Comparison of No-Shows and Dropouts

For the entire population, there was no statistically significant difference in sex ratios between no-shows and dropouts (χ^2 = 1.51, p = .22). There was also no statistically significant effect of diagnosis on the distribution of no-shows and dropouts. The ratio of no-shows to dropouts approximated 1:2 in those cases where the N was large, and in all cases dropouts outnumbered no-shows except for cardiac patients. For noncompleters who were cardiac patients (N = 12), no-shows were twice as prevalent as dropouts, suggesting that patients in this category may not have received adequate information concerning the relevance of stress reduction training for their condition or that they were referred without adequate assessment of the interest of the patient in pursuing such a course.

DISCUSSION

Previous studies have shown the SR&RP to be an effective group intervention for medical patients with stress-related disorders and chronic pain problems. The present study demonstrates that most patients complied with the original referral and completed the 8-week intervention even though in many cases, there was a substantial time lag between the referral itself and the patient's undergoing the intervention. Given the high demands of the intervention, the 76% overall rate of program completion observed among the subjects who enrolled is noteworthy. If one excludes those individuals who enrolled but did not attend any session (no-shows) from the calculation, the actual dropout rate (those who started but did not finish the program) was 17% and the rate of completion was 83%. A 76% overall rate of program completion represents a very high of degree of compliance for a population of chronic medical patients, especially considering the intensity of the intervention and its requirements for home practice. Program participants were required to make an immediate life-style change in complying with the regular practice of the meditation (45 min/day, 6 days/week) and to sustain this effort over the 8 weeks of the program.

The 76% rate of program completion obtained in this study demonstrates that an effective behavioral intervention can achieve a high level of patient compliance while making significant demands for patient participation. Moreover, these results were obtained with a relatively unselected patient population, routinely referred by their physicians and not subjected to a stringent screening process prior to enrollment. They were simply given the informantion about the program by the clinic staff and were asked to choose whether they wished to participate or not. Even among the males with chronic pain conditions, who, as a group, showed a substantially lower rate of program completion than the females with chronic pain and the subjects in the stress cohort, the majority (57%) completed the intervention.

We are unaware of published data on rates of completion for similar programs of cognitive-behavioral intervention in a medical setting. No measures of rates of compliance with medical or behavioral interventions are mentioned or compared in a recent book on patient compliance (DiMatteo and DiNicola, 1985)). However, the 76% completion rate obtained in the present study is in the range reported for compliance with keeping a *single* medical appointment when the appointment was initiated by the patient. It is much higher than the average compliance rate (50%) reported for a single medical appointment when it was initiated by a health professional (Haynes *et al.*, 1979).

In contrast, the present study obtained a 75% rate of compliance with the initial physician referral as measured by attendance at the preintervention interview (Fig. 1) even though, in many cases, several months had elapsed between initiation of the referral by the physician and patient contact by the clinic staff to schedule an appointment for the interview. More literature reports of compliance rates with appointments and with completion of different cognitive-behavioral interventions oriented toward risk factor reduction and health behavior change for well-defined populations are sorely needed to assess the factors determining compliance with clinical behavioral medicine programs such as the SR&RP and for making comparisons between different types of group interventions.

The present study found that two major factors significantly differentiated completers from noncompleters when pain and stress patients were considered independently. (1) Males with chronic pain were twice as likely to be noncompleters as females. This was the case for all pain diagnoses. (2) The OC (obsessive-compulsive) subdimension score on the SCL-90-R significantly differentiated completers from noncompleters among the stress patients, with higher OC scores increasing the likelihood of completion. Male pain patients with higher OC scores were also somewhat more likely to complete the program than were males with lower OC scores, but this observation did not reach statistical significance.

One interpretation of the observation of a relationship between OC score and program completion among the stress patients, based on the actual wording of the items in the OC subdimension, is that a high OC score in this population may reflect increased vigilance and concern about loss of control and an accompanying determination to overcome it. This interpretation is consistent with both theoretical and empirical descriptions of the phenomenon of self-regulatory failure (Kirschenbaum and Tomarken, 1982; Kirschenbaum, 1987). These authors suggest that a degree of nonpathological obsessive-compulsive style may, in fact, be necessary to succeed at the maintenance of self-regulatory strategies. In the present context, the higher mean OC scores among completers may be of clinical significance as a protecting factor against self-regulatory failure, in this case rejection of the intervention (and thereby loss of control) before completion of the training period.

Several observations in this study are of potential clinical relevance and merit further investigation. (1) Among individuals with chronic pain, longer chronicity was associated with a greater likelihood of program completion although the trend did not reach statistical significance. This observation may reflect a greater willingness to engage in and sustain effort in a program requiring a degree of self-responsibility and self-regulation among pain patients who have have a longer course of traditional medical therapies for pain. This conjecture could be tested by comparing internal vs external locus of control measures between completers and noncompleters in the chronic pain category. (2) Among the male cardiac patients, the extremely low mean GSI score of the noncompleters ($m = .229$) may reflect denial of psychological distress and of the significance or extent of their heart disease and, therefore, rejection of the notion that modifying health behaviors may be important. This conjecture is supported by the observation that only among male cardiac patients was the number of no-shows greater than the number of dropouts. Denial may be a major factor contributing to the higher no-show rate and to the higher overall noncompletion rate among male cardiac patients compared to the males in the other stress related diagnostic categories. Thus, these patients may have required greater reinforcement from the physician or from the program staff to understand the need for the referral and the importance of attending the program. (3) Chronic medical patients in general who show very low OC scores on the SCL-90-R may be at greater risk for ignoring or denying the importance of compliance with a referral for self-regulatory training and may require additional explanations or behavioral contracting both prior to the referral and prior to enrollment.

Specific Aspects of the Intervention that May Explain the High Rate of Program Completion

We believe that the high overall rate of program completion observed is due in large part to a number of design features of the SR&RP, the combination of which is unusual and perhaps unique among currently practiced cognitive/behavioral interventions. These design features can be broadly characterized as either functional or structural.

Functionally, three features of the intervention are likely to positively affect overall compliance as reflected in the program completion rate. (1) The intervention was challenging to the patients in a number of ways but, above all, in what it asked and required of them in terms of frequency and duration of daily practice of the formal and informal meditation techniques (see Methods). The program was presented to the patients from the start as a personal challenge to develop their inner resources for growth and change and the message was clearly given that it would be "stressful to take the Stress Reduction Program." The low percentage of patients who decided not to enroll following the initial evaluation interview (10%), as well as the 24% overall noncompletion rate, suggest that the great majority of the patients appreciated being related to in this way and responded positively to being given permission to explore the limits of their own potential and a supportive vehicle for doing so. (2) The major cognitive/behavioral modality utilized in the intervention was the cultivation of mindfulness. Regular formal practice of mindfulness meditation and mindful yoga was framed as a practical way to improve directly the quality of one's life and health. However, their practice was presented as a "way of being" rather than reductionistic "techniques" or "exercises" to be practiced to achieve immediate ends. When this non-goal-oriented approach is taken (paradoxical in this context since all the patients were referred for help with specific problems or symptoms), both meditation and yoga are most likely to result in feelings of relaxation, well-being, and acceptance. It was not unusual for the patients to report moving insights about themselves and their problems which came to them during meditation and yoga practice. These positive experiences, shared during the classes, probably reinforced many patients' motivation to complete the intervention, either through direct self-efficacy experiences (Bandura, 1982) or through the belief that if someone else could have a positive experience, then it might be possible in one's own case as well. (3) The use of both yoga and a number of different meditation techniques for cultivating mindfulness (Kabat-Zinn *et al.*, 1986c; Chapman-Waldrop and Kabat-Zinn, 1987) increased the probability that patients with different needs and preferences would be able to find at least one major technique which would be congruent with their needs and thereby minimized resistance to regular practice. Thus the use of multiple techniques may have served to keep the maximum number of patients engaged in the intervention through to completion.

Structurally, the intervention relied on a unique combination of personal attention (given to the participants in the individual evaluation sessions) and group training (in classes). It is likely that the combination of individual and group formats contributed significantly to the high program completion rate by creating a socially supportive context in which to pursue intensive self-regulatory training while, at the same time, honoring and adjusting for individual identity and personal circumstances.

The approach of mixing patients with very different diagnoses in the treatment sessions and teaching all individuals the same methods of self-regulation departs significantly both from the traditional medical model, in which the physician intervenes to prescribe a specific course of treatment for a specific disorder or disease, and from the traditional psychotherapeutic model, which does not include training in intensive self-regulatory practices and which usually relies on either individual or group therapy (but not in combination) to accomplish change.[4] In the SR&RP, the same basic mindfulness techniques were taught to all participants, regardless of their specific medical diagnosis, and all individuals were encouraged to take responsibility for adapting the techniques to their own specific life circumstances and health problems, in collaboration with the program staff. Patients commonly reported that they learned about their own strength and resources by observing their coparticipants cope with medical problems different from their own. In addition, the mixing of patients with different medical problems and, therefore, life circumstances related to illness allows the training to focus largely on "what is right" with the participants and to emphasize their hardiness and the robustness of their inner resources, while minimizing the tendency

[4] Recently, the potential benefit of a combined approach integrating mindfulness meditation into psychotherapy has been noted (Kutz *et al.*, 1985).

for discussions to dwell on "what is the matter," as can happen when a group's medical problems are more homogeneous.

Positive outcome expectations on the part of the patients, resulting from a physician's referral to a highly demanding hospital-based behavioral medicine clinic with a positive reputation in the community, may have been another contributing factor to the high rate of program completion observed.

The Question of Patient Selection

The fact that 476 different physicians referred patients to the SR&RP during the study period suggests that the program functioned as a broad-based outpatient service and that referral to it was routine. However, each physician made decisions about whom to refer and whom not to refer to such a service. These decisions were likely to include considerations of patient motivation, the need to learn coping skills and make behavioral changes, and issues related to the severity of the patient's medical condition and the need for further medical intervention. The precise criteria employed by physicians for patient referral to the SR&RP are a subject of current investigation (Kabat-Zinn and Skillings, 1988). Although the degree of patient selection in this study was not determined, our informal impression from the initial patient evaluation interviews was that most patients were told little about the program but were told that it would help them to relax and to cope better with stress. This suggests that the criteria employed for referral were relatively nonrestrictive and that referral for stress reduction was a routine matter.

CONCLUSION

The rate of program completion in this study is evidence that intensive training in mindfulness mediation and yoga is acceptable to large numbers of patients with different medical problems in the context of a physician referral for stress reduction training. Taken together with the outcome and long-term follow-up results of previous studies (Kabat-Zinn, 1982; Kabat-Zinn *et al.*, 1985, 1986a,b), these findings suggest that the intervention was highly effective in involving the majority of patients referred to it in the behavior change process and that it met at least some of their major health needs and expectations. However, although it appears from this study that a routine physician referral to the SR&RP was sufficient to achieve a high rate of program completion by medical patients with a wide range of diagnoses, further work is required to identify and quantify the selection criteria applied by the physicians in the process of making a referral so that the generalizability of the present findings to the full spectrum of patients with chronic medical problems can be assessed. This is a subject of current investigation (Kabat-Zinn and Skillings, 1988).

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Effectiveness of relaxation and visualization techniques as an adjunct to phototherapy and photochemotherapy of psoriasis

To the Editor: We read Winchell and Watts' review of relaxation therapies in the treatment of psoriasis with great interest (J AM ACAD DERMATOL 1988;18:101-4). We have also been intrigued by the role of stress in psoriasis. Recently we began a study to assess the utility of meditation and visualization techniques as adjuncts to phototherapy and photochemotherapy (PUVA) in the treatment of psoriasis. We believed that the time spent in the isolation of an ultraviolet treatment unit could be ideal for patients to learn and engage in meditation and visualization strategies under the guidance of instructional audiocassette tapes. We hypothesized that if stress is a factor in psoriasis, patients actively engaged in practicing stress reduction techniques during ultraviolet treatment sessions might achieve more rapid clearing than patients receiving the same treatment without practicing these techniques. We report our preliminary findings here.

In a randomized study approved by the institutional human subjects review board, patients about to commence conventional ultraviolet B (UVB) or PUVA treatment were assigned to either of two treatment conditions: tape or no-tape. We made different guided audiotapes for use with UVB treatments and for use with PUVA treatments so that specific information about the treatments could be included in the visualization component. The meditation techniques used were similar to those we have used in self-regulation of chronic pain.[1,2] They included mindful focusing on breathing, proprioception, and music. They were played by patients in the experimental group during ultraviolet treatments on portable players with earphones and were programmed to provide increasing material as the length of UVB or PUVA treatments increased. Clinic nurses recorded a "turning point," when improvement in psoriasis could first be detected, a "halfway point," when patients had only about half of the amount of psoriasis they started with left, and a "clearing point," when less than about 5% of the patient's original amount of psoriasis remained.

To date 12 patients have entered the study and completed the protocol. Eight were randomized to receive the tape intervention and four underwent conventional treatment without the tape. Although results for such a small sample size can be considered only preliminary, we believe that they are striking enough to merit reporting at this time. Comparison of the two treatment groups showed that the turning point for the group who practiced the relaxation/visualization techniques in conjunction with their phototherapy or photochemotherapy treatments occurred significantly earlier (mean treatment number, 8.4) than it did for the group who did not receive the tape (mean treatment number, 16.3; $p = 0.008$ by Wilcoxon's rank sum comparison). Clearing was achieved earlier as well. Seven of the eight patients in the tape group achieved 95% clearing in a mean of 18.9 treatment sessions, whereas only one patient in the control group achieved clearing in less than 40 sessions ($p = 0.055$ by Wilcoxon's rank sum comparison). Psychologic tests were also performed at intervals during the treatment of both groups, and the data from these will be analyzed and reported later.

These results are preliminary but are consistent with the proposition (1) that stress reduction techniques, including visualization of the therapeutic process and meditation, may be helpful in the treatment of psoriasis, and (2) that it may be particularly logical to employ them during ultraviolet treatment sessions. One possible interpretation of our findings, if confirmed by larger studies, is that attentional manipulations engaged in by patients can positively influence physiologic factors in psoriasis. However, expectation effects may also play a role in treatment outcomes and need to be controlled in future experiments. The phototherapy clinic is an ideal setting for the experimental manipulation and analysis of psychologic factors that may have an effect on the healing process. Our experiment is ongoing. We also intend to expand the trial to include other treatment centers in the hope that our initial observations can be replicated and extended.

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Four-Year Follow-Up of a Meditation-Based Program for the Self-Regulation of Chronic Pain: Treatment Outcomes and Compliance

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Abstract: Two hundred twenty-five chronic pain patients were studied following training in mindfulness meditation. Large and significant overall improvements were recorded post-intervention in physical and psychological status. These gains were maintained at follow-up in the majority of subjects. Follow-up times ranged from 2.5–48 months. Status on the McGill Melzack Pain Rating Index (PRI), however, tended to revert to preintervention levels following the intervention. Most subjects reported a high degree of adherence with the meditation techniques, maintenance of improved status over time, and a high degree of importance attributed to the training program. We conclude that such training can have long-term benefit for chronic pain patients.
Key Words: Chronic pain—Self-regulation—Meditation—Stress reduction—Relaxation.

Relaxation techniques, breathing exercises, and attention self-regulation methods are currently being taught to chronic pain patients to improve their ability to cope (1,2). Such exercises derive directly or indirectly from meditation techniques (cf. 4) which have a long history of use in other cultures (3) and are now being applied in some clinical settings as strategies for self-regulation (2,4,5). These methods have been incorporated into many multidisciplinary pain clinic treatment programs as auxilliary therapies and into a cognitive-behavioral approach to pain management (1,5). However, to date, there has been a paucity of follow-up studies which assess the long-term effects of such methods and the degree of patient adherence to such self-regulatory approaches (6,7). Most psychological interventions for chronic pain achieve a degree of short-term improvement (8,9), making it important to determine how much of the initial improvement (observed over the course of an intervention) is maintained over time, and the degree of adherence or compliance with the methods used in the intervention. It is also relevant to determine to what degree the subjects in a follow-up study attribute change to the intervention, since they may have had a multiplicity of treatments for pain over the follow-up period.

In previous reports (4,10,11) we demonstrated the short-term effectiveness of a Stress Reduction and Relaxation Program (SR&RP) based on training in mindfulness meditation in reducing pain and pain-related behaviors in 90 subjects with chronic pain. It was also reported (4) that improvement was maintained for periods of up to 15 months and that compliance with the meditation remained

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high. By the end of its fourth year (June 1983), the number of pain patients who completed the SR&RP had increased to 225. The present study analyzes the pain and psychological status of the entire participant population (n = 225) over time, from the initial assessment prior to meditation training through the end of the program (8 weeks) and then at various times following completion of the program up to 4 years. The aim was to determine the long-term effects of meditation training in a chronic pain population and the degree of compliance with the major techniques used in the intervention. These follow-up results have been previously reported in abstract form (12).

This study was conducted to extend the 15-month follow-up results reported previously (4). In particular, we wished to:

1. Determine the time course up to 4 years post-intervention of the mean levels on the pain [PRI (See Methods and Discussion sections for outcome measures and abbreviations) BPPA], physical and psychological symptom (MSCL, GSI), and overall outcome (OA) measures used to assess change during the intervention.
2. Compare the behavior on the PRI to that of the other indices to reconfirm our original observations that mean PRI levels tended to return to pre-intervention levels on follow-up while improvement on the other indices tended to be maintained.
3. Assess the degree to which subjects considered the intervention to be of lasting value and what aspects were most valued, if any.
4. Assess the relationship between the improvement in pain status and the degree to which that improvement is ascribed to participation in the SR&RP.
5. Assess the follow-up compliance with the major techniques in which the subjects were trained during the intervention.
6. Determine the extent to which compliance correlated with degree of improvement at follow-up.
7. Compare those subjects responding to each follow-up questionnaire (responders) with the nonresponder population to assess potential distortion due to selective returns.
8. Compare the follow-up experience of subjects who did and did not participate in maintenance SR&RP programs (graduate programs) to assess the effect of further intervention on the overall follow-up results.

METHODS

The intervention and all outcome measures have been described elsewhere (4,10,11). The major intervention techniques consisted of formal meditation practice both lying down and sitting, gentle hatha yoga exercises done in a slow, meditative fashion emphasizing moment to moment mindfulness, and an informal meditative practice which involved linking mindfulness coping strategies in stressful situations to an awareness of breathing. Instructions in the techniques were integrated within an overall context of stress reduction and health promotion. Follow-up assessment of pain and psychological status, and of pain-related behaviors (thoughts, attitudes, activities) was accomplished by sending questionnaires to all subjects who completed the SR&RP at approximately 12-month intervals. These questionnaires contained the McGill Melzack Pain Rating Index (PRI), the Body Parts Problem Assessment Scale (BPPA), a Medical Symptom Checklist (MSCL), the SCL-90-R, an overall change measure (OA), and a section on compliance. The follow-up questionnaire is available upon request.

Two hundred twenty-five consecutive subjects who completed the Stress Reduction and Relaxation Program at the University of Massachusetts Medical Center in the four years between the Fall of 1979 and the Spring of 1983 were included in this observational study. Three "cycles" of the SR&RP were conducted in each calendar year for a total of twelve consecutive cycles (numbered 0–11). Four follow-up questionnaires were mailed out during the four years. Subjects from the earliest cycles (0, 1, and 2) received all four questionnaires; subjects from cycles 3 and 4 received three; subjects from cycles 5 and 6 received two; and subjects from cycles 7–11 received one (Table 1). Data were obtained from respondents following completion of the intervention at times ranging from 2.5 months to 4 years. For ease of presentation and analysis, the follow-up time periods were clustered. Thus, subjects responding in the range of 2.5–7.5 months post-SR&RP on any questionnaire were grouped as 6-month follow-up, (in the cases of Cycle 0, only the longest follow-up time was used when responses to two questionnaires fell within the clustered time period) 8.5–14.5 months as 12-month follow-up, 17–24 months as 24-month follow-up, 29–36 months as 36-month follow-up, and 42–48 months as 48-month follow-up. These groupings had similar frequency distributions of subjects by gender, age, or chronicity as determined by ANOVA (13) and had high response rates to the questionnaires ranging from 53–70% of all possible responders.

In this report, outcome for men and women and all pain diagnoses are considered together. All subjects were originally referred to the SR&RP by physicians and had enrolled in the program voluntarily following an initial evaluation (cf. 4,10). Thirty percent were referred from the Pain Clinic, 17% from Primary Care Clinic, 12% from Orthopedic Clinic, and 12% from Neurology Clinic. The remainder of the referrals came from other medical clinics in our institution and from physicians at other institutions. The three major pain categories in this population were chronic low back pain (37.9%), headache (29.0%), and neck and/or shoulder pain (9.8%). The remaining subjects had noncardiac chest pain (4.5%), abdominal pain (6.3%), extremity pain (4.4%), or total body pain (4.5%). In all cases, the pain problem was of greater than 6-month duration with a mean of 8.1 years with the problem. Men constituted 31.3% of the population. Response rates to the follow-up questionnaires were high (Table 1).

RESULTS

Time course of outcome variables

Data from pre- and post-intervention assessments and from all responses to the follow-up questionnaires were compiled to determine the overall behavior of the outcome variables as a function of time. These are displayed in Fig. 1 for the PRI (IA), the BPPA (IB), the MSCL (IC), and the GSI (ID). The curves clearly display highly significant reductions in the mean values of these outcome measures over the course of the intervention (dotted lines), as previously reported (4,10,11). Regression analysis using the least-squares method of fit for the post and follow-up values showed no significant deterioration in the mean post-intervention levels on the BPPA, MSCL, and GSI among those responding to the questionnaires as a function of time following completion of the SR&RP. (We recognize that regression analysis is not strictly appropriate in this case because of the lack of independence of the follow-up data points. However, we felt it served a useful summary function in the longitudinal representation of the data.) In almost all cases, the mean values at follow-up were significantly different from the pre values for the responders at each follow-up time.

However, the response to the PRI at follow-up differed notably from that of the other indices. The mean PRI level achieved post-intervention was not reliably maintained over the period of follow-up and tended to return to the pre-intervention level within 6 months as reported previously (4). Follow-up mean PRI levels fluctuated to a much higher degree than for the other indices.

In addition to the results obtained with the individual outcome measures displayed in Fig. 1, the mean score on the measure of overall improvement (OA) was stable in a range of 3.8–4.0 over the entire follow-up period (Table 2). This indicated maintenance of the mean level of moderate improvement achieved immediately post-intervention.

Perception of pain improvement and its association with participation in the SR&RP

Table 3 shows the degree of improvement reported retrospectively as a function of follow-up time. From 30–55% of responders rated their pain as "greatly improved" since taking the SR&RP. Sixty to seventy-two percent of the responders reported moderate or great improvement. A small

TABLE 1. *Number of months post SR&RP at which follow-up status was obtained for each cycle*

	Year 1 (cycles)			Year 2 (cycles)			Year 3 (cycles)			Year 4 (cycles)			
Follow-up no.	0 (n = 14)	1 (n = 10)	2 (n = 16)	3 (n = 24)	4 (n = 22)	5 (n = 18)	6 (n = 24)	7 (n = 20)	8 (n = 24)	9 (n = 22)	10 (n = 15)	11 (n = 17)	% returns
1	11	7.5	5										30/40 = 75%
2	18[a]	14.5	12	6	2.5								63/86 = 73
3	24[a]	20.5	18	12	8.5	6	2						56/125[b] = 45
4	48	44.5	42	36	32.5	30	24	20.5	18	12	8.5	6	142/210[b] = 68

[a] Just used the later follow-up time in this case.
[b] Corrected for deceased subjects and individuals who had relocated.

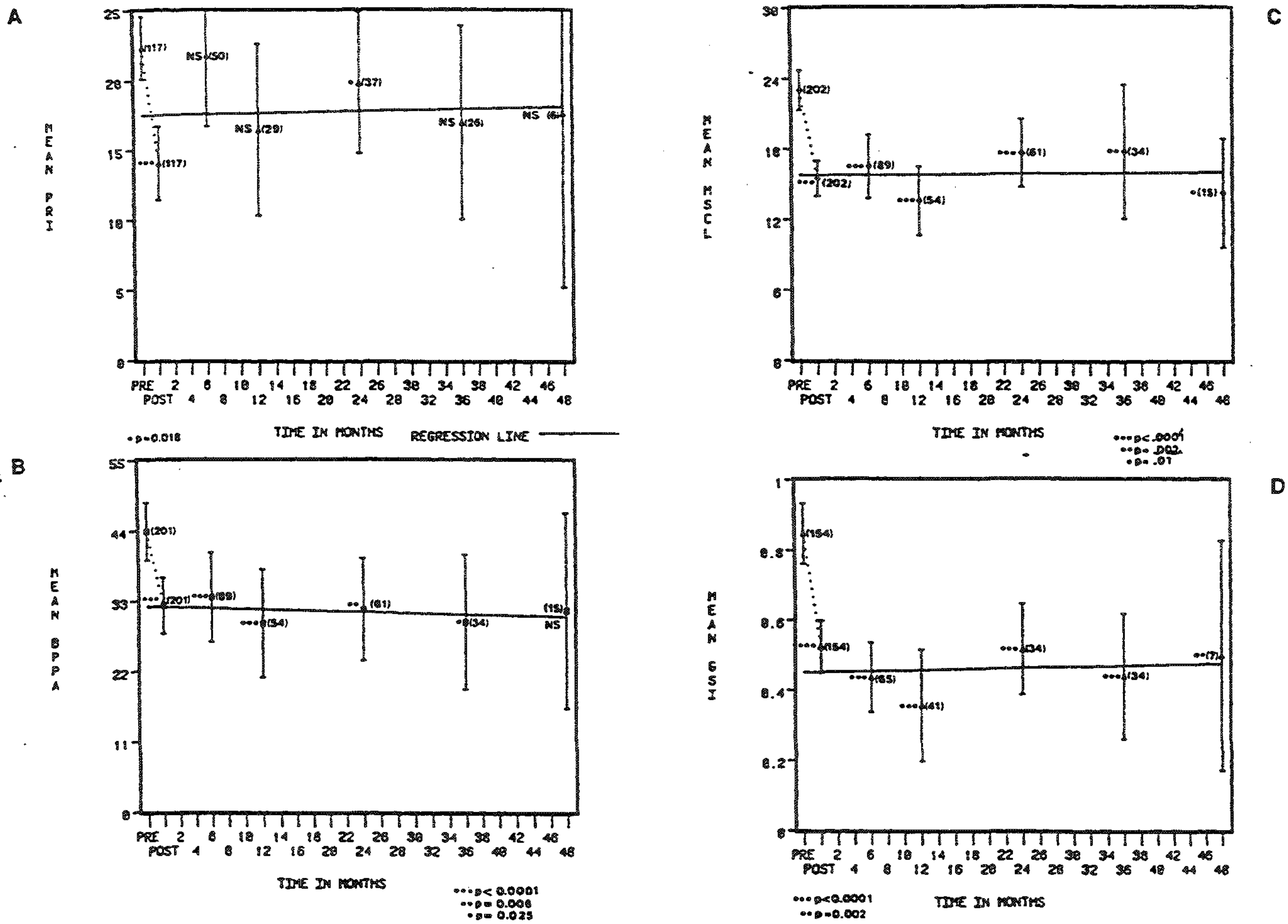

FIG. 1. Mean values for (A) Pain Rating Index (PRI), (B) Body Parts Problem Assessment Scale (BPPA), (C) Medical Symptom Checklist (MSCL), and (D) General Severity Index (GSI) as a function of time. Pre- and post-values are the means for all subjects with both pre- and post-data for that index. Follow-up values are the means for all responders at each clustered time point. In each p values result from the paired t-test (two-tailed) comparing responders at each follow-up point to their initial (pre) scores on each measure. The error bars represent 2 times the SEM. The dotted lines represent changes in mean value over the intervention period. The solid lines are the least squares fit of the post values and all follow-up values.

fraction (1–15%) of the population experienced a worsening of pain status and approximately 25% reported no change in pain status since taking the SR&RP. This pattern remained relatively constant over time (Table 3).

On the fourth questionnaire, subjects were also asked to rate the percent of improvement which they considered to be directly due to their participation in the SR&RP. Of the 80 subjects who rated their pain as moderately (n = 35) or greatly (n = 45) improved since taking the SR&RP, and who responded to this item, 34 (43%) said that 80–100% of their improvement was due to the SR&RP. An additional 20 responders (25%) rated 50–80% of their pain improvement as due to the SR&RP. There were significant correlations for each follow-up time (from $r = 0.36$ to $r = 0.79$) between the degree of improvement reported at follow-up and the percent ascribed to the SR&RP. Thus the reported degree of improvement in pain is positively related to ratings of how much the SR&RP contributed to the improvement.

The questionnaire also asked subjects if they felt they got something of lasting value or importance from taking the SR&RP. Of 141 responders for whom there were data, 85.8% (121) replied in the affirmative and 6.4% (9) replied in the negative. An additional 7.8% (11) replied that they were uncertain of its value for them. When asked to rate on a scale of 1–10 how important participation in the SR&RP was (where 0 = not at all important and 10 = very important), the majority rated its importance between 8 and 10 at each time period except at 3 years, and a large proportion of subjects rated

TABLE 2. *Mean improvement (OA) scores as a function of follow-up time*

Mean OA scores		n
Post	3.8	175
6 months	3.8	91
1 year	4.0	64
2 years	3.8	71
3 years	3.9	35
4 years	3.8	22

[a] Determined as the average of responses to 10 questions pertaining to pain frequency, severity, use of drugs to control pain, activity levels, hindrance at work, energy levels, feelings in general, ability to cope with stress, frequency of physician visits, and blood pressure. The rating scale for each item was 1 to 5: 3, no change; 5, great improvement; 4, some improvement; 2, worse; and 1, much worse, with the exact wording of each question topic appropriate. If certain items were not applicable or unknown, the patient circled an option to that effect and the outcome average (OA) was calculated for the number of questions answered.

it a 10 at 6 months, 1 year, and 4 years follow-up (Table 4).

The fourth questionnaire asked subjects to report as well in free text comments any specific changes which they felt resulted from the SR&RP. The responses were categorized, and the first response from each subject was tabulated. Of 115 responses to this item, 20% cited a "new outlook on life," 40% the ability to control or understand or cope better with pain and stress, 15% cited the specific techniques of meditation, yoga, and awareness of breathing, 14% cited relaxation, 6% an ability to live with pain, and 5% an awareness of the causes of pain.

Assessment of compliance

The analysis of compliance with the meditation techniques at the time of follow-up was based on

TABLE 3. *Mean improvement in pain as a function of follow-up time*

	Follow-up time				
Pain status[a]	6 months n(%)	1 year n(%)	2 years n(%)	3 years n(%)	4 years n(%)
Worse	1(1)	2(3)	3(4)	2(6)	3(15)
No change	25(28)	16(25)	23(33)	7(22)	5(25)
Moderate improvement	36(40)	21(33)	23(33)	11(36)	1(5)
Great improvement	29(32)	25(39)	21(30)	11(36)	11(55)

[a] Determined by response to rating scale of 1 to 5: 1, much worse; 2, worse; 3, no change in pain status; 4, moderate improvement; and 5, great improvement relative to pain level prior to undergoing intervention.

TABLE 4. *Patient ratings of the importance of the SR&RP*

	Follow-up time				
Rating[a]	6 months n(%)	1 year n(%)	2 years n(%)	3 years n(%)	4 years n(%)
8–10	7(64)	14(58)	26(52)	16(44)	14(67)
10	5(46)	11(46)	16(32)	8(22)	11(52)

[a] Determined by response to a rating scale of 0 to 10 where 0 = not at all important and 10 = very important.

data from all four follow-up questionnaires. In the first year, over 80% of responders reported that they continued to meditate in response to the question "Do you meditate anymore?" This percentage did not decrease significantly as a function of time following the SR&RP (Table 5) nor did it differ between men and women (data not shown).

To determine compliance behaviors with greater precision, subjects were asked to respond to a number of questions about the specific techniques they used, and their frequency and duration of practice.

Adherence to formal meditation practice

Intensity of formal meditation practice in those claiming to be meditating was calculated from responses to questions assessing frequency and duration of practice. Data on the exact techniques they utilized were also obtained. However, this study did not differentiate between the two formal meditation practices (body scanning and mindful sitting).

At 6-month and one-year follow-ups, more than half of the subjects reported that they continued to meditate three or more times per week and 15 min or more at a time. These individuals were defined as "regular meditators" (4). In the subsequent years of follow-up the proportion of subjects in this category declined to 30% at 4 years (Table 6).

Approximately 20% of the responders could be characterized as sporatic meditators on the basis of

TABLE 5. *Compliance with the meditation practice as a function of follow-up time*[a]

Follow-up time	Number of S not meditating	Number of S meditating	% meditating
6 months	15	77	82
1 year	11	52	83
2 years	21	49	70
3 years	15	21	58
4 years	4	17	81

[a] Response to the question: "Do you meditate anymore?"

TABLE 6. *Levels of compliance with formal meditation practice as a function of time*

	Follow-up time				
	6 months (%)	1 year (%)	2 years (%)	3 years (%)	4 years (%)
Regular meditators[a]	56	56	32	42	30
Sporadic meditators[b]	19	20	20	16	20
Marginal meditators[c]	25	24	48	42	50
Total n	81	54	59	24	20

[a] ≥3 times weekly and ≥15 min/time.
[b] <3 times weekly but >1 time weekly and >15 min/time or >3 times weekly and <15 min/time.
[c] <1 time weekly for any amount of time or <3 times weekly and <15 min/time.

their responses (Table 6). This percentage did not change over time. Table 6 also shows that between 26 and 50% of those claiming to meditate formally were doing so at a minimal level (<1 time weekly for any amount of time or <3 times weekly and <15 min/time). We consider this level to be the functional equivalent of no *formal* meditation practice although it may still be of some benefit (see Discussion). The percentage of subjects in this category increased over time as the percentage of regular meditators declined between 1 and 2 years of follow-up.

Use of yoga

In addition to formal meditation practice, 40–70% of all responders, depending on follow-up time, claimed to be practicing the yoga at some level. At six-month follow-up, 44% of the responders claimed to be practicing yoga two or more times per week. This proportion decreased to 27% by 4-year follow-up (Table 7). Duration of practice was not specified in this item.

TABLE 7. *Compliance with the highest level assessed for yoga practice (% of responders)*

	Follow-up time				
	6 months	1 year	2 years	3 years	4 years
Yoga (≥2 times weekly)	44%	33%	19%	32%	27%
n[a]	40	20	13	11	6

[a] Number of responders in this category.

TABLE 8. *Compliance with the highest level assessed for awareness of breath in daily life*

	Follow-up time				
	6 months	1 year	2 years	3 years	4 years
AOBDL ("often used")	51%	55%	47%	44%	50%
n[a]	47	34	33	15	11

[a] Number of responders in this category.

Use of awareness of breathing

Between 78 and 90% of responders, depending on follow-up time, claimed to use awareness of breathing to some extent in daily life situations (AOBDL). As can be seen from Table 8, the percentage of responders in the highest compliance category (who reported using it "often") for this informal dimension of meditative practice approximated 50% of all responders and did not decrease over time. Moreover, 46–57% of all responders reported it to be *very useful* in coping successfully with stressful situations (Table 9) and another 28–37% reported it to be *moderately useful* (data not shown). It is noteworthy that the percentage of responders in the highest compliance category for this item does not decrease as a function of follow-up time suggesting that the majority of subjects continued to find it "very useful" over the four years of the study regardless of their compliance with the other techniques under investigation.

Overall use of the techniques

When data for all the self-regulatory techniques were pooled, it was found that at every follow-up time, at least 93% of responders reported that they were still practicing one of the three techniques at some level, while at least 36% reported practicing all three.

TABLE 9. *Compliance with the highest level assessed for the usefulness of AOBDL in coping with stress*

	Follow-up time				
	6 months	1 year	2 years	3 years	4 years
U AOBDL ("very useful in coping")	46%	57%	40%	56%	54%
n[a]	43	35	35	18	12

[a] Number of responders in this category.

Relationship of outcome to compliance

To determine whether there was a relationship between the degree of improvement in overall status and the level of compliance with the major intervention techniques, subjects were dichotomized into categories based on reported compliance levels. "Highest compliers" were defined as those who were meditating regularly (three or more times per week for 15 min or more per session) and who also reported using awareness of breathing in daily life (AOBDL) "often." Outcomes for this cohort were compared with those for a cohort of "lowest compliers," defined as individuals who reported they meditated formally less than three times per week for less than 15 min per time or less than one time per week for any period of time, *and* "rarely or never" used AOBDL. This cohort was small at all follow-up times and obviated statistical comparison with the highest compliers. Although a statistical analysis was not possible in this case, at each follow-up time except 3 years, the highest compliers showed a mean outcome average, representing the degree of overall improvement, considerably above the lowest compliers (Table 10). To compare a larger group of relatively low compliers with the highest compliers, a cohort of low compliers was defined by relaxing the AOBDL constraint applied to the lowest complier category. Outcome scores for these individuals were consistently between the highest and lowest compliers although no significant differences from the highest compliers were observed using the *t*-test and correcting for multiple measures (Table 10). (It was not possible to do a more powerful statistical analysis of this data using a repeated measure analysis of variance because the data base is not homogeneous with respect to individuals over time. This is also the case for the data in Table 11.) The highest compliers also consistently showed much larger positive changes on the individual pain and symptom indices (PRI, BPPA, MSCL, GSI) than did the lowest compliers as measured by the mean percent change on each index at 6-month, 1 year, and 2 year follow-ups using the pre level as baseline (data not shown). Beyond 2 years, there do not appear to be any reliable differences in outcome between subjects in the highest compliance category and those in the low compliance category.

The highest complier cohort also consistently showed greater improvement in pain status than did the low compliers at all follow-up times except 4 years on the scale retrospectively rating improvement in their condition (Table 11). Although the differences did not reach statistical significance, the trend is apparent: the means for the low complier improvement scores were consistently lower than those of the highest compliers (except at 4 years). However, the mean improvement rates at each follow-up time for this low compliance cohort were well above the 3.0 level which indicated no change, as was the case on the overall outcome measure (Table 10). Thus low compliers tend to show a high intermediate improvement on both indices, although not as high as the high compliance cohort.

Low compliers ascribed less of their improvement to the SR&RP at 1 year, 2 years, and 3 years than the highest compliers, but at 6 months and 4 years they ascribed as much or more of their improvement to the SR&RP as the highest compliers. The percent of the improvement ascribed to the SR&RP by the highest compliers increased over time from around 50% in the first 2 years to 85% at 3 years and 70% at 4 years (data not shown).

The highest compliers also rated the importance of the SR&RP to them very highly (from 8.5 at 6 months to 9.6 at 4 years on a scale of 1–10). At 2 and 3 years, the differences between the highest and the low compliers on this item were highly sta-

TABLE 10. *Comparison of improvement (OA) scores for highest, low, and lowest compliers*

	Outcome average (n)				
	6 months	1 year	2 years	3 years	4 years
Highest compliers[a]	3.92(25)	4.20(20)	4.22(12)	4.42(5)	3.90(5)
Low compliers[b]	3.68(21)	3.70(13)	3.56(27)	4.10(9)	3.78(10)
	NS[d]	NS	NS	NS	NS
Lowest compliers[c]	3.38(6)	3.00(4)	3.50(4)	4.25(2)	3.70(4)

[a] Regular formal meditators (meditating >3 times weekly and >15 min/time) and using AOBDL "often."
[b] Marginal formal meditators or stopped completely.
[c] Marginal formal meditators or stopped completely *and* using AOBDL "rarely if at all."
[d] Statistical significance was assessed using the *t*-test with the Bonferroni correction for multiple tests applied to the p values (25).

TABLE 11. *Mean improvement rating*[a]

	6 months	1 year	2 years	3 years	4 years
Highest C	4.08(26)	4.15(20)	3.92(12)	4.5(4)	4.0(5)
Low C	3.81(22)	3.92(13)	3.63(27)	3.8(10)	4.0(10)
	NS[b]	NS	NS	NS	NS

[a] Determined by response to rating scale of 1 to 5: 1, much worse; 2, worse; 3, no change in pain status; 4, moderate improvement; and 5, great improvement.
[b] All comparisons made using the *t*-test and correcting from multiple comparisons.

tistically significant in the *t*-test corrected for multiple tests ($p < 0.0005$) (data not shown). This analysis is weighted against finding such differences because of the less stringent definition of low compliers when the AOBDL constraint is not applied. The low compliers rated the importance of participation in the SR&RP as high as the highest compliers at 6-month follow-up, but this rating decreased relative to the highest compliers cohort by 1-year follow-up, although it remained in the range of 6 to 7 between 1-year and 4-year follow-up.

Responders to the follow-up questionnaires compared to nonresponders

Responders to the follow-up questionnaries were compared with nonresponders at each follow-up time to assess the likelihood of response bias in the follow-up results due to differences in demographic variables or differences between these populations in initial response to the intervention. Table 12 shows the results for the mean outcome average (OA) scores. No significant differences were found between responders and nonresponders on the outcome average attained post SR&RP. Nor were significant differences found for age, years with pain problem, sex ratios, nor in the mean percent change in the PRI, BPPA, MSCL, or GSI over the course of the intervention (data not shown). In fact,

TABLE 12. *Comparison of status post SR&RP of responders and nonresponders at each follow-up time*

	Mean post OA scores				
	6 months	1 year	2 years	3 years	4 years[a]
Responders	3.9(70)	3.9(37)	3.7(49)	3.9(34)	—
Nonresponders	3.8(31)	3.9(41)	3.6(16)	4.0(25)	—
	NS[b]	NS	NS	NS	

[a] OA was not in use when these individuals were in the SR&RP.
[b] Using multiple *t*-tests and the Bonferroni correction method (25).

the mean percent change on the PRI, BPPA, and GSI were higher for the nonresponders at 1 year follow-up, indicating that these subjects did at least as well on the average in terms of pain reduction, improvement of negative body image, and psychological improvement during the intervention as did the responders. We conclude from this comparison that the responders, who constituted the majority at all follow-up times, were representative of the entire population of SR&RP, at least in terms of success during the intervention period.

Effects of participation in a maintenance program on the follow-up results

As has been described elsewhere (4), a maintenance program for graduates of the SR&RP was available. Between 23–52% of the responders had taken one or more graduate programs at various follow-up times (Table 13). Cohorts of responders who had taken at least one maintenance program had higher mean OA scores at every follow-up time. The difference in OA scores was statistically significant in the *t*-test corrected for multiple tests. Thus, participation in a maintenance program did not contribute significantly to higher outcome scores at follow-up. However, when the time-dependent behavior of the PRI, BPPA, MSCL, and GSI were analyzed separately for the cohort of subjects who had not taken a maintenance program and for the cohort which had and were then compared, no statistically significant differences in the means were found at any follow-up time up to four years and the shapes of the follow-up curves were similar for both cohorts. Thus the overall follow-up

TABLE 13. *Effects of participation in a maintenance program on follow-up results*[a]

	Mean OA score at follow-up (n)				
	6 months	1 year	2 years	3 years	4 years
No maintenance	3.7(54)	3.9(35)	3.7(45)	3.7(25)	3.7(10)
≥1 maintenance program	4.0(16)	4.2(21)	4.0(26)	4.2(10)	4.0(11)
Percent of responders receiving maintenance	23%	38%	37%	29%	52%
p value[b]	0.025	0.026	0.041	0.037	2.6
	NS	NS	NS	NS	NS

[a] No information on maintenance program attendance was obtained in the first follow-up questionnaire. For this reason, some responders were excluded from this table in the 6 month and one year time periods.
[b] Corrected for multiple *t*-tests.

results presented in Fig. 1 were not significantly distorted by further intervention with a subset of the population.

DISCUSSION

Aronoff et al. (14) in reviewing the follow-up studies of pain units as of 1983 noted a number of methodological problems plaguing such reports, including obtaining follow-up data only by telephone, lack of use of standardized measures for assessing the multiple dimensions of pain status and of pain behaviors, lack of appropriate comparison controls, lack of large numbers of subjects, lack of direct assessment of status at time of follow-up to support retrospective judgments of degree of improvement, and overdependency on self-report data.

While this observational study suffers from some of these difficulties, and in particular the lack of a comparison control group and the reliance on self-report data, it has succeeded in obtaining outcome data from a large number of chronic pain patients following a well-described intervention based on self-regulation and in assessing their status at follow-up longitudinally with standardized measures as well as with retrospective judgments of improvement. It has also demonstrated a relatively high on-going compliance with the three major self-regulatory techniques utilized in the intervention, and demonstrated a relationship between compliance and a positive outcome. This relationship was difficult to quantitate, however, because over 93% of the follow-up responders continued to comply at some level with the intervention techniques, thus leaving a very small number of true noncompliers for statistical comparison.

Longitudinal behavior of outcome variables

The present study has expanded our original observations on 90 patients to a total of 225. Subjects were referred by their physicians with a range of chronic pain conditions for training in mindfulness meditation within the context of a Stress Reduction and Relaxation Program (SR&RP). This study confirmed an earlier finding (4,10,11) that large and significant improvements in measures of negative body image (BPPA), medical symptoms (MSCL), global psychological symptomatology (GSI), and overall improvement (OA) can be obtained in such a program by a chronic pain outpatient population over an 8-week intervention period. It also extended follow-up from 1.5 years (4) to 4 years and showed that the gains realized during the intervention period were maintained longitudinally in the population as a whole up to four years post intervention. The study also confirmed that the follow-up behavior on the PRI is different from the other outcome measures we used, as reported previously (4).

It is not clear whether the tendency of the PRI to return to pre-intervention levels at follow-up is an artifact due to a change in mode of administration of the instrument (pre- and post-assessments were conducted verbally in the hospital; follow-up was by self-administration at home) or represents a true worsening in present moment pain (4). The observation that the mean BPPA score remained at post-intervention levels over the follow-up period in spite of the behavior of the mean PRI rating suggests that many subjects were evaluating their pain problems as less problematic than prior to the intervention. One interpretation of this finding is that the patients at follow-up experienced a worsening of present-moment pain (PRI score) yet were better able to cope with it (BPPA score). However, since the majority of subjects were also retrospectively reporting moderate to great improvement in their pain since taking the SR&RP (Table 3) and showed an overall improvement as measured by the outcome average (OA) of between 3.8 and 4.0 at all follow-up times (4.0 = moderate improvement) (Table 2), it remains questionable whether the responses obtained at follow-up on the PRI represent a true reading of present-moment pain in most subjects.

As noted above, it was found that the majority of subjects at all follow-up times reported moderate to great improvement in pain status (Table 3). The fourth questionnaire had subjects rate the percent of their improvement they felt to be due directly to participation in the SR&RP (see Results). Sixty-eight percent of those responders who reported improvement in their pain ascribed 50% or more of that improvement to participation in the SR&RP, and 43% ascribed 80–100% of their improvement to the SR&RP. There was no decline in this rating as a function of time. Additional evidence that the SR&RP was instrumental in the change in pain status observed at follow-up comes from the response of subjects to two additional items on the fourth follow-up questionnaire. The first asked subjects if they felt they got "something of lasting value or importance" from the SR&RP. Over 85% responded in the affirmative (see Results). The second asked them to rate the importance of the SR&RP on a scale of 0–10. These ratings were also very high at all follow-up times (Table 4). In a section requesting subjects to describe in their own words what they valued most from the intervention, a range of first responses were obtained. The largest response category cited control over pain and stress (40%) and the next largest a new outlook on life (20%). Fifteen percent cited the specific techniques of meditation, yoga, and awareness of breathing, and 15% relaxation.

Taken together, these results suggest that the improvements observed longitudinally on the outcome measures (Fig. 1, Table 2, Table 3) following the intervention were accompanied by reports of an important experience for the majority of subjects (Table 4) and an increased sense of control over pain and stress up to four years following the program.

Compliance

This four-year follow-up study also extended our earlier observation (4) that pain patients continued to adhere to a combination of formal and informal uses of the meditative techniques and the yoga in which they were trained in the SR&RP. Between 58 and 83% of responders at the various follow-up times reported that they continued to meditate at the time of inquiry, while over 93% reported using at least one of the techniques at least some of the time (see Results). Since mindfulness meditation techniques can be applied informally as well as through formal practice, detailed information on frequency and duration of formal meditation sessions was obtained, thus allowing us to define with some precision three compliance categories for the formal meditation practice (Table 6). The highest compliance category for formal meditation, labeled regular meditation practice, was defined by practicing three or more times per week for 15 min or more at a time. Fifty-six percent of the responders at 6 months and 1 year were in this category. Another 20% practiced once a week or more for more than 15 min per time or more than 3 times per week for less than 15 min per time. As the percentage of individuals in the highest category declined after one year, that in the lowest compliance category (less than one time per week and less than 15 min at a time) increased.

These results compare very favorably with other studies of compliance with relaxation and meditation techniques. In a 1- to 5-year follow-up of relaxation practice following biofeedback therapy for 58 patients, most of whom had headache disorders, Libo and Arnold found that 74% of the responders to follow-up were practicing the relaxation techniques occasionally, which was defined as "less than once a week or as needed" (15). In a study of meditation and relaxation techniques in a working population, Carrington et al. found that at 5.5 months post-instruction, 53% of compliers were practicing frequently, defined as "several times a week or more," while 47% were practicing occasionally, defined as "once a week or less" (16). In neither study was length of the practice session determined. By these authors' definitions of frequent practice, both regular and sporadic meditators in our study would be termed "frequent" practitioners without any consideration of duration of practice.

Compliance with the mindful yoga exercise at a frequency of twice or more weekly (duration not specified) was 44% at 6-month follow-up and declined to 27% of responders by 4 years (Table 7). Since this technique necessitates working with stretching and musculoskeletal strengthening, it is not surprising that compliance is lower in a chronic pain population than for the meditation techniques (body scan or sitting) which do not involve movement and exploring one's physical limits. We consider 44% compliance at 6 months to be high for this technique and this population (see below).

In the case of the informal meditation technique of awareness of breathing in daily life situations (AOBDL) (Table 8), no physical effort is required, nor any extra time demanded to engage in this practice. It is simply an intentional shift in awareness invoked to cultivate relaxed moment-to-moment attention (mindfulness) during one's day. Thus it is not surprising that a large percentage of the responders reported using it "often" on a daily basis. It corresponds to a moment of mindfulness or awareness. Its use did not decline over the study period and a large percentage of respondents reported it to be "very useful" in coping (Table 9).

As pointed out in Results, at every follow-up time up to four years, at least 93% of responders reported practicing one of the three techniques (formal meditation, yoga, awareness of breathing) at some level, while at least 36% reported practicing all three. This is a very high level of overall compliance with a cognitive-behavioral intervention, particularly for a chronic pain population.

The meaning of compliance results

In discussing the meaning of compliance with, or more appropriately, adherence to self-regulatory techniques such as meditation, yoga, and informal awareness of breathing, it is crucial to define the spectrum of adherence behaviors as precisely as possible since the descriptors "high" and "low" contain little information. We consider that making at least 15 min available at least three times per week for a formal period of "non-doing," in which one resides in a moment-to-moment awareness of breathing, body sensations, and other internal and external perceptions, is a significant change in cognitive-behavioral patterning for any individual, particularly if it is maintained over months and years. The cohort exhibiting this behavior was labeled "regular" meditators (Table 6). We consider this cohort to be "high" in compliance with this particular formal meditation practice. In evaluating compliance with the informal meditation practice of awareness of breathing (AOBDL) those individuals who reported engaging in this behavior "often" as opposed to "sometimes," "rarely," or "never," were classified as "high" compliers for this particular technique. We then defined a "highest complier" category for the purpose of comparing the extremes of the compliance spectrum in terms of outcome (see below). The "highest complier" category included those subjects who were high compliers for both the formal and the informal meditation practices.

Other authors have applied different standards in evaluating compliance. Different subjective attributions of "high" and "low" compliance make comparisons between interventions difficult and problematic as do different populations of subjects. For this reason, the actual data on frequency and duration of practice are important in interpreting levels of compliance. For example, Lutz, et al., in a study of 57 chronic pain patients who were assessed via questionnaire or telephone interview an average of 23.4 months following a 4-week multidisciplinary pain program, reported an average daily compliance rate for separate therapy regimens (i.e., PT and OT exercises, relaxation and self-hypnosis exercises, and use of proper body mechanics) of 42% and an overall compliance with all three regimens of only 12% (7), which they termed a "strikingly low" compliance rate for their population. Yet if those subjects who reported following the regimens three or more times per week had also been included, their compliance rate would have been 71%. Since they explicitly note for separate regimens that pain patients are likely to "drop large segments of their prescribed regimens," and that this behavior is "both understandable and predictable given the demanding and complex nature of the post-treatment regimens prescribed" (7) this study demonstrates the importance of carefully evaluating the stringency of post-treatment compliance demands and their effect on actual compliance and outcome, and of presenting the actual compliance data. This is crucial to be able to assess and compare compliance behaviors between studies.

Our approach has been to offer patients a demanding 8-week training program which includes at least one 45-min session of formal meditation or yoga at least six times per week at home (using audiocassette tapes for guidance) in addition to a 2-h class once a week and one 8-h "meditation retreat" which takes place *in silence* with on-going alternating of mindfulness practices over the course of the full 8 h. The majority of patients appear to adhere closely to the practice schedule during the intervention (Kabat-Zinn, unpublished). Following completion of the program, however, subjects are encouraged to "make the techniques their own," and to pursue only the ones that they feel are beneficial or that they enjoy. They are also encouraged to modify them to suit their needs. Thus, while we do strongly suggest to all SR&RP completers the importance of continuing to practice the meditation techniques learned in the SR&RP, we also emphasize that they should experiment with different lengths of time, practice without use of tapes whenever possible, and use the techniques in ways that will fit in with demands of their particular life situations. We think it is noteworthy that 56% of the responders at one year and 30% of the responders at 4 years in the present study continued to make use of the most difficult and demanding techniques (the formal meditation practices) they learned with a frequence of three or more times per week and a duration of 15 min or more per day (Table 6), and that approximately 80% of all subjects reported some level of meditation practice (Table 5) when technique, frequency, and duration are not specified. Many of the subjects responding negatively to this item actually were meditating formally at a marginal level in response to more precise inquiries of technique, frequency, and duration (Table 6).

The high level of overall compliance at follow-up in this study is probably due in large measure to the fact that during the intervention subjects routinely practiced formal meditation or yoga for 45 min at a time, six days per week. No other outpatient program we know of requires this amount of time spent in practicing self-regulation techniques. As noted above, if one includes use of the yoga exercises and awareness of breathing in daily life (AODBL), greater than 93% of the responders at all follow-up times reported continued involvement with the techniques of the intervention. That these self-regulatory techniques continued to be utilized in a self-motivated manner by patients long after the initial training program ended suggests that they are of considerable and lasting value for many, if not most, of the ambulatory chronic pain patients in this study—as in fact they reported in their free-text comments and in response to specific items on the follow-up questionnaires (see Results).

Thus, while the definitions of "high compliance" and of "frequent" vs. "occasional" practice vary from study to study and are somewhat arbitrary and subjective, particularly with regard to chronic pain patients, the results of this study suggest that realistic standards can be applied to optimize the probability that a practical level of adherence to self-regulating regimens can be adhered to over a long time period following intervention.

Relationship of compliance levels to outcome

Where outcomes for the highest compliers and low compliance cohorts were compared, the results showed only a modest relationship between degree of compliance and improvement, particularly in the first two years of follow-up (Table 10). Those subjects in the highest complier category had higher OA scores than low compliers at most follow-up times. However, in no case was the difference statistically significant when the p values in the *t*-test were corrected for multiple tests. However, most subjects in the low compliance category reported making use of AOBDL often or occasionally and thus were utilizing an informal meditation technique on an "occasional" or "as needed" basis. A "lowest complier" cohort was established by excluding these subjects. However, the n for this cohort was very small at each time period because almost all subjects were in relatively high compliance with either formal meditation or AOBDL. The lowest compliance subjects had mean OA scores well below that of the highest and the low compliance categories at four of the five follow-up times. Thus, we conclude that there is a modest relationship between compliance as defined and improvement in overall status. Thus, in this population, at least some of the improvement in pain status appears to be related to the degree of meditation practice; and it may be that whether one practices at all is of greater importance than how much one practices, as suggested by the study of Carrington et al. as well (16) (see below). A more precise quantitative and statistical analysis was not possible in the present study as noted previously (see Results).

There are conflicting reports in the relaxation literature concerning the quantitative relationship between compliance and therapeutic results. However, no compliance study has utilized a chronic pain population to address this question. In a study of a working population trained in different meditation and relaxation techniques for stress management, Carrington et al. (16) found that improvement in psychological distress scores on the SCL-90-R was not related to whether subjects reported frequent or occasional practice. Occasional practice (once a week or less) was as effective in symptom reduction as regular practice. However, subjects who no longer practiced at all by 5.5-month follow-up had significantly lower SCL-90-R sources which were indistinguishable from those of a control group which had never practiced the techniques. A similar finding was reported by Libo and Arnold (15). These studies suggested that, at least for the populations studied, it is whether one is practicing at all which makes the difference in outcome, rather than how much one is practicing. This result differs from a number of studies using TM, cited by Carrington, which reported positive effects of frequent as opposed to occasional practice of meditation on a number of psychological parameters. Carrington et al. suggested that population differences might account for some of this discrepancy and that "when stress symptoms approach clinical levels, even a moderate amount of meditation or the use of strategic meditation when needed, is sufficient to achieve sharp reductions in symptomatology" (16). They did note that frequent practitioners were more satisfied with their techniques than occasional practitioners.

Similarly, in our population of chronic pain patients, the cohort of highest compliers attributed greater importance to the SR&RP as a whole than did low compliers at all follow-up times except 6 months. These differences were statistically significant at 2 and 3 years (data not shown). Our results also showed a modest relationship between *amount* of practice and level of improvement in a chronic pain population, although as noted, even low compliance was associated with moderate improvement. These findings say nothing about the reasons for this relationship. Further studies are necessary to determine whether a positive outcome is causally related to degree of compliance.

The role of program effects

Although an association between compliance with the meditation practices and improvement in status was found, quantitative measures of therapeutic efficacy cannot be ascribed to individual components of the intervention, including the meditation techniques, in this type of study. While some individuals reported that the benefits came primarily from the techniques themselves, overall program effects are also at work and different subpopulations may have found different aspects of the intervention beneficial. For instance, the majority of the low compliers at follow-up had good improvement measured by the OA, suggesting that an intense 8-week intervention in and of itself can have an effect on an individual by providing information, group support and empathy, problem sharing, practice and reinforcement of new behaviors, and a structured approach to behavior change. Learning theory (17) suggests that various components of the SR&RP intervention could have had a critical effect on subjects' attitudes, behaviors, and cognitions which may not have required reinforcement in some individuals via continued adherence to the techniques or by participation in maintenance programs. Having had an experience of self-efficacy in regard to pain self-regulation may be sufficient in some individuals to produce a positive outcome at follow-up without further formal adherence to the techniques. Just knowing they are available as internal resources to be elicited when needed may suffice in such individuals.

The present intervention is based on the theoretical assumption that training in a rigorous consciousness discipline (18), such as mindfulness meditation, in a clinical setting can optimize multiple aspects of the cognitive-behavioral learning process in chronic patients and thereby promote positive change. The meditation practice evokes a new pattern of perceiving based on intentionally paying attention in a moment-to-moment mode. It is thus potentially applicable to a wide range of human activities and experiences. Mindfulness meditation can be thought of as a generalized reference-frame shift from partial awareness (an "automatic pilot" mode of functioning) to moment-to-moment awareness with a nonjudgmental, witnessing quality (10). Once one has been exposed to this approach in a formal setting, the application of moment-to-moment mindfulness to one's life experience has the potential to modify the way one perceives one's self and one's experience. It can also influence how one responds to pain and stress. In this regard, an ability to use awareness of one's breathing in daily life (AOBDL) as an anchor for moment-to-moment awareness and as a reference point for responding with awareness to pain or to stressful situations becomes particularly relevant, since this is by far the most popular and most used meditation technique among our patients (Kabat-Zinn, unpublished) and can be done under almost any circumstances. There are strong theoretical and practical reasons which suggest that a learned and intentional use of moment-to-moment awareness can have a profound effect on pain perception, the experience of suffering, and on stress reactivity (10). The follow-up findings in the present study support the concept that such a mode of being and perceiving may be of on-going value in coping with the experience of chronic pain even in subjects who no longer practice the more formal dimensions of the meditation or practice them infrequently (see Tables 8 and 9).

The effect of maintenance programs and partial returns on the follow-up outcome

The subjects who participated in a maintenance program prior to the time of follow-up assessment consistently had higher improvement (OA) scores than subjects who had had no further formal exposure to the techniques through the SR&RP, although the difference was not statistically significant. This finding does not imply causality, as these subjects may have already had a higher affinity for the techniques and might have continued to maintain or improve status without a maintenance program. The overall reductions observed in Fig. 1 were not significantly affected by inclusion of those subjects who had participated in maintenance programs at the time of follow-up.

The responders to the follow-up questionnaires did not differ from the nonresponders, at least at the time of completion of the SR&RP, in any detectable way on our indices, suggesting that the results of this study probably accurately reflect the status of the entire population. Some nonresponders indicated by phone or at the hospital that they were doing well but no longer wanted to fill out questionnaires.

Comparison with other follow-up studies

The improvement in chronic pain status reported here and its maintenance over time following a cognitive-behavioral intervention are similar in magnitude to results reported by Toomey et al. (19) in a five-year follow-up study of nerve block treatment outcomes. It would be interesting in this regard to compare for particular diagnostic entities the cost–benefit of the self-regulatory approach based on meditation training in a stress reduction setting to those of a medically oriented pain clinic, based on more technological and expensive interventions. This is particularly compelling in light of a previous finding (4) of significant improvements in chronic pain patients in the SR&RP compared to a comparable but not randomly defined cohort of patients receiving pain clinic intervention alone.

Shortcomings of the method

Self-report questionnaires are intrinsically limited and open to response biases of particular kinds. By making the follow-up questionnaires extremely detailed, we hoped to discourage exaggeration of compliance and improvement. However, it is possible that the results have been distorted to some extent by such factors. This is particularly true for the reports of compliance with the formal meditation techniques in light of the findings of Taylor et al. (20) and Hoelscher et al. (21) who showed that subjects consistently exaggerated reports of compliance with a taped relaxation technique when assessed by objective methods, and the fact that we had no objective method for ascertaining veracity of reporting.

Of the small number of follow-up studies which have been conducted following psychological interventions for pain control, very few include a no-treatment control group (22–24) and none of these were for an outpatient intervention oriented toward learned self-regulation. Since the present study is observational, it also lacks a no-treatment control. In a previous study (4) we compared the SR&RP intervention with pain clinic treatments and found, as noted above, substantially greater improvement in the former. However, the comparison group in this study was too small to make long-term follow-up feasible.

SUMMARY

Two hundred and twenty five consecutive chronic pain outpatients who completed the meditation-based intervention were studied longitudinally. Measure of follow-up status was obtained on four questionnaires, mailed to the study population over the four-year follow-up period. Rates of return on the questionnaires were high (75%, 73%, 45%, and 68%, respectively). Large and significant reductions were observed in the group means on the Pain Rating Index (PRI), and measures of negative body image (BPPA), number of medical symptoms (MSCL), and global psychology symptomatology (GSI of the SCL-90-R) over the course of the 8-week intervention. Reductions in BPPA, MSCL, and GSI were maintained over the four-year follow-up period. The PRI tended to return to pre-intervention levels at follow-up. This may be due to a change in method of administration of the measure at follow-up. A retrospective measure of overall improvement (OA) also showed maintenance of the post level of outcome across all follow-up times. Seventy-two percent of responding subjects reported moderate to great improvement in pain status at 6 months, 1 year, and 3 years, while 62% and 60%, respectively, reached this level at 2 years and 4 years. A high proportion of responders rated the SR&RP as very important to them at all follow-up times and attributed much of their improvement in pain status to the intervention.

A compliance analysis showed that the majority of responders continued to meditate at follow-up and that males and females did not differ in this regard. Over 93% of responders reported practice of at least one of the intervention techniques at some level. Formal meditation was practiced by 56% of the responders at 6 months and 1 year at a rate of three or more times per week for 15 min or more at a session. An additional 20%, approximately, practiced once a week or more but less than three times per week. Compliance at the "once a week or more" level was over 50% at all follow-up times. Compliance was also high for yoga practice and for use of awareness of breathing in daily life (AOBDL), an informal mindfulness technique used as the basis for a number of coping strategies. A positive outcome tended to reflect the level of compliance with a combination of formal and informal meditation techniques, although statistical significance was not attained in this analysis. No major

biases were introduced via selected returns from the questionnaires nor from additional interventions. We conclude that mindfulness meditation training in the context of stress reduction results in long-term improvement of an ambulatory chronic pain population, continued compliance with the techniques, and reports of high patient satisfaction with the intervention.

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The Clinical Use of Mindfulness Meditation for the Self-Regulation of Chronic Pain

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Ninety chronic pain patients were trained in mindfulness meditation in a 10-week Stress Reduction and Relaxation Program. Statistically significant reductions were observed in measures of present-moment pain, negative body image, inhibition of activity by pain, symptoms, mood disturbance, and psychological symptomatology, including anxiety and depression. Pain-related drug utilization decreased and activity levels and feelings of self-esteem increased. Improvement appeared to be independent of gender, source of referral, and type of pain. A comparison group of pain patients did not show significant improvement on these measures after traditional treatment protocols. At follow-up, the improvements observed during the meditation training were maintained up to 15 months post-meditation training for all measures except present-moment pain. The majority of subjects reported continued high compliance with the meditation practice as part of their daily lives. The relationship of mindfulness meditation to other psychological methods for chronic pain control is discussed.

KEY WORDS: meditation; pain; self-regulation; coping; stress.

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INTRODUCTION

Achieving improvement in the quality of life for individuals suffering from chronic pain presents a profound dilemma for the clinician, perhaps reflecting a deep dilemma in the paradigm of medicine itself (Cassel, 1982; McCue, 1982). In spite of the modern armamentarium for directly treating persistent pain with analgesics, narcotics, and surgery, reliable relief from chronic pain in many cases remains an elusive goal. With this has come the recognition of the need to intervene to treat the psychological dimensions of chronic pain (Melzack and Wall, 1970; Sternback, 1978). This view has led to a range of psychological interventions, many emphasizing strategies of self-regulation. The latter have included biofeedback, relaxation training, hypnosis, and cognitive-behavioral therapies (see Melzack and Wall, 1983; Turk *et al.,* 1983). Studies employing psychological modalities in the treatment of chronic pain have been recently reviewed and critically discussed by Turner and Chapman (Turner and Chapman, 1982a,b). All the modalities reviewed have proven useful in certain circumstances, and all have particular limitations in perspective (Turner and Chapman, 1982a,b).

In an even more recent development, meditative practives from oriental traditions such as Zen Buddhism, Vipassana, and Yoga, without their original religious, cultural, and ideological forms, have been introduced into some therapeutic settings as strategies for self-regulation (Shapiro, 1980; Deatherage, 1975; Shapiro and Giber, 1978; Kutz *et al.,* 1985a,b) and have also become the focus of systematic research efforts (Benson, 1975; Burns and Ohayv, 1980; Davidson, 1976; Maliszewski, 1981; Walsh, 1977, 1978, 1983; Woolfolk, 1975). It has been suggested that these practices, collectively termed "consciousness disciplines," are based on assumptions about human nature which differ in fundamental ways from the paradigms upon which Western psychology and behavior science rest (Walsh, 1980). These assumptions include (1) that "our usual state of consciousness is severely suboptimal" and (2) that "through intensive mental training it is possible to attain states of consciousness and psychological well-being beyond those currently described by traditional Western psychologies, as well as profound insight into the nature of mental processes, consciousness, and reality" (Walsh, 1980). Commenting on methods of psychological transformation, C. G. Jung once remarked that the "methods and philosophical doctrines [that] have been developed [in the East] simply put all Western attempts along these lines into the shade" (Jung, 1969). If such views have any substance, they suggest that the meditative traditions may have important and unique viewpoints and methods to offer behavioral science in general and clinical behavioral medicine in particular (Deikman, 1982). It is also plausible that the relaxation exercises and cognitive and behavioral therapies developed within the Western psychological paradigm might be further developed and deepened via exposure to rigorous meditation practice and a systematic study of its empirical effects (Burns, 1973). There is no doubt that the Eastern traditions can also benefit from the psychological sophistication of the West (see, e.g., Butler, 1983) and that both paradigms can be enriched by cross-fertilization. It was with these notions in mind that we chose to create a behavioral medicine clinic based on training in meditation.

This paper describes the clinical use of relatively intensive training in the consciousness discipline known generically as *mindfulness* or *awareness meditation* in a hospital outpatient stress reduction program and the outcome for 90 patients referred to it for chronic pain conditions in its first 2 years of operation. Preliminary results have been reported (Kabat-Zinn and Burney, 1981; Kabat-Zinn, 1982). Initial observations suggested that training in meditation is acceptable to a broad spectrum of medical outpatients and can be effective in reducing pain and pain-related behaviors for a range of chronic pain conditions.

Mindfulness meditation has roots within Theravada Buddhism, where it is known as *satipatana vipassana* or insight meditation (Nyanaponika, 1962), in Mahayana Buddhism in Soto Zen practices (Suzuki, 1970), and in the Yogic traditions as expressed in the contemporary writings of J. Krishnamurti (1979), Vimila Thakar (1977), and Nisargadatta Maharaj (1973). This form of meditation is a highly developed, coherent, systematic, and multimodal utilization of attention. One of its primary goals is the development of "insight" into the actuality of phenomena, achieved by the cultivation of what the Buddhists refer to as "bare attention" or "detached observation" (Nyanaponika, 1962). This is a moment-to-moment effort to perceive a phenomenon and to allow it to register with full awareness, as it is, without gross distortion of the bare percept from associated and second-order meanings to the ego of the observer (see Naranjo and Ornstein, 1971). The meditation instructions themselves are an active support in minimizing distortion of this kind.

In the case of pain perception, the cultivation of detached observation of the pain experience may be achieved by paying careful attention to and distinguishing *as separate events* the actual primary sensations as they occur from moment to moment and any accompanying thoughts about pain. The rationale for the choice of this form of meditation and a description of its use in the stress reduction program have been presented elsewhere (Kabat-Zinn, 1982).

In this outcome study, we sought to address the specific questions listed below. For clarity, after each question the indices which measure the relevant parameters in this study are listed in parentheses (see Methods).

Can mindfulness meditation training in the context of stress reduction effectively

(1) reduce pain levels over an extended period of time (10 weeks)? (PRI, BPM);
(2) lead to improvement in body image and reduced somaticizing? (BPPA, SOM scale of SCL-90-R);
(3) help in coping with persistent pain so that it will interfere less with the performance of routine activities of normal living? (TLI);
(4) reduce the characteristically elevated negative affective states in chronic pain patients, in particular depression, hostility, low self-esteem, and anxiety? (POMS, SCL-90-R);
(5) compare favorably in outcome with more traditional and more expensive medical treatments for the same pain conditions? (comparison with nonmeditating Pain Clinic patients);
(6) produce positive long-term improvements in pain, coping behaviors, and affect? (follow-up questionnaire); and
(7) lead to a continued, voluntary practice of the meditation following training? (follow-up questionnaire).

METHODS

Program Design

The meditation training took place in a 10-week Stress Reduction and Relaxation Program (SR&RP). The SR&RP is a clinical service of the Division of Preventive and Behavioral Medicine in the Department of Medicine at the University of Massachusetts Medical Center. Chronic pain is one reason for referral to this program. Approximately 60% of the patients are referred for stress-related medical problems having nothing to do with pain. This report concerns only those patients referred in the first 2 years of the program with a diagnosed pain condition of greater than 6 months' duration, well substantiated by medical history, who had not improved with traditional medical care. All patients were physician referred.

Each individual was seen initially in an evaluation interview which included a detailed description of the program. The description emphasized that the program was educational in nature and that a high degree of discipline on the patient's part was required. It was explained that the SR&RP was based on intensive, daily practice of meditation and on the practical application of meditation for coping with stress and pain. The program was explicitly differentiated from behavior modification programs and from group therapy. If the patient chose to enroll, a battery of interviewer-administered and self-report questionnaires (see below) was given. The information from these instruments constituted the pre-meditation-training data base (pre).

The SR&RP courses are conducted in cycles three times a year. Each cycle consists of ten 2-hr classes, one per week, in which a variety of forms of fulness meditation are taught and practiced [for details see Discussion and Kabat-Zinn (1982)].[5] All subjects in this study were required to meditate formally for a minimum of 45 min per day, 6 days per week, for homework, using an audiocassette tape in the beginning weeks for guidance. Instruction and practice of Hatha Yoga were included as a form of meditative exercise for those who could do it. It functioned primarily to improve musculoskeletal strength and flexibility and reduce disuse atrophy. The Yoga was taught emphasizing mindfulness (Kabat-Zinn, 1982).

Each SR&RP course was conducted by an instructor on the SR&RP staff. The instructors have practiced mindfulness meditation regularly for many years and continue to engage in periodic retreats for intensive training and practice.

Following the course, each patient was seen individually in a second evaluation interview, during which post-meditation-training data (post) were obtained.

Patient Characteristics

The subjects in this study were trained in meditation in five consecutive 10-week cycles of the SR&RP in 1980 and 1981. Referrals were from four major sources within the hospital: the Pain Control Center (Pain Clinic; PC) [low back, neck, shoulder, arm, leg, and facial pain and multiple-site pain (chronic pain syndrome) ($N = 21$); the Orthopedic Clinic (similar to the PC profile)] ($N = 18$); the Neurology Clinic (headaches, including migraine and tension; low back pain; and peripheral nerve problems) ($N = 8$); and the Adult Primary Care Clinic (headaches and chest pain) ($N = 23$). The remaining 20 subjects in this study were referred for pain problems from medical subspecialists such as gastroenterologists and cardiologists, from psychiatrists, or from physicians outside the hospital.

All patients were enrolled if they met the entry criteria for the SR&RP and agreed to make the necessary commitment of time and effort. Over 90% of the patients contacted after referral came for an initial evaluation interview, and 80 to 90% of those enrolled in the program. Of the patients beginning the program, 80-90% completed it. These percentages varied within these limits for different cycles of the program. Data from all the cycles have been

[5] The SR&RP was recently changed to an 8-week course including an additional 8-hr intensive "retreat" session.

pooled and averaged in reporting the results except for the follow-up study, in which each cycle is plotted separately. The patient characteristics are shown in Table IA. The majority had long histories of medical treatment for their conditions, with little or no improvement in either pain status or affective and cognitive/behavioral status prior to enrolling in the SR&RP.

Subsequent Intervention. The SR&RP offers as a sequel an "advanced" course to deepen the process begun in the initial mediation training. This graduate SR&RP is an 8-week course with a format similar to that the of basic SR&RP. The periods of meditation are longer and less guided. Some of the patients in this study had taken one or more graduate courses at the time some of the follow-up data were obtained (see Results).

Follow-Up

Follow-up data were solicited from all patients who completed the SR&PR by periodic mailing of questionnaires at approximately 2.5, 4.5, 7, 12, and 15 months after completion of the program. In addition to follow-up information on pain and psychological status, detailed information was obtained about whether and how much individuals were meditating and about the techniques they had found the most useful.

Comparison Group

One of our objectives was to compare the outcome of this nontraditional approach with that of a more traditional medical, pain-specific approach with similar patients. To this end we compared outcomes between pain patients trained in meditation and pain patients undergoing treatment but who were not trained in any form of self-regulation. This was possible because the same battery of data instruments given to the meditators pre and post was also employed with all outpatients in the Pain Clinic at the initial visit and at a clinic visit 10 weeks later. A cohort of 21 consecutive patients who were being treated by the traditional methods of the PC (which include nerve blocks, TENS, physical therapy, analgesics, antidepressants) and who had not been referred to the SR&RP at the time of the comparison was monitored over a 10-week period (PC comparison group). The outcome for these individuals was compared with that for those patients ($N = 21$) referred to the SR&RP from the Pain Clinic (PC referrals). During the meditation training some, but not all, of the PC referrals received periodic treatments at the Pain Clinic and continued to take prescribed medication. The remainder had completed their treatmentcourse in the pain Clinic. In all cases, however, individuals were referred to the SR&RP because they had continued to have pain without improvement at the time of referral.

It is important to note that this is not a prospective randomized study but a descriptive comparison of two functioning hospital clinics. In both clinics, referral includes elaborate placebo concomitants such as enthusiastic referral to a special program and high expectation of pain relief. It was hypothesized that both cohorts in the comparison would show positive changes in pain status associated with these placebo elements to a similar extent and that quantitative differences due to the specific interventions might be distinguishable in the comparison. However, the fact that the patients were not distributed randomly to the two interventions to be compared means that conclusions based on the observations must be limited (see Discussion). The relevant differences between the comparison groups are cited in Table IB.

Pain Indices and Psychological/Behavioral Measures

A number of different self-report indices was used to assess the multiple aspects of pain and certain pain-related behaviors of interest to us in addressing the questions posed in the Introduction. The McGill–Melzack Pain Rating Index (PRI) (Melzack, 1975) measured present-moment pain; the Body Parts Problem Assessment (BPPA) Scale (Kabat-Zinn, 1983) measured how problematic the patient viewed various body parts; the Table of Levels of Interference (TLI) measured how pain affected activities of normal living (Kabat-Zinn, 1982); and the three-color Body Pain Map (BPM)[6] assessed changes in pain distribution, intensity, and frequency (Kabat-Zinn, 1982). In addition, the total number of symptoms reported in the preceding month was monitored using a medically oriented symptom checklist (MSCL) (Kabat-Zinn, 1982). These indices measure overlapping aspects of pain and are not completely independent of each other.

Affective status was assessed using the Profile of Mood States (McNair *et al.*, 1971) and is represented in the results by the summary Total Mood Disturbance (TMD) score.

Psychological symptomatology was assessed using the revised Hopkins Symptom Checklist (SCL-90-R). The SCL-90-R is a validated 90-item inventory (Derogatis, 1977) consisting of nine symptom dimensions: Somatization (perceptions of bodily dysfunction), Obsessive-Compulsive, Interpersonal Sensitivity (feelings of personal inadequacy and inferiority, lack of self-esteem); Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism. The summary score, termed the General Severity Index (GSI), combines information on numbers of symptoms and intensity of per-

[6]Previously used with dermatomes and referred to as the Dermatome Pain Map (DPM).

Table I. Patient Characteristics

	No. of males	No. of females	Mean age (years)	Mean chronicity' (years)	No. of surgeries for pain	Major diagnostic category: LBP	Headache	Neck/shoulder	Other
(A) Total population ($N = 90$)	30	60	44	8.1	—	31	24	15	20
(B) PC referrals ($N = 21$)	5	16	48	8.0	1.95	13	—	2	6
PC comparison group ($N = 21$)	13	8	37	4.6	1.10	9	—	9	3

ceived distress (Derogatis, 1977). The SCL-90-R has been shown to correlate well with comparable scales on the MMPI (Derogatis *et al.*, 1976).

The POMS and the SCL-90 (R) were employed together to obtain profiles of affective status and psychological symptoms since chronic pain is known to cause or be accompanied by severe mood disturbance as well as by depression, loss of self-esteem, irritability, and anxiety. These instruments have been shown to have independent predictive variance (Haskell *et al.*, 1969).

A Summary Outcome Questionnaire was used with the SR&RP patients both post-meditation training and at follow-up. This instrument was designed to yield a single number representative of the average degree of change in 10 relevant symptom and behavioral parameters since taking the SR&RP. It consisted of 10 questions pertaining to pain frequency, severity, use of drugs to control pain, activity levels, attendance at work, energy levels, feelings in general, ability to cope with stress, frequency of physician visits, and blood pressure. The rating scale was from 1 to 5, where 3 represented "no change," 5 "great improvement," 4 "some improvement," 2 "worse," and 1 "much worse," with the exact wording of each scale topic appropriate. Ratings for the 10 questions were averaged to give the Summary Outcome Score. If certain items were not applicable, the patient circled an option to that effect, and the average was calculated for the number of questions answered.

Data Analysis

Data were analyzed using standard SPSS programs. The matched t test was used to determine significance for paired pre-post or pre-follow-up results for the same subjects over time. The unmatched t test was used to determine significance in the comparison of outcomes for the PC patients trained in meditation with the patients in the PC comparison group. The Bonferroni adjustment was then applied to the P values from all t tests as recommended by Ingelfinger *et al.* (1983) to reduce the risk of type 1 error from multiple comparisons. Further analyses to identify possible predictors of outcome were undertaken using linear regression and discriminatory analysis (unpublished results).

RESULTS

Pain Outcome

Outcome was first analyzed for the total group. For every pain index, the mean value was reduced significantly ($P < 0.003$) between pre- and postin-

Table II. Pain Outcomes for the Total Population

	(A) Group means[a]		
	PRI	BPPA	TLI
Pre	19.3	41.6	11.8
Post	8.2	29.6	8.2
% change in mean	58[c]	29[c]	30[c]
N	57	87	61

	(B) Individual gains[b]				
	ΔPRI		ΔBPPA		ΔBPM
Level of reduction	≥33.3%	≥50%	≥33.3%	≥50%	+ +/+ + +
Number reaching this level	41/57	35/57	48/86	36/86	42/87
% of total patients	72	61	56	42	48

[a]PRI, Pain Rating Index; BPPA, Body Parts Problem Assessment score; TLI, Table of Levels of Interference with daily activities.
[b]Fraction of individuals achieving the indicated level of reduction or improvement on each index. The TLI is not included. BPM, Body Pain Map; scored by comparison of pre and post drawings of the patient's pain (see Kabat-Zinn, 1982). The fraction represents the number of individuals in the population who were scored as either + + (moderate improvement) or + + + (great improvement). The PRI values have been corrected for zero values (Melzack, 1975).
[c]$P < 0.003$ in t test adjusted for multiple comparisons using the Bonferroni method (Ingelfinger *et al.*, 1983).

tervention assessments (Table IIA). Quantitatively similar results were obtained for the mean percentage change (Melzack and Perry, 1975) in each index (data not shown). The group mean value of the PRI was reduced 58%, that of the BPPA was reduced 29%, and that of the TLI was reduced 30%.

Outcome was also expressed in terms of individual achievements (Table IIB) following the format of Melzack and Perry (1975). By the end of meditation training, the large majority (72 and 56%, respectively) of the patients had achieved levels of pain reduction on the PRI and negative body image on the BPPA of greater than or equal to 33%, and 61 and 42%, respectively, achieved reductions of greater than 50%. The Δ BPM column in Table IIB shows that 48% achieved moderate to great improvement (+ +/+ + +) between initial drawings of their pain and drawings done following meditation training.

Symptom, Mood, and Psychological Outcome

In parallel with the pain outcome, the mean scores for the number of symptoms reported for the preceding month (MSCL), mood disturbance

(TMD), and psychological symptomatology (GSI) were reduced by 35, 55, and 35%, respectively ($P < 0.003$) (Table IIIA). The majority (54 and 59%, respectively) achieved reductions of greater than 33% on the MSCL and the GSI,[7] and 37 and 39%, respectively, achieved reductions of greater than 50% (Table IIIB). There were significant mean reductions in all dimensions of the SCL-90-R; these were largest for anxiety and depression (unpublished data).

Overall Outcome

The distribution of Summary Outcome Scores for cycles 3, 4, and 5 reflected these improvements. These subjects ($N = 59$) had filled out the Summary Outcome Questionnaire (see Methods) at the end of meditation training as part of the battery of post outcome measures. This measure has a scale from 1 to 5, where 3 represents no change, 1 represents a large negative change, and 5 represents a large positive change. The mean score was 3.9: 76% of the patients (45 of 59) scored 3.5 or above, and 61% (36 of 59) scored 3.8 or above. The range from 3.8 to 5.0 empirically reflects a moderate to great improvement in pain and in overall health status. One item asked for changes in medications for pain control. Of the patients in these cycles who were using drugs to control pain before taking the SR&RP ($N = 39$), 17 (44%) reported reduced drug dosages, and an additional 11 individuals (28%) reported rarely or never using medication for pain relief by the end of the SR&RP.

Analysis by Pain Category

A comparison of outcomes for the three major diagnostic classes of pain among the patients was performed. These were (1) low back pain with or without leg pain ($N = 31$), (2) headache including migraine and tension headaches, ($N = 24$), and (3) neck and shoulder pain ($N = 15$). The results are presented in Table IVA. As expected, the mean initial levels for headache patients were consistently lower than those for patients with low back pain or neck and/or shoulder pain on all indices.[8] Patients in all three diagnostic categories achieved comparable degrees of improvement based on the Summary Outcome Scores available for cycles 3, 4, and 5 ($N = 59$). Mean Summary Outcome Scores were 4.0 for the low back-pain patients, 3.9 for the

[7]Due to negative scaling in the low range of the TMD scale, changes in an individual's TMD cannot be expressed readily as a percentage.

[8]The one exception was the number of symptoms reported in the previous month (MSCL pre mean, 23.3), which exceeded that for the low back-pain patients.

Table III. Symptom, Mood, and Psychological Outcomes for the Total Population

	(A) Group means[a]		
	MSCL	TMD	GSI
Pre	22.3	47.8	0.77
Post	14.4	21.5	0.50
% change in mean	35*	55*	35*
N	87	73	74

	(B) Individual gains[b]			
	ΔMSCL		ΔGSI	
Level of reduction (%)	≥33.3	≥50	≥33.3	≥50
Number reaching this level	47/87	32/87	44/74	29/74
% of total patients	54	37	59	39

[a]MSCL, number of symptoms on a Medical Symptom Checklist; TMD, Total Mood Disturbance score on the Profile of Mood States (POMS); GSI, General Severity Index (SCL-90-R).
[b]The TMD is excluded because the percentage change could not be calculated due to negative scaling.
*$P < 0.003$ in t test adjusted for multiple comparisons using the Bonferroni method (Ingelfinger *et al.*, 1983).

headache patients, and 3.9 for the patients with neck and shoulder pain. These differences were not statistically significant. Patients with neck and shoulder pain had higher mean pre and post values than the low back-pain patients on the BPPA, MSCL, TMD, and GSI. Neck and/or shoulder pain was consistently reported as more severe and more debilitating than low back pain.

Analysis by Gender

The female-to-male ratio for the population was 2:1 (Table IVB). Males consistently had higher initial mean levels of mood disturbance (TMD) and of psychological symptomatology (GSI) than females. They were also less successful in lowering the mean scores on these indices than the females during meditation training. SCL-90-R profiles for the males showed higher levels of Somatization, Depression, Anxiety, Hostility, and Phobic Anxiety than those for the females both before and after meditation training (unpublished data).

The mean Summary Outcome Score for the females in cycles 3, 4, and 5 ($N = 41$) was 4.0, and that for the males ($N = 18$) was 3.8 (Table IVB). This difference was not statistically significant. Forty-four percent of the males and sixty-eight percent of the females were in the 3.8 to 5.0 range, reflecting a moderate to great overall improvement.

Table IV. Group Mean Values Pre- and Post-Meditation Training: Breakdown by (A) Diagnosis and (B) Sex[a]

	PRI		BPPA		BPM	TLI		MSCL		TMD		GSI		Mean post Summary Outcome Score[b]
	Pre	Post	Pre	Post		Pre	Post	Pre	Post	Pre	Post	Pre	Post	
(A)														
LBP (N = 31)	17.6	8.7	41.2	27.2	1.3	14.5	11.1	20.8	13.1	51.2	18.8	0.78	0.47	4.0 (N = 16)
Headaches (N = 24)	12.5	3.4	34.8	33.6	1.3	8.6	4.7	23.3	14.8	39.4	19.8	0.71	0.47	3.9 (N = 13)
Neck/shoulder (N = 15)	16.9	8.0	57.5	37.6	1.6	12.1	9.7	25.5	20.9	58.7	33.4	1.0	0.74	3.9 (N = 14)
(B)														
Males (N = 30)	16.1	7.3	45.8	33.1	1.3	10.9	8.1	19.4	12.5	51.0	33.1	0.84	0.60	3.8 (N = 18)
Females (N = 60)	16.1	6.4	40.0	27.2	1.6	12.3	8.3	23.8	15.2	45.1	18.3	0.75	0.45	4.0 (N = 41)

[a] PRI, Pain Rating Index; BPPA, Body Parts Problem Assessment score; BPM, Body Pain Map. BPM group outcomes are expressed as the numerical averages of individual change scores. Numerical values were assigned as follows: − = −1; 0 = 0; + = +1; ++ = +2; +++ = +3. TLI, Table of Levels of Interference with daily activities; MSCL, number of symptoms on a Medical Symptom Checklist; TMD, Total Mood Disturbance score on the Profile of Mood State (POMS); GSI, General Severity Index (SCL-90-R).

[b] For patients in cycles 3, 4, and 5 only. N = 59, of whom 43 were in the three dominant pain categories.

Comparison of Pain Clinic Meditators with Other Pain Clinic Patients

The reductions in pain and pain-related affect and symptoms observed consistently on the self-report indices the patients filled out before and after the program were paralleled by clinical improvements in many cases. These took the form of an increased capacity to sit, stand, or walk and an improvement in appearance and affect. The combined weight of these observations suggested a clinically important change in overall health status for the majority of patients trained in the meditation. To address the question of how these results might compare with the effects of a more traditional medical intervention, we compared as a cohort the mediators who had been referred for meditation training from the Pain Clinic with a cohort of 21 consecutive patients receiving the standard treatment course in the Pain Clinic (see Methods and Table IB).

Table VA shows that the patients undergoing the traditional treatment course showed little improvement in pain, symptoms, or affect. The meditators had large mean decreases on all the test measures, which reached significance in four of six cases. In no case did the change in the mean value of any index reach statistical significance for the PC comparison group.

The mean percentage change for each index was also calculated to compare outcomes for the two groups. The mean percentage changes in the PRI, BPPA, MSCL, and GSI were negative and close to zero for the PC comparison group. The mean percentage change in the TLI was positive and approximated one-third the value of the mean percentage change for the PC referrals to the SR&RP. The mean percentage changes in the PRI and the GSI were statistically significantly different between the two comparison groups in the unpaired t test corrected for multiple testing ($P < 0.005$ for the PRI; $P < 0.05$ for the GSI).

The initial mean PRI for the PC comparison group was 9 points higher than the mean PRI for the PC referrals to the SR&RP. This was not a significant difference. The initial (pre) mean scores on all indices for both groups were similar in spite of the major differences in group composition (see Methods).

Comparison of the subdimensions of the GSI showed that the Pain Clinic meditators were reporting major reductions in Anxiety (65%), Depression (59%), Hostility (57%), and Somatization (30%), while the Pain Clinic comparison group reported mean reductions of 29% for Anxiety, 18% for Depression, 7% for Hostility, and 0% for Somatization. The reduction in interpersonal Sensitivity (lack of self-esteem) was 45% for the meditators and 34% for the nonmeditators.

Few individuals in the comparison group achieved the 33.3% improvement level (or the + +/+ + + level for the BPM) on any of the pain-related indices (PRI, BPPA, TLI, BPM) (see Table VB). Approximately 25% of the patients achieved the greater than 33.3% reduction level in the number of medical symptoms (MSL) and in overall psychological symptomatology (GSI). These individuals constituted a much smaller fraction of their cohort than did those among the PC referrals trained in the meditation (Table VB). Individuals achieving greater than a 50% reduction level were far less evident in the traditional-care cohort than among the meditators.

Follow-Up Studies on the SR&RP Patients

Three follow-up questionnaires were sent to these patients. Depending on when they took the program, the most recent follow-up to date, measured from the time the meditation training ended, was 15 months (cycle 1), 12 months (cycle 2), 4.5 months (cycle 3), or 2.5 months (cycle 4). Of the 72 questionnaires sent in the most recent survey to all subjects who completed the SR&RP in cycles 1 through 4, 56 were returned (78%). In three other cases partial information (the Summary Outcome Score) was obtained via telephone interviews. For the patients for whom 15 months of follow-up had elapsed, 80% (8 of 10) responded; at the 12-month follow-up, 69% (11 of 16) responded; at the 4.5-month follow-up, 67% (16 of 24) responded; and at the 2.5-month follow-up, 95% (21 of 22) responded.

A comparison of responders to nonresponders was undertaken to examine potential bias in the follow-up results, since one might assume that the individuals with more successful outcomes would be more likely to respond to the questionnaires. In the case of cycle 3, the first cycle in which post Summary Outcome Scores were obtained and also the cycle with the lowest percentage of returns (67%), the nonresponders (8 individuals) had a mean post score of 3.8; the 15[9] responders had a mean post score of 4.2. The difference is not statistically significant and both means were in the range empirically defined as successful (3.8–5.0). This suggests that nonresponders probably did not differ remarkably from responders in terms of successful outcome in the SR&RP itself. BPM scores were also compared for the responders and nonresponders in all cycles and no significant differences found.

Figure 1 plots the group mean values as a function of time for the (A) Pain Rating Index (PRI), (B) Body Parts Problem Assessment (BPPA) score, (C) number of symptoms (MSCL), (D) Total Mood Disturbance (TMD) score, and (E) General Severity Index for each cycle of the SR&RP for which follow-up data were obtained. The follow-up values are the means for those individuals in each cycle responding to that follow-up questionnaire. In all cases,[10] there was a pronounced and statistically highly significant reduction in the

[9]The post Summary Outcome Score was missing for one responder.
[10]The one exception was the BPPA for cycle 1.

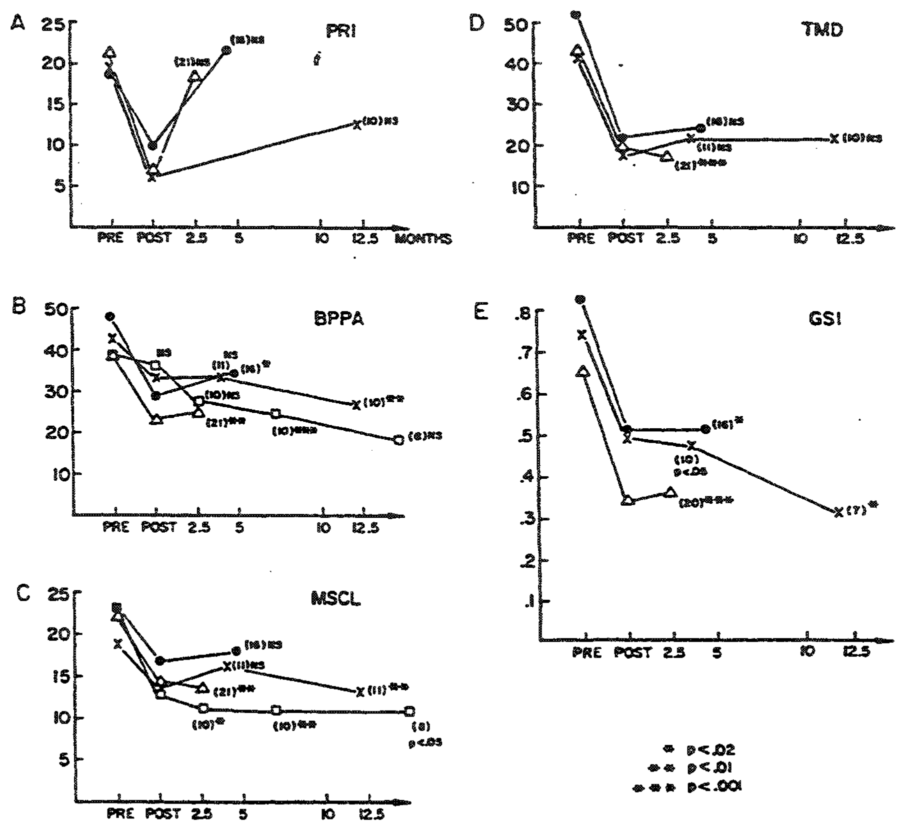

Fig. 1. Time dependency of outcome measures with follow-up. (A) Pain Rating Index; (B) Body Parts Problem Assessment score; (C) number of symptoms on a Medical Symptom Checklist; (D) Total Mood Disturbance score on the POMS; (E) General Severity Index on the SCL-90-R. Pre represents the initial mean levels for the patients in each cycle; post represents the mean levels after the 10-week meditation training. Follow-up times are expressed as months following the completion of the SR&RP. Open squares represent patients in cycle 1 (N = 10); crosses, patients in cycle 2 (N = 16); filled circles, patients in cycle 3 (N = 24); and open triangles, patients in cycle 4 (N = 21). The numbers of individuals responding to follow-up questionnaires are given in parentheses next to the corresponding data points. The follow-up points represent the mean scores for the respondents. P values for each follow-up point represent paired t-tests with pre values. Paired t tests grouping 2.5- to 7-month returns together gave P values of < 0.0001 on all indices except the PRI when comparing pre and follow-up levels for each responder. Similarly, t tests for the 12- to 15-month returns gave P values of < 0.01 for the BPPA and MSCL. All P values are adjusted values after application of the Bonferroni correction for multiple tests. The PRI values have been corrected for zero values (Melzack, 1975).

level of each index between the initial assessment (pre-meditation training) and the immediate post meditation assessment, reflecting the pre/post results presented in Tables IIA and IIIA. Mean scores for each measure tended to remain at the postintervention level for periods of up to 15 months following completing of the SR&RP, with the notable exception of the PRI. The responses between 2.5 and 7 months postintervention were grouped together for each measure and tested for significance in the paired t test, matching pre values with follow-up values for the responders and adjusting for multiple tests using the Bonferroni method. With the exception of the PRI, all were highly significant ($P < 0.0001$). Combining the 12- and 15-month follow-up results, the means of the MSCL and the BPPA also differed significantly from the pre but not from the post means using the same method ($P < 0.01$). In the case of the TMD and GSI, the mean values at the 1-year follow-up could not be shown to reach statistical significance compared to the mean pre levels. This appeared to be due to the smaller sample size because no data on these indices were collected in cycle 1. Nevertheless, the TMD and GSI means for the responders were always lower than the pre level at 1 year.

The Pain Rating Index (PRI) clearly differs from the other indices in its follow-up profile. In two of three cycles, on follow-up the PRI rose to levels exceeding the pre level, and in no case did the mean differ significantly from the pre mean value. The difference in behavior between the PRI and the other indices on follow-up is discussed below.

The results in Fig. 1 were not significantly affected when individuals who had taken a graduate SR&RP course were excluded from the follow-up analysis (data not shown). The finding that the mean improvements observed post-SR&RP are maintained over time (Figs. 1B through E) is thus not explainable solely by the additional training experienced by a minority of the responders.

Compliance with the Meditation

The third follow-up questionnaire probed the frequency and duration of formal meditation practice with a set of three precise questions which made it difficult to exaggerate compliance without frank dissimulation. This format reinforced the face validity of this section of the questionnaire. On the basis of their responses, individuals were grouped in five classes: (A) regular meditation practice ($\geq 3\times$ per week and $\geq$ 15 min at a time); (B) sporatic practice ($< 3\times$ per week but $> 1\times$ per week and $\geq$ 15 min at a time or $\geq 3\times$ per week and $<$ 15 min at a time); (C) infrequent practice ($\leq 1\times$ per week and $\leq$ 15 min at a time); (D) no longer meditating; and (E) no information—did not answer the questions accurately or at all.

Table V. Comparison of Outcomes Between Pain Clinic Meditators (PC Referrals) and Nonmeditators (PC Comparison Group)

(A) Group means[a]

	PRI[b]	BPPA	TLI	MSCL	TMD[c]	GSI
PC referrals (meditators)						
Pre	23.7	47.8	15.4	20.0	41.4	0.62
Post	15.2	30.1	11.2	13.6	8.4	0.33
% change in mean	36 (ns)[d]	37*	27 (ns)	32**	87***	47***
N	15	21	14	21	15	15
	42††	28	22	23	—	41†
PC comparison group (nonmeditators)						
Pre	32.5	44.4	17.7	22.9	51.1	0.74
Post	32.4	43.4	15.0	20.6	39.3	0.66
% change in mean	0 (ns)	2 (ns)	15 (ns)	10 (ns)	22 (ns)	11 (ns)
N	20	21	21	21	20	20
Mean % change	−2	−4	7	−5	—	−6

(B) Individual gains[e]

	Δ PRI[b]		ΔBPPA		ΔBPM[f]	ΔMSCL		ΔGSI	
	≥ 33.3%	≥ 50%	≥ 33.3%	≥ 50%	++/+++	≥ 33.3%	≥ 50%	≥ 33.3%	≥ 50%
PC referrals (meditators)									
Number	10/14	8/14	10/21	10/21	7/19	10/21	6/21	11/15	6/15
%	71§§§	57§§§§	48 (ns)	48§§	37§	48 (ns)	29 (ns)	73§§	40§

PC comparison group (nonmeditators)									
Number	2/19	0/19	5/21	2/21	1/19	5/21	4/21	5/20	1/20
%	11	0	24	10	5	24	19	25	5

[a]PRI, Pain Rating Index; BPPA, Body Parts Problem Assessment score; TLI, Table of Levels of Interference with daily activities; MSCL, number of symptoms on a Medical Symptom Checklist; TMD, Total Mood Disturbance Score (POMS); GSI, General Severity Index (SCL-90-R).

[b]Corrected for zero values (see Melzack, 1975).

[c]Mean percentage change not calculated.

[d]Not significant ($P > 0.05$).

[e]Fraction of individuals achieving the indicated level of reduction or improvement on each index.

[f]Body Pain Map. The fraction represents the number of individuals in the population who were scored as either + + (moderate improvement) or + + + (great improvement).

*$P < 0.012$; significance of pre/post t tests of group means corrected for multiple comparisons.

**$P < 0.006$.

***$P < 0.003$.

†$P < 0.05$; significance of unpaired t test comparing the mean percentage change of PC referrals and the PC comparison group, corrected for multiple-comparisons.

††$P < 0.005$.

§$P < 0.05$ comparing PC referrals to the PC comparison group in the chi-square test (1df) or Fisher's Exact Test applied following the guidelines of Cochrane cited by Armitage (1971).

§§$P < 0.025$.

§§§$P < 0.01$.

§§§§$P < 0.001$.

More than 70% of the respondents in each cycle described themselves as still meditating (up to 15 months) following the end of the meditation training. Patients in classes A and B together constituted 54% (30/56) of all respondents (23 in class A, 7 in class B). Of the regular meditators (class A), 14 of 23 reported that they were "meditating everyday (almost)." Twenty-nine percent of the responders (16/56) were in the class of infrequent practice. Those who reported not meditating at all constituted 13% (7/56) of the respondents. The remaining 5% (3/56) either did not answer this section or answered ambiguously.

Seventy percent of the individuals with Summary Outcome Scores below 3.5 also claimed that they were still meditating. Thus, in many cases in which marginal or no improvement was detectable on the outcome indices, some factor appears to have motivated these individuals to continue to practice the meditation. The percentage of individuals in classes A and B among this cohort was lower (40%) than for those who had Summary Outcome Scores above 3.8 (53%).

The follow-up questionnaire also measured informal use of the meditation in addition to assessing the level of compliance with the formal practice. Patients were asked to rate the frequency with which they used awareness of breathing in daily life and to rate its utility as a coping strategy in stressful situations. This mindfulness strategy was used by more patients and more frequently than any of the formal techniques. Patients with Summary Outcome Scores above 3.5 rated awareness of breathing much higher in usefulness and reported using it more regularly in daily life activities than did individuals with scores below 3.5 (data not shown).

DISCUSSION

The data suggest that mindfulness meditation training in the context of a Stress Reduction and Relaxation Program can be highly effective in reducing self-reports of both pain and pain-related behaviors in the majority of the patients referred to it for chronic pain. Significant group improvements were recorded over the 10 weeks of the program for present-moment pain (PRI), negative body image (BPPA), degree of inhibition of everyday activities by pain (TLI), medical symptoms (MSCL), mood and affect (TMD), and psychological symptomalolgy (GSI) including somatization, anxiety, depression, and self-esteem.

The specific outcome measures employed were chosen to assess the physical and psychological dimensions of chronic pain and appeared to reflect accurately our clinical impressions of the patients. Each index was reduced significantly when the results were averaged over the entire population and high proportions of individuals made major improvements on all indices.

This combined assessment of group and individual outcomes suggests a profound change in the majority of the patients due to the SR&RP intervention. How much of this improvement is placebo related, i.e., due to the *fact* of intervention rather than to the *nature* of the intervention, can be investigated only using placebo control groups in a prospective, randomized study. However, the mean chronicity of this population (8 years) and the fact that these patients had received extensive medical treatment without attaining this level of improvement speaks against a simple placebo effect, as does the lack of significant improvement in the comparison group of Pain Clinic patients, who were exposed to strong positive placebos in the form of enthusiastic referral to a specialty service, high expectation of relief, and pain-specific medical treatment protocols.

Thus, within the limits inherent in a descriptive outcome study, the specific questions posed in the Introduction concerning the empirical effectiveness of mindfulness meditation in the context of a stress reduction program have been answered in the affirmative both qualitatively and quantitatively.

A number of observations merit explicit discussion.

(1) The relative degree of improvement was independent of the referral source, pain severity, diagnosis (Table IVA), and gender (Table IVB). Thus the mechanism(s) which underlies the observed pain reductions is elicitable by individuals with different types of pain and over a wide range of intensities. This suggests a generalized applicability of the method for pain reduction and coping.

(2) The mean improvements observed on all indices during the intervention were maintained in the period from 2.5 to 7 months postintervention, with the exception of the PRI, with a high degree of statistical significance for the responders. Mean improvements in negative body image (BPPA) and symptoms (MSCL) were maintained at a significant level for the period of 12 to 15 months postintervention as well. Improvements in mood (TMD) and psychological symptomatology (GSI) tended to be maintained but did not reach statistical significance. The responders represented the majority of the study subjects. Since these indices in combination measured important aspects of a person's well-being, their coordinated improvement suggests a fundamental and long-lasting improvement in health status.

(3) The mean PRI tended to return to the original (pre) level by the time of follow-up. This finding can be interpreted in two ways: either (a) the PRI cannot be used effectively by mail in conjunction with previous PRI scores obtained in interviews (the pre and post data were obtained in individual interviews) and the rise is

an artifact of mixing the modes of administration of the instrument or (2) the rise on follow-up in the PRI above the postintervention level is real and reflects a worsening of the pain status. If we assume the latter, it is important to note that the increased PRI levels on follow-up were apparently no longer interpreted in the original (pre) way, because the mean BPPA score remained low on follow-up for the same patients. We believe that the stable reduction in the BPPA score reflects a newly developed ability to live with and cope with pain and reinterpret its meaning. Many of the patients trained in the SR&RP reported on follow-up that their pain is "still there" but that their relationship to it has changed, i.e., there is less fear of pain, less self-pity, and less willingness to let pain or fear of pain restrict activity. However, an analysis of the components of the total PRI (sensory, affective, evaluative) on follow-up did not yield discrimination of this kind as might have been expected. It remains for a carefully controlled study to elucidate this observation.

(4) The high compliance with the meditation practice achieved during the SR&RP appears to have been maintained over time. Seventy percent of the respondents reported that they still meditate (in response to the question, "Do you meditate anymore?"). A likely explaination for such a high proportion of individuals who claim to still be meditating on follow-up is that the meditation practice has an informal dimension in addition to the more time-consuming formal discipline. Thus subjects can honestly report that they still meditate in the sense that, from time to time, they consciously bring attention to the moment-to-moment events and experiences of their daily lives. On the basis of precise questions about the frequency, duration, and type of practice, 41% could be classified as regular meditators (class A; see Results.).

(5) Among the most successful individuals (those with Summary Outcome Scores above 3.8), there appeared to be two equal classes of pain outcome: (a) those for whom the pain was greatly reduced or eliminated and (b) those who reported that the pain was unchanged but that they were coping with it differently and therefore it was not as problematic as before the meditation training. Patients with diagnoses of headache predominated in the former class, but some individuals with chronic gastrointestinal, chest, and facial pain also reported sustained disappearance of pain. Low back-pain patients predominated in the latter class, but headache and other classes of pain were also present.

(6) There were considerable differences in the composition of the two cohorts of Pain Clinic patients compared here, and the potential

influence of these differences on the results observed is unknown. For this reason, the comparison suffers obvious shortcomings and needs to be repeated in a randomized prospective study.

(7) It is important to emphasize that the intervention makes use of meditation practice within a context of stress reduction and health promotion. Because of the short period of the training and its clinical orientation, it cannot be compared facilely with the years of intensive meditation training common in the more traditional contexts in which such consciousness disciplines are pursued. Nevertheless, the fact that even at an introductory level, such training appears to be enthusiastically received and useful and practical for patients with long-term pain problems attests to the potential power and depth of such approaches (see Burns, 1973).

For mindfulness meditation to be considered a practical tool in clinical behavioral medicine, it must be investigated and conceptualized within the theoretical and experimental perspective developing from the study of the psychological interventions currently in widespread use for chronic pain relief. At present, the most widely used and accepted of these are progressive relaxation, biofeedback, operant conditioning, hypnosis, and cognitive-behavioral therapies (Turner and Chapman, 1982a,b). One element which the above methods have in common and which may be of central and underestimated therapeutic importance is attention regulation. Each of these methods necessitates a conscious primary utilization of attention: either to muscle tension and relaxation (progressive relaxation and biofeedback), to a feedback stimulus (biofeedback), to exclusive expression of nonpain behaviors (operant conditioning), to suggestions of altered proprioception (hypnosis), or to events, emotions, and thought patterns in relationship to symptom onset (cognitive-behavioral procedures). Attention is directed to quite different objects in these different therapies. Yet it may be the regulation and the intensity of one's attention, and one's belief in a method based on past experience, rather than the particular object or process attended to, which are of greatest therapeutic value. Indeed, it is well known that any strategy for the self-regulation of attention, including purposeful distraction, can be used with some effectiveness in coping with pain both in the laboratory and in the clinic.

In this regard, recent laboratory studies using the cold pressor stimulus have shown that a strategy of attention to proprioception during the trial results in significantly less distress and higher tolerance than strategies utilizing distraction or expression of emotions (Ahles *et al.*, 1983) and that attention to sensation becomes a relatively better coping strategy the longer the trial (McCaul and Haugtvedt, 1982). In these laboratory studies, the word "pain" was studiously avoided because it had been observed (Levinthal *et al.*, 1979) that mention of the word pain negated any positive effects of attending to sensations. This lability of the attentional strategy to the mention of the word pain suggests that training in detached observation of sensations through mindfulness meditation techniques could greatly enhance the positive effects of the attentional strategy used in these experiments since subjects were untrained and merely instructed to describe aloud the sensations that they were experiencing (Ahles *et al.*, 1983). This possibility could be tested by comparing experienced meditators with naive subjects using the cold pressor test and carefully documenting the precise strategies subjects *actually* used during the trials.

In terms of chronic pain, the results of our study suggest that the systematic cultivation of a flexible attentional capacity for detached observation of proprioception can enhance whatever the patient's previously (and often inadequate) coping strategies have been and reduce the level of distress. Holroyd and Andrasik (1980) have observed, in carefully controlled studies with tension-headache patients, that pain relief following EMG-biofeedback training was the result not of self-control of muscle tension but of learning to recognize the onset of headache symptoms. There is now increasing evidence that the use of biofeedback for pain control offers no therapeutic benefit in most situations beyond that attributable to the relaxation that is taught in conjunction with it (Zitman, 1983; Turner and Chapman, 1982a) and/or the cognitive and behavioral changes that often arise spontaneously within the therapeutic context (Turk *et al.*, 1979). Indeed, each patient's own private strategies need to be inquired into and cultivated when appropriate, rather than imposing the therapist's choice of method. When Holroyd and Andrasik's patients were taught to recognize the onset of symptoms, they spontaneously changed the ways in which they were coping even when no coping skills were taught. These authors concluded that "it may be less crucial to provide clients with specific coping responses than to insure that they monitor the insidious onset of symptoms and are capable of engaging in some sort of cognitive or behavioral response...this response need not be relaxation and in certain circumstances where...inappropriate, should not be relaxation."

These observations imply that moment-to-moment mindfulness may, in this and other interventions, itself be the principal, if implicit, coping mechanism. While there may be a variety of cognitive and behavioral strategies to enhance this capacity, the clinical results of our study suggest that the systematic formal practice of mindfulness meditation, which in this context emphasizes attending from moment to moment to proprioception and to stress reactions, may provide a therapeutic dimension which includes both physiological relaxation *and* cognitive-behavioral changes and which goes deeper than the methods currently in use. We suggest that the evidence is strong enough to merit a comparative study of mindfulness meditation and other psychological interventions under rigorously controlled conditions in both the laboratory and the clinic.

COMMENT

To be effective, it is likely that any clinical approach in behavioral medicine seeking to relieve suffering and improve the quality of life for patients with chronic medical problems must require an *active participation* by the patient to develop and utilize his or her full range of internal resources, including deep relaxation, physical fitness, self-confidence, and even wisdom.

Mindfulness meditation has a number of unique features which recommend it as a clinical method for teaching self-regulation and as a psychological intervention in chronic pain. (1) It is much less expensive to introduce than elaborate inpatient behavior modification programs, and training is readily accomplished in groups of up to 30 individuals. The high compliance we observed during and after training suggests that meditation can be both enjoyable and beneficial to large numbers of patients. (2) Its emphasis on self-observation and on self-responsibility can enhance realizations of self-worth and help people to perceive conditioned patterns of (illness) behavior more clearly. (3) Since this form of meditation is a systematic development of the basic human capacity to attend intentionally to events, percepts, and cognitions in the field of consciousness, it has a generalized applicability within a wide range of perceptual, cognitive, and behavioral contexts, which includes but is not limited to pain relief. (4) As with other meditative practices, mindfulness meditation can facilitate deep physiological relaxation (Benson, 1975). In contrast to relaxation techniques, however, it has the further property of enhancing what the Buddhists call "insight" (Nyanaponika, 1962). Walsh (1980) and Wilber (1980) suggest, as do the classical Buddhist meditation texts (see Nyanaponika, 1962), that mindfulness meditation accesses the deep structure or "core" of one's being and can potentiate the experience of what has become known in contemporary psychological circles (see Walsh and Vaughan, 1980) as "transpersonal" levels of consciousness. Potential benefit may thus be derived from training in this form of meditation on a multiplicity of levels, ranging from relaxation and anxiety reduction to profound personal transformation (Wilber, 1979). Mindfulness meditation has recently become a subject of exploration by psychiatrists (Burns, 1973; Burns and Ohayv, 1980; Walsh, 1977, 1978, 1983; Deikman, 1982; Kutz *et al.*, 1985a) and clinical psychologists (Brown and Engler, 1980; Deatherage, 1975; Shapiro, 1980). Attempts to integrate meditation practice into psychotherapy in appropriate instances are currently in progress (Deatherage, 1975; Kutz, *et al.*, 1985a,b; Shapiro and Giber, 1978). (5) An increasing number of Westerners are being trained in mindfulness meditation without cultural, religious, or ideological overtones at meditation centers in the West. It is certainly no longer merely an esoteric "Eastern" phenomenon. As yet, it is unclear whether the other major class of meditative practices, known generically as concentration meditation, would achieve similar clinical results. Mindfulness is a generic term, encompassing a range of techniques and traditions, all utilizing attention in a well-defined way which differs substantially from the concentration practices but which, nevertheless, requires a foundation in concentration. It remains for further studies to clarify this point. (6) The physiology (see Davidson, 1976), psychophysiology (Woolfolk, 1975), and phenomenology (Maliszewski *et al.*, 1981) of intensive meditation practice are becoming fields of serious scientific research. While presently in its infancy, in the future this research may provide an important foundation for understanding the underlying psychobiological mechanisms of meditation and of the self-regulation of pain and point to new ways to maximize the subjective and latent dimensions of human consciousness for achieving wholeness and well-being, even in the midst of suffering.

NOTE ADDED IN PROOF

A recent study has demonstrated the reproducibility of the results reported here and has extended the follow-up time to four years post SR&RP (Kabat-Zinn *et al.*, 1984).

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An Outpatient Program in Behavioral Medicine for Chronic Pain Patients Based on the Practice of Mindfulness Meditation:

Theoretical Considerations and Preliminary Results

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Abstract: *The practice of mindfulness meditation was used in a 10-week Stress Reduction and Relaxation Program to train chronic pain patients in self-regulation. The meditation facilitates an attentional stance towards proprioception known as detached observation. This appears to cause an "uncoupling" of the sensory dimension of the pain experience from the affective/evaluative alarm reaction and reduce the experience of suffering via cognitive reappraisal. Data are presented on 51 chronic pain patients who had not improved with traditional medical care. The dominant pain categories were low back, neck and shoulder, and headache. Facial pain, angina pectoris, noncoronary chest pain, and GI pain were also represented. At 10 weeks, 65% of the patients showed a reduction of ≥33% in the mean total Pain Rating Index (Melzack) and 50% showed a reduction of ≥50%. Similar decreases were recorded on other pain indices and in the number of medical symptoms reported. Large and significant reductions in mood disturbance and psychiatric symptomatology accompanied these changes and were relatively stable on follow-up. These improvements were independent of the pain category. We conclude that this form of meditation can be used as the basis for an effective behavioral program in self-regulation for chronic pain patients. Key features of the program structure, and the limitations of the present uncontrolled study are discussed.*

Introduction

This paper presents the theoretical underpinnings and reports on the structure and outcome of an outpatient service in an academic medical center piloted to explore the clinical effectiveness of meditation as a self-regulatory coping strategy for long-term chronic patients for whom the traditional medical treatments have been less than successful. In its first two years it has been attended by patients referred for a wide range of chronic conditions. This report presents only the summary outcome for the chronic pain patients; the complete outcome data for the pain patients, and the results with other classes of patients are presented elsewhere (1, 2). These results have recently been reported in abstract form (3).

The service, known as the Stress Reduction and Relaxation Program (SR&RP), utilizes training in a form of meditation known as mindfulness or awareness meditation as the major self-regulatory activity. All meditation practices used in the SR&RP were taught independent of the religious and cultural beliefs associated with them in their countries and traditions of origin.

Rationale

In the hospital, the SR&RP functions as a "net" to catch patients who tend to "fall through the cracks" in the health care delivery system, neither improving in their primary medical condition over time nor feeling satisfied with the results of the traditional

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medical management of their problem(s). The SR&RP is based on the systematic development of the internal resources of the patient. It provides a welcome alternative for motivated patients and a useful referral outlet for staff physicians. Many chronic pain patients ultimately receive the verdict that "you're going to have to learn to live with this." The SR&RP helps patients teach themselves the *how* of living with chronic pain. Self-regulation is promoted and learned via the directed attention characteristic of mindfulness meditation. The choice of mindfulness meditation was based on the author's experience of meditation, on reports in the traditional meditation literature concerning how to handle pain during intense meditation practice (4, 7), and on theoretical considerations of pain perception, attention, and their interaction. Since mindfulness meditation is intellectually and experientially unfamiliar in our culture, it is described here in some detail to clarify the rationale for its use in promoting self-regulation.

Mindfulness Meditation

Meditation can be defined as the intentional self-regulation of attention from moment to moment [modified from Goleman and Schwartz, (5)]. It is neither contemplation nor rumination, as in thinking about a conceptual theme. There are two major classes of meditation practice: concentration meditation and mindfulness meditation (6). The latter is also referred to as awareness meditation and for present purposes the two terms are used here interchangeably.[1] They differ radically in the way in which attention is utilized.

Concentration methods, the most widely known and studied of which is Transcendental Meditation (TM), involve the restriction of attention to a single point or object, commonly a mantra (mental sound), the experience of breathing, a visual object, or a Koan (in the Rinzai Zen tradition) and holding it in the mind for extended periods (commonly 20-60 min). Any other mental activity is perceived as a distraction from the object of concentration.

Mindfulness meditation has roots in Theravada Buddhism where it is known as *sattipatana vipassana* or Insight Meditation (7), in Mahayana Buddhism in Soto Zen practices (8), and in the yogic traditions as expressed in the contemporary writings of J. Krishnamurti (9, 10), Vimila Thakar (11), and Nisargadatta Maharaj (12). The practice of mindfulness meditation presupposes concentration to maintain steady attention. Rather than restricting attention to one object, however, this approach emphasizes the detached[2] observation, from one moment to the next, of a constantly changing field of objects. This flexibility is achieved by concentrating on one primary object (commonly the successive flow of inbreaths and outbreaths), until attention is relatively stable, and then allowing the field of objects of attention to expand (usually in stages) to include, ultimately, all physical and mental events —body sensations, thoughts, memories, emotions, perceptions, intuitions, fantasies—exactly as they occur in time. Expansion of the field of attention is taught gradually over a number of sessions.

Detached self-observation is not a trivial task. The mind has a strong tendency to wander and invariably becomes preoccupied with the content of thoughts and emotions, which often take form as memories, anticipations, ideas, opinions, and desires. The result is a reduction or complete loss of moment to moment attention and observation. When recognition of this drift from awareness occurs, the meditator simply brings attention to a detail of momentary reality, usually the breath or a sensation, to (re)anchor the attention in the present. When the faculty of detached observation becomes stable, the field of awareness is allowed to expand again. With practice, any event that arises in the field of one's awareness momentarily becomes the object of meditation until the next event (which may also be the experience of "absence of event") arises. In awareness meditation practice, no event is considered a distraction (not even the wandering of the mind); it is simply another object of observation. Moreover, no mental event is accorded any relative or absolute value or importance in terms of its content. All thoughts are treated the same: they are simply noted as they arise. The state achieved by adopting this stance towards self-observation is referred to in the meditation literature variously as bare attention (7), choiceless awareness (9), *shikan-taza* [Japanese for "just sitting," see Kapleau (13)], and "just like this mind" [see Seung Sahn, (14)].

[1]Strictly speaking, the practice of mindfulness can and should lead to greater awareness if practiced correctly.

[2]In this context, the word "detached" means that the objects of observation are intentionally regarded with an effort to avoid judgment or interpretation or, with an effort to be aware of judgment or interpretation or categorizing if they occur. It should be emphasized that it does *not* mean lack of empathy, interest, compassion or caring, nor neurotic or pathological distancing or withdrawal.

Pain and Meditation

Pain is the result of the functioning of a normally adaptive neurological pathway. Pain alerts the organism to somatic damage via an arousal and alarm reaction and usually produces an appropriate motor response. In its chronic pathological form, however, pain is of no benefit to the organism and imposes severe emotional, physical and economic stresses on the patient and the patient's family (15).

Sternbach recently emphasized that psychological and behavioral strategies for pain control may provide a more therapeutic and satisfactory long-term solution than either surgery or drugs for most chronic pain patients (16). A decade ago, Melzack and Wall (17) stressed that motivational and cognitive contributions to the complex phenomenon of pain needed to be considered on an equal footing with sensory pathways and mechanisms if adequate and appropriate strategies for chronic pain relief were to be developed. The gate control theory provided a psychophysiological model for conceptualizing and explaining the long-known modulating effects that attention, distraction, suggestion, trance, anxiety, depression, and other emotional states, past experience, cultural tradition, family attitudes, and countless other higher nervous system behaviors can have on the perception and interpretation of pain (18). There is at present anatomical and physiological evidence for three interacting dimensions of the pain experience, termed sensory-discriminative, motivational-affective, and cognitive-interpretative (19). The gate control theory suggests that activity in the cognitive and/or motivational modes can modulate sensory transmission at the spinal cord entry level via descending pathways, thereby influencing the sensory dimension of the pain experience.

Meditation practice can be accompanied by intense pain in some ways resembling chronic pain. Dedicated western meditators practicing in the Zen and Vipassana traditions periodically engage in extended periods of meditation practice lasting weeks, and in some cases months, during which they may sit cross-legged on a cushion on the floor a total of 12 or more hr a day. The meditation periods are usually motionless and last from ½ hr to 1½ hr, with 1 hr being common. During such rigorous meditation practice, extreme forms of pain invariably arise. The body can ache and hurt day after day. Traditional meditation texts are replete with recommendations for cultivating detachment to intense pain through the specialized use of attention and careful self-observation which characterizes mindfulness meditation [see (4, 7)]. It therefore seemed reasonable to hypothesize that insights stemming from the observation of pain arising during meditation might serve as a model for developing a testable intrapsychic strategy that patients may use for coping with chronic pain. Note that mindfulness requires focusing *on* unpleasant and painful sensations when they are present and discourages efforts to escape them by distraction or by absorption in some other object of attention. Although this specialized use of attention can be used for the purpose of coping with pain in meditation sessions, it did not develop historically for that purpose. It is the essence of mindfulness meditation *per se* (7, 10).

The potential benefit of using meditation for the self-regulation of chronic pain would depend on the patient's developing an ability to observe intense feeling in the body as bare sensation. By repeated practice the patient might learn to assume intentionally an attitude of detached observation toward a sensation when it becomes prominent in the field of awareness, and to observe with similar detachment the accompanying but independent cognitive processes which lead to evaluation and labeling of the sensation as painful, as hurt. By maintaining a perspective during periods of formal meditation (see Methods) in which no mental event (including perceptions) is accorded any content value, the strong alarm reaction (the interpretation of the sensation as pain, i.e., "It's killing me", often accompanied by future thinking, i.e., the thought that it will last for a long time or forever) can lose considerable power and urgency *simply by being observed as separate*. This is because the associated thoughts can be perceived simply as events in the mind, not necessarily any more accurate or important than any other thoughts passing through the mind (such as the memory of yesterday's dinner). In effect, assuming this attentional stance appears to produce a spontaneous (and momentary) uncoupling of the sensory component of the pain from the affective and cognitive dimensions (alarm reaction). If assumed regularly in the presence of pain, the attentional stance of detached observation can result in a specific deconditioning of alarm reactivity to primary sensation. This amounts to a learned *recognition* of primary sensation. The nociceptive signals (sensory) may be undiminished, but the emotional and cognitive components of the pain experience, the hurt, the suffering, are reduced.

Uncoupling as defined would be an event associated with higher brain centers. We may speculate that in some cases this event may generate descending signals to close or "narrow" the spinal gate, resulting in reduction in the primary sensory dimension as well. Both outcomes have been observed in patients [see Kabat-Zinn et al. (1)].

The uncoupling hypothesized here does not involve a hypnotic trance state of reduced sensitivity or reduced awareness, but a refinement of awareness. The patient's altered relationship to primary sensation relies on a simple method of observation, and therefore need not be restricted to periods of formal meditation. It becomes accessible in everyday life via the conscious utilization of the learned attentional and attitudinal shift. We refer to this phenomenon as "carry-over" [see (20)] to suggest that the self-regulating benefits of the meditation continue beyond the period of formal practice (see Discussion).

There exist dramatic accounts in the literature of the complete uncoupling of the sensory from the affective and interpretive components of pain, with resulting loss of alarm reactivity and pain behavior. It can be achieved surgically (21, 22). It was reported for strong motivation in the classical observations of Beecher (23, 24). The experience of practitioners of mindfulness meditation suggested that a similar uncoupling is learnable via voluntary attentional control initiated from internal and intentional cues within the nervous system. The choice of mindfulness meditation as the modality on which to base a strategy of self-regulation for chronic pain patients followed logically from the above considerations.

Methods

Structure of the Stress Reduction and Relaxation Program

The program was a 10-week course which patients attended once a week for 2 hr. Three mindfulness meditation practices were taught. These were:

A. Sweeping: a gradual sweeping through the body from feet to head with the attentional faculty, focusing on proprioception, and with periodic suggestions of breath awareness and relaxation. This was usually practiced in the supine position.
B. Mindfulness of breath and other perceptions. This form was practiced sitting in a chair or on a cushion on the floor.
C. Hatha Yoga postures. The yoga introduced a dimension of meditative exercise designed to reverse disuse atrophy of the musculoskeletal system while developing mindfulness during movement. Although hatha yoga *per se* is not a traditional mindfulness technique, it was taught emphasizing mindfulness.

As in traditional monastic teaching, mindfulness meditation was also taught using the activities of walking, standing, and eating. The use of a range of objects of meditation helps to develop an ability to bring mindfulness into the varied circumstances of daily living.

Meditation instructions were as follows:

1. Bring your attention to the primary object of observation.
2. Be aware of it from moment to moment.
3. When you notice that the mind has drifted into thought, revery, and so forth, bring it back to awareness of the present moment, to the observation of what is dominant in that moment. In the sweeping meditation, the primary object is that region of the body through which one is moving at any moment.
4. When a strong feeling or emotion arises (i.e., a state of fear, pain, anger, anxiety), direct your attention to the feeling as it occurs and just be with it, observing it. When it subsides, return to the primary object of observation. Distinguish between observation of the experience itself and thoughts and interpretations of the experience.
5. Observe the thinking process itself. Avoid becoming involved in the content of individual thoughts. Observe them as impermanent mind events and not necessarily accurate. Treat all thoughts as equal in value and neither pursue them nor reject them.

For the first four weeks, sweeping was practiced for homework. A 45-min guided sweeping meditation on one side of a homework audio cassette tape was used at least once per day 6 days per week. In the weekly hospital sessions patients were taught mindfulness of breath and sensation during this period and were encouraged to supplement the tape by using it for 5 min each day while sitting formally, and as much as possible at other times. After 4 weeks, hatha yoga was introduced and the patients began to alternate the sweeping with the yoga (sides 1 and 2 of the tape) for homework each day. The guided yoga sequence was also 45 min. In weeks 7 and 8 patients were instructed to practice for 30–45 min per day, alternating either lying or sitting forms with the yoga but *not* using the tape for guidance. And in weeks 9 and 10, they were encouraged to practice any form they wanted for 30–45 minutes per day, either using the tape or not.

Instructions were given before and during guided group meditations in the hospital sessions and were expanded upon and refined in the discussions. The questions and difficulties raised by individual patients about the homework were used to illustrate and fine-tune the meditation instructions. This approach made the meditation more understandable and personal, and minimized the tendency to approach meditation by mechanically pursuing a set formula.

Didactic material on the physiology of stress and on methods of coping with stress was presented during hospital sessions and discussed. Mindfulness coping strategies were frequently assigned for homework in addition to formal meditation.

Key Elements of the Program

Care was taken to incorporate features which were thought to be important for a successful program. Some of these are meditation-specific, while others are common sense features of any optimal learning environment.

1. A group format. The group format increases the efficiency of patient education. Fifteen to twenty patients were taught in each group. The patients helped each other by sharing their experiences. Group support enhanced individual motivation and compliance.

2. Expectation of relief. Meditation was presented with the suggestion that the techniques are powerful and that regular practice can bring relief from pain in many cases. In this way the positive placebo effect was maximized.

3. Non-goal orientation. Since the practice of mindfulness meditation is fundamentally one of awareness in each moment, the appropriate attitude to cultivate is one of non-striving (8). This attitude (appreciated by the American Transcendentalists, Thoreau and Emerson) is the only way to practice this meditation correctly and, paradoxically, the best way to derive benefit from it. Non-striving was emphasized repeatedly in the hospital sessions and on the audio cassette tape used for homework. A byproduct of this orientation is that performance anxiety is minimized at the beginning stages.

4. Self-responsibility. It was repeatedly emphasized that internal resources for self-healing can only be developed by sustained work on the part of the individual.

5. High demand characterisics. The amount of work required of the patients in the program was impressed upon the patients in the initial evaluation interviews. A sense of satisfaction and accomplishment usually accompanied compliance.

6. Spectrum of meditation techniques. A number of different techniques were offered by which the patients might experience and cultivate detached observation. This approach underscores that there is no one right way to meditate or to relax and that any method is only a tool. The spectrum of meditative activities was provided to accommodate a range of somatic and cognitive dispositions among the patients (25). The gentle full-body conditioning introduced through the hatha yoga appeared to help many of the patients reduce musculoskeletal disuse atrophy and feel better about their bodies. It also demonstrated in a tangible way that one's perceived limits can recede with disciplined work at those limits.

7. Didactic material. Didactic material was presented on the relationship of stress to illness, the consequences of suppression of the Flight or Fight Response, and the Relaxation Response as a balance to autonomic arousal. Such material strengthened the belief that meditation can have significant physiological effects. It also served to encourage the patients to think about the functioning of their bodies. Homework assignments encouraged the patients to bring mindfulness to stressful situations in their daily lives. This facilitated the discovery of new personal resources for coping.

8. Finite duration. The course was long enough for most patients to grasp the principles of self-regulation and to develop skill and some autonomy in the meditation practice. It was also short enough to discourage dependency on the program and on the group support. The goal was for patients to achieve self-reliant well-behavior.

9. Long-term perspective. Patients were encouraged to view their experience in the SR&RP as a first step towards optimizing their health: a direct experience of the influence one can have on one's own health and well-being.

10. "Advanced" program. A 10-week "graduate" cycle was instituted for patients who wanted to continue the work begun in the SR&RP. The structure and outcome of this program has been reported elsewhere (1).

Table 1. Patient numbers and age range

	Cycle I	Cycle II	Cycle III
Number screened	16	19	28
Number starting	13	18	27
Number finishing	11	16	24
Number dropouts	2	2	3

	Cycle I		Cycle II		Cycle III	
	Males	*Females*	*Males*	*Females*	*Males*	*Females*
Number	3	8	6	10	9	15
Mean age	41	47	44	47	46	48
Range	35–58		22–67		29–75	

11. Low cost. The cost for the 10-week program was $100.00 per person.

Subjects

Fifty-one patients, 18 males and 33 females ranging in age from 22 to 75, completed one of the three 10-week cycles of the Stress Reduction and Relaxation Program discussed here (Table 1). All were outpatients referred by their physicians to the SR&RP for a chronic pain condition or for another condition accompanied by chronic pain. Major presenting pain complaints and group profiles are presented in Table 2. Duration of the primary pain complaint at time of referral ranged from 6 months to 48 years with medians of 7, 6, and 2.5 years in the three cycles. The pain complaints ranged from those due to gross somatic pathology to those with no physical findings or diagnosis. Consistent with present thinking in the field of chronic pain, no formal distinction was made between "somatic" and "psychogenic" pain (26). In all cases, the patients had verified medical histories corroborating extended suffering. Few patients (less than 5%) were involved in pain-related disability litigation at the time they took the program.

Classes of Pain

The largest classes of pain complaint were low back pain, upper back and shoulder pain, cervical pain, and headache (see Table 2).

Pre- and Post-evaluation Interviews

All patients were seen individually in an initial screening and evaluation interview prior to admission to the program (pre). The purpose of this interview was to acquire baseline data on the patient's pain and psychological status before the intervention and to inform the patient of the high demand characteristics of the program as a screen for motivation. Any patient who chose to take the program after the initial interview was permitted to do so. As can be seen in Table 1, greater than 90% of those screened started the program, and greater than 85% of those starting completed the program.

A "debriefing" interview following the program was used to obtain similar data (post) to document outcome, and to make individual recommendations for the continued practice of the meditation.

Table 2. Medical Profile of Patients*

	Cycle I N = 11	Cycle II N = 16	Cycle III N = 24
LBP	5	9	8
Migraine	3	4	0
Tension headache	2	1	3
Facial pain	1	1	0
Upper back/shoulder pain	1	1	9
Major extremity pain	3	2	1
Angina	2	1	0
NCP	0	1	2
Cervical pain	2	2	7
Cancer pain	0	1	0
Back/neck surgery	2	6	3
Arthritis	2	1	2
Stroke	1	1	0
Mastectomy	1	0	1
Pelvic pain	0	0	1
Abdominal pain	0	0	2
Mean # years with pain problem	11.2	10	4.3
Median # years with pain problem	7	6	2.5
Range (in years)	0.5–40	1–48	0.5–16

*Legend: Numbers of patients in each cycle presented with the medical diagnoses and histories listed. Many patients had more than one condition. LBP is low back pain; NCP is noncoronary chest pain.

Pain Measures

A series of pain indices was used to probe diverse aspects of the pain experience as reported by the patient. These were:

1. The McGill-Melzack Pain Rating Index (PRI). The PRI is the best nontechnological method presently available for the measurement of pain. It has been shown to provide valid reliable scores which reflect the quality and intensity of clinical

pain experienced by patients (27). It is administered verbally in the "right now" time frame. The ratings are expressed as PRI(R) scores (27) by adding the rank values of the words chosen.

2. A Body Parts Problem Assessment scale (BPPA) (28). This measures the patient's view of how problematic his/her body parts are. The measure consists of a list of 53 body areas, each of which the patient rates on a scale of zero to 5 where zero is no problem and no discomfort, and where 5 represents great discomfort and very problematic. The time frame for this index is "this week, including today." The sum of ratings for the individual body parts gives the BPPA score. Normative values for this self-report are available (28).
3. A three-color Dermatome Pain Map (DPM) to visualize the areas and intensities of the pain. Red is used to depict intense pain; orange, pain of intermediate intensity; and brown a dull or aching pain. It is filled in while the interviewer observes. The colored areas are coded for frequency of occurrence by the interviewer after questioning the patient.
4. A Table of Levels of Interference (TLI) [modified from (29)]. This index asks the patient to report the frequency with which pain interferes with a variety of life activities (i.e., sex, eating, sleeping).
5. In cycle III, daily pain-related drug use and activity levels were assessed using home diaries (data not included).

Non-Pain Measures

Several non-pain-related aspects of the patient's health were elicited along with the primary pain data. These were:

1. The number of medical symptoms checked as problems in the past month on a medical symptom checklist (MSCL) modified from Travis (30).
2. Change in emotional affect and mood were assessed using the Profile of Mood States (POMS) inventory (31). The results are expressed as a summary score known as the Total Mood Disturbance (TMD).
3. Change in psychological symptomatology was determined using the SCL-90-R inventory of Derogatis et al. (32, 33). Summary results for this index are expressed as the General Severity Index (GSI) score.
4. The Multidimensional Health Locus of Control (MHLC) was used to determine change in the patient's health-related beliefs (data not shown).
5. A ten question outcome questionnaire (see follow-up) was included in the post battery of instruments.
6. Three target complaints (34) (patient-defined goals) were elicited in the pre interview. The patients were asked post-training to rate numerically the degree of progress towards their goals (data not shown).

Follow-up

Follow-up questionnaires were mailed out at approximately 2.5, 7, and 11 months after completion of the SR&RP. Data are presented here for the 2.5 and 7 month follow-ups (Cycles II and I). Eleven month follow-up data obtained from members of the initial 10-week cycle of the SR&RP were rudimentary and qualitative (not reported here). The follow-up questionnaire consisted of two parts [see (1)]: the first was a series of 10 questions designed for the patient to score the degree of change for relevant parameters, with 5 being great progress or goal achieved, 3 signifying no progress or change, and 1 signifying considerable worsening. The average score was used to decide the therapeutic value of the SR&RP to the patient (1). Part II contained a range of questions pertaining to compliance (data not included). The mailed questionnaire was accompanied by the BPPA, the MSCL, the POMS and the SCL-90-R.

Results

Pain-Related Outcome

All pain-related data for the three cycles are summarized in Table 3. The PRI was not obtained in cycle I, and the TLI was not obtained in cycles I and II.

Pain Rating Index

In cycle II, the PRI decreased from a mean of 17.5 premeditation training to a mean of 7.9 postmeditation training for the 10 individuals for whom both pre and post questionnaires were obtained. This represents a 51% reduction and is highly significant in the matched (pre and post) t-test ($P < .001$, $df = 9$, two-tailed). Of the remaining 6 individuals, for whom the PRI data were incomplete, four reported reduction in overall pain on other indices,

Table 3. Summary of outcome: Primary pain-related measures

Pain measure	Cycle I n = 11					Cycle II n = 16				Cycle III n = 24		
Total Pain Rating Index (PRI)						*Pre*		*Post*		*Pre*		*Post*
Mean						17.5		7.9		16.7		9.9
Mean Δ			—				9.6				6.8	
SE							1.7				2.2	
% redn							51%				41%	
P<							.001 (*df* = 9)				.01 (*df* = 23)	
Body Parts Problem Assessment (BPPA)	*Pre*		*Post*	2.5 mo	7 mo	*Pre*		*Post*	4 mo	*Pre*		*Post*
Mean	38.2		35.5	26.3	22	41.4		31.3	32.6 (n = 11)	47.7		29.3
Mean Δ		2.7		11.9	16.2		10.1		8.0		18.4	
SE					2.9		6.4		7.5		5.0	
% redn		8%		31%	42%		24%		20%		39%	
P<		NS		NS	.001		NS		NS		.01	
Dermatome Pain Map (DPM)												
Pre–post Δ	– 0		+ ++	+++		– +		0 + ++	+++	– ± 0 + ++ +++		
# patients	0 3		2 2	3		1 1		2 1 4	6	1 2 2 5 5 8		
Improved:												
+/++/+++	7/10		70%			11/15		73%		18/23	78%	
++/+++	5/10		50%			10/15		67%		13/23	57%	
Table of Levels of Interference (TLI)										*Pre*		*Post*
Mean			—					—		12.4		8.1
Mean Δ											4.1	
SE											1.3	
% redn											34%	
P<											.001	

*Legend: Mean scores, differences in mean scores (mean Δ) and standards errors (SE) are listed for all pain (Table 3) and non-pain (Table 4) indices used in each cycle. Pre represents before the SR&RP, post represents after the SR&RP, and 2.5, 4, and 7 mo means follow-up, measured from the end of the SR&RP with times indicated in months. Percent reductions of the group mean values were calculated between the time in question and the mean Pre scores. *P* values represent two-tailed *t*-test statistics, with the degrees of freedom (*df*) as noted. Change in DPM was rated by visual inspection on a scale from – to +++ (see text) and the number of patients in each category is listed below it. Where follow-up returns were not complete, the mean Δ's and *t*-tests were calculated only for the individuals for whom complete data was available.

one was illiterate and could not respond validly, and one experienced an increase in pain over 10 weeks. Thus the missing cases probably do not invalidate the generality for the group of the mean PRI reduction observed in the cohort of patients for whom complete data were available.

In Cycle III, pre and post data on all 24 individuals in the cycle were obtained. The initial mean level was 16.7 and decreased to 9.9 post, a reduction of 41% ($P < .01$, $df = 23$, two tailed). Pooling the individual results for the two cycles, 22 out of 34 subjects (65%) achieved pain reduction of 33% or

Table 4. Summary of Outcome: Secondary Symptom Measures

Measure	Cycle I n = 11					Cycle II n = 16				Cycle III n = 24		
Medical Symptom Checklist (MSCL) (# of symptoms)	*Pre*		*Post*	*2.5 mo*	*7 mo*	*Pre*		*Post*	*4 mo*	*Pre*		*Post*
Mean #	24.3		13.1	11.3	10.8	18.7		13.2	15.8	23.9		16.4
Mean Δ		11.1		13.0	13.5		5.5		2.73		7.5	
SE		3.6		3.8	3.6		1.7		2.9		1.4	
% redn		46%		54%	56%		29%		16%		31%	
P<		.02		.01	.01		.005		NS		.001	
Total Mood Disturbance (POMS)						*Pre*		*Post*	*4 mo*	*Pre*		*Post*
Mean score		—				42.1		16.8	21 *n* = 11[a]	51.5		20.2
Mean Δ							25.3		18.1		31.3	
SE							8.7		9.2		6.2	
% redn							60%		46%		61%	
P<							.02		NS		.001	
General Severity Index (SCL-90-R)						*Pre*		*Post*	*4 mo*	*Pre*		*Post*
Mean score						.74 n = 16		.49 n = 14[a]	.47 n = 10[a]	.82 n = 23		.51 n = 23
Mean Δ							.25		.22		.31	
SE		—							.09		.06	
% redn							34%		32%		38%	
P<							.05		.05		.001	

[a] Mean Δ's and t-test for these are calculated using matched pre and post or follow-up results.

greater, and 17 out of 34 (50%) achieved pain reduction of 50% or greater over the 10-week period during which they practiced mindfulness meditation (Table 5).

Body Parts Problem Assessment

In Cycle I (N = 11), the BPPA did not show a significant reduction until 7 months follow-up, at which time the reduction was 42% and was highly significant. All 11 patients (100%) returned follow-up questionnaires on both occasions. Several patients in Cycle I had very elevated post scores on the BPPA due to pain from acute episodes unrelated to their primary pain complaints. These scores initially obscured the progress the majority had made on the BPPA when averaged in.

Reductions relative to the pre level in Cycle II (N = 16) were 24% at 10 weeks and 20% at 4 months follow-up (11 responders). Neither reached statistical significance.

In cycle III (N = 24), the average pre score was higher (47.7) than for the previous cycles and the reduction at 10 weeks greater, 39%. This was highly significant in the *t* test. In total, 57% of the patients achieved a reduction of 33% or greater on the BPPA at 10 weeks, and 43% achieved a reduction of 50% or greater (Table 5).

Dermatome Pain Map

The DPM provided a visual dimension to the pain-assessment battery. The definitive and highly selective choices pain patients make when given lists of pain descriptors to choose from, as noted by Melzack (27), were also observed in choice of color and areas when they were asked to draw in their pain on the DPM. As with all the outcome measures, the patients filled out the post DPM without access to their pre DPMs. They were specifically questioned as to its completeness and accuracy.

The DPM has potential as a quantitative assessment of pain. In the present study, however, its use was restricted to a qualitative assessment of the direction and degree of change between the pre and post results (scored by the author). The rating scale ranged from − (which signified that the change from the pre to the post evaluation indicated that the pain was either more intense, more frequent, occupied a greater area or some combination of the above) to +++ (which signified a highly visible reduction area, intensity, or frequency, or a combination of the above). Table 3 shows that greater than 70% of the patients in each cycle were in the +/++/+++ ("improvement") class, and 50% or more in the ++/+++ ("moderate or great improvement") class.

Table of Levels of Interference

In cycle III, the average score dropped from 12.4 to 8.1, or 34%. This represents a significant improvement in the ability to engage in ordinary life activities *while in pain*. This index does not take into account the frequency of occurrence of interfering pain. Many patients remarked that their scores on this instrument did not reflect their improved pain status because it demanded the degree of interference only for those times when they had pain.

Non-Pain Related Outcome

Summary data on the secondary dimensions of symptomatology and mood are found in Table 4.

Medical Symptom Checklist

In cycle I, the percent reduction in the mean total number of symptoms was 46% at 10 weeks, 54% at 2.5 months follow-up, and 56% at 7 months follow-up, all highly significant by matched *t* test.

In cycle II, the percent reduction of the mean was 29% at 10 weeks and was highly significant statistically. At 4 months follow-up, it was 16% and was no longer statistically significant.

In cycle III, the percent reduction of the mean number of symptoms was 31% at 10 weeks. The 46% reduction in number of medical symptoms in cycle I was impressive compared to the 29% and 31% reductions at 10 weeks recorded in cycles II and III. Whether this difference and the differences in direction and magnitude at follow-up are due to random group differences remains to be defined from subsequent cycles. Nevertheless, we may minimally conclude that on the average close to one-third of the medical symptoms present on initial referral were no longer problematic after the 10-week training in mindfulness meditation.

Table 5. Summary of patient achievement of fixed levels of improvement at 10 weeks

	PRI		BPPA		DPM	MSCL		TMD		GSI	
Cycle	≥33%	≥50%	≥33%	≥50%	mod/great improvement	≥33%	≥50%	≥33%	≥50%	≥33%	≥50%
I N = 11	ND	ND	6	5	5	7	4	ND	ND	ND	ND
II N = 16	7/10[a]	5/10[a]	9	8	10	7	5	11/14[a]	9/14[a]	7/14[a]	5/14[a]
III N = 24	15	12	14	9	13	14	8	17/23[a]	14/23[a]	14/23[a]	7/23[a]
Total N = 51	22/34	17/34	29/51	22/51	28/51	28/51	17/51	28/37	23/37	21/37	12/39
%	65	50	57	43	55	55	33	76	62	57	32

[a]where the entire group did not complete the pre and post questionnaires, the number who did answer is shown in the denominator.

Legend: Each column shows the number of individuals who achieved score reductions on a particular index of greater than or equal to 33% and greater than or equal to 50%. Totals are given in the bottom row and are expressed as the percentage of the total number of patients for whom complete data was available. ND means not done.

In total, 28 out of 51 patients (55%) reported a reduction on the MSCL of greater than or equal to 33%, and 17 out of 51 (33%) reported a reduction of greater than or equal to 50% at 10 weeks (Table 5).

Total Mood Disturbance

There was a substantial and highly significant reduction in negative affect in cycles II and II at 10 weeks (60%). For cycle II, for the 11 individuals responding (69%) to the 4 month follow-up questionnaire, the mean reduction from the mean pre level was 46%, below statistical significance.

In total, 28 out of 37 patients (76%) reported a reduction in TMD of greater than or equal to 33%, and 23 out of 37 (62%) a reduction of greater than or equal to 50% at 10 weeks (Table 5). This constitutes an impressive improvement in affect for the vast majority of the pain patients over the 10 weeks of the meditation training.

General Severity Index

In Table 4, it can be seen that in cycles II and III, 10 week mean reductions of 34% and 38% respectively were recorded, the former being stable at 4 months follow-up for the responders. All reductions reached high statistical significance. In total, 21 out of 37 patients (57%) in cycles II and III reported a reduction in GSI of greater than or equal to 33%, while 12 out of 37 (32%) reported a reduction of greater than or equal to 50% at 10 weeks (Table 4).

Summary Outcome Score at Follow-up

Part one of the Follow-up Questionnaire provided the opportunity to assign a mean summary outcome score to each individual on the basis of the response to 10 questions thought to be relevant to a clinical judgment of improvement [see (1)]. On a scale of 1 to 5 where 3 represents no change or improvement, 5 is great progress, and 1 is major worsening, an empirical cut off was set at a mean score for the 10 questions of 3.4. This served to separate those who could clearly be labeled as improving from those who clearly did not improve. The range of 3.0 to 3.4 contained a few individuals who we knew (from the other data and from personal discussions) had made more progress in some areas than the score indicated. For sake of consistency, however, all individuals scoring below 3.5 were assigned to the no improvement category.

In cycle I, 3 out of 11 patients (27%) scored between 2.7 and 3.4 at 7 months follow-up. The remainder (73%) scored above 3.5 on the outcome questionnaire. The mean score for all 11 patients was 4.2.

In cycle II, with 11 respondents out of 16 at 4 months follow-up, 2 out of 11 (18%) had scores below 3.5 (2.9 and 1.8). The mean score for all 11 patients was 3.7.

In cycle III, at the end of the 10-week training period, 5 patients out of 24 were in the no progress category (21%) with the rest (79%) scoring above 3.5. The mean score was 4.0.

In each cycle a number of individuals scored above 4.3, an indication of considerable progress towards less pain, greater energy, and improved coping. This suggested a substantial general improvement in health status remarkable for this difficult chronic population. This was confirmed for these individuals by their large change scores on at least some of the pain indices and non-pain measures.

Discussion

The results presented above are a summary of the outcome data obtained in three sequential cycles of the Stress Reduction and Relaxation Program[3] in which a total of 51 chronic pain patients participated. The most striking observation was that the majority of patients experienced considerable improvement in their conditions over the course of the 10 week training program in mindfulness meditation. Improvement was observed for all categories of chronic pain. Most of the pain reduction and affect improvement was maintained on follow-up at 2.5, 4, and 7 months. The follow-up data, however, are limited at the time of writing to two of the three cycles and to only one pain measure (the BPPA)[4] in addition to the pain-related questions in the summary outcome questionnaire.

Pain Outcome

Because of the higly subjective nature of the pain experience and the difficulty in acquiring precise measurements of pain and suffering, a spectrum of pain indices was used to assess different but over-

[3]Cycle I, Winter 1980; Cycle II, Spring 1980; Cycle III, Fall 1980.

[4]The PRI and the DPM were not included in the follow-up mailing because of the need to administer them in the presence of an interviewer for reliability and accuracy.

lapping dimensions. The Pain Rating Index relies on linguistic/verbal discrimination and on the choice of pain descriptors. The Body Parts Problem Assessment probes feelings about body parts. The Dermatome Pain Map subserves visual, spatial, and tactile dimensions as the patient colors in his/her pain. The Table of Levels of Interference assesses a behavioral dimension of pain. Different time frames add to the breadth of the spectrum. The PRI was used to assess *present pain* while the others were used in a "past week including today" mode. For correlation studies on these indices, see (1).

In each cycle, more than 50% of the patients reported greater than or equal to 33% reduction in both present pain (PRI) and general body problems (BPPA), and approximately 50% were in the "moderate to great improvement" category as judged by their drawings on the DPM (Table 5). Between 35% and 50% of the patients in each cycle reported greater than 50% reduction on the PRI and the BPPA. These results suggest a pronounced decrease in severity and frequency of pain over a 10-week period. It is important to note that they do not represent reductions measured over a therapy session as in Melzack and Perry (20). The pain reductions reported here compare favorably with those reported by these authors for a similar but more stringently defined chronic pain population. In fact, if we had expressed our results as the mean percent change in PRI by summing the individual net percentage changes for each subject (pre − post/pre) and correcting for initial values of zero (27), the percent reductions would in most cases be considerably higher than the values listed in Table 3. This applies to all the other indices in Tables 3 and 4 as well, which are expressed as the percentage change of the group mean, giving more weight to those individuals reporting high scores, and thus making it more difficult to obtain a numerically impressive improvement.

Melzack and Perry noted that the duration of relief from pain in some individuals lasted for several hours after training sessions in which EEG-α-biofeedback combined with hypnosis was the therapeutic modality, and referred to this phenomenon as carry-over. Our data suggest a similar phenomenon of carry-over as a result of training in mindfulness meditation. Pre and post pain measures for individual meditation sessions were not elicited, because this would have contradicted the emphasis on non-striving and on direct observation and acceptance of the pain as experienced in each moment. The decreases in pain we observed over the 10-week training period therefore represent a generalized pain reduction not restricted to the occasions of formal meditation practice. This suggests that the improvements in the majority of patients were profound. The observed pain reductions are consistent with the hypothesis (see Introduction) that the direct observation of pain as one of a number of objects of awareness can reduce the affective and cognitive dimensions of the experience. Evidence from the non-pain outcome measures (see below) suggests that the pain reductions are related to changes in attitudes and modes of perception of pain. An analysis of the sensory and affective components of the PRI may shed light on possible differential effects of the meditation strategy on the component dimensions of the pain experience.

In assessing the contribution of any self-regulatory intervention to an observed therapeutic result, it is important to cite the work of Holroyd and Andrasik (35). They observed, in carefully controlled experiments, that improvement in tension headache in patients following EMG-biofeedback training was a result of cognitive and behavioral changes in recognizing and coping with headache eliciting situations rather than from the learned self-control of muscle tension. They pointed out that when taught to recognize the onset of headache symptoms, their patients changed the ways they were coping with these stressful situations *even when no coping skills were taught*. They concluded that "it may be less crucial to provide clients with specific coping responses than to insure they monitor the insidious onset of symptoms and are capable of engaging in some sort of cognitive or behavioral response... this response need not be relaxation and in certain situations where... inappropriate... should not be relaxation." These observations imply that moment to moment mindfulness may itself be the underlying coping mechanism. The experience of patients practicing mindfulness meditation suggests that increased awareness and sensitivity to the attributes of pain and to stress reactions *in the moment*, lead to the spontaneous development of new cognitive and behavioral coping responses to pain and stress, replacing nonadaptive conditioned pain behaviors and knee jerk stress reactions (1, 2).

Non-Pain (Symptom and Affect) Outcome

The overall health of the patients was monitored as part of the outcome determination. Meditation and yoga embody and reinforce well-behavior and might presumably have an effect on symptoms and affect through generalized reduction in arousal, regular deep physiological relaxation, and insight into one's potential inner resources for growth and self-regulation. Ideally, measurements of ego development (Loevinger), self-actualization and improved coping would be appropriate for defining changes in this area. However, these have either technical or methodological shortcomings and therefore none was monitored. The analysis was confined to the number of medical symptoms reported, to a psychiatric symptom profile, and to a mood indicator profile (Table 4).

The mean number of medical symptoms was impressively lower after 10 weeks in every cycle of the SR&RP. Reductions ranging from 29% to 46% were recorded. For the patients in cycle I, the mean symptom reduction increased with time to reach 56% at 7 months follow-up. Combining the three cycles, 55% of the patients reported symptom reductions of 33% or greater at 10 weeks, and 33% reported reductions of 50% or greater (Table 5).

The mean Total Mood Disturbance (TMD) score on the Profile of Mood States decreased by approximately 60% at 10 weeks in cycles II and III (Table 4), reflecting a shift to greater vigor and reduced fatigue, confusion, depression and tension. At 4 months follow-up, the bulk of this reduction (46%) was still apparent. A total of 76% of the individuals in the three cycles combined recorded a reduction in TMD of 33% or greater, and 62% a reduction of 50% or greater (Table 5).

The mean summary measure of psychiatric symotomatology on the SCL-90-R, the GSI, decreased by between 34% and 38% ($P < .05$, $df = 14$, two-tailed; $P < .001$, $df = 22$, two-tailed) respectively in cycles II and III and was conserved at 4 months follow-up of the patients from cycle II. On the profiles, the largest mean reductions were in the dimensions of depression, anxiety, obsessive-compulsive behavior, and somatization (1). Fifty-seven percent of the patients in the three combined cycles reduced the General Severity Index by 33% or more, while 32% reduced it by 50% or more (Table 4). Mean GSI changes of this magnitude are impressive and were significant statistically.

The mean reductions in the non-pain indices suggest that the chronic pain patients responded to training in meditation on a variety of interrelated fronts. Symptoms were sufficiently reduced over the 10 weeks to conclude that the patients were in fact exercising self-regulation and wellness behaviors. This conclusion was supported by the large reductions observed in negative mood states including depression, tension, anxiety, fatigue and confusion and by an increase in vigor. Nonquantifiable free-text statements by many patients claimed growth in areas of self-esteem, communication, and coping. These changes have been maintained in some cases for up to 1.5 years follow-up and in most cases improvement continues (1).

The SCL-90-R was used by Carrington et al. (36) to probe stress symptom changes in a working population as a function of on the job training in progressive relaxation and several concentration meditation techniques. They observed a remarkable decrease in GSI in the control population which did not undergo any intervention except pre and post testing and passage of time. The authors attributed this reduction to a nonspecific placebo effect associated with high expectations generated by the experimental design. Their finding underscores the caution necessary in interpreting the pain and symptom reductions we have observed until comparison controls are available. Nevertheless, it is highly unlikely that a chronic pain population would respond as dramatically as the Carrington et al. control group without a specific therapeutic intervention, and our recent work (1) clearly shows that the mean reductions reported here were *not* observed in a control group of patients receiving the traditional medical therapies in the Pain Clinic over a comparable period of time.

Limitations of the Present Work

1. The lack of matched comparison control groups makes a rigorous interpretation of the role of the meditation in the reported pain reduction impossible at this time.

2. Most of the data are based on paper and pencil patient self-reports, and are therefore subject to response sets and bias to some degree, motivated by denial, exaggeration, or desire to please. This problem is offset somewhat by use of the spectrum of pain indices, which averages out response biases to specific measures by individual patients. For most patients, reports of reduced pain and decreased pain-related behavior were reflected in observable changes in affect and reduced dependency on prescription medication and nerve blocks (1). We therefore assume that to a first approximation the patients were in fact reporting their status accurately.

3. Ideally the change in DPM should be rated by a panel of independent judges rather than by the author.

Summary and Conclusion

The preliminary results from the Stress Reduction and Relaxation Program suggest that it is possible to structure and conduct a successful outpatient behavioral medicine clinic in a hospital setting, and that many chronic pain patients can benefit dramatically from such a program. The program structure incorporated common sense features for catalyzing behavioral improvement such as encouraging self-responsibility, positive placebo factors, a group setting, a short-course format, low cost, and a unified gamut of techniques for self-regulation. These features are probably essential ingredients for any successful behavioral medicine outpatient program. They were used to maximize the effectiveness of the specific intervention: mindfulness meditation.

Beyond the reduction in pain levels and pain-related behaviors, the majority of patients evidenced attitudinal and behavioral changes which can be attributed to the regular practice of mindfulness meditation: an ability to observe mental events, including pain, with a sense of detachment; cognitive changes which appear directly related to the experience of detachment; and an increased awareness of oneself in relationship to others and to the world. Deep personal insights, greater patience, a new ability to relax in daily life situations, and a willingness to live more in the present moment were commonly reported, as were increased awareness of stressful situations and improved ability to cope successfully. While this work does not prove that the meditation practice is directly responsible for these changes, it does suggest it. A methodologically stringent placebo controlled study is in the design stage to test the hypothesis that the major therapeutic benefits stem from the meditation practice itself.

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Abstract

A QUALITATIVE CASE ANALYSIS OF MINDFULNESS MEDITATION TRAINING IN AN OUTPATIENT STRESS REDUCTION CLINIC AND ITS IMPLICATIONS FOR THE DEVELOPMENT OF SELF-KNOWLEDGE

Saki F. Santorelli, Ed.D.

Qualitative and quantitative methods were combined to examine the experience if eight randomly selected adults referred for mindfulness meditation training (MMT) within the context of a group, out-patient, hospital-based stress reduction clinic. Through interviewing, observation and document analysis, three aspects of experience were investigated; the subjective experience of learning meditation; the application of meditation-based coping skills in daily life; and the effects of training on perception of self. Individual and cross-sectional case study methods were used to examine longitudinally, the classes and common patterns of the intervention. In addition, the experience of participants was examined within the theoretical framework of Self-Knowledge Development Theory (SKT) in an attempt to understand how people at differing stages of self-knowledge, as delineated by the theory, experienced and utilized MMT. Results suggest that 1) the majority of participants showed reductions in medical symptoms (MSCL) and in clinically elevated levels of psychological distress (SCL-90R) on pre/post and follow-up measures: 2) common patterns of experience emerged progressively during and following the intervention among patients with diverse diagnosis: 3) there appears to be an interactive, cyclic relationship between skill development, application of skills in daily life, and perception of self that functions as a self-motivating force, fostering continued skill development after the conclusion of the intervention; and 4) there was a variance I the participant's use of the intervention that appears to be consistent with and further defines elements of the situational and pattern stages of Self-Knowledge Development Theory.

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