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ORIGINAL PAPER

Does Mindfulness Meditation Enhance Attention? A Randomized Controlled Trial

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Abstract Mindfulness-based interventions have been incorporated into a variety of psychotherapies. Attentional disruptions are common in many mental disorders, and it seems generally accepted that practicing mindfulness enhances attention. We tested the hypothesis that mindfulness training would enhance four components of attention: sustained vigilance, concentration, inhibition of distraction, and executive control. A randomized three-group design included: (1) a mindfulness meditation group, (2) a progressive muscle relaxation group to control for effects of physical relaxation on attention, (3) a wait-listed group to control for practice effects of repeated measures. Fifty-three community adults were randomly assigned to one of these groups. Forty-five participants completed the 4-week program. After training and 4 weeks of twice-daily practice, the mindfulness group demonstrated significantly greater discriminability on a signal detection task than did the other groups. Significant improvements in sustained attention were found following mindfulness meditation, which did not appear to be mediated by relaxation or practice effects. Performances on measures of concentration and inhibition of distraction did not support the hypothesis. These results partially support current considerations of mindfulness meditation to enhance attention.

Keywords Attention · Mindfulness · Meditation · Progressive muscle relaxation · Randomized controlled trial

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Introduction

Mindfulness practices and meditation are not synonymous, either in theory or in practice, and research terminology has evolved over the past 5 decades. However, most mindfulness-based interventions utilize some form of meditative practices. Many of the techniques now being integrated into clinical interventions were adapted from Eastern contemplative practices that are believed to effect psychological as well as spiritual benefits for its practitioners (Walsh and Shapiro 2006). In the 1960s, Western scientists found that meditation typically produced a hypometabolic autonomic nervous system response that Benson et al. (1974) named "the relaxation response." Reductions in heart rate and respiration, however, are comparatively gross, and objective changes relative to the subtle and subjective shifts in awareness, emotions, and values that have traditionally been the goals of meditation practiced as a consciousness discipline (Walsh 1996). Accordingly, the rise of information-processing paradigms stimulated interest in understanding better the cognitive and affective changes resulting from meditation and mindfulness practices (Boals 1978). As the word is broadly used in clinical research today, mindfulness is considered to be an intentional deployment and management of attention (see discussion by Bishop et al. 2004).

Qualities of Mindful Attention

Decidedly difficult to describe, everyone knows exactly what to do when told to pay attention. The subjective experience of mindful attention appears to be qualitatively

different than ordinary attention. Some attributes of mindful attention may involve:

a. An intentional focusing of awareness. This awareness may be of anything (e.g., situations, physical experiences, environments, conversations, tangible objects, etc.) but also includes awareness of intrapsychic events (thoughts, emotions, and body sensations).
b. Awareness that is distinguishable from cognitions, moods, emotions, attitudes, or motivations.
c. A dynamic process that is sustained over time.
d. Attention that is not easily distractible.
e. Volition. A conscious intention toward mindful attention is present.
f. Decentered focus on present-moment events. Memories and anticipatory thoughts are identified as events in the mind, the contents of which relate to past or future events.
g. Thoughts, emotions, and body sensations are experienced as intrapsychic events.
h. Noncritical or nonjudgmental awareness of the object of attention.
i. Efficient utilization of an optimal level of arousal.[1]

Considering these qualities in combination suggests that experiences may be seen more clearly, so that mindfulness practices could effect a reduction in habituated or inappropriately reactive behaviors. We suggest that on a dimensional continuum, ordinary attention lies somewhere between mindlessness and mindful attention. At one extreme, mindlessness may be broadly characterized by inconsistent awareness, unstable focus, distractibility, emotional reactivity, and attention to past or future experiences. Absent-mindedness, which is looking without actually seeing what one is looking at, is one example of mindlessness. Being caught up in an "uncontrollable rage" of anger is another. At the other extreme, mindful attention is present-focused, voluntarily directed, stable, not easily distracted, and utilizes optimal arousal necessary for each situation. Mindful attention means seeing with clarity, stability, minimal distraction, and little affective reactivity.

Buddhist psychology suggests that personal suffering may lessen as one focuses nonjudgmental attention toward fully experiencing present-moment events, clearly identifying intrapsychic events as such, and avoiding clinging to that which is impermanent (Bhikkhu Bodhi 1993). Affective equanimity and increased well-being have long been associated with advanced meditation practices. Restated as a cognitive model, the cultivation of attention may reduce psychological distress by correcting distorted and maladaptive attentional biases in cognitions and perceptions (Blackburn and Davidson 1995). Kabat-Zinn (1994) suggested that mindfulness allows one to observe the workings of the mind moment-by-moment, to see thoughts as "just thoughts," and allow the thoughts to come and go without getting caught in the stories they relate. Mindful seeing, without the distortions produced by internal stories, emotions, desires, expectations, and beliefs about experiences should therefore enhance the ability to respond appropriately to intrapsychic, interpersonal, and situational events.

Research on Mindful Attention

Deikman (1966) observed that repetition of perceptual patterns and cognitive categorizations resulted in a cognitive state in which conditioned or over-learned responses were more difficult to suppress. The "Stroop effect" is one well-known example of this. Deikman hypothesized that meditation practices interrupt automatic responding by "reinvesting actions and percepts with attention" (p. 329). He referred to this attentional management of over-learned or habituated responses "de-automatization." Deikman believed that de-automatization would produce more flexible and adaptive cognitive processing. Wenk-Sormaz (2005) tested Deikman's theory and found that compared with cognitive and resting control groups, as little as one 20-min meditation session, with meditation-naïve participants, reduced the Stroop effect. Wenk-Sormaz concluded that improved attentional control reduced the automaticity of the responses, supporting Deikman's concept of de-automatization. Moore and Malinowski (2009) compared a group of experienced meditators with non-meditators and found a similar reduction of the Stroop effect. They also found that self-reported mindfulness and other measures of attention were higher in meditators than in non-meditators.

Duration and quantity of meditation practice may be associated with greater increases in mindful attention. Davidson et al. (1976) found increases in attentional capacity that significantly correlated with the duration of the practitioner's meditation experience. Valentine and Sweet (1999) reported that experienced meditators were more adept at a test of sustained attention than non-meditators, and that long-term meditators showed better attentional performance than short-term meditators. Another study found that relative to a non-meditating comparison group, participants in an intensive 10-day meditation retreat showed significant improvements in performance measures of sustained attention (Chambers et al. 2008).

Different mindfulness practices may differentially affect attention. Jha et al. (2007) compared a group of mindfulness-naïve individuals participating in an 8-week Mindfulness-Based Stress Reduction program (MBSR; Kabat-Zinn 1994) with a group of experienced meditators who were partici-

[1] One of the most consistent findings in psychology is that optimal arousal is necessary to produce efficient performance for any given task (Broadbent 1958).

pating in an intensive 30-day meditation retreat. Results from a psychophysical measure of attention; the Attention Network Test (ANT, Fan et al. 2002), showed that participation in the MBSR program improved orienting, while the retreat participants demonstrated improvements in receptive attentional skills. Jha and her colleagues suggested that mindfulness training might differentially enhance specific components of attention. Results from another study of self-reported mindfulness correlated with psychophysical measures of attention suggest that mindfulness may be inversely related to exaggerated lapses of attention (Schmertz et al. 2009). Tang et al. (2007) reported that compared with a control group, an experimental group given 5 days of brief meditation training showed greater improvement in conflict scores on the ANT as well as significant increases in immunoreactivity and decreases in stress-related cortisol.

Studies using imaging techniques have reported neurobiological changes in brain structure (Lazar et al. 2005) and functioning (Davidson et al. 2003) that seem to be related to practicing mindfulness. Meditative practices also appear to increase activity in the anterior cingulate cortex, an area of the brain associated with the self-regulation of attention (Tang and Posner 2009).

Two studies have investigated the relationship between mindfulness and attention in children. Rani and Rao (1996) evaluated a small group of children (ages 9 to 11) who meditated regularly with an age- and gender-matched, non-meditating comparison group. They found that the meditation group demonstrated greater attention regulation capacity than the controls. In a randomized controlled study of clinic-referred children (ages 9 to 13), significant reductions in attention-related problems were found after completion of a 12-week mindfulness training program. Following the intervention, program participants demonstrated significantly fewer attention-related problems than wait-listed controls (Lee et al. 2008; Semple et al. 2010). Results from a mixed group of adolescents and adults with Attention Deficit-Hyperactivity Disorder (ADHD) who practiced meditation for 8 weeks showed reductions in ADHD symptoms and improvements on tasks of attention and cognitive inhibition (Zylowska et al. 2008).

Only one study was found that reported no relationship between mindfulness and attention. In this study, participants were randomized to an MBSR group or wait-listed control group. Following the intervention, no significant differences in performance were found on measures of sustained attention, switching, elaborative processing, and non-directed attention (Anderson et al. 2007).

The definitions, methodologies, and measurements of attention vary across these studies, as do the mindfulness techniques, modes of training, and levels of experience. This obviously makes it difficult to compare studies using meta-analytic methods. Rubia (2009) suggested that one aim of meditation practices was to reduce or eliminate irrelevant cognitive processes through training of internalized attention. Reviewing the combined evidence from neurobiological and clinical studies seems to show some support for the notion that mindfulness practices enhance attention.

Current evidence suggests that mindfulness-based clinical interventions can be effective in treating a variety of medical and psychiatric disorders (Allen et al. 2006; Baer 2003; Bondolfi 2005; Grossman et al. 2004). Enhanced attention may be one path by which these benefits are realized. In this study, we explored the use of meditative practices to enhance attention and examined relationships between mindful awareness, relaxation, and well-being. We hypothesized that meditation would enhance four components of attention: sustained vigilance, concentration, inhibition of distraction, and executive control. A randomized three-group design was used to control for changes resulting from nonspecific effects of physical relaxation and repeated-measures practice effects.

Method

Participants

Adult volunteers were recruited through newspaper articles and flyers posted on community bulletin boards. Seventy-eight volunteers responded to the notices and underwent brief telephone screens. Applicants were excluded if they reported having prior experience with any meditation technique. They were only initially informed that the research was to study physical and psychological effects associated with stress and relaxation. In order to minimize expectancy effects, the words "mindfulness" and "meditation" were avoided (Shapiro 1987).

Fifty-three participants began the study (39 females, 14 males). Six females and two males dropped out before completing the program (84.9% retention rate). The 45 participants who completed the program were between 23 and 56 years of age (M=40.2, SD=8.9). Forty participants (89%) described their ethnicity as *Caucasian* and five (11%) described themselves as other. Participants attended two individual training and assessment sessions and were requested to maintain twice-daily home practice sessions during the 4 weeks of the program. Each participant received an instructional audiotape, written practice instructions, and a practice record log. This study was approved by the University of Auckland Institutional Review Board. Informed consent was obtained from each participant.

Study Design

The research design was an independent groups, repeated-measures 3×2 factorial design. Participants were randomly

assigned to one of three groups (see Fig. 1, CONSORT participant flow diagram). Mindfulness meditation (MM; n=15) was referred to as the Benson Technique (Benson et al. 1974). The second group (n=14) was assigned a modified progressive muscle relaxation (PMR) procedure (Bernstein and Borkovec 1973; Jacobson 1925/1987), which was labeled the Jacobson Technique. The primary purpose of the PMR group was to control for nonspecific effects of physiological relaxation on attention. The third group (n=16) consisted of wait-listed controls (CT). These individuals were not informed that they were controls, but only that their training would begin in a "few" weeks. The CT group controlled for practice effects on the performance measures and for normal and expectable fluctuations in anxiety and mood states over time. CT group assessments were completed on schedules equivalent to both training groups.

Individual pretest and posttest sessions, 1 month apart, were conducted with all participants. At pretest, baseline data were collected, and participants were taught and practiced either MM or PMR or placed on the wait-list for future training. Each training group participant received an audiotape of pre-recorded MM or PMR instructions. Participants were asked to practice the 20-min technique twice daily and record the date, time, and duration of each practice. At the individual posttest sessions, a 20-min mindfulness or relaxation practice was conducted before posttest data were collected. With one exception, test administrations were counterbalanced between groups and across sessions. As the principal measure of attention, all participants at posttest were administered a continuous performance test (CPT) immediately following the mindfulness or relaxation practice. Given that the participants were novices, state effects of mindfulness and/or relaxation on attention were expected to decline quicker than what might be expected from more experienced practitioners.

Measures

Assessments included measures of attention and measures of well-being. Participant demographics, characteristics, and health and lifestyle data were also collected. Three psychophysical instruments were chosen to evaluate some of the theoretical qualities of mindful attention: a Continuous Performance Test, Digit Symbol Substitution, and the Stroop Color and Word Test. The State-Trait Anxiety Inventory and the Profile of Mood States assessed well-being because of its potential relationship with attention.

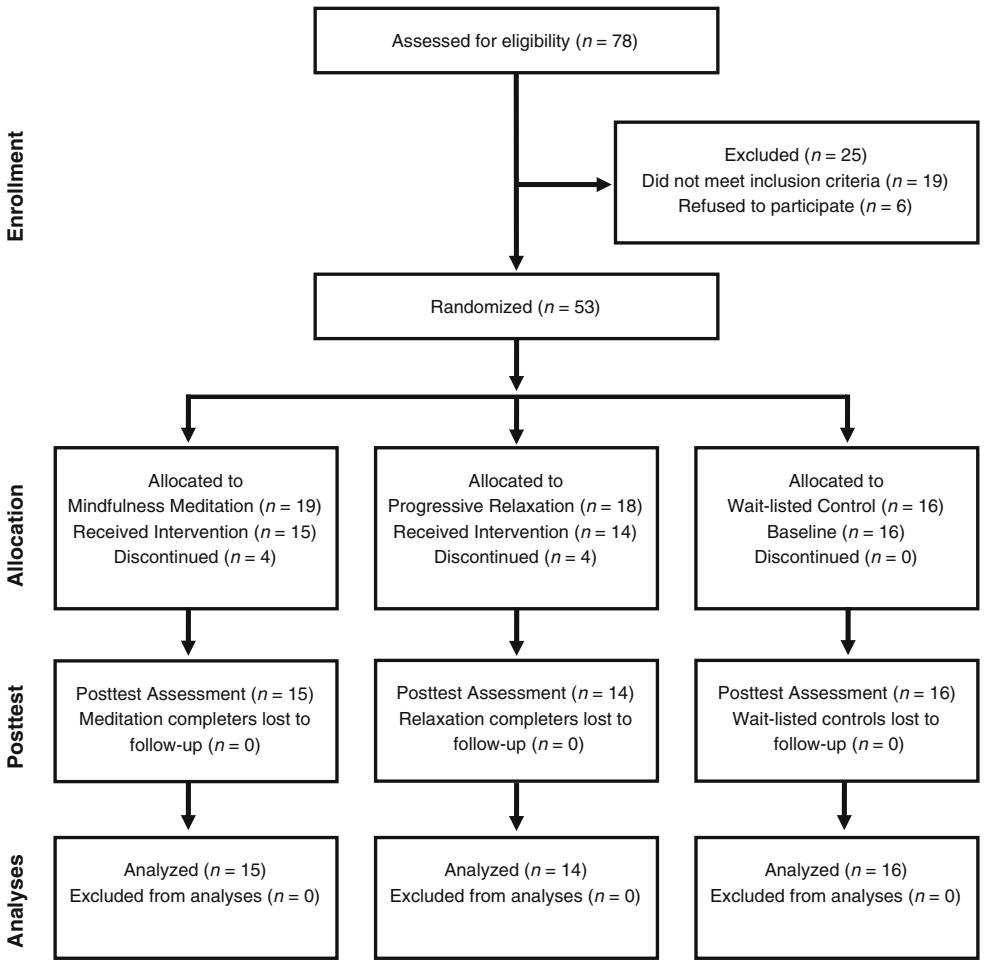

Fig. 1 CONSORT participant flow diagram.

Continuous Performance Test

The CPT is a target-detection sustained vigilance task originally developed by Rosvold et al. (1956). A computerized A–X version of the CPT was used. Software used to control the display presentation and timing of the stimuli was developed at the University of Auckland. Amber-colored block letters, 4.5 cm high, were presented one at a time at the center of a black monitor screen. Eleven letters were used, all having angular shapes (A, E, F, H, L, N, T, V, X, Y, Z). Each stimulus was presented at the center of the screen for 300 ms with a fixed interval of 400 ms between presentations. The target was the letter X, but only if it appeared immediately following the letter A. Participants were instructed to press a blue button when they saw the target and a red button after every other "non-target" letter. Six hundred letters were presented in pseudo-random sequence, with the A–X target sequence programmed to appear on 12% of the presentations. The combinations A then * (A preceding any other letter) and * then X (any other letter preceding X) each occurred on 12% of the presentations. Test administration lasted 7 min. The order of presentation was randomly varied on the posttest administrations.

Interpretation of the CPT

Response events included targets correctly detected (hits); targets missed (misses); positive responses to non-signals (false alarms); and correctly rejected non-targets (correct rejections). Signal detection methods permit a statistical estimation of errors of commission (response bias or β) and errors of omission (discriminability or log d) of a visual signal. Limited attentional capacity seems to effect rapid reductions in perceptual sensitivity (Nuechterlein et al. 1983), so the 7-min vigilance task was considered to be adequately sensitive to detect changes in attention. Of primary interest was the measure of discriminability (log d), which is an estimate of the participant's ability to discriminate signal from noise. Executive control, sustained alertness, orientation to cues, and resistance to distraction during the entire 7-min trial was required to produce higher log d scores. Higher measures of discriminability were considered to represent a greater degree of mindful attention. Reaction times are influenced by factors not of interest in this study and therefore were not recorded or examined.

Digit Symbol Substitution

Digit Symbol Substitution (DSS) is a performance subtest from the Wechsler Adult Intelligence Scale, Third Ed. (Wechsler 1997). A coding key pairs ten simple symbols with ten single-digit numbers. Participants substitute the matching symbol for a random succession of numbers. Scoring is based on the number of accurate written substitutions completed in 90 s. Performance is relatively unaffected by intellectual prowess, memory, or learning. The DSS is considered a test of focused concentration and freedom from distractibility. It also appears to be a sensitive measure of selective attention (Lezak et al. 2004). Advantages of the DSS include the short administration time and availability of reliable normative data.

Stroop Color and Word Test

The Golden version (1978) of the Stroop assesses attentional conflict, orientation to cues, and the ability to ward off distractions (MacLeod 1991). Selective responding to competing stimuli activates executive control functions necessary to resolve the conflicts. The interference phenomenon known as the Stroop effect appears to decrease with age. Using age-adjusted norms, pure interference scores were calculated which corrected for the base reading level of each participant. This method also controls for the superior color-naming skills often seen in women (Golden 1978). Test–retest reliability coefficients range from 0.69 to 0.86 (Jensen and Rohwer 1966). Administration time is approximately 5 min.

Spielberger State-Trait Anxiety Inventory

The Spielberger State-Trait Anxiety Inventory (Spielberger 1983) is a self-report instrument that provides scores for state anxiety (SA), which measures current apprehension, tension, worry, and nervousness, and trait anxiety (TA), which reflects relatively stable dispositional tendencies to perceive stressful situations as threatening. The SA and TA scales each consist of 20 short self-statements that are rated on 4-point scales of frequency. State anxiety is variable, so a reported test–retest reliability of 0.33 on the SA scale is acceptable. The TA scale has shown high test–retest reliability at 0.77 (Spielberger 1983). Appropriate gender and age-stratified norms are available. Administration time is approximately 6 min.

Profile of Mood States

The Profile of Mood States (POMS) (McNair et al. 1992) is a 65-item self-report measure of general mood states. Scoring consists of six mood factor scores (tension–anxiety, depression–dejection, anger–hostility, vigor–activity, fatigue–inertia, confusion–bewilderment) and a total mood disturbance (TMD) score. TMD is intended to be a reliable global estimate of current affective state. Gender-stratified norms are available. Administration time for the POMS is approximately 5 min.

Participant Characteristics

Data were collected on seven health and lifestyle variables: general physical health, general mental health, ability to handle stress, amount of cigarette smoking, amount of alcohol consumption, amount of exercise, and amount and quality of sleep. Expectations of benefits to be gained from mindfulness practice appear to be related to the frequency of practice (Delmonte 1987), so ratings of motivation (desire) and self-confidence (efficacy) were included. Each participant characteristic was self-rated on a 7-point, Likert-type scale.

Procedures

At pretest, demographic data and baseline assessments were collected. Training and on-site practice (90 min) in the respective mindfulness or relaxation technique was followed by 1 month of twice-daily home-based practice. For both training groups, pretest measures were completed before the training began. The pretest session for the control group did not include an instruction and practice period and lasted just under 1 h. The author contacted each participant via telephone twice during the 1-month period of home practice (approximately every 10 days). The purpose of this follow-up was to encourage maintenance of the twice-daily practice, to offer advice regarding daily scheduling issues, and respond to questions about the techniques. Posttest procedures were similar. For both training groups, the posttest session began with a brief review of the training technique followed by a 20-min practice session. Posttest data were collected immediately after the practice session. Participants completed a program evaluation, were debriefed about the purpose of the study, and thanked for their participation. CT group participants were advised that they had been controls and offered an opportunity to learn a relaxation technique. All accepted and then received training and instructional materials in one technique of their choice.

Results

Repeated-measure ANOVAs were conducted appropriate to the 3×2 factorial design. Three groups (mindfulness, relaxation, and control) were evaluated at pre- (time 1) and post- intervention (time 2). Participant variables were analyzed using one-way ANOVAs for interval scale data and Kruskal–Wallis H tests for ordinal scale data. No significant group differences were found for any participant variable at pretest, so no covariates were included in the initial analyses. Alpha of 0.05 was used for all tests. CPT data were corrected for extreme proportions using a log linear correction (Hautus 1995). Average log d estimates were calculated to provide a less-biased group total than that obtained by pooling the raw data prior to estimating population log d for each group (Hautus 1997).

Figure 2 shows the mean changes between sessions for discriminability (log d) on the CPT. Mean discriminability for the MM group increased markedly from pretest to posttest session, while the PMR and CT groups achieved modest increases across sessions. The increase observed across all groups suggests that practice improves CPT performance. Discriminability across groups differed significantly [F (2, 42)=3.71, $p< 0.05$]. Scheffé post hoc analysis showed that the MM group achieved a significantly greater improvement in discriminability than either the PMR or CT group. Significant changes in log d were found in the session×group interaction [F (2, 42)=6.79, $p< 0.01$]. This finding supports the primary research question, à propos the capability of mindfulness practice to enhance attention independent of the potential influence of relaxation on attention.

Mean age between groups was not significantly different, but age proved to be a significant correlate of CPT performance (r_s=0.35, $p<0.05$). A repeated-measures ANCOVA was calculated for log d, with age as a covariate. A significant session×group interaction effect ($p<0.01$) was still found, although the main session effect disappeared. A significant session×age interaction effect was found [F (1, 41)=7.30, $p<0.01$], which suggests a positive relationship between age and improvement across sessions. Older participants tended to improve more than did younger participants.

All groups demonstrated significant mean improvements in performance on the DSS and the Stroop. This supports earlier findings that practice improves performance on these measures. No significant group differences or session× group interaction effects were found. Thus, results from the DSS and Stroop did not support the hypothesized enhancement of attention for either training group.

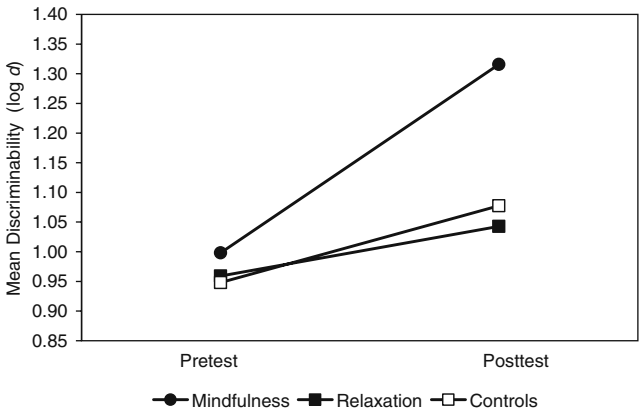

Fig. 2 Continuous performance task: mean discriminability at pretest and posttest ($p<0.01$).

Both training groups reported significant declines in mean state (SA) and trait anxiety (TA) scores [F (2, 42)=18.61, $p<$ 0.001 and F (2, 42)=12.33, $p<0.001$, respectively], while the CT group showed little pre–post change. Although trait anxiety is a relatively stable measure of anxiety proneness, familiarity with the setting, researcher, and test instruments probably accounted for some of the reductions in TA scores. No significant group differences were found on SA or TA scores (Fig. 3). The session×group interaction effect for SA scores approached significance [F (2, 42)=3.14, p=0.054. The MM and PRT groups both showed significantly decreased state anxiety, which was not matched by the CT group.

Modest declines were found on all six mood-state factors of the POMS across groups. The total mood disturbance score showed a significant decline across groups [F (2, 42)=10.56, $p<0.01$]. No significant session×group interaction effects were found for any POMS factor. Mindfulness and relaxation training did not differentially affect participants' mood states. To further explore the hypothesized relationship between attention and well-being, correlation coefficients were calculated for mean group changes in the attention and well-being measures. No significant relationships were found.

Correlation coefficients between each participant variable with the attention and well-being measures were calculated as independent, two-tailed tests using Spearman's rank order correlation coefficients (r_s). Using change scores from pretest to posttest for all measures controlled for individual differences. Given the exploratory nature of this study, no corrections for multiple correlations were effected, which increased the probability of type I errors occurring.

Only age was significantly related to changes in performance on the CPT, although accounting for just 12% of the variance (r_s=.35, $p<0.05$). Self-ratings of motivation and self-confidence were not related to the outcome measures. In general, there was little association between health and lifestyle variables and the outcome measures, with only a self-reported mental health rating correlating with changes in state anxiety, r_s=0.36, $p<0.05$, and amount of sleep correlating with changes in the POMS total mood disturbance score, r_s=0.30,$p<0.05$.

Frequency of practice was associated with lower state anxiety, r_s=−0.49, $p<0.01$. Post hoc analysis found this relationship to be significant only for the mindfulness group, r_s=−0.65, $p<0.01$, a strength of relationship that predicted a significant portion (42%) of the variance for this group.

Days between individual pretest and posttest sessions ranged from 24 to 40 but were not significantly different across groups [$M_{\text{mindfulness}}$=31.8, SD 4.2; $M_{\text{relaxation}}$=33.2, SD=4.4; M_{control} = 29.8, SD=3.4]. Although the MM group practiced slightly more frequently than the PMR group ($M_{\text{mindfulness}}$=8.6 weekly, SD=3.5; $M_{\text{relaxation}}$=8.0 weekly, SD=3.3), a two-tailed, independent samples t test showed no significant group difference. There was no significant relationship between frequency of practice and CPT performance.

Participants Who Dropped Out

Eight participants (four from each training group) did not complete the program or the posttest assessments. Mean age of those who dropped out was 35.0 years (SD 9.2). Mean age of those who completed the program was 41.1 years (SD 9.0). This difference was not statistically significant, t (51)=3.15, $p<0.08$. Mean education level for those who dropped out was significantly lower than for those who completed the program, t (51)=7.44, $p<0.05$. No other significant demographic differences were found.

Fig. 3 State-Trait Anxiety Inventory: mean state anxiety at pretest and posttest (p=0.054).

Discussion

After 1 month of twice-daily mindfulness practice, a community sample of randomly assigned adults demonstrated significant improvements in discriminability on a vigilance task. This enhanced attentional performance was not matched by a similar group trained in progressive relaxation or by a wait-listed control group. Improved performance was not directly mediated by physical relaxation. No significant relationships were found between changes in CPT performance and changes on two other measures of attention, the Digit Symbol Substitution (DSS) or the Stroop Color and Word Test (Stroop). Age was the only participant variable significantly related to changes in discriminability, but this was not a simple relationship. While younger participants tended to record higher scores at pretest than older ones, improvements in performance

across sessions correlated significantly with increasing age. No significant relationships were found between changes in attentional performance and anxiety, mood states, level of motivation, self-confidence, or frequency of practice. Mindfulness and progressive muscle relaxation both effected significant reductions in state anxiety that was not found in the wait-listed controls. Lower state anxiety was significantly associated with frequency of practice only for the mindfulness group. Given that all three attention instruments used in this study purport to measure focused and sustained attention, we should consider why the CPT alone detected attention changes resulting from mindfulness practice, while the other attention measures showed few changes.

First, let us suppose that personal experiences are created from the integration of actual perceptual representations (i.e., "reality") and subjective interpretations that are influenced by thoughts, feelings, and body sensations (Hameroff et al. 1996). What we "see" is the reality of the object augmented with cognitive and affective elaboration. In Buddhist psychology, thoughts might be considered as being somewhat like static in a radio signal. Consequently, thinking can interfere with perceiving the present moment clearly or accurately. Enhanced CPT performance requires alertness, accurate observation, and attentional dexterity, meaning the ability to shift attention from moment to moment. Participants generally accurately identify the target sequences. However, the CPT presentation rate is sufficiently rapid that thoughts, like static, may interfere with attentional dexterity, slowing executive control of attention. The stars are always in the sky, but the sun must set before they can be seen. I suggest that the capacity for mindful attention is always present, but may be obscured by this chronic static of thoughts. If mindfulness enhances the ability to decenter from thoughts, then the skills needed for superior CPT performance are consistent with the specific type of attention developed through mindfulness practices. The Stroop and DSS seem to assess different components of attention than the CPT. Superior performances on these measures require suppression of over-learned habits of reading and writing, respectively. Resolution of the conflict necessary to achieve superior performance on the Stroop and DSS require conscious suppression of an externally imposed distracter. Although lower distractibility is one component of mindful attention, our findings suggest that managing intrapsychic distracters (i.e., thoughts and emotions) may access different components of attention than what may be required to manage competing environmental demands.

Mindful attention is a non-elaborative apprehension of moment-by-moment experiences. Mindful attention is receptive to present-moment experiences with minimal cognitive processing. Information processing is instrumental, characterized by elaborative and sequential thought, and functions to act on the environment. Alternatively, a receptive form of information-processing functions to enhance awareness of the environment. A shift from instrumental to receptive information processing may occur when practicing mindful awareness (Ornstein 1986). Superior performance on the CPT calls for a receptive awareness of quickly changing environmental stimuli, while the Stroop and DSS require instrumental suppression of over-learned cognitive responses.

The cultivation of mindfulness is generally believed to depend on consistent and prolonged practice. Self-confidence seems likely to help sustain a daily mindfulness practice that can at times feel challenging to the practitioner. I had hypothesized that self-confidence, motivation, and frequency of practice would be associated with improvements in attention, but none of these appeared to mediate attentional performance or well-being. Noting the extended time associated with traditional contemplative meditation practices, the brief duration of the study likely reduced the strength of these relationships. Many studies have reported significant reductions in anxiety consequent to mindfulness training and practice. In this study, we found that mindfulness and progressive muscle relaxation both effected reductions in anxiety; however, a significant relationship between frequency of practice and lower anxiety was found only for the mindfulness group. Mindfulness and relaxation practices may differentially affect the cognitive and somatic manifestations of anxiety. This would be consistent with the hypothesis of Davidson and Schwartz (1976) about the specificity of effects when practicing mindfulness, which is associated more with cognitive anxiety in contrast to relaxation techniques, which are generally associated with somatic anxiety. Evidence suggests that mindfulness shares with relaxation an autonomic quiescence but also enhances some attentional skills. Do nonspecific reductions in anxiety, associated with mindfulness and relaxation practices, improve overall well-being? Both training groups reported small but significant reductions in anxiety, but only modest changes in mood states. Considering these data in conjunction with the significantly different changes in discriminability between groups, we cannot conclude that enhanced well-being is a prerequisite to developing mindful attention, nor is it necessarily a consequence of mindful attention.

The limitations of this study are similar to many of this kind. Mindfulness and relaxation training sessions were conducted by a researcher who was not blind to the hypotheses. The relatively small group sizes limited the statistical power of the analyses. Although research has shown that improvements in mood are common sequelae of mindfulness practices, the restricted range in this community sample reduced the likelihood of detecting significant changes. Another limitation of this study was its short duration. Affective, cognitive, physiological, and behavioral

changes resulting from long-term mindfulness practices are likely to differ from short-term effects. Self-report measures of mindfulness may have aided interpretation of our findings but were unavailable at the time.

Indications from this and other studies suggest that attention enhanced through mindfulness practice may develop over time. Although finding significant increases in a measure of sustained attention, 1 month of twice-daily practice may not have been sufficient to demonstrate lasting effects of mindfulness on components of attention. Evaluating the effects of mindfulness meditation practices over time would increase our understanding of meditation as attention training. Comparing selected components of attention in mindfulness practitioners adept at different techniques and with varying levels of experience might also expand our understanding of this relationship.

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