Effects of a Single Session of Large-Group Meditation and Progressive Muscle Relaxation Training on Stress Reduction, Reactivity, and Recovery

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Three hundred eighty-seven undergraduate students in a large-group setting were exposed to 20 min of either meditation, progressive muscle relaxation (PMR), or a control condition, followed by 1 min of stress induction and another 10 min of each intervention. Participants in the meditation and PMR groups decreased more in cognitive, somatic, and general state anxiety than controls. The PMR group had the greatest decline in somatic anxiety, lending some support to the cognitive/somatic specificity hypothesis. After exposure to a visual stressor, those in the relaxation conditions had higher levels of anxiety and recovered more quickly than controls. Findings demonstrated the effectiveness of brief group training in meditation or PMR in reducing state anxiety after exposure to a transitory stressor.

Keywords: stress, stress reactivity, meditation, PMR, progressive muscle relaxation

A recent study conducted by the National Center for Complementary and Alternative Medicine and the National Center for Health Statistics reported that, as of 2002, 62% of Americans had used some form of complementary and alternative medicine (CAM) and 52% had used mind–body techniques, such as meditation or progressive muscle relaxation (PMR) (Barnes, Powell-
Griner, McFann, & Nahin, 2004). Despite such widespread use, questions remain regarding the comparative effectiveness of these techniques, how they work, and for whom they work best. The present study compares the effectiveness of meditation and PMR as anxiety management techniques for individuals exposed to a short-term stressor.

MEDITATION AND PMR

Meditation and PMR have both been shown to produce a range of positive outcomes. Reported effects of meditation include decreased stress (Janowiak & Hackman, 1994), anxiety (Delmonte, 1985), and physiological arousal (Harmon & Myers, 1999), as well as empathy development (Wolf & Abell, 2003) and increased rate of autonomic recovery from laboratory-induced stressful events (Goleman & Schwartz, 1976). PMR techniques have been found to be effective in controlling anxiety (e.g., Carlson, Bacaseta, & Simanton, 1988; Carrington, Collings, Benson, Robinson, Wood, Lehrer, et al., 1980; Pawlow & Jones, 2002), decreasing cortisol levels (Pawlow & Jones, 2002), reducing pain (Gada, 1985), regulating physiological processes (Carlson et al., 1988), and increasing overall quality of life (Carrington et al., 1980). In contrast to conclusions about PMR, conclusions regarding meditation’s beneficial effects have been tempered by criticisms that some studies have not evaluated “pure” meditation uncontaminated by combination approaches and that many studies have been poorly controlled (e.g., Smith, 1990; Perez-De-Albeniz & Holmes, 2000). Both approaches are nonetheless generally accepted and recommended by clinicians as anxiety management procedures (Auerbach & Gramling, 1998; Barlow, 2001; Lehrer & Woolfolk, 1993; Smith, 2005a).

Questions of comparative effectiveness and of whether the techniques produce different kinds of effects have been addressed but not resolved. Benson (1975) proposed that meditation, PMR, and all the relaxation techniques elicit a generic “relaxation response” and are therefore interchangeable and likely equally effective. Consistent with this notion, Wallace and Benson (1972) found that both meditation and PMR produced a general hypoarousal effect including decreases in heart rate, respiration, skin resistance, metabolism, and brain activity. Others have found the two techniques to be equally effective in reducing anxiety (e.g., Raskin, Bali, & Peeke, 1980; Thomas & Abbas, 1978; Woolfolk, Lehrer, McCann, & Rooney, 1982). The search for specific treatment effects has been largely oriented around Davidson and Schwartz’s (1976) cognitive/somatic specificity hypothesis, which posits that cognitive techniques such as meditation will produce effects primarily in the domain of cognitive anxiety whereas somatic relaxation
procedures such as PMR will primarily affect somatic anxiety. Findings of the relatively few studies that have directly tested this hypothesis (e.g., Lehrer, Schoicket, Carrington, & Woolfolk, 1980; Lehrer, Woolfolk, Rooney, McCann, & Carrington, 1983) have been mixed.

**THE PRESENT STUDY**

Many other comparative relaxation studies (e.g., Throll, 1981; Woolfolk et al., 1982; Zuroff & Schwarz, 1978) have evaluated outcomes solely using a generalized self-report measure of state anxiety and thus have not differentiated between the cognitive and somatic domains. In the present study, we use separate self-report measures of cognitive and somatic anxiety along with a generalized state anxiety measure to evaluate the Davidson and Schwartz specificity hypothesis. In contrast to many previous studies comparing relaxation techniques (Carrington et al., 1980; Delmonte, 1984; Schwartz, Davidson, & Goleman, 1978; Warrenburg, Pagano, Woods, & Hlastala, 1980), we used a rigorous randomized control group design with live trainers.

**METHOD**

**Participants**

Undergraduate students enrolled in various psychology courses at a large urban university were recruited for participation in this study. All research participants were offered either extra credit or course credit for participating in the study. They were recruited via advertising that was posted on a computerized Internet program. When participants arrived at a designated classroom, the experiment trainer gave an overview of the informed consent. Once all participants had signed their informed consent, the experiment began.

There were 405 participants in the study. Eighteen (4.4%) reported that they regularly or daily practiced either meditation or PMR. To maintain a homogeneous sample of novice meditators, these eighteen participants were excluded from data analyses. Of the resultant sample of 387 participants, the majority (52.2%) identified themselves as Caucasian, followed by 28.9% identifying as African American. Overall, 71.3% were female. Most identified as being single (93.3%), and the mean age of the sample was 19 years ($SD = 3.37$), with a range of 17–42 years.
Measures

State-Trait Anxiety Inventory (STAI)—State Version

The State Anxiety Scale of the STAI (Spielberger, 1983) was used to evaluate state or transitory anxiety levels. This 20-item inventory assesses current feelings of apprehension, nervousness, tension, and worry. Items are rated on a 4-point scale. Alpha reliability coefficients are reported to be greater than .90.

Cognitive Anxiety Scale

The Cognitive Anxiety Scale (CAS; Smith, 2005b) is a 6-item scale that reflects content areas typically measured by cognitive anxiety inventories such as worrisome thoughts. A state format was used in which participants indicate the extent to which a cognitive anxiety statement fits at the present moment using a 5-point Likert scale. Alpha reliability has been .92.

Smith Somatic Stress Symptoms Scale—State (SSSSS-S)

The SSSSS (Smith, 1990) is a 16-item measure of somatic anxiety. A state format was used in which participants indicate the extent to which each somatic stress statement fits in the present moment using a 5-point Likert scale. It has a coefficient alpha reliability of .89.

Demographic Questionnaire (DQ)

A demographic questionnaire assessed participant characteristics including age, gender, ethnicity, level of education, occupation, marital status, previous experience with both meditation and PMR, and annual income.

Photographic Stimuli

Four negative affect- and arousal-evoking photographic slides from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997, 1999) were used as visual stressors in the present study.
Pictures from this slide set have been used in numerous studies on psychophysiology and emotion (Lang et al., 1999). In standardization studies of the IAPS, 700 slides were rated on a 9-point scale for valence (emotions ranging from sad to happy) and arousal (calm and sleepy to excited) dimensions by college students in groups (Lang et al., 1999). The 4 slides chosen for the present study (numbers 3000, 3010, 3015, and 9433) depicted multicultural human trauma and trauma aftermath and are among the lowest valence ($M = 1.63$) and highest arousal ($M = 6.55$) slides in the picture library. The slides were shown from a Proxima projector onto a screen at the front of a classroom for 15 s each, continuously, for a total viewing time of 1 min.

**Procedure**

The study was conducted in a large classroom. Participants were randomly assigned to one of the three intervention groups (meditation, PMR, or controls). After obtaining informed consent, participants were given an overview of the experiment and the opportunity to ask questions. Participants first completed the following baseline measures: DQ, STAI, CAS, and SSSSS (phase 1). They were then given approximately 3–4 min of instruction in either meditation, PMR, or eyes-closed rest (control) and were instructed to perform their relaxation technique for 20 min (phase 2). Participants then immediately completed the STAI, CAS, and SSSSS, responding in terms of their current feelings to assess state anxiety levels (phase 3). They were then shown the four negative-emotion-evoking slides from the IAPS for 15 s each (phase 4). Participants were instructed to watch the slides for the entire duration and not close their eyes. After viewing the slides, participants again immediately completed the STAI, CAS, and SSSSS responding in terms of their current feelings (phase 5). Subsequently, participants were instructed to again use their designated relaxation technique (meditation, PMR or eyes-closed rest) for 10 min (phase 6). They again responded immediately to the STAI, CAS, and SSSSS in terms of their current feelings (phase 7). This design allowed the researcher to assess for effects of the relaxation techniques, stress reactivity differences, and recovery from the stressor.

**Interventions**

All intervention groups (meditation, PMR, and eyes-closed rest) were conducted by a live trainer for the same time periods (20 min relaxation prior
to stressor exposure and 10 min after stressor exposure). All groups were given identical manualized instructions; only the specific instructions regarding the treatment varied. All conditions asked participants to close their eyes. All of the groups met in an academic classroom with 20–40 other participants. Participants sat in hard chairs behind a desk. Floors were hard tile. Lights were dimmed during relaxation phases, turned off during slide viewing, and turned on when measures were filled out. There were a total of 13 experimental groups (4 control, 4 meditation, and 5 PMR). Trainer 1 (a Caucasian advanced graduate student in psychology and course instructor in stress management) conducted 3 control, 3 meditation, and 4 PMR groups. Trainer 2 (an African American advanced undergraduate psychology honors student who was blind to the hypotheses and who received instruction and practice in implementing all techniques in large groups from both a senior faculty member and trainer 1) conducted one of each of the groups. Assignment of trainers to groups was random. Both were trained extensively in teaching the intervention techniques to others. To reach proficiency before running experimental groups, the trainers completed home study, role-playing activities, direct and audio-taped supervision, observation, and mentored individual and group administration before independently running experimental sessions.

**Meditation**

Participants in the meditation group were instructed in a noncultic form of mantra meditation similar to Clinically Standardized Meditation (CSM; Carrington & Ephron, 1978). The only differences were in the teaching style (we did not teach individually and did not repeat the mantra aloud to the participants) and the type of mantra chosen (we allowed participants to choose their own mantra with no phonetic restrictions). Participants were first given a 3- to 4-min overview of how the technique would be executed; Then they were shown a projection slide with various mantras (words or short phrases to be repeated) to choose from but were also given the option to choose their own mantra. However, participants were advised not to choose a word associated with negative emotions or profanity (e.g., kill, hate). After choosing one mantra, they were instructed to focus on the mantra and to continually repeat their mantra mentally. They were also told that when their mind wandered to other thoughts, they should gently bring it back to focus on the mantra. Participants were given a short 1-min meditation practice time and the opportunity to ask any questions. Then participants were given either a
20- or 10-min (depending on the phase of the experiment) time period to meditate.

**PMR**

Participants in the PMR condition were instructed in an abbreviated PMR technique, which involves tensing and then relaxing nine muscle groups (Gramling & Auerbach, 1998, pp. 25–33). The technique used nine main muscle groups: (a) hands and forearms; (b) upper arms; (c) forehead; (d) eyes, nose, and cheeks; (e) jaw, chin, front of neck; (f) back of neck; (g) upper body; (h) legs up with toes pointed down; and (i) legs up with toes pointed up. Participants began by taking a few deep breaths, tensing muscles for approximately 15 s, and then releasing and focusing on the difference between tension and relaxation for approximately 30 s. Participants were first given a 3- to 4-min overview of how the technique would be executed, then instructions with a short 1-min practice using their fist, and the opportunity to ask any questions. Then, participants were guided through either a 20- or 10-min (depending on the phase of the experiment) session of PMR by the instructor.

**Control**

Participants in the control condition were instructed to sit with their eyes closed and relax during the intervention periods. This condition was designed to control for the nonspecific effects of trainer interaction, social interaction, attention, environment, time, and closed eyes. Participants in the control condition followed an identical procedure and time periods as the two experimental groups (with the exception of a 1-min practice in the other two groups). For instance, when the experimental groups relaxed for 20 min, the control group was asked to sit with eyes closed and relax for 20 min. They were given the following verbatim instructions: “Now, we are going to practice relaxing. For 20 minutes I would like you to sit with your eyes closed and relax. Please do not do anything else during this time. Keep all of your things put away. Do not worry about the time—I will be keeping track of the time. Anything that you still have waiting for you will still be there waiting when we finish. Do not worry about time. I will let you know when the time is up. Now close your eyes and relax.” For the second short session they were told: “We are going to practice our relaxation again. Please sit with your eyes closed again for 10 minutes.”
RESULTS

Preliminary Analyses

For all subsequent analyses, preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance–covariance matrices, and multicollinearity, with no violations noted. To examine possible differences among intervention groups on demographic variables, independent sample $t$-tests and chi-square tests were conducted. There were no significant differences among groups on any of the demographic variables. One-way analyses of variance (ANOVAs) revealed that there were no significant differences among groups on any baseline measures. There were also no significant differences between participants who had different trainers on any of the demographic variables or baseline measures.

Effects of Relaxation Techniques: Meditation Versus PMR Versus Control

To evaluate the effects of the relaxation techniques on general, cognitive, and somatic anxiety prior to stressor exposure, a 3 (group) × 2 (time periods [before and after the initial 20-min relaxation]) repeated measures multivariate analysis of variance (MANOVA) was conducted.

Irrespective of intervention condition, there was an overall decline in anxiety following the initial 20-min intervention period relative to baseline on the combined dependent variables: $F(1, 339) = 81.45, p < .001$; Wilk’s lambda = .59; partial eta squared = .42. As noted in Figures 1a–1c, when the dependent measures were considered separately, a significant decrease over time was observed on each measure: general state anxiety (STAI) $F(1, 339) = 155.34, p < .001$, partial eta squared = .32; cognitive anxiety (CAS) $F(1, 338) = 186.82, p < .001$, partial eta squared = .36; and somatic anxiety (SSSSS) $F(1, 339) = 60.15, p < .001$, partial eta squared = .15.

Additionally, there was a significant group × time periods interaction effect on the combined dependent variables $F(2, 339) = 4.79, p < .01$; Wilk’s lambda = .92; partial eta squared = .05. When each dependent measure was considered separately, there was a significant interaction effect for general state anxiety (STAI) $F(2, 339) = 9.57, p < .001$, partial eta squared = .05, and somatic anxiety (SSSSS) $F(2, 339) = 3.27, p < .05$, partial eta squared = .04. The interaction for cognitive anxiety (CAS) was not significant: $F(2, 339) = 1.605, p = .20$. Post hoc analyses using Tukey’s B indicated that (a) the decrease in state anxiety (STAI) was greater within the meditation and PMR groups from pre- to post-relaxation relative to the
Figure 1. Group differences in general state anxiety (STAI) scores before and after 20-min relaxation (a), group differences in cognitive anxiety (CAS) scores before and after 20-min relaxation (b), and group differences in somatic anxiety (SSSSS) scores before and after 20-min relaxation (c).
control group, and (b) the decrease in somatic anxiety (SSSSS) was greater within the PMR group from pre- to post-relaxation relative to the other two groups (all $p$’s <.05; see Figures 1a–1c).

**Stress Reactivity and Recovery**

To evaluate stress reactivity, a $3 \times 3$ (group $\times$ time periods) repeated measures MANOVA was performed to investigate group (control, meditation, PMR) differences in anxiety scores (STAI, CAS, SSSSS) across the stress reactivity and recovery phases. The between-subjects variable was group (meditation, PMR, and control), and the within-subjects factor was time period (after the initial 20-min relaxation, after stressor exposure, and after 10-min recovery relaxation). Univariate analyses indicated that the phase 3 (after initial 20-min relaxation) group differences on each measure were not significantly different from each other; therefore no covariate was needed in these analyses.

A repeated measures MANOVA produced a main effect for time periods: $F(2, 322) = 38.86, p < .001$, Wilk’s lambda = .67, partial eta squared = .46. When the dependent measures were considered separately, there was a significant effect for each of the variables: general state anxiety (STAI) $F(2, 322) = 86.06, p < .001$, partial eta squared = .19; cognitive anxiety (CAS) $F(2, 322) = 56.72, p < .001$, partial eta squared = .16; and somatic anxiety (SSSS) $F(2, 322) = 67.44, p < .001$, partial eta squared = .18. As may be noted in Figures 2a–2c, these effects were due to a sharp increase in anxiety on all measures after exposure to the stressor and a subsequent sharp decrease after 10 min of recovery relaxation.

Additionally, there was a significant group $\times$ time periods interaction effect on the combined measures: $F(2, 322) = 5.48, p < .001$, Wilk’s lambda = .94, partial eta squared=.033. When the results for the dependent measures were considered separately, there was a significant interaction effect for general state anxiety (STAI): $F(2, 322) = 4.78, p < .01$, partial eta squared = .05, but no significant interaction effects for either cognitive anxiety (CAS), $F(2, 322) = .15, p = .96$, or somatic anxiety (SSS), $F(2, 322) = .68, p = .60$. Secondary analyses confirmed that the STAI interaction was significant for both phases 3–5 (before and after picture viewing), $F(2, 322) = 10.22, p < .01$, and phases 5–7 (before and after recovery), $F(2, 322) = 3.00, p = .05$. Post hoc analyses using Tukey’s B revealed that participants in both the meditation and PMR conditions reported significantly greater increases than the control group in general state anxiety (STAI scores) from phase 3 to phase 5 (before and
Figure 2. Group differences in stress reactivity and recovery on general state anxiety (STAI) (a), group differences in stress reactivity and recovery on cognitive anxiety (CAS) (b), and group differences in stress reactivity and recovery on somatic anxiety (SSSSS) (c).
after picture viewing) (all p’s < .05). Additionally, as shown in Figure 2a, participants in both relaxation groups reported significantly greater decreases relative to the control group in general state anxiety (STAI scores) from phase 5 to phase 7 (before and after the 10-min relaxation after picture viewing).

**High-Anxiety Participants**

Because our population was relatively healthy and had normal initial levels of anxiety (mean STAI = 40.41), we conducted further analyses on a subset of participants (n = 66) with anxiety levels greater than 1 SD above the mean (STAI > 48). Initial analyses revealed that there were group differences on baseline measures of somatic anxiety (SSSSS; F = 3.75, p = .03), with mean levels of anxiety as follows: PMR group, M = 120.48; meditation group, M = 116.86; control group, M = 108.60. Therefore, to account for these differences, the subsequent analyses were run with baseline SSSSS as a covariate. To evaluate the impact of the initial 20-min stress reduction, a MANCOVA with before and after change scores and baseline somatic anxiety (SSSSS) as a covariate was conducted. Group designation was the between-subjects variable, and all three anxiety measures were the dependent variables.

Irrespective of intervention condition, there was an overall decline in anxiety following the initial 20-min intervention period relative to baseline on the combined dependent variables: F(1, 59) = 25.56, p < .001, Wilk’s lambda = .41, partial eta squared = .59. When the dependent measures were considered separately, a significant decrease over time was observed on each measure: general state anxiety (STAI) F(1, 339) = 155.34, p < .001, partial eta squared = .32; cognitive anxiety (CAS) F(1, 338) = 186.82, p < .001, partial eta squared = .36; and somatic anxiety (SSSSS) F(1, 339) = 60.15, p < .001, partial eta squared = .15.

Additionally, there was a significant group × time periods interaction effect on the combined dependent variables: F(2, 339) = 4.79, p < .01, Wilk’s lambda = .92, partial eta squared = .05. When each dependent measure was considered separately, there was a significant interaction effect for general state anxiety (STAI) F(2, 339) = 3.42, p < .001, partial eta squared = .13, and somatic anxiety (SSSSS) F(2, 339) = 4.44, p < .05, partial eta squared = .17. The interaction for cognitive anxiety (CAS) was not significant: F(2, 339) = 1.605, p = .92. Inspection indicated that PMR was more effective in reducing somatic anxiety than either meditation or eyes-closed rest. Additionally, the greatest reductions in general state anxiety were reported in the meditation group, followed by PMR; eyes-closed rest had the smallest reductions.
To evaluate the stress reactivity and recovery differences in those with high levels of anxiety, a 3 (group) × 3 (time points) repeated measures MANCOVA was performed with baseline somatic anxiety (SSSSS) as a covariate. There was a significant group × time interaction for the combined dependent measures: $F(3, 52) = 1.93, p < .05$, Wilk’s lambda = .56, partial eta squared = .25. When each dependent measure was considered separately, there was a significant interaction effect for STAI only: $F = 2.53, p < .01$, partial eta squared = .15. The results were not significant for cognitive (CAS), $F(3, 52) = 1.17, p = .12$, and somatic anxiety (SSSSS), $F(3, 52) = 1.92, p = .12$. Secondary ANCOVA analyses indicated that the interaction was significant for both the stress reactivity, $F(2, 49) = 6.65, p < .01$, partial eta squared = .21, and recovery, $F(2, 49) = 2.67, p = .05$, partial eta squared = .09, phases. Inspection indicated that those in the meditation and PMR groups reacted significantly more to the stressor and recovered more effectively from the stressor than the control group.

**DISCUSSION**

**Impact of Stress Reduction Techniques**

The present findings indicate that a single 20-min group session of meditation or PMR effectively elicits reductions in anxiety in novice users that are measurably different from those obtained sitting with one’s eyes closed. They are consistent with results of other studies reported with college students demonstrating anxiety reduction effects with relaxation interventions (Astin, 1997; Wolf & Abell, 2003). Although various relaxation procedures are commonly used in clinical settings (Barlow, 2001), meditation in particular is often overlooked or avoided because of its association with spiritual and/or religious domains (Bogart, 1991). However, individuals who already have a spiritual or religious orientation may be more inclined toward meditation as a relaxation procedure. Further, it may be particularly useful for other populations such as those who are physically disabled, who are elderly, and who work in a formal setting with limited time or opportunity to practice a physical procedure.

**Specific Effects**

Some support was obtained for the specific effects hypothesis (Davidson & Schwartz, 1976) in the present study. Consistent with this hypothesis, PMR, which involves contraction and relaxation of the muscles, was asso-
associated with greater reductions in somatic anxiety than meditation or eyes-closed rest. Meditation, which solely involves focusing and concentration, produced a greater decline in cognitive anxiety, but this result was not statistically significant. From a clinical standpoint, the findings suggest that individuals with elevated somatic anxiety may benefit more from a somatic technique such as PMR. Further, these results also suggest that continued research into the specificity hypothesis, research that largely disappeared after 1985, is warranted, particularly using physiological measures to assess somatic anxiety.

Stress Reactivity and Recovery

Consistent with previous research on stress reactivity (Goleman & Schwartz, 1976; Kutz, Leserman, & Dorrington, 1985; Lehrer et al., 1980), the present study supported findings that meditation plays a unique role in reactions to laboratory stressors in that meditators tend to react more and recover faster from stress. PMR also played a similar role in the present study. Although stress reactivity studies utilizing meditation have primarily relied upon physiological markers, few studies have reported these findings with self-report measures (e.g., Lehrer et al., 1980). In the present study, participants in both the meditation and PMR conditions reported more state anxiety relative to the control group after viewing the stressor. Although this response could be viewed negatively, Lehrer and colleagues (Lehrer et al., 1980) as well as Goleman and Schwartz (1976) interpreted this arousal among meditators as a form of anticipatory coping response that prepares the individual better for stress, and they suggested that meditation heightens this response. Further, they suggest that this response is only maladaptive when it is maintained and when a quick recovery does not occur. However, it should be noted that it is also possible that all three groups reacted to the visual stressor with some anxiety, but that the experimental conditions had more of a change in their scores only because they started completely relaxed. Therefore, it is possible that the stressors simply brought relaxed individuals out of their relaxation state, and then all three groups responded with similar anxiety to the stressors. In the present experiment, both the meditation and the PMR groups also reported greater recovery (reductions in state anxiety) than the control group after a short 10-min relaxation period following the picture viewing.

It is important to note that these effects were observed after a single session of either meditation or PMR in novices. Very few prior studies report using a single session of relaxation training as an intervention (Carlson et al., 1988). Most studies have used 6- to 12-week interventions that meet approx-
imately 1 to 3 hr a week with daily home practice included (e.g., Astin, 1997; Carrington et al., 1980; DeBerry, 1982; Delmonte, 1984; Gada, 1985; Kutz et al., 1985). Clinically, the present findings suggest that the use of meditation or PMR to ameliorate short-term stress reactions may have greater therapeutic potential than previously realized. Because 65% of Americans reported feeling a significant amount of stress one or more times a week (Janowiak & Hackman, 1994), and 66% feel that stress is impacting their health (KRC, 2003), there is great potential benefit of promoting these techniques for stress management.

**High-Anxiety Participants**

Because it is well known that healthy individuals are able to relax easily and the generalizability of findings from our sample of healthy undergraduates may be limited, we also analyzed the effects of anxiety changes as a function of the experimental conditions in a subset of 66 highly anxious participants. These analyses addressed the question of whether the present findings have potential relevance to individuals with clinically significant levels of anxiety and the question of the clinical versus statistical significance of the findings given the power inherent in the large sample size. We obtained essentially the same results for this subsample as for the much larger sample of unselected students. In the highly anxious subsample, PMR was most effective for reductions in somatic anxiety, and both meditation and PMR were effective for reducing general state anxiety, although meditation produced the largest effects. Although these novice participants began the experiment with clinically elevated levels of anxiety (STAI > 48), a mere 20 min of these group interventions were effective in reducing anxiety to normal levels. Additionally, after being exposed to a stressor, merely 10 min of the interventions allowed this high-anxiety group to recover from the stressor. Thus, brief interventions of meditation and PMR may be effective for those with clinical levels of anxiety and for stress recovery when exposed to brief, transitory stressors.

**Strengths and Limitations**

Participants were recruited from a population of college students who were reacting to experimentally induced versus real-life stressors. We chose this population because it allowed us access to a diverse group of novice meditators. College students also are said to experience high levels of ongoing stress. However, the unique characteristics of the sample may
restrict the generalizability of the findings to other populations. Also, the setting for this study was an academic classroom with seating at wooden desks, in a large-group format in which the relaxation procedures were taught. Individuals generally do not learn and practice relaxation procedures in such a setting. This environment may have inhibited participants’ full relaxation and limited the anxiety-reducing impact of the interventions. Our findings revealed that participants were able to relax in this setting, although it may have been somewhat uncomfortable. Although participants showed measurable changes from the interventions, the full extent of these changes may not have been exhibited because of the environment in which the study took place. From another standpoint, the effects of meditation in particular may have been underestimated. Meditation, because of its novelty, often requires more than one session to have an impact, whereas PMR is more likely to produce effects immediately because overt physical activity is involved. It should also be noted that some of the obtained effect sizes were small, limiting the practical applicability of the findings.

REFERENCES


