Weekly Change in Mindfulness and Perceived Stress in a Mindfulness-Based Stress Reduction Program

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Objective: The purpose of the study was to examine weekly change in self-reported mindfulness and perceived stress in participants who completed an 8-week course in mindfulness-based stress reduction (MBSR). **Method:** Participants were 87 adults with problematic levels of stress related to chronic illness, chronic pain, and other life circumstances (mean age = 49 years, 67% female) participating in MBSR in an academic medical center. They completed weekly self-report assessments of mindfulness skills and perceived stress. It was hypothesized that significant improvement in mindfulness skills would precede significant change in stress. **Results:** Mindfulness skills and perceived stress both changed significantly from pretreatment to posttreatment. Significant increases in mindfulness occurred by the second week of the program, whereas significant improvements in perceived stress did not occur until week 4. Extent of change in mindfulness skills during the first three weeks predicted change in perceived stress over the course of the intervention. **Conclusions:** Evidence that changes in mindfulness precede changes in perceived stress in a standard MBSR course is consistent with previous studies suggesting that improvements in mindfulness skills may mediate the effects of mindfulness training on mental health outcomes. © 2012 Wiley Periodicals, Inc. J. Clin. Psychol. 68:755–765, 2012.

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The benefits of mindfulness training for a variety of problems, disorders, and populations are increasingly recognized. Mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1982, 1990) is among the most commonly cited of the empirically supported mindfulness-based interventions. It was developed in a behavioral medicine setting for heterogeneous groups suffering from a variety of pain and stress-related complaints and has been adapted for a wide range of populations. In its standard form, it includes eight weekly sessions of 2.5 hours, with an all-day session during Week 6, for groups of up to 30 participants. Sessions include intensive practice of three primary mindfulness-based meditation exercises: the body scan, sitting meditation, and gentle yoga, all of which encourage nonjudgmental observation and acceptance of bodily sensations, cognitions, emotional states, urges, and environmental stimuli as they arise. Participants are encouraged to practice these exercises for up to 45 minutes per day, 6 days per week, using recordings for guidance, and to integrate mindfulness skills into routine daily activities such as eating and walking.

In clinical settings, mindfulness can be seen as a coping resource to deal with the vicissitudes of illness and stress. Reviews of the empirical literature have concluded that participation in MBSR provides significant psychosocial benefits for a variety of populations, including patients with cancer and other chronic diseases (Bohlmeijer, Prenger, Taal, & Cuijpers, 2010; Ledesma & Kumano, 2009), people with anxiety and depression (Hofmann, Sawyer, Witt, & Oh, 2010), nonclinical samples complaining of stress (Chiesa & Serretti, 2009), and health care professionals subject to work-related stress (Irving, Dobkin, & Park, 2009).

While initial trials were concerned primarily with the evaluation of clinical outcomes, studies have recently begun to examine the mechanisms or processes that may account for the beneficial effects of mindfulness training. Mindfulness-based treatment manuals (e.g., Segal, Williams, & Teasdale, 2002; Hayes & Smith, 2005, Linehan, 1993), as well as contemporary writings in the Buddhist meditation tradition (Goldstein & Kornfield, 1987), suggest that the regular practice of mindfulness should cultivate the ability to respond mindfully to the experiences of daily life, which in turn is believed to facilitate improved psychological health and symptom reduction.

A growing empirical literature supports this general model. For example, Carmody and Baer (2008) found that increases in self-reported mindfulness mediated the relationship between the extent of home mindfulness practice (in total minutes over the 8-week course) and improvements in psychological health. That is, the more the participants practiced, the more their mindfulness skills improved and the more their psychological symptoms were reduced. In a randomized trial, Nyklicek and Kuijpers (2008) found that increases in self-reported mindfulness fully or partially mediated the effects of MBSR (compared with the waitlist control group) on general distress, exhaustion, and quality of life in a community sample. Similarly, Bränström, Kvillemo, Brandberg, and Moskowitz (2010) reported that increases in self-reported mindfulness fully mediated the effects of MBSR on stress, posttraumatic avoidance, and positive states of mind in cancer patients.

Although these studies suggest that increased mindfulness in daily life may be a mechanism through which MBSR leads to improved mental health, they assessed mindfulness and psychological symptoms only at pre- and posttreatment. At posttreatment, improvements in both mindfulness and psychological functioning were observed and significant relationships between treatment participation and outcome were completely or partially accounted for by changes in self-reported mindfulness. However, recent discussions suggest that studies of mechanisms of change with treatment are more convincing when change in the proposed mediator precedes changes in the outcome variables (Kraemer, Wilson, Fairburn, & Agras, 2002). Establishing the sequence in which variables change requires more frequent assessment over the course of treatment. The patterns of weekly change in mindfulness and mental health over the course of the MBSR program have not previously been studied and it is unknown whether change in one precedes change in the other or if they change together. Previous studies also have not investigated whether changes occur steadily over the eight weeks or in some other pattern.

The purpose of the present study, therefore, was to examine the trajectories of change in both mindfulness and perceived stress, an important mental health outcome in MBSR participants, using weekly self-report assessments in participants who completed an 8-week MBSR course. Consistent with previous studies, we hypothesized that mindfulness skills would increase from pre-MBSR to post-MBSR and that perceived stress would decrease. In accordance with prevailing conceptualizations suggesting that improved mindfulness skills mediate therapeutic outcomes, we also hypothesized that significant changes in mindfulness skills would precede significant changes in perceived stress. We used a multidimensional measure of mindfulness to examine whether particular mindfulness skills change earlier than others. Because this question has not previously been examined, analyses of mindfulness subscales were exploratory.

Method

Participants

Study participants were enrolled in the MBSR program at the University of Massachusetts Medical School and participated in one of seven MBSR groups during the fall of 2008 and winter of 2009. All participants reported problematic levels of stress related to chronic illness, chronic pain, or other personal or employment-related circumstances. About half were referred to the program by a healthcare practitioner whereas others were self-referred. Self-report data for program evaluation are routinely collected during group orientation sessions before the first class and again at the end of each 8-week group. All participants are asked on the intake questionnaire whether the information they provide can be used for research purposes, on the

condition that they are not identified as individuals; typically about 95% of participants have agreed that their data can be used for this purpose.

A total of 87 participants in seven MBSR groups who consented to the use of their data completed the preintervention measures. Of these, 72 (83%) attended six or more of the 8 weekly sessions, whereas 15 (17%) attended five sessions or fewer. All 87 provided at least some of the weekly assessment data (described later). Of the initial 87 participants, 75 (86%) also completed the postintervention measures. Thus, pre-post analyses were based on 75 participants with complete pre-post data.

Differences between the participants who failed to provide posttreatment data (n = 12) and the rest of the sample (n = 75) were examined using the Mann-Whitney test (which corrects for unequal group sizes) and chi-square analyses. No significant differences were found for demographic variables (age: Mann-Whitney Z < 1.0, p > .10; gender: chi-square < 1, p > .10; marital status: chi-square = 2.61, p > .10; perceived stress: Mann-Whitney Z < 1.0, p > .10; or mindfulness: Mann-Whitney Z < 1.0, p > .10.)

Participants' mean age was 48.83 years (standard deviation [*SD*] = 10.60, range 24-79) and 67% were female. Most (67%, n = 58) were married or cohabitating, whereas 12.6% (n = 11) were single, 12.6% (n = 11) were separated, divorced, or widowed, and 8% (n = 7) did not answer this question. Most participants reported white collar and professional occupations.

Procedure

Prospective MBSR participants attend a group orientation and information session during the three weeks prior to the beginning of each 8-week group. In this session the goals and format of the program are explained and questions about participation are addressed. The preprogram questionnaires were completed immediately prior to these orientation sessions. Postprogram instruments were completed during the final MBSR session. In addition, participants were given weekly home mindfulness practice logs and asked to record the number of minutes spent listening to the home practice CD each day and to rate the degree to which they felt they adhered to the instructions. Participants who forgot to bring their log to class were asked to fill out a retrospective log for that week. Participants were also given abbreviated weekly versions of the perceived stress and mindfulness questionnaires (described later) and asked to complete them at home on the day before each class session. Participants placed their completed weekly logs and questionnaires in the slot of a closed purpose-built box in the classroom each week. The study assistant collected these materials from the box following each session. Respondents were assured that their responses would not be seen by the instructor.

Measures

Demographic characteristics were assessed at preintervention. Participants reported their age, gender, marital status, and occupation.

Mindfulness was assessed at baseline and posttreatment (end of session eight) using the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). This instrument was derived from a factor analysis of questionnaires measuring a trait-like general tendency to be mindful in daily life. It comprises 39 items assessing five facets of mindfulness: *observing, describing, acting with awareness, nonjudging of inner experience*, and *nonreactivity to inner experience*. Items are rated on a Likert-type 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 (alpha) in several samples and significant relationships in the predicted directions with a variety of constructs related to mindfulness (Baer et al., 2006; Baer et al., 2008). Studies have shown increases in FFMQ scores with participation in MBSR (Carmody & Baer, 2008) and significant correlations with extent of meditation experience in long-term practitioners (Lykins & Baer, 2009). In the present sample, alphas for the full length FFMQ subscales ranged from .74 to .90 at baseline and from .81 to .94 at posttreatment.

To reduce participant burden, we used an abbreviated 15-item version of the FFMQ for weekly assessments of mindfulness during the intervention. Three items for each of the five

facets were selected based on their factor loadings in Baer et al. (2006) and to represent the breadth of content of each facet. Alphas for these abbreviated three-item subscales ranged from .60 to .94 across the course of the intervention. Of the 35 subscale scores (5 subscale scores weekly for 7 weeks), only four had alphas below .75, suggesting that internal consistency was largely adequate despite the brevity of these subscales. Alphas for the total mindfulness score for this abbreviated version (computed by summing the 15 items, with appropriate item reversals) ranged from .80 to .85.

Perceived stress was assessed at baseline and session eight using the 10-item Perceived Stress Scale (PSS; Cohen & Williamson, 1988). To minimize participant burden, weekly assessments used the 4-item version of the PSS (Cohen, Kamarck, & Mermelstein, 1983). The PSS is a widely used and well-validated 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, Baer, Lykins, & Olendzki, 2009). Cohen et al. (1983) reported good internal consistency (alpha) and expected correlations with other variables for both the short and long versions. In the present sample, alphas for the 10-item version were .88 at baseline and .91 at posttreatment. Alphas for the 4-item weekly version ranged from .75 to .85.

Home mindfulness practice was assessed using weekly homework logs. Participants were asked to record the number of minutes of daily home practice of the formal meditation practices taught in the program (body scan, mindful yoga, sitting meditation). They were also asked to rate from 1 to 5 the degree to which they felt they had followed the mindfulness instructions on the CD (1 = not at all, 5 = very much). The instruction made clear that they were not being asked whether they felt it was a "good" practice session, but the degree to which they felt they followed the CD instructions.

Results

Pre-Post Changes in Mindfulness and Perceived Stress

Based on past research, our first hypothesis was that mindfulness scores would increase during the 8-week course, whereas perceived stress scores would decrease. This hypothesis was tested using paired-sample *t* tests. As shown in Table 1, participants reported significantly higher levels of mindfulness skills at posttreatment than at pretreatment (*t*'s ranging from 2.14 to 7.95, all *p*'s < .05). Participants also reported significant decreases in perceived stress (*t* = 9.32, *p* <

Table 1

Means and SDs for Mindfulness and Perceived Stress at Pre-MBSR And Post-MBSR, Paired Sample t Tests, and Pre-Post Effect Sizes (N = 75)

Variable	Pre-MBSR M (SD)	Post-MBSR M (SD)	t	d
Mindfulness Facets[a]				
Observe	26.68 (5.15)	30.73 (4.38)	7.95[c]	.90
Describe	22.34 (3.72)	23.16 (5.12)	2.14[c]	.24
Act with awareness	20.18 (5.39)	24.16 (4.95)	3.68[c]	.41
Nonjudge	20.54 (6.69)	29.67 (5.96)	7.38[c]	.84
Nonreact	19.17 (4.80)	23.26 (4.82)	7.32[c]	.83
Perceived Stress[b]	20.16 (6.17)	14.28 (6.50)	9.32[c]	1.04

Note. MBSR = mindfulness-based stress reduction; SD = standard deviation.
[a] Measured with 39-item Five Facet Mindfulness Questionnaire.
[b] Measured with 10-item Perceived Stress Scale.
[c] *p* < .05.

.05). Pre-post effect sizes were calculated using the formula suggested by Rosenthal (1984) for matched pairs data (d = t/√degree of freedom [df]). Effect sizes were large for the *observing, nonjudging,* and *nonreactivity* facets of the FFMQ and for perceived stress and small for the *describing* and *acting with awareness* facets of the FFMQ.

Weekly Changes in Mindfulness and Perceived Stress

Our second hypothesis was that significant changes in mindfulness would precede significant changes in perceived stress. We tested this hypothesis by examining changes in mindfulness and perceived stress during each week of the intervention using the short forms of the FFMQ and PSS described earlier. Repeated measures analysis of variance, using total mindfulness score (15-item version of FFMQ) for Weeks 1 through 7 (data collected at sessions two through eight) as the dependent variable, revealed a main effect of time, $F(6, 300) = 20.52$, $p < .01$ (this finding remained significant when we used the Huynh-Feldt correction for sphericity), suggesting that significant changes in mindfulness occurred at least once during the 7 weeks. We then examined changes at each consecutive time point using follow-up paired sample *t* tests (comparing each week to the following week), which revealed that significant changes from the preceding week occurred during Weeks 2, 3, 4, 6, and 7 (*t*'s ranged from 2.30 to 6.01, all *p*'s < .05; see Table 2). Additional paired sample *t* tests showed that scores for Week 2 and all subsequent weeks were significantly different from the score obtained at Week 1.

Next, we examined changes in perceived stress in the same way. First, we conducted a repeated measures analysis of variance (ANOVA) with perceived stress scores (4-item version of PSS) for each of the 7 weeks as the dependent variable; this analysis revealed a main effect of time, $F(6, 306) = 9.53$, $p < .01$, suggesting that significant changes occurred at least once during the 7 weeks. To identify when these changes occurred, we conducted follow-up paired sample *t* tests comparing each week's score to the score for the following week. These analyses revealed that weekly changes in perceived stress were not statistically significant until the last week of the program (*t*'s ranged from 2.8 to 6.00, *p* < .05 only for Week 7; see Table 2). Additional paired sample *t* tests revealed that the scores obtained at week 4 and all subsequent weeks were significantly different from the score obtained at Week 1.

Weekly changes in mindfulness and perceived stress are shown graphically in Figure 1. To present both variables on the same scale, we transformed the mindfulness and stress scores to *z*-scores by subtracting the mean score for the 7 weeks from the score for each week and dividing the difference by the standard deviation for that week. For ease of visual presentation, we reversed the standardized scores for the PSS so that increases represent improvement for

Table 2
Weekly Scores for Mindfulness and Perceived Stress (Raw Total Scores)

Week	FFMQ[a] M (SD)	PSS[b] M (SD)
1	48.10 (7.01)	6.56 (2.71)
2	49.37 (8.44)[c,d]	6.29 (2.64)
3	50.89 (6.63)[c, d]	6.35 (2.68)
4	51.43 (7.75)[c,d]	5.94 (2.93)[d]
5	52.52 (7.07)[d]	5.46 (2.93)[d]
6	53.72 (7.26)[c,d]	5.29 (2.66)[d]
7	55.31 (9.36)[c,d]	4.40 (2.56)[c,d]

Note. FFMQ = Five Facet Mindfulness Questionnaire; PSS = Perceived Stress Scale. Data for the first full week of the program (Week 1) were collected at session two, and so on. N's ranged from 64 to 87.
[a]Total score for 15-item version, possible range = 15-75.
[b]Total score for 4-item version, possible range = 0-16.
[c]Score is significantly different from preceding week's score (*p* < .05).
[d]Score is significantly different from Week 1 (*p* < .05).
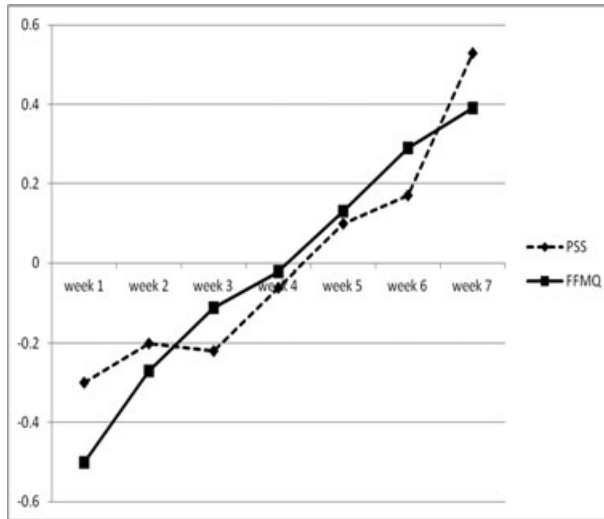
Figure 1.   Weekly change in standardized scores for total mindfulness and perceived stress.
PSS = Perceived Stress Scale (weekly 4-item version); FFMQ = Five Facet Mindfulness Questionnaire (weekly 15-item version). PSS scores are reversed so that increases in scores represent improvement for both variables.

both mindfulness and stress. Consistent with the *t* tests just described, improvements over the first three weeks are larger for mindfulness skills than for perceived stress. After week 3, both mindfulness and perceived stress improved fairly steadily.

Exploratory analyses examined the pattern of weekly change in the FFMQ subscale scores (abbreviated 15-item version) using repeated measures ANOVA for each subscale. Data are presented in Table 3. Main effects of time for Weeks 1 through 7 were significant for all five subscales (*F*'s ranged from 6.15 to 20.07, all *p*'s < .01), suggesting that significant change occurred at least once during the seven weeks for all mindfulness skills. Follow-up paired sample *t* tests showed that significant increases from the preceding week occurred at different points for each subscale. Scores for *observing, acting with awareness,* and *nonreactivity to inner experience* showed significant increases from Week 1 to Week 2 and at various other points during the intervention. In contrast, scores for *describing* showed significant weekly change only once, near the end of the intervention, and scores for *nonjudging of inner experience* showed significant weekly changes at Week 3 and Week 7 (*p*'s < .05). Additional *t*-tests showed that the point at which cumulative

Table 3
Weekly Scores for Abbreviated Mindfulness Facets

Week	Observe M (SD)	Describe M (SD)	Act with awareness M (SD)	Nonjudge M (SD)	Nonreact M (SD)
1	9.66 (2.11)	10.48 (2.57)	8.46 (1.85)	11.16 (2.64)	5.41 (1.40)
2	10.01 (2.19)[a,b]	10.59 (2.57)	8.86 (1.99)[a,b]	11.12 (3.01)	8.78 (2.31)[a,b]
3	10.51 (2.19)[a,b]	10.68 (2.51)	9.23 (1.87)[a,b]	11.57 (2.49)[a,b]	8.88 (1.98)[b]
4	10.37 (2.40)[b]	10.71 (2.62)	9.53 (1.98)[a,b]	11.62 (2.58)	9.30 (2.20)[a,b]
5	10.77 (2.04)[b]	10.88 (2.64)	9.97 (1.30)[b]	11.69 (2.41)	9.31 (2.16)[b]
6	11.26 (1.94)[a,b]	11.34 (2.32)[a,b]	10.29 (2.01)[b]	11.58 (2.64)	9.36 (2.28)[b]
7	11.48 (2.45)[b]	11.72 (2.50)[b]	10.35 (1.89)[b]	12.39 (2.54)[a,b]	10.20 (2.34)[a,b]

Note. SD = standard deviation. Possible range for each score = 3-15. N's ranged from 63 to 87.
[a]Score is significantly different from preceding week's score (*p* < .05).
[b]Score is significantly different from Week 1 (*p* < .05).

weekly change was significantly different from Week 1 also varied across subscales. For the *observing*, *acting with awareness*, and *nonreactivity* subscales, scores obtained at Week 2 and all subsequent weeks were significantly different from the score obtained at Week 1 (p's < .05). In contrast, scores for the *describing* subscale did not differ from Week 1 until Week 6. Responses on the *nonjudging* subscale differed from Week 1 during Week 3 and again during Week 7 (p's < .05); responses during Weeks 2, 3, 4, and 5 were marginally significantly different from Week 1 (p's < .10).

Weekly changes in the five mindfulness subscales are shown graphically in Figure 2. All scores increased over the course of the intervention. The score for the *nonreactivity* subscale was notably lower than the other subscales at Week 1 and showed a large improvement following Week 2.

Weekly Change in Home Practice and Following Instructions

We also examined weekly changes in home practice and following the instructions on the CD's. Mean home practice times are shown in Table 4 and ranged from 193 minutes (32.17 minutes per day) in Week 1 to 264 minutes (44.00 minutes per day) in Week 6. Repeated measures analysis of variance, with summed home practice times for each week as the dependent variable, revealed a main effect of time, suggesting that practice times varied across the 7 weeks, $F(6, 264) = 4.95$, $p < .01$. Follow-up paired sample t tests revealed that time spent in home practice was initially steady, increased during week 4 ($t = 2.10$, $p < .05$), and decreased during the last week of the course ($t = 3.43$, $p < .05$). We conducted the same analyses for following instructions on the CDs. Although mean compliance ratings appeared to increase somewhat over time, repeated measures analysis of variance revealed that the main effect of time was only marginally significant, $F(6, 204) = 2.0$, $p = .06$.

Relationship Between Early Change in Mindfulness and Overall Change in Perceived Stress

Next, we examined whether early change in mindfulness skills (over the first three weeks) was a significant predictor of overall change in perceived stress. We chose change in mindfulness over the first three weeks as our independent variable because, at this point in the intervention,
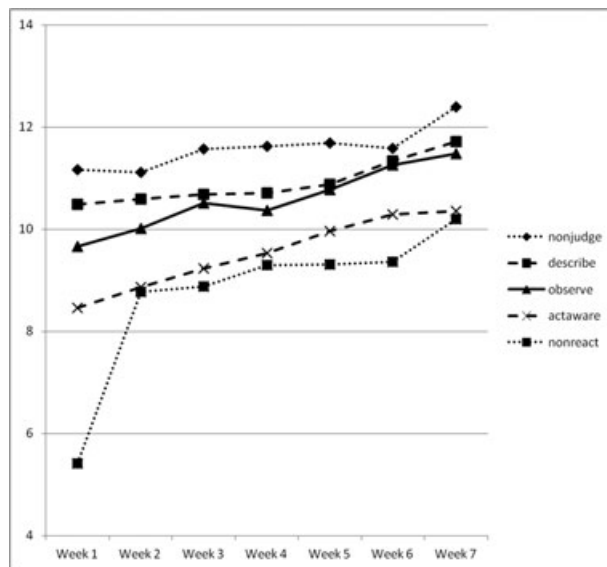

Figure 2. Weekly change in raw scores for mindfulness subscales, using the 15-item version of the FFMQ (possible range = 3-15).
FFMQ = Five Facet Mindfulness Questionnaire.

Table 4
Weekly Total Minutes of Home Mindfulness Practice and Self-Ratings of Following Instructions

Week	Total practice time[a] M (SD)	Followed instructions on CD[b] M (SD)
1	193 (107)	3.48 (1.22)
2	212 (122)	3.41 (.85)
3	224 (123)	3.92 (1.42)[c]
4	249 (130)[c]	3.93 (1.20)
5	233 (112)	3.84 (.78)
6	264 (148)	4.02 (.79)[c]
7	219 (121)[c]	4.02 (.95)

Note . N's ranged from 51 to 86.
[a]Total minutes of reported home practice.
[b]Range $= 1$ (followed instructions not at all) to 5 (followed instructions very much).
[c]Significantly different from the preceding week ($p < .05$).

mindfulness had changed significantly whereas perceived stress had not. We regressed change in perceived stress across the intervention on change in mindfulness score across the first three weeks. This relationship was significant, $B = -.63$, standard error $[SE] = .02$, $p < .01$, showing that the extent to which participants learned mindfulness skills early in treatment predicted the extent of improvement in perceived stress over the course of treatment.

We examined both home practice times and ratings of following the instructions on the CDs as potential independent variables for a mediation analysis in which early change in mindfulness skills (over the first three weeks) mediates the relationship with change in perceived stress. Home practice time over the first three weeks of the intervention was not significantly correlated with improvement in mindfulness over this period or with change in perceived stress over the course of the intervention. The degree to which participants followed instructions during the first three weeks of the training predicted increases in mindfulness during that time, $B = .26$, $SE = .57$, $p = .02$. However, following instructions during the first three weeks was not significantly associated with change in perceived stress over the course of the intervention. Therefore, conditions for a full test of mediation were not met.

Discussion

The primary purpose of this study was to examine weekly patterns of change in self-reported mindfulness skills and perceived stress in MBSR participants. Our first hypothesis was that, consistent with previous studies, participation in MBSR would be associated with significant decreases in perceived stress and significant increases in mindfulness skills. This hypothesis was supported. All variables changed significantly in the expected directions and several showed large effect sizes. Our second hypothesis was that significant change in mindfulness skills would precede significant change in perceived stress. This hypothesis also was supported. Statistically significant change in mindfulness occurred by Week 2, whereas significant change in perceived stress did not occur until Week 4, suggesting that stress changed only after participants had begun to experience improvements in mindfulness skills. Results also showed that change in mindfulness over the first three weeks predicted change in perceived stress over the course of treatment. The pattern of findings is generally consistent with the widely held view that mindfulness training should increase the ability to respond mindfully to the experiences of daily life, which in turn should lead to improvements in a variety of mental health outcomes, including responding adaptively to stress.

Examination of mindfulness skills at the subscale level showed that the *observing, acting with awareness,* and *nonreactivity* facets all showed statistically significant changes by Week 2 and that the *nonjudging* facet had improved by Week 3. The magnitude of change was largest for the *nonreactivity* subscale, which was notably lower than the other subscales at Week 1 and

showed a large improvement following Week 2. This finding suggests that skills for allowing internal experiences to come and go on their own time, without becoming absorbed or caught up in them, may have been relatively unfamiliar to participants early in treatment, and that substantial improvements occurred after 2 weeks of mindfulness practice.

The lack of significant early change in the *describing* facet is not surprising. In comparison to other mindfulness-based interventions, mindfulness exercises in MBSR place relatively little emphasis on verbal labeling or noting of present-moment experience, and this facet has shown the smallest increases in other studies of MBSR (Carmody & Baer, 2008; Carmody et al., 2009). The increase in the *describing* scale near the end of the intervention in the present study suggests that the tendency to apply labels to ongoing experience may emerge even without explicit instruction. During the inquiry or discussion periods that follow each in-class exercise, MBSR teachers typically engage in description and reflection of participants' experiences during the practices ("Ah, it sounds like you noticed a few thoughts, along with some bodily sensations . . . "). Such comments by the teachers may function as models for participants who eventually begin to internalize the labeling of their experiences.

Although significant changes in mindfulness skills preceded significant changes in perceived stress, both variables improved reasonably steadily across the entire intervention. This also is not surprising. Even before learning any mindfulness skills, nonspecific factors such as coming to a treatment group with empathic leaders and sharing with fellow participants who have similar concerns probably led to modest decreases in perceived stress. As mindfulness skills begin to develop, additional decreases in stress are likely to occur. As both mindfulness and stress gradually improve they may reciprocally influence each other, leading to the roughly parallel increases seen in Figure 1, especially after the first three weeks of the intervention.

The present study did not find a significant relationship between extent of home mindfulness practice and changes in mindfulness or perceived stress. The previous literature on this question is mixed, with some studies finding significant relationships (e.g., Carmody & Baer, 2008) whereas others have not (e.g., Davidson et al., 2003). We also asked participants to rate how well they felt they had followed the instructions on the CDs while engaged in home practice of mindfulness exercises. Mean ratings over the first three weeks were significantly associated with the extent of improvement in mindfulness skills, but not with change in perceived stress over the course of the intervention.

The present study has several limitations. The lack of a control group makes it impossible to conduct mediation analyses in which participation in MBSR versus a comparison group serves as the independent variable. Furthermore, the study sheds no light on whether interventions other than MBSR would have similar outcomes. Other stress reduction treatments that teach relaxation and cognitive restructuring, rather than mindfulness meditation, may also lead to increases in self-reported mindfulness; this possibility has not been investigated. Participants were not asked whether they were engaged in other interventions while completing the MBSR course. An additional limitation is that all of our participants had agreed to participate in an intensive mindfulness-based treatment and most were relatively well educated, middle class, and White. Therefore, our findings may not generalize to populations with other characteristics.

Measurement issues also must be considered. To avoid overloading the participants with weekly data collection, we examined weekly change only in mindfulness and perceived stress. Weekly changes in other psychological symptoms were not examined. Although participants were asked to complete the home practice logs daily, some occasionally forgot their logs and completed retrospective ones during the session. Whether home practice was recorded daily or retrospectively for each week was not recorded. Retrospective memory of practice times may be inaccurate. Finally, the abbreviated version of the FFMQ use for weekly data collection has not previously been studied. Although internal consistency was largely adequate, additional study of its psychometric properties is needed.

In spite of these limitations, the present study makes important contributions to the literature on MBSR. It is the first to examine weekly change in mindfulness skills and perceived stress, an important outcome for most MBSR participants. It is also the first to provide evidence that changes in mindfulness precede changes in perceived stress during a standard MBSR course, and that change in mindfulness skills early in treatment predicts extent of overall improvement

in perceived stress. This latter finding provides additional support for the growing literature suggesting that increases in mindfulness skills are an important mediator of the beneficial effects consistently observed in MBSR participants.

Future research could incorporate the weekly assessment methods used here into randomized controlled trials that compare MBSR to other stress reduction interventions. This would allow more conclusive investigation of the role of increased mindfulness skills as a mediator of treatment effects. Examination of other dependent variables (depression, anxiety) and other potential mediators (rumination, self-compassion) also would be very useful.

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