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ORIGINAL PAPER

The Mediating Effects of Mindfulness and Self-Compassion on Trait Anxiety

Dessa Bergen-Cico · Sanghyeon Cheon

Abstract Research has found meditation to be associated with improved mental health; however, less is known about how these positive outcomes develop. To better understand the operant effects of meditation on mental health, this study is set forth to examine the potential mediating effects of commonly measured constructs of mindfulness and self-compassion on trait anxiety, a personality trait prevalent in many psychiatric conditions. This longitudinal study uses a meditation treatment (n=108) and comparative control (n=94) designed to examine relational changes in mindfulness, self-compassion, and trait anxiety data collected in three waves: (a) baseline, (b) mid-program, and (c) post-program. Structural equation modeling (SEM) revealed significant increases in mindfulness and self-compassion scores among the treatment cohort and cross-lagged regression models that revealed significant reductions in trait anxiety were mediated by preceding increases in mindfulness. SEM model testing found that increases in mindfulness precipitate increases in self-compassion, but neither self-compassion nor anxiety mediated mindfulness. Whereas both self-compassion and mindfulness were associated with reductions in anxiety, the cultivation of mindfulness had the most robust mediating effect on reductions in trait anxiety. These finding reinforce previous studies that have suggested that increases in mindfulness skills may mediate the effects of meditation on mental health outcomes. Among the strengths of the current study are the longitudinal three waves of data, including mid-program data that enables cross-lagged regression. The cross-lagged models indicate the temporal ordering of changes and reveal mindfulness as the key mediating variable preceding substantive changes in self-compassion and trait anxiety.

Keywords Mindfulness · Meditation · Trait anxiety · Self-compassion · Mediation analysis

Introduction

Early research on the efficacy of the meditation practice known as mindfulness-based stress reduction (MBSR) focused on its benefits for physical health and pain management (Kabat-Zinn 1982; 1990; 1996). More recently, the scope of research on mindfulness-based practices has expanded from the realm of physical health to include cognitive and emotional processes (Davidson 2010; Kabat-Zinn et al. 1992; Lee et al. 2006; Segal et al. 2002). Through this expanded scope, researchers have begun to examine the mechanisms underlying mindfulness training and meditation practice as they relate to cognitive and emotional regulatory problems such as anxiety. As evidence of the benefits of mindfulness based meditation accumulates, there is increasing interest in elucidating the specific facets of mindfulness that mediate enhanced psychological well-being in relation to reduced stress and anxiety (Arch and Craske 2006; Baer 2003; Brown et al. 2007; Carmody and Baer 2008; Jain et al. 2007; Murphy et al. 1997; Shapiro et al. 2006; Shapiro et al. 2007). The study of effective means of reducing anxiety is important because anxiety is prevalent in most psychiatric conditions and is associated with diverse impairment profiles. Moreover, reductions in anxiety are associated with improvements in psychological health across multiple domains (Aderka et al. 2012; Pahl et al. 2012).

In order to examine the mechanisms of mindfulness, one must understand that mindfulness is both a state of awareness

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and a way of being (trait). Trait mindfulness has been found to be evident at varying rates among the general population, even without intervention or intentional attempts to develop mindfulness skills (Baer et al. 2006; Carmody and Baer 2008). Mindfulness can be strengthened through training and cultivated through regular meditation and mind-body practices. Mindfulness is more than the relaxed state of open awareness experienced while one is engaged in the practice of meditation. Whereas a calm open meditative state can be experienced temporarily, mindfulness can also wax and wane. Meditation is an important foundation or "scaffolding" through which mindfulness can be cultivated and integrated into a person's cognition and way of being (Kabat-Zinn 1990, 2003; Shapiro et al. 2006). According to Jon Kabat-Zinn, mindfulness arises from the simultaneous cultivation of three mechanisms: (a) intention and understanding of why one is engaging in the practice of mindfulness (e.g., self-regulation, stress reduction), (b) attention to one's moment-to-moment observations and experiences without judgment or analysis, and (c) attitude of acceptance, kindness, compassion, openness, patience, nonstriving, equanimity, curiosity, and non-evaluation (Carmody et al. 2009; Kabat-Zinn 1994; 1996 Shapiro et al. 2006).

Mindfulness-Based Stress Reduction

A prevalent form of meditation practice cited in empirical research literature is the structured 8-week MBSR program developed by Jon Kabat-Zinn, which incorporates metacognition, quiet sitting meditation, body scanning, and moving meditation (e.g., walking meditation, yoga; Kabat-Zinn 1990). The standard 8-week MBSR program yields positive changes in psychological well-being across age groups as evidenced by decreases in stress, anxiety, depression, mood disturbance, self-criticism, competitive comparisons, and self-judgment, coupled with improvements in emotional processing and increased self-esteem (Farb et al. 2010; Goldin and Gross 2010; Hargus et al. 2010; Jha et al. 2010; Wang et al. 2010; amd Williams 2010). A growing body of research supports the efficacy of mindfulness-based interventions such as MBSR with clinical and nonclinical populations. MBSR research addressing non-clinical populations can make important public health contributions because the majority of people in need of mental health services do not access or receive treatment (e.g., American College Health Association 2009; Mechanic and Bilder 2004; National Advisory Mental Health Council 1990).

Anxiety and the Body–Mind Connection

Whereas nonjudgmental and nonreactive awareness of emotions, cognitions, and somatic sensations are characteristics of mindful awareness, anxiety is typified by emotions and cognition laden with reactivity and self-judgment that fosters tense somatic sensations (Foa and Kozak 1991; Zajonc and Markus 1984). Anxiety is assessed and experienced as a state and trait (characteristic). Trait anxiety refers to a relatively stable personality attribute that characterizes an individual's tendency to perceive stressors as threatening. This in turn may elevate an individual's state anxiety resulting in emotional, cognitive, and physiological reactions (Spielberger et al. 2010). Trait anxiety represents individual differences in the frequency and intensity with which anxious states occur and the probability that they will experience state anxiety (Spielberger 1977, 1983; Spielberger et al. 2010). Whereas state anxiety is transient and reductions in state anxiety simply reflect temporary and proximate changes in response to stressful situations. Trait anxiety is a characteristic; therefore, reductions in trait anxiety decrease the probability that an individual will experience anxious states and the psychophysiological effects of anxiety. Adults and children with clinically diagnosed anxiety disorders have been found to benefit from mindfulness strategies experiencing reductions in anxiety through the cultivation of present moment attunement, enhanced self-awareness, self-regulation, and attentional self-management (Baer 2003; Kabat-Zinn 1990; Kabat-Zinn et al. 1992; Lee et al. 2006; Miller et al. 1995; Segal et al. 2002; Semple et al. 2005).

Anxiety is characterized by forward focused distracted attention and physical tension. Because of the impact of anxiety on both body and mind, it is widely investigated in mind–body research and mindfulness-based meditation studies. Anxiety is understood as a psychological problem with cognitive origins that concomitantly produces complex physiological reactions such as rapid heart rate, elevated pulse, sweating, muscle tension, and digestive dysregulation. Anxiety tends to be rooted in a future-oriented mindset that engenders a mood-state focused on coping with potential future negative outcomes, rather than present centered awareness (Barlow 2000). In contrast to the future-oriented focus of anxiety, the operational definition of mindfulness is a present-centered state of consciousness that entails attending nonjudgmentally to one's moment-to-moment experiences on purpose (Brown and Ryan 2003; Kabat-Zinn 1990, 2003). The contrast in temporal focus between anxiety and mindfulness suggests that the cultivation of mindfulness could have beneficial effects on anxiety.

Shapiro and colleagues examined the effects of an MBSR course on graduate students' anxiety, stress, mental health, and well-being; however, the mechanisms by which these changes related to mindfulness were not examined (Shapiro et al. 2007). Similar to the design of our present study, the study by Shapiro and colleagues compared changes in anxiety and stress between two groups of college students. The treatment group was enrolled in a semester-long course that integrated MBSR into their curriculum and the comparison control cohort consisted of students enrolled in a course

without the MBSR curriculum. Students enrolled in the course that incorporated MBSR showed significant pre–post declines in state and trait anxiety, perceived stress, and rumination in addition to significant increases in positive affect and mindfulness (Shapiro, et al. 2007).

Self-compassion as a Potential Mediating Factor

Anxiety can be exacerbated when one over-identifies with successes, setbacks, or failures. However, the cognitive impediments of anxiety can be attenuated through the cultivation of self-compassion and associated reductions in over-identification (Neff et al. 2007; Leary et al. 2007). Self-compassion as a central concept is a relatively new field of study in clinical, personality, and social psychology (Gilbert 2005; Neff et al. 2007). Moreover, mindfulness-based intervention researchers have found self-compassion to be an important mechanism of change (Bögels et al. 2010; Germer 2009; Kuyken et al. 2010; Raes 2011).

Recent research suggests that mindfulness and self-compassion mediate one another in mindfulness practice; however, the change process and relationship between these constructs is not clearly understood (Baer et al. 2012; Van Dam et al. 2011). Whereby self-compassion is implicit in mindfulness practice, mindfulness is implicit in self-compassion research (Germer 2009; Neff 2003; Neff et al. 2007). Self-compassion is a macro concept that has been operationally defined as being understanding toward oneself and holding painful thoughts and feelings in balanced awareness, rather than over-identifying with these negative psychological constructs (Neff 2003; Neff et al. 2007). Moreover, self-compassion entails being discerning towards oneself when faced with hardship while recognizing that suffering, failure, and perceived inadequacies are part of the human condition; and that everyone, including oneself, is worthy of compassion (Akin 2010; Neff 2003; Neff et al. 2007). Using Neff's self-compassion scale (SCS) as the instrument of measure, research has found that lower levels of self-compassion are related to anxiety and are characterized by the construction of a negative self-narrative (e.g., judgmental, self-critical, over-identification with negative emotions), whereas higher levels of self-compassion are associated with lower levels of anxiety and objective, less distorted self-reflection, and observation of direct self-experience (Neff 2003; Neff et al. 2007; Raes 2010). The cultivation of self-compassion is an important progress marker in cognitive-behavioral training and mindfulness-based practices and partially mediates the link between cognitive factors and well-being among young adults (Neff 2003; Neff and McGeehee 2010).

Self-compassion is a particularly relevant concept for the young adult target group in our study because this is an age group characteristically in a perpetual process of self-evaluation and social comparison as they individuate from their family of origin while establishing their personal identity and social positioning (Brown and Lohr 1987; Lapsley et al. 1989; Neff and McGeehee 2010). Among high school and college students there are additional comparative stressors related to academic performance, the need for peer acceptance, and physical or sexual attractiveness which carry an undertone of self-judgment and over-identification that is associated with depression and anxiety (Harter 1990; Neff and McGeehee 2010; Twenge 2006). Given the relationship between these factors, we felt it was important to include self-compassion as a central variable in this study to examine the sequencing, and of changes, and relationships between anxiety, mindfulness, and self-compassion. We selected the SCS for inclusion in our model because the SCS subscale elements relate to the psychometric measures for anxiety (e.g., self-criticism, self-judgment, and over identification) and the Kentucky Inventory of Mindfulness Skills (KIMS) measures of mindfulness (e.g., common humanity and isolation) that are cultivated through MBSR (see Neff 2003; Baer 2003).

Little is known about the interplay and interaction of changes in self-compassion, mindfulness, and anxiety. With a few exceptions, existing literature uses cross-sectional or pre–post treatment study designs which present limitations in understanding the mechanisms of change during meditation programs. Neither cross-sectional or pre–post treatment designs provide the opportunity to measure temporal ordering of changes in mindfulness, self-compassion, or anxiety. Research to date has not been designed in ways that enable us to understand if reductions in anxiety precede and thereby enable a person to become mindful or whether the cultivation of mindfulness precedes and enables a person to reduce anxiety. Do increases in self-compassion need to precede changes in mindfulness and trait anxiety before improvements of mental health can occur? Does the cultivation of self-compassion reduce self-criticism and over-identification thereby reducing anxiety? These are just some of the questions unanswered in the literature to date. In an effort to decipher the temporal order and process of changes, we designed this study to examine the sequence of changes among the three variables (mindfulness, self-compassion, and trait anxiety) by measuring these facets during the midpoint of the meditation program in addition to baseline and post-program follow-up. We hypothesized that participation in the meditation program would reduce trait anxiety, increase self-compassion, and increase mindfulness. We further hypothesized that increased mindfulness would mediate reductions in trait anxiety and increased self-compassion would mediate reductions of trait anxiety among the meditation group. With regard to temporal ordering of changes, we hypothesized that increases in mindfulness would precipitate improvements in self-compassion and trait anxiety.

Method

This study employs a quasi-experimental research design, similar to Shapiro et al. (2007), to evaluate mediating effects of mindfulness and self-compassion in relation to changes in self-reported measures for trait anxiety, mindfulness, and self-acceptance among a nonclinical population of college students. The authors received approval to conduct this research from the human subjects institutional review board at the university where the study was conducted and informed consent was obtained from each participant prior to their involvement in the data collection processes.

Participants

All full-time and part-time students enrolled in elective courses on addictive behaviors at a private university were eligible for participation in this study. The students were placed into one of two groups, treatment or control, based on the academic course they enrolled in. Because these were elective courses open to all students at the university, the participants in this study represent a diverse cross section of students from broad academic disciplines. The "treatment" group consists of undergraduate and graduate students enrolled in an academic course on addictive behaviors that incorporated mindfulness-based meditation practice in the weekly course structure. The treatment and control classes met during evenings, once per week for 2.5 h over the course of the 14-week semester. The parallel control course encompassed didactic lecture and interactive response exercises but no other form of experiential learning or mindfulness meditation practice.

Both groups engaged with curriculum that addressed the role of anxiety in mental health and substance use, the important role of empathy when trying to help people with addictions, and the value of being cognitively and physically present in class and in the moment. Students enrolled in both the "treatment" and "parallel control" courses were taught by the same professor. Thus, the comparative control and treatment groups were both exposed to curriculum content pertinent to the measurement variables, which reduced the potential for influence of demand characteristics in either one of the groups. Furthermore, the study was designed to minimize potential confounding influences and demand characteristics by having third party observers attend the classes to ensure validity of the MBSR content delivery and the absence of leading statements that could influence student responses. The outside observers were known to, but not associated with, the researchers.

Measures

Anxiety Trait anxiety was measured using Spielberger's State–Trait Anxiety Inventory—Trait form (STAI-T, Form Y-2), a 20-item inventory with each item scored from 1 to 4 points. STAI-T measures trait anxiety as a psychological construct involving self-perception in addition to measuring higher-order factors of negative emotional experience and sub-factors of depression and anxiety (Bieling et al. 1998; Spielberger 1983; Spielberger et al. 1995). The potential scores for the STAI-T range from a low trait anxiety score of 20 to a high of 80; mean cross cultural STAI-T scores for college students is 39.48±.36 (Baloglu et al. 2007). The STAI-T alpha coefficient for the present study is .91.

Mindfulness Mindfulness was measured using the KIMS developed by Baer (2003). The KIMS contains 39 items measuring mindfulness as an aggregate score in addition to four subscale facets of mindfulness: (a) observing, (b) describing, (c) acting with awareness, and (d) acceptance without judgment. Participants rate the degree to which the KIMS statements reflect their current experience, using a five-point Likert scale (ranging from never true=1 to always true=5). The four subscales of the KIMS are based on Linehan's dialectical behavioral therapy (Linehan 1993). Subscale scores are obtained by reversing negatively worded items then summing individual items that make up each of the four subscales (a) observing (12-item subscale), (b) describing (8-item subscale), (c) acting with awareness (10-item subscale), and (d) acceptance without judgment (9-item subscale). The four subscales are added together to yield an aggregate score indicating an individual's level of mindfulness. Aggregate KIMS scores can range from a low of 39 to a potential high of 195, the higher score indicates a greater use of mindfulness skills. Internal consistency of the KIMS is high (.87); alpha coefficients range for the four subscales are as follows: observing (.85–.91), accepting without judgment (.87–.88), describing (.84–.93), and acting with awareness (.76–.83; Baer et al. 2004; Baer et al. 2006; Frewen et al. 2008). The alpha coefficients for the present study are as follows: KIMS composite score .84, observing .88, accepting without judgment .89, describing .88, and acting with awareness .77. The KIMS was designed for use by individuals who may not have experience in mindfulness based practice or familiarity with the lexicon of meditation and mindfulness. Therefore the KIMS can be used with subject samples that may have no experience, language, or context for the inventory of questions, notably baseline and control group measures (Linehan 1993; Baer et al. 2004).

Self-Compassion Self-compassion was measured with the SCS, a 26-item survey with high test–retest reliability (.93) developed by Neff (2003). Participants respond to each item by rating the degree to which they feel the statements reflect their current view of themselves using a five-point Likert scale (almost never=1 to almost always=5). There are also six SCS subscales consisting of 4 to 5 items categorized as (a) self-kindness (five items), (b) self-judgment (five items),

(c) common humanity (four items), (d) isolation (four items), (e) mindfulness (four items), and (f) over-identification (four items; Neff 2003). Subscale and composite scores are calculated by first reversing negatively worded items and then adding the scores for each item in the six subscale categories and summing the subscale scores to yield a composite score. The Self-Compassion Scale alpha coefficients for the present study are as follows: SCS composite .91, self-kindness .82, self-judgment .79, common humanity .84, isolation .79, mindfulness .82, and over-identification .76.

Procedures

The three waves of repeated measures data were collected from the treatment and control cohorts for three measures: anxiety (Spielberger's State–Trait Anxiety Inventory STAI-T), self-compassion (SCS), and mindfulness (KIMS; Baer 2003; Neff 2003; Spielberger 1983). All data were collected using secure online surveys emailed directly to participants. The online surveys were disseminated simultaneously to participants in the parallel control and treatment groups to ensure that the windows within which the participants complete the surveys were consistent. The timing of the data collection used the start date of the MBSR meditation program for the treatment cohorts as the criterion point of day 0 for baseline measurement. The first wave of data was collected from participants in the treatment group prior to their introduction the MBSR and prior to engaging in MBSR style meditation. Wave 1, the baseline measurement point was centered around the start date for the first MBSR meditation session: baseline= −4.3 days (−.62 weeks; SD=4.3 days/.62 weeks) from the start of the first MBSR meditation session. Subsequent waves of data collection coincided with the mid-point of the MBSR course (wave 2) and immediately after the conclusion of the MBSR course (wave 3). Wave 2, the mid-course measurement point was=6.7 weeks (SD=.71 weeks) from the baseline measure. Wave 3 post-course data collection occurred at 11.54 weeks (SD=.67 weeks) from baseline and the interval from measurement at wave 2 was 4.9 weeks). To examine if the differences in the average duration between each of the adjacent waves of data collection had an impact on the longitudinal relationship between the variables, we compared models with and without stability constraints for longitudinal paths.

Analysis

We examined the potential changes in composite scores for mindfulness (KIMS), anxiety (STAI-T), and self-compassion (SCS) across three waves of data using data from wave 1 as the baseline reference point for subjects in the control and treatment cohorts. The data were analyzed using structural equation modeling (SEM) to test mediation models for mindfulness, self-compassion, and trait anxiety. Statistical analysis was conducted using SAS (version 9.2) and Mplus (version 6.11).

Cross-Lagged Regression Models Longitudinal mediation analyses requires a minimum of three time points to measure longitudinal relations (Cole and Maxwell 2003); therefore, we designed the present study using three waves of data collection to optimize the application of this statistical model. We employed a cross-lagged regression model to test the potential mediating effects of mindfulness on trait anxiety. Before testing the cross-lagged model that coupled the mindfulness and anxiety variables, we tested autoregressive models with each individual variable to ensure stable relationships within the same measure and to test the overall effect of meditation on each variable.

Model Fit Index Cut-Off Criteria Each of the cross-lagged regression models was evaluated with multiple model fit indices. Hoyle and Panter (1995) recommend using multiple indices when establishing criterion fit; therefore, we present five indices for each model tested in this paper. The scores for the predictive fit indices are listed below each of the respective figures for the models tested. The Akaike Information Criterion (AIC) and other predictive fit indexes are used in SEM to select among competing nonhierarchical estimation models that use the same data (Kline 2005). In addition to the AIC, we present the Bayesian Information Criterion (BIC), which is used in time series and linear regression to identify the strongest model by comparing the BIC scores across all tested models. A comparative fit index (CFI) with values greater than .90 indicates a reasonably good model fit (Hu and Bentler 1999; Kline 2005). Models with the root mean square of error approximation (RMSEA) of .06 or less are considered a good fit; values between .06 and .08 suggest reasonable error of approximation, whereas values of .10 or higher indicate a poor fit for the model (Browne and Cudeck 1993; Hu and Bentler 1999). Values less than .10 for the standardized root mean square residual (SRMR) are generally considered favorable (Kline 2005). The Tucker–Lewis index (TLI) is also presented with each figure as an indication of the goodness of fit for each model. TLI values over .90 are considered acceptable (Hu and Bentler 1999).

To examine the effects of meditation, we examined the potential mediating relationship between mindfulness, trait anxiety, and self-compassion using cross-lagged path analysis with KIMS, STAI-T, and SCS composite scores to construct and test models for their goodness of fit. Preliminary analysis used a single group design in which meditation participation is represented as a bivariate variable (control=0, treatment=1). The use of a bivariate independent variable in single group design is common and accepted research design for SEM in health intervention research

(Blood et al. 2010; MacKinnon et al. 2002; Sobel 1986). The three variables (KIMS, STAI-T, and SCS scores) were simultaneously modeled to provide a more comprehensive understanding of the dynamic effects of the meditation program on these three constructs. Finally, we conducted post hoc analysis using a two-group design for SEM to identify the model with the best fit for mediation analysis within the treatment and control group. The model building process and the results of the models tested are presented in figures and tables in the "Results" section.

Results

Demographics

In total, there were 202 participants with 53 % (n=108) in the MBSR treatment group and 47 % (n=94) in the parallel control cohort. The majority of the participants are female 73 % (n=148). The mean age of the participants is 23.17±6.84 (range 19–61); note that the age data for 21 % (n=43) participants was missing. The racial composition of study participants is relatively diverse. The majority of the White (62 %), Black (12 %), and Asian (12 %) participants are equally represented, whereas Hispanic (8 %) and Native American (5 %) participants comprised smaller percentages of participants. We conducted chi-square analysis for gender and race, and t test for age and found no significant differences in demographics variables between the treatment and the control group.

Missing Data

Portions of data within the three waves of repeated measures were missing; baseline—wave 1 (17 %), mid-course—wave 2 (25 %), and post-course—wave 3 (21 %). Missing data were due to non-responses by participants to some of the survey measures. Logistic regression was used to test the randomness of missing data. The results of the logistic regression tests support the assumption that data missingness is missing at random (MAR). Sex was the only influential factor whereby female participants were less likely to have missing data at baseline, and therefore, we controlled for sex in the data analyses model. Sex was controlled for by assigning a dummy variable (0=male, 1=female) and including it in the regression equations for each outcome variables along with the independent variable assigned to indicate participation in meditation (0=no meditation, 1=meditation). Moreover, nonresponse at one wave was not related with outcome variables at other waves, indicating that it is unlikely that missing data are associated with outcome variables and that missing data are MAR. For data to meet the criteria of MAR, it requires that missingness does not depend on the values of the unobserved outcome variables. Since the very data required for the test are not practically available, mean values of the outcome variables at previous waves were used for the MAR criteria test. In these tests, the probability of data missingness could not be predicted by mean value of the outcome variables at previous waves (p>.05 for all three outcome variables, p=.055 for anxiety, p=.368 for mindfulness, and p=.676 for self-compassion; Hedecker 2012). Under the MAR assumption, the analysis procedures used all available data to estimate the model using full information maximum likelihood without imputation, which is the default mode of the Mplus program (Muthén, and Muthén 2010). We reran the SEM excluding participants with missing data and found that the fit indices were acceptable and these new regression coefficients revealed similar results.

Descriptive Statistics

Means, standard deviations, and zero-order correlations for the 11 variables used in the main analyses are shown in Table 1. Data were checked for normality by examining normal probability plots. No extreme skewness or kurtosis was detected. Thus, data were considered as normally distributed.

Program Effectiveness

Figures 1, 2, and 3 show the auto-regressive models with longitudinal constraint for trait anxiety, mindfulness, and self-compassion respectively. Figures 1, 2, and 3 are single group designs in which meditation participation is represented as a bivariate variable (control=0, treatment=1) for SEM as recommended in health intervention research (Blood et al. 2010; MacKinnon et al. 2002; Sobel 1986).

Constraining paths, from wave 1 to wave 2 and wave 2 to wave 3, as equal did not significantly weaken the model fits for any of the three models; thus, the two longitudinal paths in each model are constrained as equal over time for parsimony of the model. The paths from wave 1 to wave 3 are also included in the models because it improved the model fit significantly with the exception of the self-compassion model. The path from wave 1 to wave 3 in self-compassion is not significant in the autoregressive model; however, it is significant in the integrated cross-lagged path model. The model fit indices of all three autoregressive models were soundly acceptable.

The hypotheses regarding the program effectiveness stated that the participation in the meditation program would reduce trait anxiety, increased mindfulness, and increase self-compassion. The estimated coefficients in Figs. 1, 2, and 3 support these three hypotheses. It is noteworthy that the nearly all of the coefficients are significant except for the mid-point (wave 2) trait anxiety variable. Meditation was

Table 1 Means, standard deviations, and zero-order correlations

	M	1	2	3	4	5	6	7	8	9	10	11
1. STAI1	40.14	8.99	.69***	.65***	−.57***	−.42***	−.38***	−.78***	−.55***	−.42***	.01	.21**
2. STAI2	39.87		8.51	.81***	−.54***	−.59***	−.51***	−.57***	−.78***	−.62***	−.14†	.05
3. STAI3	37.99			8.38	−.51***	−.61***	−.67***	−.51***	−.70***	−.77***	−.19*	.03
4. KIMS1	124.30				15.44	.65***	.59***	.57***	.49***	.40***	.06	−.22**
5. KIMS2	128.32					17.14	.82***	.44***	.67***	.65***	.31***	.01
6. KIMS3	132.08						19.61	.34***	.60***	.72***	.41***	.01
7. SCS1	83.04							15.42	.66***	.46***	.01	−.18*
8. SCS2	85.68								14.32	.76***	.27***	−.03
9. SCS3	88.59									15.72	.30***	.04
10. MED	.53										.50	.11
11. SEX	.73											.44

Note MED (0=control, 1=treatment). SEX (0=male, 1=female). Standard deviations are displayed along the diagonal line

$STAI_j$ State–Trait Anxiety Inventory at Wave$_j$, $KIMS_j$ Kentucky Inventory of Mindfulness Skills at Wave $_j$, SCS_j Self-Compassion Scale at Wave$_j$

†p<.10; *p<.05; **p<.01; ***p<.001

only marginally effective in reducing trait anxiety during the first half of the program (β=−0.108, p=.070).

Mediation Analyses

Integrated cross-lagged path models involving all three outcomes were tested for mediation analyses. Figure 4 illustrates the hypothetical model used to test mediation analyses for trait anxiety, mindfulness, and self-compassion. Consistent with the labeling in the previous figures, the labels for Fig. 4 include "Anxiety" in reference to trait anxiety, "Mindful" refers to mindfulness, and "SC" refers to self-compassion (SCS). In the Fig. 4 model, sex was controlled for, but is not displayed for purposes of parsimony and clarity. Unidirectional arrows indicate regression paths. Arrows without the starting point variables indicate disturbances at wave 2 and wave3.

We tested four alternative models and compared them for the degree of constraints in paths using the standard range of model fit indices (RMSEA, SRMR, CFI, TLI, AIC, BIC). Model 1 allowed all paths between variables to be freely estimated without constraints. Model 2 set the longitudinal paths within each measure constrained as equal. For example, paths from "Mindful1" to "Mindful2" and "Mindful2" to "Mindful3" were set up as equal. Model 3 additionally constrained the cross-lagged paths between two measures at different waves as equal. For example, path from "Mindful1" to "Anxiety2" and "Mindful2" to "Anxiety3" was constrained as equal. Model 4 dropped all insignificant paths from model 3. The results of the model fit indices for each of the four models are displayed in Table 2, which shows that the fit indices for all four models were acceptable.

Building on the results of the analysis presented in Table 2, our next step was to examine potential chi-square difference, AIC difference, and BIC difference to determine the best model. The comparisons of the goodness of fit indices are presented in Table 3 with the favored models bolded and underlined.

The model fit was improved from model 1 to model 2 by constraining longitudinal paths within each measure as equal, $\Delta\chi^2$ (3)=1.218, p=.749. Model fit was also improved from model 2 to model 3 by additionally constraining cross-lagged

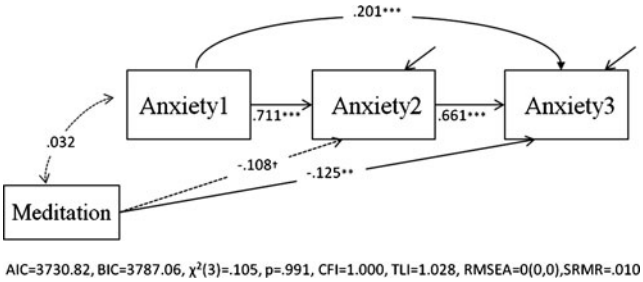

Fig. 1 Univariate autoregressive model (Anxiety). 'Anxiety' refers to trait–anxiety measured by State–Trait Anxiety Inventory—Trait. Values shown are standardized coefficients after controlling for sex. †p<.10; **p<.01; ***p<.001

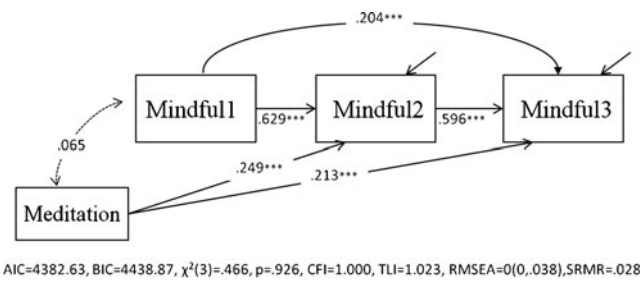

Fig. 2 Univariate autoregressive model (Mindfulness). 'Mindful' refers to mindfulness measured by the Kentucky Inventory of Mindfulness Skills (KIMS). Values shown are standardized coefficients after controlling for sex. ***p<.001

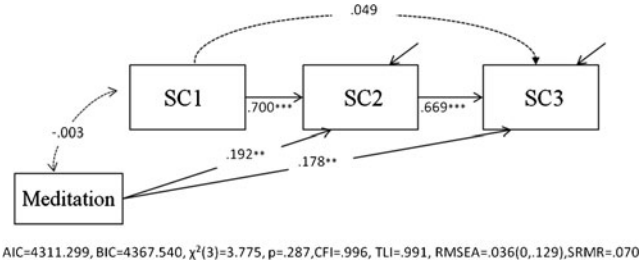

Fig. 3 Univariate autoregressive model (Self-Compassion). 'SC' refers to self-compassion measured by the self-compassion scale (SCS). Values shown are standardized coefficients after controlling for sex. **p<.01; ***p<.001

paths from one measure to another as equal, $\Delta\chi^2$ (6)=3.580, p=.733. Moreover, dropping insignificant paths did not increase χ^2 index significantly. Thus, the more parsimonious model 4 (noted as M4) was determined as the final model. However, the results of model 3 (noted as M3) are also presented to demonstrate the mediation process more clearly by showing insignificant or weakened paths which were originally significant when the mediator variable was not controlled for. Figure 5 illustrates the cross-lagged regression model with stability constraints and cross-lagged constraints from model 3 (noted as M3 in Tables 3 and 4).

In testing the hypothesis for the mediating role of cultivated mindfulness on trait anxiety, our analyses met all three of the conditions required by the Baron and Kenny (1986) mediation model: (a) the initial grouping variable (meditation practice) was associated with the outcome (decreased anxiety; see Figs. 1, 2, and 3); (b) the initial grouping variable (meditation practice) is correlated with the mediator variable (enhanced mindfulness; see Figs. 1, 2, and 3); and (c) the mediator variable (mindfulness) affects the outcome variable (trait anxiety; see Fig. 5). In addition, the originally significant path from "Meditation" to "Anxiety at Wave 3," as shown in Fig. 1, became insignificant after controlling for influence of "Mindfulness at Wave 2" on "Anxiety at Wave 3" (β=−.080, p=.103, see Fig. 5). These results show that mindfulness mediates the effect of meditation on trait anxiety. The opposite possibility of trait anxiety as a mediator between meditation and mindfulness was excluded because the conditions for the mediation model were not satisfied. The effect of meditation on "Anxiety at Wave 2" was not significant (β=−.097, p=.104). Moreover, the path from "Anxiety at Wave 2" to "Mindfulness at Wave 3" was not significant (β=−.024, p=.669).

Self-compassion did not have a mediating effect on trait anxiety among meditators and therefore did not meet one of the key conditions for meditational analysis (Baron and Kenny 1986). As displayed in Fig. 5, the path coefficient from the mediator (self-compassion at wave 2) to the outcome (anxiety at wave 3) was not significant (β=−.015, p=.807). Thus, self-compassion's mediating role was not supported. Following the same analytical pattern, self-compassion did not meet the criteria of a mediator between meditation participation and trait anxiety.

Finally, we explored whether mindfulness mediated the effect of meditation on self-compassion or if self-compassion mediated the effect of meditation on mindfulness. Both paths from "Meditation at Wave 1" to "Mindfulness at Wave 2" and from "Mindfulness at Wave 2" to "Self-compassion at Wave 3" were significant, but the direct path from "Meditation at Wave 1" to "Self-compassion at Wave 3" remained significant after controlling for "Mindfulness at Wave 2." These results suggested that mindfulness partially mediates the effect of meditation on self-compassion. On the other hand, the effect of meditation on mindfulness through self-compassion was not supported. The effect of self-compassion at wave 2 on

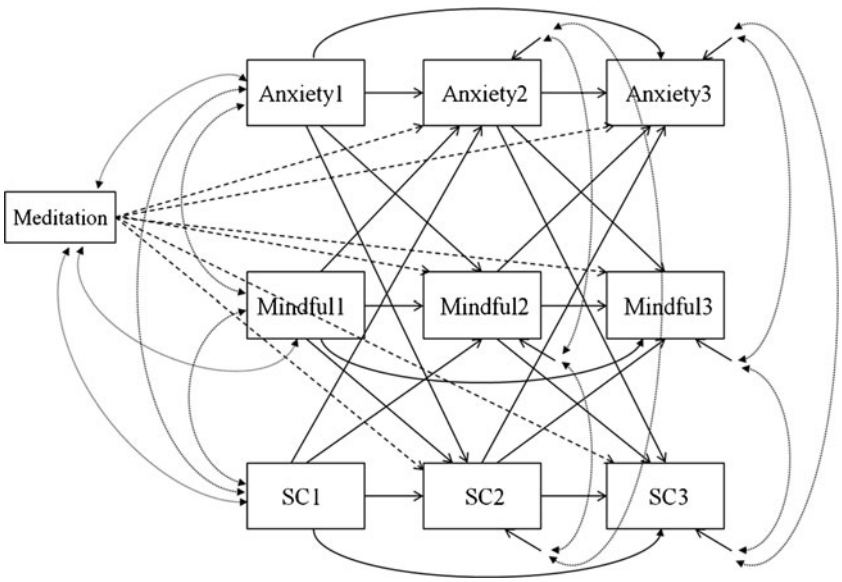

Fig. 4 Cross-lagged path model of trait anxiety, mindfulness and self-compassion. 'Anxiety' refers to trait–anxiety measured by State–Trait Anxiety Inventory—Trait. 'Mindful' refers to mindfulness measured by Kentucky Inventory of Mindfulness Skills. 'SC' refers to self-compassion measured by Self-Compassion Scale. Sex was controlled for, but not displayed for the parsimony of the figure

Table 2 Fit indices of the models tested

Model	χ^2 (*df*)	*p*	RMSEA (90 % CI)	SRMR	CFI	TLI	AIC	BIC
M1:Free loading	7.379 (8)	.496	0 (0, .078)	.009	1.000	1.003	10824.99	11053.26
M2: Stability Constraints	8.597 (11)	.659	0 (0, .060)	.019	1.000	1.010	10820.21	11028.55
M3: Cross-lagged constraints	12.177 (17)	.789	0 (0, .043)	.024	1.000	1.012	10811.79	11010.29
M4: Dropping insignificant	13.913 (21)	.789	0 (0, .031)	.033	1.000	1.015	10805.53	10990.79

Note *RMSEA* root-mean-square error of approximation, *SRMR* standardized root mean squared residual, *CFI* comparative fit index, *TLI* Tucker–Lewis index, *AIC* Akaike's information criterion, *BIC* Bayesian information criterion

mindfulness at wave 3 was not significant (β=.009, *p*=.884). Table 4 summarizes the mediation analyses result for the effect of meditation on the three variables.

As demonstrated in Fig. 5 and elaborated in Table 4, two mediating processes were detected: Meditation → Mindfulness → Anxiety and Meditation → Mindfulness → Self-compassion. The size of the mediation effect has been calculated by multiplying the two coefficients: (a) independent variable to mediator and (b) mediator to outcome, e.g., "Meditation" to "Mindfulness at Wave 2" and "Mindfulness at Wave 2" to "Anxiety at Wave 3" .253 × (−.170)=−.043 (see Fig. 5). The results have also been matched with the result from the Mplus output (−.043). This indirect effect amounts to 24 % of the total effect of meditation on anxiety at wave 3. In addition, mindfulness at wave 2 contributed 10.5 % of the effect of meditation of meditation on self-compassion at wave 3. Table 4 also indicates that neither self-compassion nor trait anxiety mediate the effect of meditation on mindfulness.

Post Hoc Analyses

Sensitivity Analyses Two sensitivity analyses were conducted to test if missing data or demographic outliers (participants over age 25) impacted the main analysis results. The sensitivity test did not alter the trends of the main analysis results, and therefore, these demographic factors do not influence the conclusions of the current study.

Two-Group Analysis Following completion of our single-group design analysis, we conducted post hoc two-group analysis comparing changes and stability among the three outcomes for the treatment and control group. Means, standard deviations, and zero-order correlations of the outcome variables in each group are presented in Table 5.

A multi-group structural equation model approach was used to compare the treatment group and the comparison group on the path coefficients among the outcome variables. The conditions of model 3 of the single group analysis in Table 3 were used as the basic conditions of the models within each group. To test the invariance of path coefficients across groups, the chi-square from the model with group invariance was compared to the chi-square from the model with group variance. Table 6 displays the model comparison results.

As shown in Table 6, the group variance model was significantly better than the group invariance model. Also, the SRMR of the group invariance model was not acceptable whereas the SRMR of the group variance model was acceptable. The findings suggest that the path coefficients among outcome variables differ across groups. Moreover, investigation of the path coefficients of the group variance model reveals that the significant paths among outcome variables within the treatment group are largely consistent with the significant paths of the single group model whereas there were no significant cross-lagged paths among outcome variables within the control group. Figure 6 shows the significant paths within the treatment group.

Table 3 Comparative fit indices

Model comparison	$\Delta\chi^2$	Δdf	*p*	AIC difference	BIC difference
M1 vs **M2**	1.218	3	.749	−4.78	−24.71
M2 vs **M3**	3.580	6	.733	−8.42	−18.26
M3 vs **M4**	1.736	4	.784	−6.26	−19.50

Note The favored models in Table 2 are bolded and underlined. The models with the smaller AIC and BIC difference values is the model with the better fit. Minus sign of AIC or BIC difference indicates that the higher numbered model is better.

Discussion

The primary purpose of this study was to examine the potential mediating effects and temporal ordering of mindfulness, self-compassion, and trait anxiety among meditation participants. We hypothesized that regular participation in meditation would be associated with increased mindfulness and self-compassion and decreased trait anxiety. Furthermore, we hypothesized that increased cultivation of mindfulness and self-compassion through meditation would precede and mediate changes in trait anxiety. Our findings indicate that the temporal ordering of changes we hypothesized was correct regarding mindfulness, leading us to conclude that it is the cultivation of

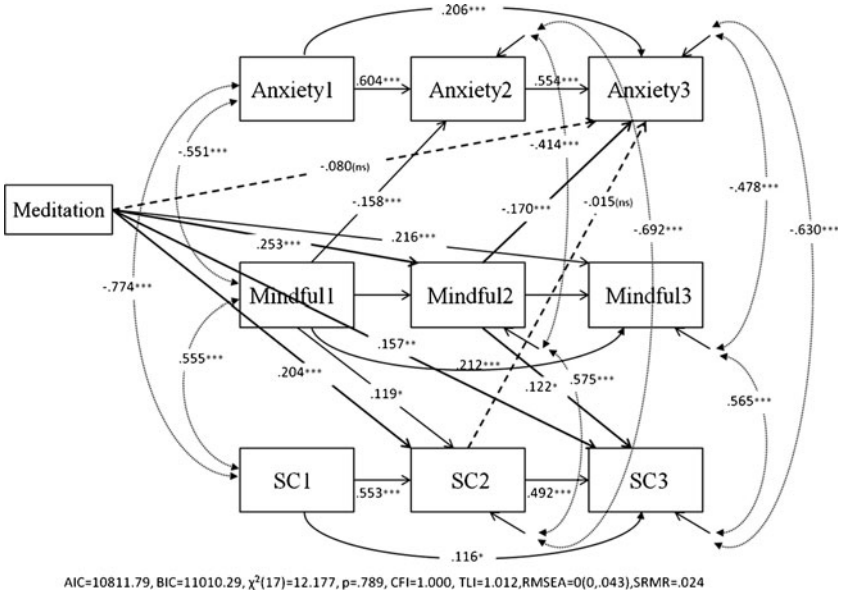

Fig. 5 Cross-lagged path model with stability constraints and cross-lagged constraints (Model 3). 'Anxiety' refers to trait–anxiety measured by State–Trait Anxiety Inventory —Trait. 'Mindful' refers to mindfulness measured by Kentucky Inventory of Mindfulness Skills. 'SC' refers to self-compassion measured by Self-Compassion Scale. Values shown are standardized coefficients after controlling for sex. Non-significant paths are not displayed except 'Meditation' to 'Anxiety3.' (ns) $p>.05$; *$p<.05$; **$p<.01$; ***$p<.001$

mindfulness through the practice of meditation that mediates changes in self-compassion and trait anxiety. As illustrated in Fig. 5 and Table 4, there are two mediating processes that emerge from the practice of meditation, and mindfulness is the mediating factor in both processes. One sequential process begins with the practice of meditation that leads to increases in mindfulness skills, which subsequently lead to reductions in trait anxiety. The other sequential process also begins with the practice of meditation fostering mindfulness then subsequently leads to increases in self-compassion. Both of these processes demonstrate that the cultivation of mindfulness skills, and therefore, meta-cognitive skills that are at the core of mindfulness are essential to and precede self-compassion. As Neff stated, self-compassion requires one to engage in metacognitive activity that allows for recognition of the related experiences of self and others (Neff 2003). We conclude that one must develop mindfulness skills in order to engage in the type of metacognitive activity that then enables one to cultivate self-compassion as a protective factor against emotional problems such as trait anxiety.

In reference to the data presented here, it should be noted that the mediator and outcome variables in the current study represent status scores (KIMS, SCS, STAI-T) rather than change scores for the mediation analyses (Ferrer and McArdle 2003). Thus, the indirect path of Meditation → Mindfulness (wave 2) → Anxiety (wave 3) cannot definitively conclude that an increase in mindfulness among the meditation group led to a decrease in anxiety. However, the significant results of the relevant paths of analysis in our models are the results of controlling for the measures from the previous waves. First, the coefficient ".253 ($p<.001$)" for the path, Meditation → Mindfulness (wave 2), is the result of controlling for the baseline mindfulness score (wave 1). Thus, the result may indicate that meditation contributes to the enhancement of mindfulness during the initial weeks of MBSR practice in the period between baseline (wave 1) and mid-course measurement (wave 2). Second, the coefficient "−.170 ($p<.001$)" for the path, mindfulness (wave 2) → anxiety (wave 3), is the coefficient result after controlling for Anxiety (wave 2) scores. Thus,

Table 4 Mediation in the effects of meditation on the outcomes at wave 3

Outcome (wave 3)	Mediator (wave 2)	Indirect effect	SE	*p*	95 % CI of indirect effect	Other indirect effect	Direct effect	Total effect	Proportion mediated
ANX	**MF**	**−.043**	**.016**	**.008**	**(−.074, −.011)**	**−.056**	**−.080**	**−.179**	**0.240**
ANX	SC	−.003	013	.807	(−.028, .022)	−.096	−.080	−.179	0.017
SC	**MF**	**.031**	**.015**	**.039**	**(.001, .060)**	**.131**	**.157**	**.294**	**0.105**
SC	ANX	.006	.007	.383	(−.008, .020)	.106	.157	.294	0.020
MF	SC	.002	.012	.884	(−.022, .026)	.146	.216	.364	0.005
MF	ANX	.002	.006	.679	(−.009, .013)	.146	.216	.364	0.005

Note The *p* values are the results of Sobel tests (Sobel 1986). The significant mediation results are bolded and underlined

ANX anxiety, *MF* mindfulness, *SC* self-compassion

Table 5 Means, standard deviations, and zero-order correlations two group analysis

	1	2	3	4	5	6	7	8	9	Treatment		
										N1	*M*	SD
1. STAI1	–	.70	.63	−.57	−.39	−.38	−.80	−.57	−.42	104	40.20	9.33
2. STAI2	.68	–	.83	−.58	−.62	−.56	−.65	−.82	−.65	87	38.84	8.40
3. STAI3	74	.75	–	−.51	−.63	−.70	−.50	−.72	−.80	90	36.56	8.91
4. KIMS1	−.56	−.44**	−.52	–	.62	.59	.58	.51	.42	104	125.03	16.86
5. KIMS2	−.52	−.51	−.50	.78	–	.80	.45	.70	.65	87	132.92	18.06
6. KIMS3	−.52	−.39**	−.57	.75	.79	–	.35	.59	.74	90	139.16	20.93
7. SCS1	−.76	−.41**	−.59	.57	.44	.38**	–	.72	.47	104	83.15	17.49
8. SCS2	−.53	−.73	−.63	.41**	.51	.49	.48	–	.74	87	88.99	15.49
9. SCS3	−.50	−.56	−.69	.32*	.47	.53	.53	.76	–	90	92.69	17.10
Control N2	64	64	70	64	64	70	64	64	70			
M	40.05	41.27	39.83	123.13	122.08	122.99	82.86	81.19	83.31			
SD	8.47	8.52	7.30	12.84	13.62	13.11	11.40	11.18	11.92			

Note N1 = 108 Treatment Group (above the diagonal), N2 = 94 Control Group (below the diagonal). STAI = State–Trait Anxiety Inventory; KIMS = Kentucky Inventory of Mindfulness Skills; SCS = Self-Compassion Scale. (The three Wave of data are represented by 1, 2, or 3 following the respective variables STAI, KIMS or SCS) * p < .05. ** p < .01

the result may also indicate that the level of mindfulness at wave 2 predicts the change in midcourse anxiety (wave 2) to post-course anxiety at wave 3.

Among the strengths of the current study is the research design, which enabled us to measure the temporal order of changes in the variables that occur during the process of the meditation course. Notably our analyses demonstrate that changes in the mediator variable (mindfulness) precede the sequence of changes in the outcome variable (trait anxiety). This is advantageous over the commonly used of statistical models that measure outcome variables with only two time points of pre-post measurement. When the pre-post research design is used, one cannot exclude the possibility that the designated outcome variable may in fact be a mediator variable. Our research design enabled us to assess the temporal ordering of changes in mindfulness, self-compassion, and trait anxiety to a certain degree. The results of our study indicate that the practice of meditation first increased participants' mindfulness at wave 2, which in turn facilitated subsequent significant decreases in trait anxiety and increases in self-compassion at wave 3.

Our conclusions differ slightly from the findings of Van Dam and colleagues (2011) who concluded that self-compassion was a better predictor of changes in anxiety and that mindfulness accounted for less variance in anxiety than did self-compassion (Van Dam et al. 2011). There are several key differences between our study and that of Van Dam and colleagues; notably, their study used a clinical sample, measured mindfulness with the mindful attention awareness scale and used only a pre–post measure (Brown and Ryan 2003; Van Dam et al. 2011), whereas our study used a non-clinical sample, measured mindfulness more frequently, included mid-course process measures, and used the KIMS mindfulness measure (Baer et al. 2006). Our findings also differ from those of Baer and colleagues (2012) who found that although both mindfulness and self-compassion appear to mediate the effects of meditation practice on well-being, self-compassion has a more significant effect on well-being. Baer and colleagues recommended caution in interpreting their results because their analyses were based on cross-sectional data only (Baer et al. 2012). Baer's study and our present study both used nonclinical populations and similar mindfulness measures (KIMS and five facets of mindfulness); however, Baer et al. measured psychological well-being whereas our study examined psychological distress measured by trait anxiety. Differences in outcomes from the present study and the findings of the Baer et al. (2012) and Van Dam et al. (2011) studies may partially relate to the difference in instruments used to measure mindfulness, the variables measured, and the type of population (clinical vs. nonclinical). Moreover, the difference in outcomes may originate from the differences in our study design and the design used by Baer et al. and Van Dam et al. It

Table 6 Comparisons of fit indices of the multigroup models

Model Comparison	χ^2	df	$\Delta\chi^2$	Δdf	P	CFI	SRMR
Group invariance	98.301	59				.960	.292
Group variance	41.176	32	57.135	27	<.001	.991	.081

Note CFI = comparative fit index; SRMR = standardized root mean squared residual

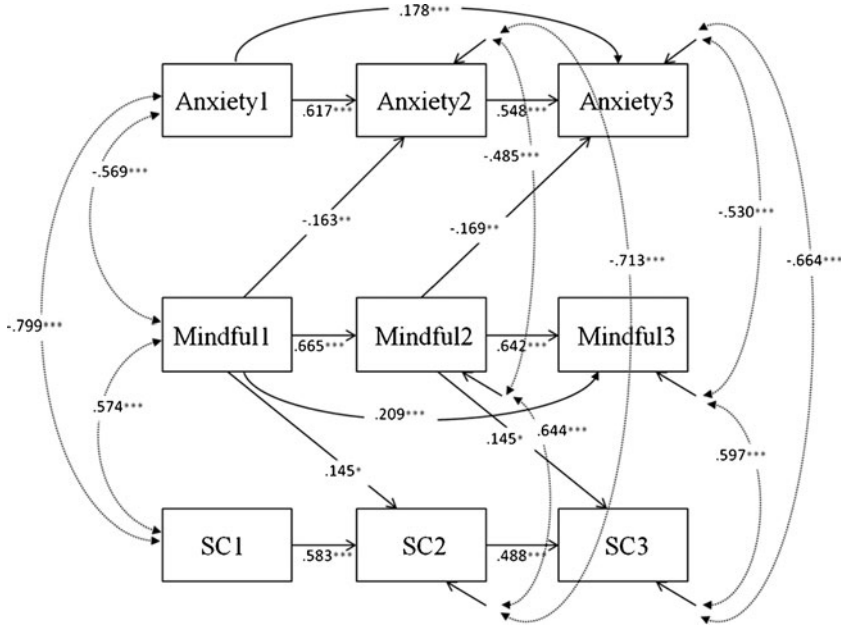

Fig. 6 Significant paths of group variance model (Treatment group). The control group is not presented to preserve space. *SC* self-compassion. *$p<.05$; **$p<.01$; ***$p<.001$

should be noted that our current study investigated the longitudinal relationships among the three psychological measures whereas the previous studies were cross-sectional (Baer et al. 2012) and pre–post measures (Van Dam et al. 2011). Considering these differences, the conclusions drawn by Van Dam et al. (2011) and Baer et al. (2012) are not necessarily in conflict with the results of the current study; however, they appear to be less nuanced. As can be seen in Fig. 6 of the present study, self-compassion was more strongly correlated with anxiety than mindfulness within the same wave. Nonetheless, among the variables in the previous waves, it was not self-compassion but mindfulness that was a significant (and strong) predictor of trait anxiety. It should be noted that the SCS includes a subscale mindfulness measure therefore the SCS measure does encompass facets of mindfulness. Whereas self-compassion may have independent effects, the current study's results suggest that self-compassion may originally develop via mindfulness. The KIMS includes subscale measures for observing, describing, acting with awareness, and acceptance without judgment; and the SCS subscales include categories for self-kindness, self-judgment, common humanity, isolation, over-identification, and mindfulness (Baer et al. 2004; Neff 2003). An itemized examination of these subscales reveals a number of similarities with regard to judgment (e.g., self-judgment and acceptance without judgment) which may confound the changes layering of changes that occur among meditators. The subscale measure of mindfulness within the SCS may also contribute to some of the unusual patterns for self-compassion that we found in our models. Notably high self-compassion at baseline was associated with modest reductions in anxiety at wave 3 even for the control group.

The results of our study do not mean that the cultivation of self-compassion does not contribute to reductions in negative psychological symptoms or enhance psychological well-being at later times. The absence of a relationship between self-compassion and anxiety in the current study may be related to the specific measure of trait anxiety or attributes of the participant's characteristics. The participants of the current meditation program were mostly beginners with little to no meditation practice. Through the practice of regular group meditation, the participant's self-compassion may be enhanced temporarily during the meditation program, however internalization of self-compassion may require a more sustained period of meditation practice in order to take hold. It is possible that the integration of true self-compassion may lead to further reductions in trait anxiety at later times. This is an area that requires further exploration of the relationships between self-compassion and trait anxiety through longitudinal studies and close examination of subscale facets.

Limitations

This study has several limitations, most notably that the participants were not randomly assigned to the MBSR treatment or parallel control group; however, between group analyses of demographic characteristics and baseline measures indicate that the control group had no prejudicing characteristics. This type of non-randomized comparison control cohort has been commonly used in similar studies with non-clinical populations (e.g. Shapiro et al. 2007). The comparative parallel control group in our study serves as a reference control group to measure and rule out any potential naturally occurring changes in trait anxiety, mindfulness, or self-compassion that may naturally occur over the course of an academic semester. The parallel control cohort also served as a reference point

against which to assess potential demand characteristics related to repeated exposure to the KIMS, STAI-T, and SCS survey items. Even in the absence of direct influencing comments and behaviors by the professor leading these courses, there is the unknown possibility of some level of demand characteristics being elicited through differences in the course content delivered to the treatment and control cohorts. Missing data may be another limitation; within the three waves of repeated measures portions of data were missing; however non-responses to survey measures were determined to MAR whereby non-response at one wave was not related to mean values of the outcome variables at previous waves. Furthermore, we conducted a sensitivity analysis by dropping participants with missing data from the study, and this did not alter the trends of the main analysis results. These additional tests and analysis results may mitigate the limitations due to missing data.

Conclusion

To explore the parameter estimation of the mediating effect of mindfulness on trait anxiety, we used a simultaneous estimation and lagged sequence strategy to examine the dynamic relationship between mindfulness and trait anxiety. Our model of analysis enabled us to ascertain that the cultivation of mindfulness, which was present only among meditators, mediates the process of change and yields improvements in trait anxiety for participants over time. This pattern was also true, but to a lesser extent, for self-compassion. It may be that the internalization of self-compassion requires more time and sustained practice than what is needed for the cultivation of mindfulness. Our results illustrate that it is not imply the physical act of meditating that yields improvements, but the cultivation of mindfulness and awareness of one's own thought processes that yield reductions in trait anxiety and support the cultivation of self-compassion. Mindfulness and self-compassion are complex concepts and the measures for mindfulness (KIMS) and self-compassion (SCS) used in this study contain diverse arrays of subscales not explored here. Future research should explore the mediating and moderating changes in the subscale facets of self compassion and mindfulness to provide further insight into the mechanisms of change that occur through the practice of meditation.

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