



## Examining the Processes of Change Associated With Mindfulness-Based Meditation and Reductions in Trait Anxiety

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### Abstract

Mindfulness Based Stress Reduction (MBSR) programs have demonstrated efficacy in reducing trait anxiety; however, there is limited understanding of the process and mechanisms of change through which MBSR programs reduce anxiety. To better understand the changes cultivated through MBSR practice, this study examined causality relationships amongst trait anxiety, self-compassion, and mindfulness. Data were analyzed from three time points (pre-intervention, mid-intervention, and post-intervention) for MBSR treatment (n = 109) and control (n = 94) groups. The inclusion of mid-program data enabled examination of causal linkages, both standard and reverse causation pathways, through cross-lagged models. Findings indicate that MBSR is effective in cultivating self-compassion and mindfulness while reducing trait anxiety for MBSR participants. Specifically, the reverse causal model, which examined causal inference leading to reductions in trait anxiety, revealed that changes in self-compassion and mindfulness at mid-program contributed to changes in anxiety following the MBSR program.

### Keywords

Mindfulness, Self-acceptance, Meditation, Self-compassion, Anxiety, Cross-lagged models

### Introduction

Anxiety is fundamentally future oriented and is experienced as physiological and emotional arousal in response to real and imagined threats [1,2]. As with many psychological disorders, anxiety involves fundamental problems with inflexibility often coupled with a lack of awareness and insight of one's thoughts and behaviors [3]. Many people, including college students, struggle with anxiety, which can have a deleterious effect of their physical and mental health [4]. Over the past decade the percentage of college students who report experiencing anxiety on a level that negatively impacts their academic and social functioning has doubled; while less than 20% of college students with anxiety report having accessed clinical counseling services [5-7]. Among college students' anxiety negatively impacts their academic progress as well as their mental physical health [8,9]. Furthermore, academic impairment and suicidal behavior are highest among non-clinical populations of college students with low levels of positive mental health [10]. As such there is a need for prevention and non-clinical programs that can reach people and help them cope with their emotional problems [11,12]. One such program, Mindfulness Based Stress Reduction (MBSR), has been found to be beneficial

for managing and dealing with anxiety among young adults [13-18]. Mindfulness based programs aim to cultivate antecedent and response focused strategies that modulate the cognitive and experiential components of emotions associated with anxiety thereby facilitating reductions in trait anxiety over time [13,19,20].

In contrast to anxiety, mindfulness is fundamentally oriented in present moment awareness imbued with conscious intentional responses to physical and emotional arousal [1,2]. Moreover mindfulness is associated with more than the absence of mental illness; it is associated with positive mental health and flourishing [10,21]. The cultivation of mindfulness fosters an awareness of thought processes

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**Table 1:** Comparative characteristics of anxiety, self-compassion and mindfulness.

Salient anxiety characteristics	Facets of self-compassion according to (SCS)	Facets of mindfulness (KIMS)
Future oriented, consumes attentional resources	Mindful-present centered focus	Mindful-present centered focus
Unaccepting	Self-acceptance	Acceptance
Unaware, unconscious automatic pilot	Mindfulness	Acting with conscious awareness
Over identification with successes and failures	Not over-identifying with successes or failures	
Judgmental	Non-judgmental	
Self-evaluative	Self-kindness	
Self-criticism	Self-kindness and self-compassion	
Lack of awareness, or maladaptive response to, internal and external experiences		Acting with conscious awareness.  Observing, noticing internal and external experiences.  Able to describe and name emotions and experiences.
Isolation, self-focused	Connected common humanity, not isolated	

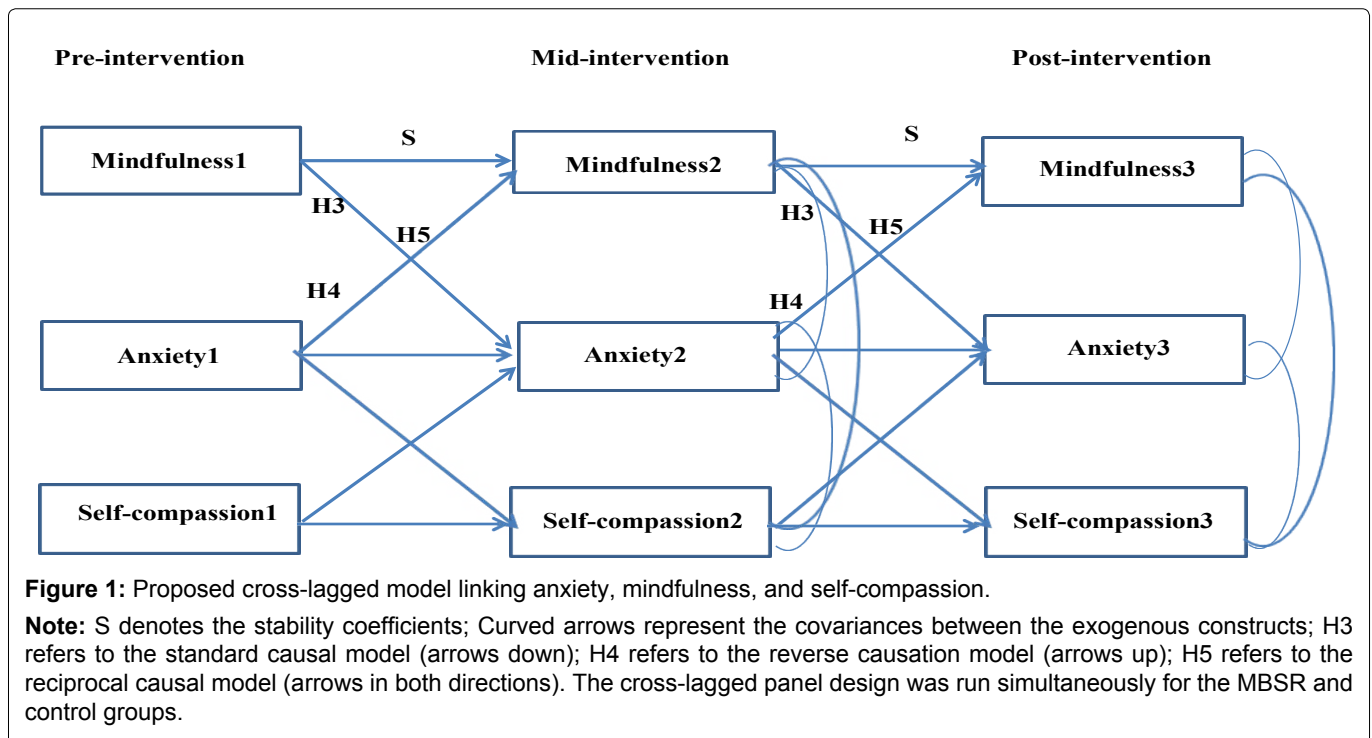
Words in bold represent specific measures from the Self-Compassion Survey (SCS) or the Kentucky Inventory of Mindfulness (KIMS) that are associated with key indicators of anxiety.

associated with anxiety, such as worry and rumination. Mindful awareness enables one to recognize one's thoughts, emotions, and behaviors; therefore when a person recognizes that they are fretting, the individual has an opportunity to alter their thought processes, interrupt chronic worry and interrupt anxious rumination [22]. This quality of conscious awareness, and its association with mindfulness, has profound implications for understanding the nature of one's thoughts and the interaction between mind and body; thereby freeing oneself from thought patterns that impede optimal mental and physical health [23].

MBSR facilitates not only mindfulness but self-compassion as well [13]. Self-compassion is a psychological construct characterized as understand toward oneself during difficult times and holding painful thoughts and feelings in balanced awareness rather than over-identifying with them [24]. In contrast, anxiety is characterized by self-evaluation that is often harshly self-critical, rigid, highly self-controlling and negative [25-28]. Self-compassionate self-appraisal is characterized by non-judgment and self-kindness [24,29,30]. Lower levels of self-compassion are characterized by the construction of a negative self-narrative (e.g. judgmental, self-critical, over-identification with negative emotions) and are related to depression and anxiety; whereas higher levels of self-compassion are characterized by objective, less distorted observation, and self-reflection of direct experience [24,31,32]. The facets of self-compassion measured by the Self-compassion Scale (SCS) and mindfulness as measured by the Kentucky Inventory of Mindfulness (KIMS) are pertinent to assessing the impact MBSR may have on anxiety because these constructs assess mental, emotional, and sensory experiences that characterize anxiety [33]. Table 1 provides a comparative framework for un-

derstanding the salient characteristics of anxiety in relation to the facets of self-compassion and mindfulness.

Research examining the effectiveness of the MBSR programs have primarily centered on the evaluation of changes (mean differences) in anxiety, self-compassion, and/or mindfulness scores among subjects who participated in a MBSR program versus those who did not [13,34,35]. Others have examined the associations (correlations) between anxiety, self-compassion, and mindfulness scores among MBSR participants [36]. However, these analyses fall short of answering questions about the causality of relationships amongst the key constructs of interest here which are anxiety, self-compassion, and mindfulness. To elaborate, few studies have examined if mindfulness and self-compassion are related to anxiety and is anxiety associated with lowered mindfulness?. Answering these questions requires the use of a cross-lagged panel design with multiple waves of data (beyond the traditional pre-post experimental designs), an approach that has been utilized to a limited extent in this line of research [37]. Hence, the goals of this investigation are two fold: (a) to examine the changes (mean differences) in anxiety, self-compassion, and mindfulness scores among subjects who participated in an MBSR program versus those who did not; and (b) examine the causal relationships among self-compassion, mindfulness, and anxiety using a cross-lagged model design (Figure 1). The use of a cross-lagged panel approach allows for an examination of the processes of change while at the same time accounting for variations in scores of specific constructs at the previous measurement time points. The stability coefficients (S) also known as autoregressive coefficients determine the strengths of the relationships across time points for the same construct (e.g., anxiety at pre-intervention, anxiety at mid-intervention, and anxiety at post-intervention). In addition to accounting



for the autoregressive coefficients, cross-lagged, or reciprocal effects, (labeled as H3/H4/H5 in (Figure 1)) between different constructs over time are examined while also controlling for the stability pathways. The relationships between characteristics of trait anxiety, self-compassion and mindfulness informed the development of the cross lagged model (Figure 1) and these hypotheses:

### Hypothesis 1(A)

Among participants in the MBSR program, self-compassion and mindfulness would significantly improve over time; whereas these measures would remain relatively unchanged over time for the control group.

### Hypothesis 1(B)

Among participants in the MBSR program, anxiety would significantly decline over time and would remain relatively unchanged over time for the control group.

### Hypothesis 2(A)

Increases in mindfulness will be associated with reductions in anxiety and increases in self-compassion and over time. Referred to as the standard causation hypothesis, this association will be stronger for participants in the MBSR group compared to those in the control group.

### Hypothesis 2(B)

Increases in self-compassion will be associated with reduction in anxiety, and increases in mindfulness over time. Referred to as the reverse causation hypothesis, this association will be stronger for participants in the MBSR group compared to those in the control group.

## Materials and Methods

### Participants

This study employed a quasi-experimental design with non-clinical samples of college students. University students were placed into one of two groups, treatment or control, based on the section of the academic course they enrolled in. The courses that prospective participants enrolled in were elective courses open to all students at the university and therefore participants represent a culturally diverse cross section of students from broad academic disciplines. Students did not know about the mindfulness component of the class prior to enrollment. Data collection was incorporated as part of the course; however, students in the intervention/mindfulness and control groups had the option to decline participation in the data collection. Students were informed in writing and verbally about the study and the data collection process. All students enrolled in the two courses were eligible to participate, the only exclusion criteria were not being enrolled in one of these two courses. The percentage of students who declined to participate in the study data collection was 10% for the intervention group and 15% in the control group.

The study protocol was approved by the Syracuse University Institutional Review Board (IRB), and has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. Informed consent was obtained from participants prior to their engagement with the study. The participants for this study included 94 participants in the control group and 109 participants in the MBSR treatment group. The majority of participants in each group were female

**Table 2:** Demographic profile of participants in the MBSR treatment group and the control group.

	<b>MBSR treatment group (n = 109)</b>	<b>Control (n = 94)</b>
Female	78% (n = 85)	68.1% (n = 64)
Age*	25 ± 9	22 ± 4
<b>Race/Ethnicity</b>		
American Indian/Native American	9.2% (n = 10)	16% (15)
Asian	5.5% (n = 6)	4.3% (n = 4)
Black	12.8% (n = 14)	10.6% (n = 10)
Hispanic/Latino	11% (n = 12)	7.4% (n = 7)
White	61.5% (n = 67)	61.7% (n = 58)

\*Significant difference at the  $p \leq 0.05$  level.

(78% treatment; 68% control). Participants were ethnically diverse, 62% of the participants in the MBSR treatment and control groups identified themselves as White. Chi-square analyses comparing participant demographics for sex and race/ethnicity between the MBSR group and control group indicated no significant differences between the two groups. Demographic characteristics of participants are presented in Table 2.

## Measures

Surveys were administered to participants in both the MBSR treatment and Control groups using a secure web-based interface. The use of an online survey is considered a reliable and valid approach over face-face interviews in studies involving sensitive issues [38]. The online format was used to collect data at three time points: pre-intervention (~ week 0); mid-intervention (~ week 5); and post-intervention (~ week 10).

**Trait anxiety:** Trait anxiety was measured using the Spielberger Trait Anxiety Inventory Y-2 (STAI) [39]. Y-2 (STAI) is a 20-item inventory that has a strong test-retest reliability ( $r = 0.88$ ). Participants responded to each item using a four-point Likert scale (1 = almost never, 4 = almost always). Potential scores for the STAI range between 20 and 80 with a mean cross-cultural STAI score of  $39.5 \pm 0.4$  for college students. [40]. The Chronbach's alpha for the present study is  $= 0.91$ .

**Mindfulness:** Mindfulness was assessed using the Kentucky Inventory of Mindfulness Scale (KIMS) which has been validated for use with clinical and non-clinical young adult populations [41]. The KIMS is a multidimensional 39 item mindfulness inventory that yields a composite score (range: 39-195) compiled from the sum of four subscales or facets of mindfulness that measure (a) acting with awareness (attending to one's present activities and avoiding automatic pilot); (b) describing (ability to name or label experiences); (c) non-judging of inner experiences (taking a non-evaluative stance), and (d) observing (noticing internal and external experiences) [41]. Participants responded to each item using a five-point Likert scale (1 = almost never, 5 = almost always). Higher KIMS scores indicate greater lev-

els of mindfulness [41]. The Chronbach's alpha for the SCS composite score for present study is  $\alpha = 0.84$ .

**Self-compassion:** Self-compassion was measured using the 26-item Self-Compassion Scale (SCS) [24,42]. Participants responded to each item using a five-point Likert scale (1 = almost never, 5 = almost always). The SCS yields a composite score (Range: 26-130); compiled from these six subscales; self-kindness, self-judgment, common humanity, isolation, mindfulness, and over-identification. The six SCS subscales comprise three pairs of opposing subscale constructs (a) kindness-self-kindness and self-judgment; (b) connection-common humanity and isolation, and (c) mindfulness-over-identification and mindfulness; higher scores indicated greater self-compassion, measure has indicated high test-retest reliability of 0.93 [24]. The Chronbach's alpha for the SCS composite score for present study is  $\alpha = 0.91$ .

## Mindfulness based stress reduction (MBSR) program

Study participants were randomly placed into one of two groups, treatment or wait list control through random selection of the course section they registered for. The "treatment" group engaged in a Mindfulness-Based Meditation Practice (MBSR) modeled after the curriculum developed by Jon Kabat-Zinn [43]. The MBSR facilitator is certified through the UMASS Center for Mindfulness in Medicine, Health Care and Society. Students enrolled in the MBSR program met once per week over the course of 8 weeks for approximately two hours of meditation and dialogue. During each weekly MBSR class, participants engaged in mindful-based practices which included sitting meditation, awareness of breath work, guided body scan, and two forms of moving meditation-hatha yoga and walking. An external observer, who was an experienced MBSR teacher, also attended sessions to ensure curriculum fidelity. Students in the parallel control group engaged in didactic health lectures but no mindfulness practice. Participants in the parallel control group served as a referential measure to regulate for inherent changes in anxiety, mindfulness, or self-compassion that may naturally occur over the course of ten weeks during an academic semester.

## Statistical approach

The statistical approach in this study entailed two key



methods (1) examination of the causal relationships among self-compassion, mindfulness, and anxiety using a cross-lagged model design, and (2) examination of the changes in anxiety, self-compassion, and mindfulness scores among subjects who participated in the MBSR program compared to the control cohort assessing group by time interaction. The use of a cross-lagged panel enables the examination of the processes of change while at the same time accounting for variations in scores of specific constructs at the previous measurement time points. The stability coefficients (S) also known as autoregressive coefficients determine the strengths of the relationships across time points for the same construct (e.g., anxiety at pre-intervention, anxiety at mid-intervention, and anxiety at post-intervention). In addition to accounting for the autoregressive coefficients, cross-lagged, or reciprocal effects, (labeled as H3/H4/H5 in Figure 1) between anxiety, KIMS and SCS over time can be examined while controlling for the stability pathways.

Repeated measures ANOVA's were conducted to examine group by time interaction differences in the scores of anxiety, and the subscale SCS scores (humanity, isolation, self-judgment, self-kindness, mindfulness, over-identification, and total score) and the KIMS subscale scores (accep-

tance, describing, observation, awareness, and total score) across three time points-time 1 (pre-intervention), time 2 (mid-intervention), and time 3 (post-intervention). The focus of these analyses was to examine the significance of the interaction for the within-subject and the between-subject factors. When needed, for each analysis we applied the Greenhouse-Geisser correction (if the probability of Mauchly's Test of Sphericity was less than 0.01). Details of the outcomes from these analyses are presented in Table 3.

## Results

One way ANOVA was conducted between the MBSR treatment and control groups at baseline and then for each of the subsequent assessment points mid program/time 2 and post-intervention/time 3. There were no significant baseline pre-intervention differences between the treatment and control group for trait anxiety, self-compassion, or mindfulness. However, ANOVA revealed significant differences between groups for self-compassion and mindfulness at mid program/time 2 and significant differences for all measures at post-intervention/time 3. Table 4 presents the mean, standard deviation for each group and the ANOVA for between group differences at each measures phase.

**Table 3:** Path analysis summaries for cross-lagged models.

	Control group			MBSR group		
	Beta	SE	$\beta$	Beta	SE	$\beta$
<b>Stability model</b>						
Anxiety1 → Anxiety2	0.71***	0.06	0.73	0.58***	0.05	0.68
Self-compassion1 → Self-compassion2	0.65***	0.07	0.64	0.55***	0.04	0.68
Mindfulness1 → Mindfulness2	0.78***	0.06	0.77	0.50***	0.06	0.53
Anxiety2 → Anxiety3	0.56***	0.06	0.6	0.75***	0.06	0.73
Self-compassion2 → Self-compassion3	0.83***	0.05	0.81	0.76***	0.06	0.72
Mindfulness2 → Mindfulness3	0.84	0.06	0.81	0.85***	0.06	0.75
Anxiety1 → Anxiety3	0.30***	0.06	0.33	0.12**	0.05	0.14
<b>Standard causal model</b>						
Anxiety1 → Mindfulness2	0.1	0.11	0.07	0.06	0.14	0.04
Self-compassion1 → Anxiety2	0.02	0.07	0.03	-0.10**	0.04	-0.22
Anxiety2 → Mindfulness3	-0.19	0.1	-0.12	-0.24	0.14	-0.11
Self-compassion2 → Anxiety3	-0.07	0.04	-0.1	-0.04	0.04	0.08
<b>Reverse causal model</b>						
Anxiety1 → Self-compassion2	-0.18	0.14	-0.13	-0.32**	0.12	-0.2
Mindfulness1 → Anxiety2	-0.06	0.04	-0.09	-0.05	0.03	-0.1
Mindfulness2 → Anxiety3	-0.06	0.03	-0.1	-0.05*	0.02	-0.1
Anxiety2 → Self-compassion3	0.06	0.11	0.04	0	0.16	0
<b>Best fitting reciprocal model</b>						
Self-compassion1 → Anxiety2	0.09	0.08	0.12	-0.05	0.05	-0.11
Anxiety1 → Mindfulness2	0.04	0.12	0.03	-0.05	0.16	-0.03
Anxiety1 → Self-compassion2	-0.25	0.16	-0.18	-0.26	0.15	-0.16
Mindfulness1 → Anxiety2	-0.06	0.04	-0.1	-0.04	0.03	-0.09
Anxiety2 → Mindfulness3	-0.16	0.11	-0.1	-0.26	0.16	-0.11
Self-compassion2 → Anxiety3	-0.06	0.05	-0.09	0	0.05	0
Anxiety2 → Self-compassion3	0.06	0.12	0.04	-0.11	0.19	-0.06
Mindfulness2 → Anxiety3	-0.05	0.03	-0.08	-0.05	0.03	-0.09

**Note:** \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

**Table 4:** ANOVA between group differences in anxiety, mindfulness and self-compassion for baseline, mid-program and post-program.

		Mean	Standard deviation	F	p value
Baseline anxiety	Control	40.1	8.5	0.01	0.91
	MBSR	40.2	9.3		
Baseline self-compassion	Control	82.9	11.4	0.01	0.91
	MBSR	83.2	17.5		
Baseline mindfulness	Control	123.1	12.8	0.6	0.44
	MBSR	125	16.9		
Mid-program anxiety	Control	41.3	8.5	3.04	0.08
	MBSR	38.8	8.4		
Mid-Program self-compassion	Control	81.2	11.2	11.73	0
	MBSR	89	15.5		
Mid-Program mindfulness	Control	122.1	13.6	16.25	0
	MBSR	132.9	18.1		
Post anxiety	Control	39.8	7.3	6.2	0.01
	MBSR	36.6	8.9		
Post self-compassion	Control	83.3	11.9	15.26	0
	MBSR	92.7	17.1		
Post mindfulness	Control	123	13.1	31.98	0
	MBSR	139.2	20.9		

## Hypotheses 1a and 1b

To answer these hypotheses, mixed between-within subjects' ANOVAs were conducted to examine whether there were significant changes in anxiety, self-compassion, and mindfulness across three time points; pre-intervention (time 1), mid-intervention (time 2), and post-intervention (time 3) were significantly different for the two groups (MBSR and Control). Findings for anxiety indicated that there was a significant main effect for time [Wilks'  $\Delta = .41$ ,  $F(2, 200) = 9.33$ ,  $p < 0.001$ ,  $\eta^2 = 0.09$ ] and a significant interaction between group and time, Wilks'  $\Delta = 0.92$ ,  $F(2, 200) = 8.89$ ,  $p < 0.001$ , partial eta squared = 0.08].

Findings from the repeated measures ANOVA analyses for mindfulness revealed a significant main effect over time [Wilks'  $\Delta = 0.77$ ,  $F(2, 200) = 29.99$ ,  $p < 0.001$ , partial eta squared = 0.23], a significant group by time interaction, [Wilks'  $\Delta = 80$ ,  $F(2, 200) = 25.37$ ,  $p < 0.001$ ,  $\eta^2 = 0.20$ ]. Findings from the repeated measures ANOVA analyses for self-compassion also revealed a significant main effect over time [Wilks'  $\Delta = 0.91$ ,  $F(2, 200) = 9.43$ ,  $p < 0.001$ , partial eta squared = 0.09], and a significant group by time interaction, [Wilks'  $\Delta = 88$ ,  $F(2, 200) = 14.01$ ,  $p < 0.001$ ,  $\eta^2 = 0.12$ ]. The findings indicated that the MBSR treatment program was effective in cultivating mindfulness and self-compassion, as well as in lowering trait anxiety levels for participants in the MBSR group when compared to those in the control group. In short, hypotheses 1a and 1b were supported.

## Hypotheses 2a and 2b

To answer these hypotheses, we conducted cross-lagged modeling using Simultaneous Multiple Group Analysis

(MBSR and control) with the Analysis of Moment Structures (AMOS) program [44]. Prior to conducting the analysis, data were examined for skewness and kurtosis and the assessments indicated that the normality assumptions were met. To examine whether or not the pathways of association varied, or were similar, across MBSR and the control groups, we set up an unconstrained model in which the pathways of association were freed to vary across the two groups (MBSR and control) against a constrained model where the pathways of association were set to be similar across the two groups. To evaluate if the pathways of association were similar or different, the chi-square difference statistic was used. If this statistic indicated a significant difference, then the pathways of association were judged to be different for those in the MBSR group versus the control group. In addition to using the chi-square statistic and the associated  $p$ -value, three fit indices were used to evaluate model fit (a) Comparative Fit Index (CFI) (values greater than 0.90 indicate reasonably good model fit) [45]; (b) Root Mean Square of Error Approximation (RMSEA) (values of 0.06 or less are considered very good fit and values between 0.06 and 0.09 indicate reasonable error of approximation) [46,45], and (c) the Tucker Lewis Index (TLI) (values over 0.90 indicated good model fit) [45].

Following guidelines proposed by [47], the examination of the cross-lagged model was systematically conducted in a series of steps: (1) first, a stability model was run in which only the stability paths (S) and no cross lagged paths were included; (2) second, a standard causal model (H3) was run in which the paths linking mindfulness and self-compassion to anxiety were introduced in addition to the stability paths; (3) third, a reverse causation model (H4) was run in which the paths linking anxiety to mindfulness and self-compassion

sion were introduced in addition to the stability paths; and (4) fourth, a reciprocal causation model (H5) was run in which the stability paths, H3 and H4 were all included in a single model. Each of these steps were run simultaneously for those in the MBSR and control groups.

### Model comparisons

**Baseline/Stability model:** The stability model<sup>a</sup> was run simultaneously for the MBSR and control groups. Comparison of the unconstrained model  $\chi^2(40, N = 113) = 98.35$ ;  $p < 0.001$  against the constrained model  $\chi^2(47, N = 113) = 117.49$ ,  $p < 0.001$  indicated significant difference in the pathways of association between the two models  $\chi^2 \Delta(7, N = 113) = 19.13$ ,  $p < 0.01$ . The fit indices of the unconstrained model were good: GFI = 0.91, CFI = 0.97; TLI = 0.94, RMSEA = 0.09. In the MBSR and control groups, results indicated that the associations among anxiety, self-compassion, and mindfulness at each subsequent time point was strongly informed by the level of the construct at the time before (above  $\beta = 0.51$ ) with the exception of the following pathway-baseline anxiety to post program anxiety (anxiety1  $\rightarrow$  anxiety3) was of low strength (low stability) for both groups. The strength of each pair of path coefficients was also compared<sup>b</sup>. The association between baseline mindfulness to mid-program (mindfulness1  $\rightarrow$  mindfulness2); and baseline anxiety to post program anxiety1  $\rightarrow$  anxiety3 was stronger for the control group compared to the MBSR group; whereas the association between mid-program anxiety to post program anxiety (anxiety2  $\rightarrow$  anxiety3) was stronger for the MBSR compared to the control group (Table 3).

**Standard causal model:** In the standard causal model, comparison of the unconstrained model  $\chi^2(32, N = 113) = 81.81$ ;  $p < 0.001$  against the constrained model  $\chi^2(43, N = 113) = 103.25$ ,  $p < 0.001$  indicated significant difference in the pathways of association between the two models  $\chi^2 \Delta(11, N = 113) = 21.44$ ,  $p < 0.05$ . Fit indices of the unconstrained model were also adequate with GFI = 0.92, CFI = 0.97; TLI = 0.97, and RMSEA = 0.09. Baseline self-compassion was linked to lower anxiety at mid-program ( $\beta = -0.22$ ) for the MBSR group but not for the control group. The standard causal model (H3), in which the paths linking mindfulness and self-compassion to anxiety were introduced in addition to the stability paths relationships, were not significant for either group (Table 3).

**Reverse causation model:** In the reverse causation model, comparison of the unconstrained model  $\chi^2(32, N = 113) = 74.58$ ;  $p < 0.001$  against the constrained model

$\chi^2(43, N = 113) = 92.57$ ,  $p < 0.001$ ; indicated no significant difference in the pathways of association between the two models  $\chi^2 \Delta(11, N = 113) = 17.99$ ,  $p = \text{ns}$ . The overall model was similar for both groups; in fact none of the reverse pathways were significant for either of the groups (Table 4). Other fit indices of the constrained model were adequate: GFI = 0.92, CFI = 0.97; TLI = 0.95, RMSEA = 0.09.

### Between group analyses repeated ANOVA and group by time interactions

**Mindfulness measures:** For the KIMS subscale of acceptance, repeated measures of ANOVA analysis indicated a significant main effect of time  $F(1.83, 366.83) = 7.01$ ,  $p < 0.001$ , partial eta squared = 0.03. There was also a significant effect for group  $\times$  time interaction  $F(1.83, 366.83) = 4.27$ ,  $p < 0.05$ , partial eta squared = 0.02. The repeated measures of ANOVA for the KIMS subscale for describing indicated a significant main effect of time,  $F(1.90, 382.21) = 5.14$ ,  $p < 0.01$ , partial eta squared = 0.03 indicating change in describing scores across the three time points. There was a significant effect for group  $\times$  time interaction  $F(1.90, 382.21) = 11.51$ ,  $p < 0.001$ , partial eta squared = 0.05.

Repeated measures of ANOVA for the KIMS observation subscale indicated a significant main effect of time  $F(1.72, 345.21) = 27.83$ ,  $p < 0.001$ , partial eta squared = 0.12. There was a significant effect for group  $\times$  time interaction  $F(1.72, 345.21) = 28.82$ ,  $p < 0.001$ , partial eta squared = 0.13. For the KIMS subscale measure of awareness the repeated ANOVA main effect of time was also significant,  $F(2, 200) = 15.41$ ,  $p < 0.001$ , partial eta squared = 0.13. Comparison of the experimental and the control group on awareness scores indicated that the interaction between group and time was significant,  $F(2, 200) = 9.45$ ,  $p < 0.001$ , partial eta squared = 0.09.

Finally the repeated measures of ANOVA for the composite KIMS score indicated a significant main effect of time  $F(1.78, 358.47) = 37.78$ ,  $p < 0.001$ , partial eta squared = 0.16. There was a significant effect of the group  $\times$  time interaction  $F(1.78, 358.47) = 33.82$ ,  $p < 0.001$ , partial eta squared = 0.14. The pattern of change for each of the KIMS subscales and the KIMS composite differed for MBSR and the control group. The details of these KIMS measures are presented in Table 5.

**Self-compassion measures:** For SCS subscale of common humanity, the main effect of time was significant,  $F(1.83, 367.91) = 7.13$ ,  $p < 0.001$ , partial eta squared = 0.03 indicating that there was change in the common humanity self-compassion scores across the three time points. The group  $\times$  time interaction was significant,  $F(1.83, 367.91) = 4.49$ ,  $p < 0.01$ , partial eta squared = 0.02. The main effect of time was also significant for self-judgment SCS subscale,

<sup>a</sup>One additional pathway anxiety1  $\rightarrow$  anxiety3 was included to improve model fit.

<sup>b</sup>The coefficients of the association between anxiety at pre-intervention to anxiety levels at mid-intervention for the control group was compared to the same pathway for the MBSR group using the Critical Ratios for Differences feature within AMOS.

**Table 5:** Repeated measures ANOVA within group changes in anxiety, self-compassion, and mindfulness across three assessment time points.

	Intervention (MBSR) Group n = 109			Control Group n = 94		
	Baseline	Midpoint	Post-test	Baseline	Midpoint	Post-test
<b>Anxiety</b>	40.2 (9.1)	38.9 (8.2)	37.03 (8.5)*^	39.6 (7.7)	40.8 (7.7)	40.1 (7.3)
<b>Self-compassion</b>						
Humanity	12.6 (3.7)	13.5 (3.4)*	13.9 (3.5)^	12.1 (2.8)	11.96 (2.6)	12.4 (2.8)
Isolation	13.2 (3.8)	14.3 (3.2)*	14.89 (3.26)^	13.5 (2.98)	13.1 (2.7)	13.3 (2.8)
Self-judgment	16.4 (4.2)	17.3 (3.5)*	18.1 (3.85)^	16.9 (3.38)	16.1 (2.95)*	16.2 (3.4)
Self-kindness	15.4 (4.1)	16.03 (3.68)	16.9 (3.53)^	15 (2.9)	14.8 (2.9)	14.6 (2.97)
Mindfulness (SCS)	12.9 (3.4)	13.5 (2.84)*	13.9 (3.09)^	13.04 (2.75)	12.65 (2.47)	12.9 (2.60)
Over-identification	12.8 (3.4)	13.95 (3.02)*	14.6 (3.20)^	13.2 (2.88)	13.2 (2.58)	13.5 (2.62)
Self-compassion composite	83.2 (17.1)	88.6 (14.97)*	92.4 (15.9)^	83.7 (10.4)	81.96 (10.3)	82.8 (11.1)
<b>Mindfulness</b>						
Acceptance	31.7 (7.5)	33.3 (6.4)*	34.4 (6.96)^	30.1 (5.62)	30.2 (4.9)	30.4 (5.5)
Describing	26.9 (6.4)	27.3 (6.1)	29.03 (6.6)^	25.5 (5.3)	25.5 (4.9)	25.1 (5.5)
Observing	39.5 (8.5)	43.97 (6.9)*	45.4 (7.8)^	39.3 (8)	38.6 (8.2)	39.5 (8.3)
Awareness	26.7 (5.3)	28.5 (5.3)*	29.8 (5.1)^	27.7 (4.5)	27.7 (5.3)	28.1 (4.4)
Mindfulness composite	125 (16.5)	133 (16.6)*	138.7 (19.6)^	123 (11.7)	121.9 (12.0)	123 (12.9)

\* =  $p \leq 0.05$  between previous column measurement time point (e.g. baseline to mid-point or mid-point to post-test); ^ =  $p \leq 0.05$  from baseline to posttest =  $p \leq 0.05$  between previous column.

$F(1.92, 385.41) = 3.34, p < 0.05$ , partial eta squared = 0.02 indicating that there was change in self-judgment scores across the three time points. Comparison of the experimental and the control group on self-judgment self-compassion scores indicated that the interaction between group and time was significant,  $F(1.92, 385.41) = 16.03, p < 0.001$ , partial eta squared = 0.07. Repeated measures of ANOVA analysis indicated a significant main effect of time  $F(1.86, 374.47) = 3.62, p < 0.05$ , partial eta squared = 0.02. There was a significant effect of the group  $\times$  time interaction  $F(1.86, 374.47) = 11.15, p < 0.001$ , partial eta squared = 0.05. The main effect of the mindfulness SCS subscale item was significant,  $F(1.88, 378.77) = 3.32, p < 0.05$ , partial eta squared = 0.02 indicating that there was a change in mindfulness scores across the three time points. Comparison of the experimental and the control group on mindfulness scores indicated that the interaction between group and time was significant,  $F(1.88, 378.77) = 6.67, p < 0.01$ , partial eta squared = 0.03.

The SCS subscale of over-identification, repeated measures of ANOVA analysis also revealed a significant main effect of time  $F(1.80, 362.46) = 14.65, p < 0.001$ , partial eta squared = 0.07. Furthermore, there was a significant effect of the interaction between group  $\times$  time  $F(1.80, 362.46) = 9.34, p < 0.001$ , partial eta squared = 0.04. The SCS composite score main effect of time was significant,  $F(1.54, 311.21) = 13.22, p < 0.001$ , partial eta squared = 0.06 indicating that there was a significant change in self-compassion composite scores across the three time points. There was a significant effect of the interaction between time  $\times$  group  $F(1.54, 311.21) = 21.29, p < 0.001$ , partial eta squared = 0.10. The patterns of change in the each of the analyses for the SCS composite and subscales

scores differed between the MBSR and the control group. The details of the SCS subscale measures are presented in Table 5.

**Anxiety:** Repeated measures of ANOVA analysis indicated a significant main effect of time  $F(1.74, 348.86) = 7.12, p < 0.01$ , partial eta squared = 0.03. There was a significant effect of the group  $\times$  time interaction  $F(1.74, 348.86) = 11.63, p < 0.001$ , partial eta squared = 0.06. The pattern of change for trait anxiety differed for MBSR and the control group. The details of the trait anxiety measures are presented in Table 5.

## Discussion

Our analysis has broken down the change process behind the hypothesis, that participation in MBSR would reduce anxiety, by examining specific causal relationships between mindfulness, self-compassion and trait anxiety. This strategy required multiple analyses to uncover complex causal paths, because each analysis has examined one causal inference at a time. Thus, enabling us to examine the complexity and theoretical relevance of changes in mindfulness and self-compassion in relation to trait anxiety. The statistical framework centered around the standard forward causal hypothesis estimating the effects of MBSR on changes in mindfulness, self-compassion and trait anxiety. Whereas, the aim of the reverse causal hypothesis checked the model and examined which variables contributed to reductions in trait anxiety. The standard forward causal model revealed that significant decrease in anxiety mid program, among MBSR participants was related to baseline levels of self-compassion. However, there were no significant associations between any of the variables for participants in the control group. The reverse causal model, which examined causal in-



ference leading to reductions in trait anxiety, revealed that changes in mindfulness at mid-program contributed to changes in anxiety following the MBSR program; and that baseline anxiety contributed to changes in self-compassion at mid-program. These findings are supported by research which has found that mindfulness based practices reduces anxiety through the cultivation of self-compassion and facets of mindfulness [2]. However, the present study went further and provides insight into the temporal ordering of the changes in subscale and composite KIMS and SCS measures in relation to decreased trait anxiety. Specifically, we found that among the MBSR participants' significant declines in anxiety did not appear until after significant changes in common humanity, isolation, judgment, over-identification, acceptance, observance, awareness and mindfulness. Similarly, these changes preceded increases in self-kindness and ability to describe one's emotions. There were no improvements in any of the measures for the control group; the only significant change over time for the control group was a negative change in self-judgment.

The present study illustrates that reductions in trait anxiety are preceded by the increases in mindfulness at mid program, which entails the cultivation of acceptance, conscious awareness, observation of cognitive processes, and ability to describe internal and external experiences (these are the four factors of mindfulness measured). The weekly practice of mindfulness-based meditation cultivated a present centered focused awareness that may have helped counter the future oriented focus of anxiety that consumes attentional resources. The mind body practices of MBSR may also be particularly important to reducing anxiety through the cultivation of awareness and observation of internal sensations and reactions to thoughts or external experiences. Although mindfulness based practices focus on cognition and habits of the mind, grounding of the body and awareness of bodily sensations is an important foundation of the MBSR curriculum and practice. The cultivation of awareness and observation of physical sensations is coupled with present centered attention to both mind and body. Mindful awareness plays an important role in reducing trait anxiety as an antecedent focused strategy by which individuals' increase their awareness during the emotional generation process, before their anxiety fully manifests physiologically and psychologically [19].

Reductions in trait anxiety are also preceded by increases in self-compassion which entails the cultivation of self-kindness, increased understanding of one's experience as common to humanity, accompanied by decreases in self-judgment, isolation and the tendency to over identify with successes and failures. The reported increases in connection through the measures of common humanity and decreases in isolation also speaks to

MBSR's beneficial effect in reducing the self-focused tendencies of anxious people that can lead to isolation. The degree to which the group practice of MBSR contributes to connection with others is difficult to disentangle. The MBSR intervention group was integrated into an academic course that met weekly for 2 hours and followed an identical meeting structure with the parallel control group who did not yield significant reductions in isolation nor increases in common humanity.

## Limitations

There are two key limitations to this study that pertain to the sample. One of the limitations is the comparatively small sample size for this type of complex analysis. An additional limitation is the fact that the treatment and parallel control groups were not fully randomized into their conditions, rather assignment to treatment or control group was pre-determined based on the academic course students enrolled in. This study was conducted with a generally healthy sample of college students therefore the results may need to be confirmed with clinical populations. There are some limitations to this study; the data is derived from self-report data and the study should be replicated to confirm the outcomes. Although the data is self-report it is derived from validated psychometric measures. Moreover, participant responses from the parallel control group were stable across the three waves of data collection, which supports the validity and stability of these self-report measures over time.

## Conclusion

Testing multiple models in this way enabled us to eliminate confounding factors and diminish methodological deficiencies. These findings enhance understanding of the temporal ordering of changes in mindfulness and self-compassion associated with reductions in trait anxiety among people who engage in MBSR practice. The outcomes of this study illustrate that MBSR practice decreases trait anxiety even among non-clinically indicated participants. The significant improvements shown here for a well population may provide evidence for the benefits of MBSR practice among the general population. MBSR operates trans-therapeutically cultivating awareness and insight of one's thoughts and behaviors in ways that foster personal agency that shifts cognition, emotion, and behavior in ways that reduce trait anxiety. In summary an improved knowledge of the relationship between MBSR practice and mindfulness, self-compassion and trait anxiety can contribute to the development of evidence-based prevention programs for the general public as well interventions for clinical or indicated populations.

## Ethical Approval

All procedures performed in studies involving hu-

man participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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