



# The Effect of Mindfulness Programs on Collegiate Test Anxiety

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## Abstract

**Objectives** Affecting approximately one-fifth of college students, test anxiety is a source of academic failure that leads to worse exam performance and academic retention. The present study assessed the efficacy of online mindfulness-based interventions at reducing collegiate test anxiety.

**Methods** Undergraduate college students ( $N = 71$ ) were randomly assigned to a six-week mindfulness condition ( $n = 24$ ), a three-week mindfulness condition ( $n = 21$ ), or a six-week sham mindfulness active control condition ( $n = 26$ ). Participants in each condition were assigned five weekly meditations and written reflections. Responses to online surveys captured participants' reported levels of test anxiety and mindfulness pre- and post-intervention.

**Results** Increases in mindfulness were associated with decreased reports of test anxiety,  $r(69) = -.48$ . Across all conditions, self-reported mindfulness increased, and self-reported test anxiety decreased from pre- to post-test,  $F(1, 68) = 19.5$  and  $28.9$ ,  $p$ 's  $< .001$ ,  $\eta^2 = .06$  and  $.05$  respectively.

**Conclusions** Changes in the primary variables did not differ by condition, offering no empirical support for greater efficacy of a six-week as compared to a three-week intervention. The sham mindfulness control group also reported increases in mindfulness and decreases in test anxiety, raising questions about what intervention benefits are specific to mindfulness trainings. These findings suggest that online interventions are effective at reducing test anxiety in college students, though more research will inform how intervention length and content lead to changes in test anxiety and mindfulness.

**Keywords** Mindfulness · Mindfulness-based Intervention · Test Anxiety · College Students

Many students face significant stressors associated with their studies, with quizzes, tests, and exams forming a primary source of academic stress (Conley & Lehman, 2012). By the time students begin undergraduate studies, they recognize the importance of exams in shaping further educational opportunities and career aspirations. Performance on standardized tests such as the SAT, ACT, and MCAT can determine what educational opportunities individuals can pursue, and other examinations (e.g., state bar exams) are gatekeepers to employment. The high stakes of exams in American society make it unsurprising that an estimated 15–22% of undergraduate students experience test anxiety (Thomas et al., 2018; von der Embse et al., 2018).

*Test anxiety* is a psychological and physiological response occurring in evaluative situations that can increase worrying

and procrastination leading up to exams, and heightened arousal and negative self-referential thoughts during exams (Thomas et al., 2018). Not only does high test anxiety reduce student welfare; for many students, academic performance may suffer as a result (Talib & Sansgiry, 2012). The cognitive component of the construct, in particular (e.g., worrying about performance), has been associated with lower academic performance (Schillinger et al., 2021). The physiological aspects of test anxiety (heightened heart rate, perspiration on palms) are not consistently related to poor academic performance but may nonetheless pay a high toll on student well-being (Roos et al., 2021). Researchers have investigated mindfulness-based interventions (MBIs) as possible treatments for test anxiety (e.g., Dundas et al., 2016; Lothes et al., 2019) and results of those studies suggest that MBIs may be effective interventions for test anxiety in college students.

The term *mindfulness* is used to describe practices as well as a dispositional trait (Baer et al., 2019). Baer et al. (2019) define mindfulness as the general tendency to pay attention in an open, non-judgmental, curious, accepting, and compassionate way. Mindfulness is inextricably linked to active

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practice, and research using mindfulness-based interventions (MBIs) provides insight into how mindfulness can be cultivated in controlled treatment programs. The core elements of MBIs are intensive experiential training in mindfulness, emphasizing the promotion of attentional self-regulation and compassion. This programming is derived from practices spanning scientific disciplines and philosophical traditions, particularly psychology and Buddhism (Crane et al., 2017), with attention to sensory experiences and non-judgmental awareness of the present moment as key components.

Since the beginning of research into mindfulness, one of the most widely used MBIs has been the mindfulness-based stress reduction (MBSR) program (Kabat-Zinn, 2003). Despite primarily serving as a clinical intervention, MBSR programs have been extended to studies of healthy populations, where they have reduced psychological distress in college students (Canby et al., 2015). A meta-analysis of stress reduction interventions found that MBSR had a greater effect on reducing anxiety in undergraduate and graduate university students than cognitive behavioral therapy and coping skills training (Yusufov et al., 2019). These findings suggest that test anxiety in college student populations may be treatable with MBIs.

As the number of MBI studies has grown, so has an interest in dissecting the components of MBIs to isolate the effective elements of mindfulness practice. One study compared an abbreviated MBSR treatment to a somatic relaxation treatment and a waitlist control (Jain et al., 2007). Whereas both the mindfulness and relaxation interventions led to reductions in stress for participants compared to the waitlist group, only participants who received the mindfulness intervention experienced reductions in rumination and distracting thoughts. This finding indicates that mindfulness trainings can confer benefits on students that go above and beyond benefits from relaxation, particularly in reducing the negative cognitive aspects of test anxiety.

In addition to inquiries into MBI components, researchers are increasingly raising critical questions about the rigor of existing MBI study designs (Krägeloh et al., 2019). A limitation of extant mindfulness research is the high variability of MBI formats and content (Van Dam et al., 2018). Interventions often include eight weeks of daily practice, but MBIs can be as short as one hour of total training time (Zeidan et al., 2010). Difficulties in comparing the findings of studies using brief MBIs to those using longer MBIs led researchers to investigate the relationship between length of intervention and experimental outcomes (Carmody & Baer, 2009). Some researchers recommend using longer and more intensive interventions (Bergen-Cico et al., 2013), but the importance of intervention length is still a disputed and unresolved issue (Krägeloh et al., 2019). Intervention length is important because for busy individuals, there is a tension between finding time to sufficiently cultivate mindfulness in

order to receive its benefits and meeting the demands of full schedules (Klatt et al., 2009).

Another methodological issue in mindfulness research concerns delineation of group comparisons. Recently, researchers examining MBI efficacy have called for the use of active controls—specifically, control conditions that match components of the experimental manipulation (Krägeloh et al., 2019). Mindfulness-based intervention research primarily uses waitlist control groups, which fail to appropriately account for expectation effects (Baer, 2003). Given the popularity of mindfulness and mainstream advertisement of its benefits, expectation effects might cloud accurate assessment of MBI benefits (Prätzlich et al., 2016). Sham mindfulness meditations are one newer active control treatment, which instruct participants to breathe deeply with their eyes closed without providing instructional content that cultivates greater awareness of internal and external events and a sense of compassion and equanimity (Noone & Hogan, 2018; Zeidan et al., 2010). A sham mindfulness condition focused on breathing allows measurement of positive effects due to expectation and physiological relaxation, permitting comparison of the effectiveness of mindfulness interventions above and beyond benefits linked to expectations (Zeidan et al., 2010).

Characterized as a situation-specific personality trait, test anxiety encompasses a host of responses to evaluative situations (Spielberger et al., 1976). Although test anxiety manifests differently across individuals, it is commonly expressed as worrying, arousal of the autonomic nervous system, task irrelevant behavior, and an inability to concentrate (Lowe et al., 2008). Prior to and during evaluative situations, individuals with test anxiety experience physiological and cognitive reactions such as increased heart rate, negative thoughts, rumination, and catastrophizing about potential outcomes. Test-anxious individuals worry more and attend to worrisome thoughts to a greater degree than their less anxious peers, resulting in reduced cognitive resources (Thomas et al., 2018). Mindfulness practices could offer test-anxious students alternative responses to worrying that may arise before or during an exam (e.g., Hjeltnes et al., 2015).

In addition to exploring potential benefits of an MBI, a second purpose of this study was to explore relations between trait mindfulness and test anxiety. Mindfulness may aid academic performance by reducing anxious thoughts that interfere with working memory and other cognitive processes (Bellinger et al., 2015). Thus, trait mindfulness might be negatively correlated with test anxiety independently of mindfulness training.

Experimental research using MBIs provides strong evidence for an alleviating effect of mindfulness practices on test anxiety. Dialectical Behavior Therapy-influenced MBIs led to reductions in collegiate test anxiety in two recent

studies (Lothes & Mochrie, 2017; Lothes et al., 2019). A mindfulness-based leadership course led to reduced test anxiety, and compared to a waitlist control condition, participants in the mindfulness-based leadership course experienced increases in academic achievement (Sampl et al., 2017). These studies show promise for mindfulness serving as an effective tool against test anxiety, but much of the prior research used inadequate controls or no control condition at all, and questions remain regarding optimal length of training and training components.

In the present study, we used an experimental study design in which students were randomly assigned to one of three conditions: a six-week mindfulness program, a three-week mindfulness program, and a six-week sham mindfulness (active control) condition. Mindfulness and test anxiety were measured before and after treatment. We hypothesized that (1) trait mindfulness would be negatively related to students' reports of test anxiety both before and after the intervention regardless of treatment condition; (2) changes in mindfulness linked to the intervention would be negatively associated with changes in test anxiety; (3) participants in the six-week mindfulness condition would report greater increases in mindfulness than those in the three-week condition, who would report greater increases in mindfulness than those in a six-week sham mindfulness condition; and (4) compared to participants in the three-week condition and in the sham mindfulness condition, those in the six-week mindfulness condition would experience greater reductions in test anxiety upon completing the intervention.

## Method

### Participants

A power analysis showed that with an alpha level of 0.05, we had an 80% chance of detecting a medium effect size with a sample of 24 participants in each group. Initially, 119 participants responded to recruitment materials expressing interest in the study, but only 87 completed the pre-intervention survey (six-week mindfulness:  $n = 31$ , three-week mindfulness:  $n = 25$ , sham mindfulness:  $n = 31$ ). During the intervention, two participants (one in the six-week mindfulness condition and one in the three-week mindfulness condition) voluntarily withdrew, leaving 85 participants. Finally, 14 students failed to complete the post-intervention survey, resulting in a final sample of  $N = 71$  and a sample retention rate of 82% across the six weeks of the study.

Participants were undergraduate students ( $M_{\text{age}} = 19.4$  years;  $SD = 3.52$ ) at a large public university in the southeast United States with full-time enrollment. Most participants (95.7%) were recruited through the psychology department participant pool, and others responded to recruitment materials advertising a test

anxiety reduction research study. The sample was primarily female (71.8%), and identified themselves as White (59.2%), Asian (12.7%), African American (12.7%), Hispanic (9.9%), Native American (4.2%), and North African or Middle Eastern (1.4%). About half the sample (53.5%) were first-year students; 19.7% were sophomores, 16.9% were juniors, and 9.9% were seniors.

### Procedures

Participants were randomly assigned to three treatment groups using the online tool Randomizer.org (Urbanik & Plous, 2013). After completing pre-intervention measures, students completed either a six-week mindfulness program ( $n = 24$ ), a three-week mindfulness program ( $n = 21$ ), or a six-week sham mindfulness program ( $n = 26$ ). These intervals were chosen to fit within the time frame of a single semester and because of the example of Klatt et al. (2009), who found successful treatment effects with a six-week mindfulness intervention. Start dates were staggered so that each program finished shortly before the participants' final exam period to control for contextual sources of test anxiety.

Across all conditions, participants completed a pre-program survey that included measures of test anxiety, mindfulness, and demographic questions. These surveys were completed online at times and locations that were convenient for participants. After completing the pre-program survey, each student completed an individually administered online training session with a researcher. The scripts for the researcher-led training sessions appear in the Supplemental Information. The rest of the program was self-guided, with students using materials that they accessed via the internet to complete five pre-recorded meditations and reflections each week at times and locations of their choosing. At the end of each week, participants reported in an online survey the number of meditations and reflections completed. At the start of the final exam period and after completing the intervention program, participants completed the test anxiety and mindfulness measures a second time. Students in all three conditions were debriefed and were given the links to the mindfulness meditations, readings, and videos available online.

### Mindfulness-Based Programs

Both the six-week and the three-week mindfulness programs were adapted from a free, online, eight-week mindfulness-based stress reduction course developed by Dave Potter (2020), a certified MBSR instructor. Abbreviated forms of MBSR programs are common intervention modifications (Carmody & Baer et al., 2009; Krägeloh et al., 2019), and the shortened versions allowed us to assess differences in outcomes based on intervention length and to reduce the demand on participants' busy schedules compared to the

standard eight-week MBSR program. Our minor modifications prioritized content that was particularly relevant for students who experience test anxiety. For example, a video focused on managing anxiety in test situations that is provided as additional content in the original online course was included as one of the primary videos in both the three-week and six-week programs.

Each week had a theme that introduced a new meditation to be practiced throughout the intervention (Week 1: *Simple Awareness*, body scan meditation; Week 2: *Attention & The Brain*, sitting meditation; Week 3: *Stress: Responding vs. Reacting*, mountain meditation; Week 4: *Dealing with Difficult Emotions or Physical Pain*, turning toward meditation; Week 5: *Mindfulness and Communication*, lake meditation; Week 6: *Mindfulness and Compassion*, lovingkindness meditation). The three-week program used a subset of the themes and meditations (Weeks 1, 2, and 6 of the six-week program). Both programs assigned five mindfulness exercises and five written reflections to be completed on different days each week, as well as articles and videos that were related to each week's theme. Participants were given digital program manuals and reflection workbooks, shown in the Supplemental Information, that gave a weekly schedule of meditation practices and contained the readings and videos for each week.

The meditations ranged from 13 to 33 min, offering instructions that were designed to increase awareness and acceptance of thoughts, breath, and other bodily sensations, and to build compassion for living things. Consistent with the original 8-week MBSR course, participants had flexibility within the meditations assigned for some weeks, leading to variable amounts of meditation practice (total duration throughout program was 394–453 min for the three-week intervention and 745–895 min for the six-week intervention). For example, the instructions in Week 4 directed participants to practice the turning toward meditation on the first two days of practice, after which they could choose a combination of any three meditations already introduced in the program. Participants accessed the meditations through a link to an unlisted YouTube playlist with recordings of each guided exercise. The link to the recorded meditations appears in the Supplemental Information. After each meditation, participants were asked to describe their experiences in writing in the digital reflection workbook, a common component of MBSR courses (“put just a few words to remind you of your impressions of that particular session: what came up, how it felt, what you noticed in terms of physical sensations, emotions, thoughts”).

The original eight-week MBSR course included several articles and videos about the science of mindfulness and mindfulness tips from researchers and expert meditation instructors. The articles and videos provided additional knowledge and guidance to the online program that would

normally be given by a meditation instructor in face-to-face mindfulness courses. A selection of those readings and videos were used in the interventions for this study, particularly those that pertained to test anxiety (Green, 2010; TED, 2013). The six-week mindfulness program included 40 readings and videos and the three-week mindfulness program included a subset of 17 of those readings and videos that corresponded to the three weekly themes include in that program. Students who completed all assigned exercises, reflection, readings, and videos spent approximately 180 to 215 min completing the program each week. At the end of each week, participants completed short surveys reporting how many meditations, reflections, articles, and videos they had completed during the prior week. Responses to these surveys served as measures of intervention fidelity.

### Sham Mindfulness Program

The sham mindfulness program was a six-week behavioral intervention that served as an active control comparison to the mindfulness programs. Following calls for appropriately matched control conditions for studies using MBIs (Van Dam et al., 2018), the control condition was designed to match components of the mindfulness interventions in order to control for extraneous effects of those programs not attributed to mindfulness teachings and practice. Accordingly, students in the sham condition completed five guided audio exercises and reflections each week, as well as a weekly survey. In study materials accessible to participants in the sham condition, the program was called a “meditation program,” and the exercises were described as “meditations.”

Instead of the mindfulness-based meditations used in the active treatment conditions, the sham mindfulness program alternated between four different meditations that briefly guided participants' breathing without providing instruction to openly and non-judgmentally observe sensations and thoughts as they arose. Like the mindfulness meditations, these meditations were accessed by participants through a private YouTube playlist (see Supplemental Information). The meditations ranged from 15 to 30 min (total duration throughout the program was 569–679 min for students who completed five meditations each week for each of six weeks), approximately matching the mindfulness meditations in length. Each recording consisted of calming music with a guided audio, recorded by the first author, instructing participants to “breathe deeply while sitting here in meditation” and to “take deep breaths” periodically throughout the meditation. These instructions were similar to those used by Zeidan et al. (2010), who pioneered the use of sham meditations and who describe the key difference between sham mindfulness and mindfulness meditations as the former make breathing a central focus and lack instruction on basic mindfulness principles.

After each sham mindfulness meditation, participants completed written reflections. The instructions included in the digital reflection workbook (“put just a few words to remind you of your impressions of that particular meditation”) differed slightly from those in the mindfulness programs by omitting any instruction to describe mental or physical events that arose. The sham mindfulness program had no readings or videos as part of the intervention. At the end of each week, participants reported in online surveys which exercises and reflections they had completed.

## Measures

Before beginning the intervention, students completed measures of prior mindfulness practices, trait mindfulness, and test anxiety. After the intervention, students completed the measures of trait mindfulness and test anxiety a second time.

### Trait Mindfulness and Prior Mindfulness Knowledge and Experience

Three questions were used to assess pre-intervention knowledge about mindfulness as well as prior and present mindfulness practice. These self-report items had five response options (“strongly agree” to “strongly disagree”; “not at all” to “frequently”) to the statements “I am engaging in mindfulness practices at present,” “I have practiced mindfulness in the past,” and “I know a great deal about the theory underlying and the practice of mindfulness.” Responses to these questions were used as covariates in analyses rather than bases for participant exclusion.

Before and after the experimental intervention, participants completed an abbreviated version of the Five Facet Mindfulness Questionnaire (FFMQ–SF; Bohlmeijer et al., 2011). The scale included 23 items with five response options (1 = *very often or always*; 5 = *not often at all or never*). Sample items are “it seems I am ‘running on automatic’ without much awareness of what I’m doing,” “I tell myself that I shouldn’t be thinking the way I’m thinking,” and “when I have distressing thoughts or images, I can just notice them and let them go.” Items 7 through 18 were reverse scored. The measure had strong inter-item reliability (pre-intervention Cronbach’s  $\alpha=0.82$  and McDonald’s  $\omega=0.84$ ; post-intervention  $\alpha=0.83$  and  $\omega=0.85$ ).

### Test Anxiety

The Test Anxiety Inventory (TAI; Spielberger, 1980) is a 20-item self-report measure of trait test anxiety. Before and after the intervention, participants indicated agreement with 16 statements on a 4-point scale (1 = *almost never*; 4 = *almost always*). Item 1 (“I feel confident and relaxed while taking tests”) was reverse scored. Sample items are “during tests I find myself thinking about the consequences

of failing” and “even when I’m well prepared for a test, I feel very nervous about it.” The measure demonstrated strong internal consistency, Cronbach’s  $\alpha$ ’s = 0.95 and McDonald’s  $\omega$ ’s = 0.96 both pre- and post-intervention.

## Data Analyses

The software programs Statistical Package for the Social Sciences version 26 and R version 4.0.2 (R Core Team, 2020) were used to perform the statistical analyses. The packages psych (Revelle, 2022a), psychTools (Revelle, 2022b), apaTables (Stanley, 2021), and ez (Lawrence, 2016) were used in addition to R base packages to assist with analyses and formatting. Pre-post difference scores were calculated for trait anxiety and mindfulness for descriptive purposes and to use in bivariate correlations. Pairwise correlations were calculated between all integer-level variables. 3(Condition)  $\times$  2(Time) repeated measures analyses of variance were used to test treatment effects on composite mindfulness and anxiety scores. Mean numbers of completed meditations for students in the three conditions were compared with analysis of variance to assess intervention fidelity.

## Results

Twenty-four of the 71 participants failed to complete one or more of the surveys reporting how many meditations, reflections, and supplemental materials they completed each week. Levels of missing weekly survey data, shown in Appendix A in the Supplemental Information, varied across the three conditions as well as over time. During initial statistical tests, participants with missing weekly data were excluded from analyses of program completion variables (i.e., number of meditations, reflections, and supplemental materials completed). The analyses were then repeated using zeroes for missing weekly values (i.e., the number of meditations and other exercises that were completed), making those values low estimates of how much of the intervention participants completed.

Six participants reported in their weekly surveys that they completed less than a third of the intervention. These missing data presented a methodological concern for analyses because the effects of the interventions would not be accurately tested if participants failed to complete most of the intervention program. Therefore, the inferential statistical analyses were conducted twice: once excluding the six participants ( $N=65$ ) and once including them ( $N=71$ ). These two sets of results did not differ, so the reported analyses are based on the sample of 71 participants.

Bivariate correlations and means and standard deviations of study variables appear in Table 1. As hypothesized, mindfulness and test anxiety were negatively correlated at both

pre- and post-intervention,  $r(69) = -0.34$  and  $-0.47$ , respectively. Hypothesis 2 was also supported: increases in mindfulness were associated with decreases in test anxiety,  $r(69) = -0.48$ . As shown by these correlations, pre-post changes in test anxiety and mindfulness did not vary by prior mindfulness experience, meditations completed, or reflections completed,  $p's > 0.10$ .

**Intervention Effects on Mindfulness and Test Anxiety**

A 3(Condition) × 2(Time) repeated measures ANOVA tested the effects of the intervention on mindfulness, using FFMQ–SF composite scores as the within-subject, repeated variable. In preliminary analyses, age, gender, and prior mindfulness experience were included as covariates but were not significant. Given the limited sample size, those control variables were removed from subsequent ANOVAs in order to increase statistical power. Mindfulness and test anxiety scores before and after the interventions for the three treatment groups

are shown in Table 2. The main effect of Time was significant,  $F(1, 68) = 19.5, p < 0.001, d = 0.49$ . The main effect of Condition and the Condition × Time interaction were nonsignificant,  $F's < 2.0, p's > 0.15$ , indicating that the increases in mindfulness post-intervention did not differ by condition.

To test the effect of the interventions on test anxiety, we conducted a 3(Condition) × 2(Time) repeated measures ANOVA using test anxiety (TAI) scores as the within subjects, repeated variable. The main effect of Time was significant,  $F(1, 68) = 28.9, p < 0.001, d = 0.50$ . Participants' reported test anxiety decreased across time. The main effect of Condition and the Condition × Time interaction were nonsignificant,  $F's < 2, p's > 0.10$ . Thus, data did not support either Hypothesis 3 or Hypothesis 4.

**Intervention Fidelity**

Because pre-post change did not differ across the three conditions, additional analyses were conducted to examine

**Table 1** Means, standard deviations, and bivariate correlations of primary study variables ( $N = 71$ )

Variable	1	2	3	4	5	6	7	8	9
1. Prior mindfulness experience									
2. Meditations completed	-.18								
3. Reflections completed	-.16	.99**							
4. Pre-intervention mindfulness	.10	.09	.09						
5. Pre-intervention test anxiety	.01	-.22	-.20	-.34**					
6. Post-intervention mindfulness	.11	.18	.19	.58**	-.36**				
7. Post-intervention test anxiety	.09	-.30*	-.27*	-.13	.72**	-.47**			
8. Change in mindfulness	.01	.11	.11	-.43**	-.04	.49**	-.39**		
9. Change in test anxiety	.14	-.10	-.10	.26*	-.34**	-.18	.40**	-.48**	
Mean	2.52	13.65	13.32	3.00	2.52	3.21	2.21	0.21	-0.26
Standard deviation	0.69	11.72	11.76	0.42	0.64	0.43	0.61	0.39	0.44

Missing data points for meditations and reflections completed were replaced with zeros. Table generated using the R package apaTables version 2.0.8 (Stanley, 2021)

\*  $p < .05$ ; \*\*  $p < .01$

**Table 2** Pre- and post-intervention mindfulness and test anxiety scores for each treatment condition

Variables	Six-week mindfulness ( $n = 24$ ) $M (SD)$	Three-week mindfulness ( $n = 21$ ) $M (SD)$	Sham mindfulness ( $n = 26$ ) $M (SD)$	Full sample ( $N = 71$ ) $M (SD)$
<b>Mindfulness</b>				
Pre-intervention	2.93 (0.36)	2.96 (0.50)	3.12 (0.40)	3.00 <sup>a</sup> (0.42)
Post-intervention	3.19 (0.34)	3.11 (0.54)	3.32 (0.41)	3.21 <sup>b</sup> (0.43)
<b>Test anxiety</b>				
Pre-intervention	2.57 (0.70)	2.47 (0.61)	2.51 (0.65)	2.52 <sup>a</sup> (0.64)
Post-intervention	2.19 (0.72)	2.31 (0.56)	2.15 (0.55)	2.21 <sup>b</sup> (0.61)

Mindfulness scores had possible range of 1–5. Test anxiety scores had possible range of 1–4

<sup>a,b</sup>Means differed at  $p < .001$

treatment fidelity. Appendix B in the Supplement shows the rates of intervention completion in each condition and for the sub-sample of 47 students who completed all of the weekly surveys. A one-way ANOVA examining the number of completed meditations yielded a significant effect of Condition,  $F(2, 44) = 13.7$ ,  $p < 0.001$ . Consistent with the number of meditations planned in each program, participants in the six-week mindfulness and sham mindfulness control conditions completed more meditations than those in the three-week mindfulness condition, mean differences = 12.15, 95% CI: [6.45, 17.85],  $p < 0.001$ , and 7.90, 95% CI: [2.43, 13.36],  $p = 0.003$ , respectively. The number of meditations completed by students in the control and six-week mindfulness conditions did not differ. As an additional test of treatment fidelity, we compared across conditions the proportion of meditations completed. A one-way ANOVA on proportion of meditations completed yielded a significant effect of Condition,  $F(2, 44) = 3.47$ ,  $p = 0.040$ . Compared to the control condition, a greater percent of assigned meditations were completed in the three-week mindfulness group, mean difference = 0.19, 95% CI: [0.006, 0.382],  $p = 0.042$ . Students in the six-week mindfulness condition did not differ from the other two groups in proportion of meditations completed.

## Discussion

Consistent with hypotheses, increases in mindfulness were related to decreases in test anxiety in this sample of college students. However, contrary to study hypotheses, changes in test anxiety and mindfulness were similar across the three groups, with no additional benefit for students in the six-week or three-week mindfulness conditions. The interpretation of results, implications of the study, and limitations and future directions for research are presented below.

### Reduction in Test Anxiety and Increase in Mindfulness

The reported levels of test anxiety decreased among students in all three conditions, suggesting that each of the three intervention programs helped students feel less overwhelmed by examinations. The decreases in test anxiety in the two treatment groups are consistent with prior research on mindfulness-based interventions treating test anxiety (Dundas et al., 2016; Sampl et al., 2017), including an online mindfulness-based intervention (Lothes et al., 2019). Whereas reduced anxiety could be explained by expectancy effects as a result of the study descriptions, one prior test anxiety intervention found no significant effect of expectation (Gosselin & Matthews, 1995). Moreover, reduced reports of test anxiety in the three conditions are striking for two reasons. First,

measurement of students' test anxiety multiple times across the course of a semester has shown increases across time, with state anxiety peaking shortly before the final exam period (Lotz & Sparfeldt, 2017). Second, the current study was carried out in Fall 2020, when anxiety and related mental health issues were increasing because of a heated Presidential election and the COVID-19 pandemic. These factors support the contention that results were due to treatment rather than expectation effects.

As anticipated, participants who received the three- and six-week mindfulness intervention programs also reported increased mindfulness post-intervention. This finding supports the construct validity of the FFMQ as well as the validity of the mindfulness intervention. Changes in self-reported mindfulness caused by MBIs usually are of medium effect size (Visted et al., 2015). Thus, the medium effect size of increases in mindfulness scores is consistent with results of prior MBIs.

Contrary to study hypotheses, however, students in the sham mindfulness control condition also reported increases in mindfulness: Changes in participants' reports of mindfulness and test anxiety did not differ across the three conditions. The lack of differences across the three conditions might have been due to intervention fidelity as well as content of the training, which we now discuss in greater detail.

### Mindfulness and Meditation in the Treatment of Test Anxiety

Although we had anticipated that mindfulness exercises would be more effective than the active control condition, and that a six-week program would have a stronger impact than a three-week program, changes in mindfulness and test anxiety did not differ across the three groups. Whereas some prior studies show that active control interventions can lead to increases in mindfulness as measured by the FFMQ-SF (e.g., Goldberg et al., 2016), mindfulness-based interventions generally lead to small-to-medium effect sizes favoring increased mindfulness in treatment group members compared to active controls (Baer et al., 2019). In the present study, the intervention components common to all conditions—namely, reflection writing and quiet time focused on breathing—might account for the mindfulness increase and test anxiety decrease in the active control condition. Particularly in the absence of an in-person trainer or facilitator, the differences between mindfulness and the active control treatments might be diminished because of the pre-recorded, online delivery format used in the present study. Students in the active control condition who had prior experience with mindfulness techniques may have been reminded of those techniques during the intervention, leading to increases in mindfulness and decreased test anxiety at the conclusion of the study.

Few studies have compared effects of mindfulness meditations to an active (sham mindfulness) control condition, and there is no standard in experimental research for how to construct an active control condition that includes reflection and a focus on breathing in the absence of mindfulness principles. Following the description provided by Zeidan et al. (2010), we recorded four meditations of varying lengths to use as part of the active control treatment. It is possible that the relaxation created by these practices along with expectation effects of the mindfulness training were sufficient to decrease students' anxiety and increase their mindfulness. Indeed, Tasan et al. (2021) found that students' use of pranayamic breathing, a technique that fosters relaxation through a focus on controlled breathing, led to decreases in students' test anxiety among students in the experimental group compared to the control group. Other research has also shown that use of meditation, relaxation, and breathing techniques are useful in treating anxiety disorders (Jerath et al., 2015).

Results of these prior studies are in contrast to those of Zeidan et al. (2010), who reported no benefits of a "sham mindfulness" session for undergraduate students when compared to a mindfulness treatment group. In that study, students in the sham mindfulness group were told every few minutes to "take deep breaths as we sit in meditation" (Zeidan et al., 2010, p. 868). It is possible that differences in results across studies are due to the length of training, which was only one hour in Zeidan et al. (2010). Additionally, Zeidan et al. measured different dependent variables, complicating comparisons to the present study.

In addition to length of treatment, the manner in which students focus on their breathing might influence results. For example, although Tasan et al.'s (2021) total treatment was about one hour in duration, the authors instructed students to inhale and exhale in a slow, measured fashion, alternating between nostrils, and to "observe your breathing" (Tasan et al., 2021, p. 4077). In the current study, students in the sham mindfulness condition were instructed to "take deep breaths through the nose." The facilitator directed students to breathe "in...[pause]...and out...[pause]...in again... [pause]...and out." Although these instructions were less focused on the process of breathing and observations of breath than the procedures of Tasan et al. (2021), the additional time that students spent each week in a relaxed state with calm music may have led to the positive effects found in our active control condition. Thus, although mindfulness training may accrue additional benefits beyond the benefits gained by instruction in breath-focused meditation, results of the current study indicate that both approaches are useful in reducing students' test anxiety, and students' reports of increased mindfulness in the current study support contentions that mindfulness helps to reduce students' test anxiety.

Finally, efficacy of the three treatment programs should be considered in light of the population from which the

sample was drawn: Participants were students at a competitive public research university. Although the students reported moderate amounts of test anxiety, on average, before the intervention, their anxiety was not at debilitating levels, and students' desires to excel academically may have motivated them to learn and use the intervention techniques. Students' prior experience using online materials as well as their academic motivation may have contributed to the success of the three intervention programs. The sham mindfulness control condition used in the current study might have no effect on anxiety in a clinical population.

### Format and Duration of Interventions

Contrary to study hypotheses, students in the six-week programs did not show greater benefits than students in the three-week program. Because the three-week mindfulness program included fewer sessions and fewer written reflections than the other two conditions, comparing the three conditions was a justifiable means to assess whether differences in outcomes varied depending on length of intervention. Our results showed that three weeks are sufficient to promote beneficial effects, and group differences in proportion of completed exercises indicate that additional training time may lead to fatigue and non-adherence. The lack of additional benefits from the six-week programs and the high rate of completed program components in the three-week condition suggest that shorter interventions may be better-suited for meeting the demands of college students' busy schedules. Our findings are consistent with results of Carmody and Baer (2009), who found no relationship between number of program hours spent in an MBSR-based intervention and participants' outcomes. However, among the 30 studies reviewed by Carmody and Baer (2009), with one exception the number of class sessions ranged from 12 to 28; thus, it is unclear what number of hours constitutes the minimum threshold for successful effects.

The MBIs used in the current study assigned up to 216 min (i.e., about 3.5 h) of work and practice each week. The total duration of a standard 8-week MBSR course, inclusive of class time, weekly assigned practice, and an all-day retreat session, is 59.5 h. The maximum durations of the MBIs in the present study were 10.8 h and 21.2 h for the three-week and six-week interventions, respectively. The reduction of time required for the program by nearly two-thirds greatly frees up the program participants, even without accounting for travel time to and from the training site.

In addition to total time commitment, the interventions used in this study differed from other MBSR and MBI programs in being online and individually self-administered. Many standard MBSR programs have weekly in-person group sessions in addition to daily independent practice. Furthermore, many MBSR programs that are conducted



online, such as the one at University of Massachusetts Memorial Medical Center, hold synchronous class sessions for participants. This format permits interactions among participants and between instructors and participants, creating a greater sense of shared experience. Notably, Lothes et al. (2019) found no differences in post-intervention levels of test anxiety and mindfulness between an online mindfulness intervention and an in-person, group mindfulness intervention. Although online treatment programs might be synchronous (permitting interaction with an instructor and other group members) or asynchronous (providing greater scheduling flexibility), asynchronous MBIs are particularly useful for students who attend school online or who have scheduling constraints that limit options for in-person or online synchronous programs.

### Limitations and Future Research

The present study's robust design of a randomized control trial with an active control condition limits threats to internal validity, but several limitations of the study should be noted. Although 87 students began the intervention programs, the final sample ( $N=71$ ) was smaller, limiting the power of statistical analyses to detect intervention effects. Missing data from the weekly surveys hindered interpretation of the results, in particular the treatment fidelity of the interventions. Using students' self-reports, we found that participants completed approximately 80% of the meditations, reflections, readings, and videos. However, because of the large number of missing reports of program adherence, intervention fidelity could be substantially lower. The use of self-report to measure completion also raises questions about program fidelity. Although a research assistant observed each participant practicing the first mindfulness exercise in a calm, disruption-free environment, subsequent sessions may have suffered from disruptions.

An important consideration for the external validity of our findings is that the intervention took place in Fall 2020, which was marked by stressors related to COVID 19 as well as a contested US Presidential election. These contextual factors may have influenced results, either through selective attrition, or because of the unique stressors students were experiencing and their responses to those stressors (Copeland et al., 2021; Hamza et al., 2020). Although prior research has shown that students' test anxiety increases across the course of the semester, it is possible that test anxiety declines reported by students in all three conditions were linked to diminished concern about academic performance because of their concerns regarding stressors at the national level, or because of students' increased experience with taking exams. Inclusion of a waitlist control group would have permitted us to measure possible changes in test anxiety and mindfulness in the absence of treatment.

Throughout the literature on MBIs, there is a heavy reliance on self-report measures of mindfulness (Krägeloh et al., 2019), and this study also used self-report survey measures. The use of objective behavioral measures of mindfulness is nascent, and recent studies provide evidence that self-report and objective measures of mindfulness have distinct outcomes (Nyklíček, 2020). The use of self-report Likert scales as measures of both mindfulness and test anxiety is a limitation of the current study because of possible common method bias. Correlations between mindfulness and test anxiety scores may be inflated because both constructs were reported by study participants, and therefore correlations might be due to response style, priming effects, or other unmeasured variables (Podaskoff et al., 2012). Future research could benefit from using behavioral measures of mindfulness and/or anxiety to complement traditional survey measures, thereby strengthening the study design.

Research on the implementation of mindfulness in exam settings as well as its impact on course grades may increase our understanding of the mechanisms underlying mindfulness' effects on test anxiety. Throughout the duration of an MBI, participants could report mindfulness in naturalistic or laboratory exam settings, creating a more rigorous assessment of how mindfulness skills acquired through the intervention are implemented in a testing context. The control offered in a laboratory setting would also permit objective behavioral measures to better assess changes in mindfulness as well as changes in exam performance.

This study is the first to use a modified version of a free mindfulness course, Palouse Mindfulness (Potter, 2020), helping to broaden scientific knowledge of accessible treatment resources. The price of an online MBSR course taught at the University of Massachusetts Memorial Medical Center is currently \$650 for eight weeks (UMass Memorial Center for Mindfulness, 2022). Although that price helps subsidize the tuition of program participants who require financial assistance, even a fraction of that cost can be prohibitive to many college students. The flexibility and affordability of Palouse Mindfulness increase its accessibility, and we encourage researchers to study interventions that are freely available to the general public.

This study contributes to the body of evidence that MBIs, in particular, derivations of MBSR programs, are effective at reducing test anxiety in college students. The effect of the sham mindfulness program on test anxiety also suggests that structured time dedicated to quiet contemplation and reflection can be beneficial in combating anxiety related to examinations. Given the prevalence of test anxiety and the high demand for mental health treatment in college students (Shapiro et al., 2019), campus mental health services could refer students to such programs, potentially reaching students who cannot be directly served by mental health professionals.

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**Author Contribution** NP designed and executed the study, conducted data analyses, and wrote the first draft of the paper. BKC collaborated in designing the study, planning the data analyses, and in the final editing of the paper. Data collection and participant coordination were conducted by NP.

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**Data Availability** All data are available at the Open Science Framework (<https://osf.io/rsvf8/>).

## Declarations

**Ethics Approval** This study met the standard ethical requirements of the American Psychological Association and was approved by the institutional review board of the University of North Carolina at Chapel Hill, as study #20–2023. All participants gave their informed consent prior to inclusion in the study.

**Informed Consent** Informed consent was obtained from all participants prior to their participation in the study.

**Conflict of Interest** The authors declare no competing interests.

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