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To cite this article: Rongxiang Tang, Patricia C. Broderick, Tim Bono, Kamila Dvoráková & Todd S. Braver (2020): A College First-Year Mindfulness Seminar to Enhance Psychological Well-Being and Cognitive Function, Journal of Student Affairs Research and Practice, DOI: [10.1080/19496591.2020.1740719](https://doi.org/10.1080/19496591.2020.1740719)

To link to this article: <https://doi.org/10.1080/19496591.2020.1740719>



Published online: 24 Apr 2020.



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A College First-Year Mindfulness Seminar to Enhance Psychological Well-Being and Cognitive Function

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Mindfulness training (MT) has shown promise in improving psychological health among college students yet has rarely been evaluated as an addition to the college academic curriculum. Here, we demonstrate the feasibility and effectiveness of a first-year MT seminar offered to residential students at a selective private university, evaluating its impact on psychological and cognitive functioning in relationship to a comparable positive psychology seminar. The results suggest the potential for first-year programs that promote student well-being.

Introduction

The transition to college is often seen as the first stage of adulthood, with students beginning to pursue future career interests and engaging in a wider range of social interactions involving more diverse communities. Moreover, this critical period often takes place in a completely unfamiliar environment, with increased challenges from academic work, social relationships, and financial responsibility (Brougham et al., 2009; Kadison & DiGeronimo, 2004). Consequently, the college transition period is frequently associated with increased stress, compromised mental health, and problematic behaviors, such as excessive drinking and other severe forms of substance abuse (Knight et al., 2002; Zivin et al., 2009). A recent national report from college counseling centers corroborate these patterns, showing a high prevalence and severity of psychological health problems among college students across more than 600 colleges and universities (LeViness et al., 2017). Anxiety is the most prevalent disorder reported (48.2%), closely followed by stress-related health complaints (39.1%) and depression (34.5%). More alarmingly, this pattern has been persistent and increasingly severe over the past decade (Kitzrow, 2003; LeViness et al., 2017; Zivin et al., 2009), indicating a pressing need to develop and provide effective prevention and intervention programs within higher

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This article has been corrected with minor changes. These changes do not impact the academic content of the article.

education that target these detrimental psychological health problems associated with college transition and experiences.

The most deleterious aspect of mental health issues in college students is the widespread impact they have on students' academic work and co-curricular activities, including loss of productivity, suboptimal cognitive function, and increased social isolation (Brougham et al., 2009; DeBerard et al., 2004; Prince et al., 2007). For college students, emotional disturbances can significantly undermine individual well-being (Struthers et al., 2000), making them unable to cope with existing challenges, as well as potential upcoming stressors that may arise as a result of their already compromised psychological, cognitive, and social functioning. Increasingly, student affairs practitioners identify student mental health issues as the most challenging issues they confront (Reynolds, 2013). Student leaders are also concerned about the most effective ways to make referrals for peers in distress (Reingle et al., 2010). Fortunately, advances in the field of positive psychology offered insight into additional ways to respond (Mather, 2010), suggesting that more dedicated intervention programs from academic institutions are needed to prevent and ameliorate such systemic mental health challenges during this important transition. If relevant programs of this type could be integrated into the standard educational curriculum, it could potentially provide a more universal solution to the growing mental health and wellness needs of incoming students.

Accumulating evidence over the past two decades has suggested mindfulness training (MT) may serve as a promising intervention for promoting psychological wellbeing, particularly for reducing stress and ameliorating symptoms of anxiety and depression (Gu et al., 2015). A recent meta-analysis focusing on the effects of MT in post-secondary students also suggests similar psychological benefits in students with mental health related complaints (Halladay et al., 2018). Concurrently, MT may also result in cognitive benefits, in domains such as attention, working memory, and other aspects of executive function (Chiesa et al., 2011; Lao et al., 2016). MT focuses on promoting present moment attention and awareness, with a nonjudgmental and accepting attitude, which could help individuals to effectively detect and regulate thoughts, emotions, or sensations that may arise at any given moment (Hölzel et al., 2011). Nonetheless, standardized mindfulness programs including the most researched programs, Mindfulness-Based Stress Reduction (MBSR) (Kabat-Zinn, 1990) and Mindfulness-Based Cognitive Therapy (MBCT) (Segal et al., 2002), have been designed to accommodate characteristics of general adult populations. Consequently, the curriculum is not specifically adapted to meet the needs of college students and always requires a substantial time commitment outside of regular school hours and environment (Halladay et al., 2018). Similarly, even in studies that have examined MT programs specifically designed for college populations (e.g., Greeson et al., 2014; Mrazek et al., 2013; Oman et al., 2008), the training is typically offered as an extracurricular option that is completely separated from standard college curriculum.

One recent study by Morrison et al. (2013) administered a seven-week MT to undergraduate students that incorporated mindfulness practices into an introductory college seminar. The researchers found that students in the mindfulness group showed greater improvement in sustained attention after seminar completion, relative to those in a wait-list control group, suggesting the feasibility of integrating MT into the college curriculum, as well as the effectiveness of such approaches in improving cognitive outcomes. Relatedly, Dvořáková et al. (2017) provided a six-week MT using an evidence-based Learning To BREATHE program (Broderick, 2013), adapted specifically for college students. Incoming first year students who lived in residential halls were recruited to this on-site mindfulness program, allowing them to easily participate in mindfulness practices to facilitate stress reduction and cultivation of emotion

regulation skills. At the end of the program, students exhibited a significant increase in life satisfaction and a decrease in symptoms of depression and anxiety compared to a wait-list control group, indicating that a mindfulness-based program tailored to the characteristics and needs of college students within the familiar college environment can effectively improve their psychological well-being.

While these two lines of evidence are promising in demonstrating the effectiveness of integrating MT into the college curriculum and setting, the use of wait-list control groups in both studies poses a methodological limitation. Extraneous factors such as intellectual development, knowledge accumulation, and life experiences during the course of an academic semester may contribute to the observed enhancement in psychological and cognitive well-being. A further limitation of the programs described previously is that they were specialized courses presented to students as extracurricular options. A more seamless approach would be to integrate MT as part of standard first-year curricular offerings, for which students could receive academic course credit.

To extend and build upon these previous findings, the current study aimed to incorporate MT into the first-year college curriculum. An introductory mindfulness seminar was developed, similar to the one provided in the study by Morrison and colleagues but utilizing and adapting the evidence-based mindfulness program Learning to BREATHE (Broderick, 2013; Metz et al., 2013) as the core curriculum (Dvořáková et al., 2017). We evaluated the feasibility and efficacy of such a seminar in promoting psychological health and cognitive function in first-year undergraduate students through a quasi-experimental design, in which students were self-enrolled in the seminar. An introductory psychology seminar that fostered personal growth and development in college students was selected as an active control group, allowing for a more rigorous comparison of training effects. Students in both seminars self-selected to be in one of these courses and share a common interest in enhancing their psychological well-being and transition into college; consequently, any selection biases should be mitigated when comparing the two groups. We hypothesized that both psychological wellbeing and cognitive function would improve at the end of semester only for the mindfulness seminar students, while no significant changes would be observed for students in the control psychology seminar.

Methods

Participants

Participants were first-year undergraduate students who self-enrolled in a one-hour credit seminar class occurring during three different academic semesters. The experimental group consisted of students (Mean age = 18.28, $SD = 0.45$) who registered for the “Mindfulness: Science and Practice” ($N = 46$, 60.9% females). The control group (Mean age = 18.05, $SD = 0.23$) consisted of students (73.9% females) who registered for an introductory psychology seminar in Fall 2016: the “Psychology of Young Adulthood: College Years” ($N = 111$). To increase responsiveness, participants in the control group received compensation (10 USD) at baseline, as well as at the end of semester for completing a battery of cognitive assessment (10 USD plus a 5 USD bonus). Nonetheless, they did not receive any form of compensation for completing a questionnaire assessment, which was a part of their class requirements. Students in the mindfulness seminar did not receive any form of compensation, since completion of both the questionnaires and cognitive tasks were required for the class and discussed as part of the educational experience. All protocols were approved by the Institutional Review Board.

Procedure

Both classes met on a one-time-per-week basis (14 sessions in total) and were each led by a primary instructor. The mindfulness seminar instructor had over eight years of regular mindfulness practice and experience, including participation in six multi-day intensive retreats, and further received direct guidance from the L2B program developer with regard to program implementation and adaptation. The mindfulness seminar took place at a residential hall after 5PM, whereas the psychology class was held in a regular classroom setting during daytime hours. At baseline and at the end of the semester, self-report questionnaires were collected in the Research Electronic Data Capture program. A battery of cognitive tasks was administered through the Inquisit Web software program. Students did not complete these cognitive tasks or questionnaires in a laboratory setting, but rather in a more natural setting during their leisure time.

Intervention

Mindfulness Seminar Curriculum. The overarching goal of the mindfulness seminar was to introduce students to mindfulness practices as well as current scientific research in this area. Hence, the curriculum was divided into two parts: practicing mindfulness and learning the science of mindfulness. The practice component of the course consisted of learning about and practicing different mindfulness techniques and also engaging in activities and exercises that promoted mindful awareness, such as mindfulness eating, walking, and drawing. The science component of the course mainly involved reading and discussing assigned research articles and findings related to mindfulness. Mindfulness exercises and activities were primarily based on an evidence-based curriculum called Learning to BREATHE (L2B), which has been shown to improve psychological well-being primarily in adolescents (Bluth et al., 2016; Broderick, 2013; Felver et al., 2018; Metz et al., 2013; Shomaker et al., 2017) but also more recently in first-year college students (Dvořáková et al., 2017; Mahfouz et al., 2018).

Mindfulness techniques included breath focus, body scanning, loving-kindness, and open monitoring of thoughts, feelings, and bodily sensations. Students were strongly encouraged, but not required, to practice outside of class time. Some adaptation was made to the L2B curriculum in consultation with developers at Penn State University. Each one-hour class session began with a five- to ten-minute mindfulness practice (either orally guided by the instructor or through taped audio instructions). Subsequently, students either discussed key findings of research articles or divided into groups to engage in mindfulness-related activities and exercises. The class session also concluded with a five- to ten-minute mindfulness meditation (except in cases in which time ran short). During the first three weeks of the class, students met twice weekly to learn and consolidate their mindfulness techniques (discussion of research articles was not involved); the rest of the semester (eight weeks) required only one meeting per week. Outside of the classroom, students were also required to keep a daily log of their practice activities and were encouraged to practice regularly.

Psychology Seminar Curriculum. This one-hour course met once a week over the span of 14 weeks and has been taught for many years to first-year undergraduate students. The major aims were to foster psychological growth and development for students specifically during their college years and to discuss topics relevant to the developmental, social, and personal issues that confront young adults during this time period. In some ways, this class may be considered analogous to a positive psychology course, which nicely served as an appropriate comparison for the present study, since the conceptual emphasis was similar, while the didactic approach was

fairly different and complementary. The class was mainly taught in lecture style, with in-class discussion and activities. In particular, empirically supported strategies for promoting psychological growth and development were among the top emphases of this course. The goal of the course was to provide students with relevant knowledge that could be used to facilitate academic success, personal development, and a more rewarding social and academic experience over the course of college and beyond.

Assessments

Self-Report Questionnaires

Trait Mindfulness. The Mindful Awareness Attention Scale (MAAS) was used to assess individual differences in trait mindfulness, which is the ability to pay attention and be openly aware of the present moment in a calm and non-judgmental way. The questionnaire has 15 Likert-scale items that range from 1 (Almost Always) to 6 (Almost Never), tapping into the degree to which an individual goes about daily activity in a mindful vs. mindless way. The MAAS has been validated previously in numerous studies and populations as a reliable measure of trait mindfulness (Cronbach's $\alpha = 0.89\text{--}0.93$; test-retest $r = 0.35\text{--}0.52$; Black et al., 2012; Brown & Ryan, 2003).

Self-Compassion. The Self-Compassion Scale (SCS) contains 12 items that measures one's tendency to be accepting, understanding, and caring toward oneself when facing failures, struggles, and negative emotions in life (Neff, 2003). Scores for each item can range from 1 (Almost Never) to 5 (Almost Always). The SCS has been shown to have high test-retest reliability across all of its subscales ($r > 0.80$).

Self-Control. The 13-item Self-Control Scale (SCTRL) assesses the ability of people to control their own behavior and actions in relative autonomy without getting hampered by external distraction and impulses (Tangney et al., 2004). A Likert scale from 1 (Not at all) to 5 (Very much) was used to rate each described statement. It has also demonstrated good internal consistency and reliability (Cronbach's $\alpha = 0.83\text{--}0.85$; test-retest $r = 0.87$).

Satisfaction with Life. The Satisfaction with Life scale measures one's cognitive perception and judgment of one's life with five brief questions and is shown to have high internal consistency and reliability with a 0.87 Cronbach's α and a 0.82 test-retest reliability (Diener et al., 1985). Sample questions include "If I could do my life over, I would change almost nothing," and "The conditions of my life are excellent." A Likert scale from 1 (Strongly Disagree) to 7 (Strongly Agree) was used.

Sleeping Quality. The Pittsburgh Sleep Quality Index is a subjective questionnaire that assesses seven aspects of sleep over the past one month: sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction (Buysse et al., 1989). Each of these subscales ranges from 0 to 3 and are usually summed together to get a total score. Higher scores indicate poorer sleeping quality. The PSQI has been previously shown in multiple reports to have good reliability (Cronbach's $\alpha > 0.70$; test-retest $r > 0.70$).

Anxiety. The Generalized Anxiety Disorder Scale (GAD) is a 7-item measure designed to assess the frequency of experiencing anxiety-related symptoms such as worrying and feeling restless in the previous two weeks (Spitzer et al., 2006). Item score ranges from 0 (Not at all) to 3 (Nearly every day). The GAD has a 0.92 Cronbach's α and a 0.83 test-retest reliability. This scale was administered for students in Fall 2016 seminars. For those in Fall 2017 or Fall 2018

seminar, the State-Trait Anxiety Inventory (STAI) was used to measure anxiety. STAI is a 40-item measure commonly used in clinical setting to diagnose anxiety, which includes 20 items for assessing trait anxiety (how people generally feel) and 20 items for assessing state anxiety (how people feel right at this moment; Spielberger et al., 1983). Item score ranges from 1 (Not at all) to 4 (Very much so). The scale has also been shown to be highly reliable across different populations (Cronbach's $\alpha = 0.86-0.95$).

Depression. The Patient Health Questionnaire (PHQ) was used to assess depressive symptoms such as anhedonia and feeling down during the previous two weeks (Kroenke & Spitzer, 2002). Each question was rated from 0 (Not At all) to 3 (Nearly every day). This 8-item questionnaire has been commonly used as a screening scale for depression and has shown good reliability (Cronbach's $\alpha = 0.86-0.89$; test-retest $r = 0.84$).

Practice Logs. Daily logs were provided to students in the mindfulness seminar. Students were asked to record their daily mindfulness practices and related activities, as well as the corresponding duration. If they did not practice, they were asked to record zero. Typical mindfulness techniques include breath counting, loving kindness, focused attention, or other well-known practices taught in class, while mindfulness activities include daily activities such as eating and exercising, during which students reported to have engaged in them with intentional mindfulness.

Cognitive Tasks

Attention Network Test (ANT). This task is thought to measure the function of three core attention networks (alerting, orienting, executive control; Fan et al., 2002). Specifically, participants were presented with arrows either above or below a fixation cross shown on a computer screen and asked to determine the pointing direction of the center arrow. The task has three flanker conditions: (a) neutral, when the center arrow is not flanked by arrows but by straight lines, (b) congruent, when the center arrow is flanked by arrows pointing to the same direction, and (c) incongruent, when the center arrow is flanked by arrows pointing to the opposite direction. In addition, there were four cue conditions (no cue, center cue, double cue, spatial cue) that may alert participants that targets are about to come on screen and potentially where on the screen (above or below the cross). The center cue and double cue indicated targets are about to appear on screen, but did not provide any location information, whereas spatial cues indicated where arrows are about to show up on screen. The frequency of each cue and flanker condition appeared in trials was equal. The task comprised one block of 24 practice trials with feedback and two additional test blocks of 64 trials. Reaction time (RT) and accuracy were both recorded for later calculation of the efficiency of three attention networks. Specifically, these efficiencies are defined as the following: alerting effect = RT no cue – RT center cue, orienting effect = RT center cue – RT spatial cue, conflict effect = RT incongruent – RT congruent.

Sustained Attention to Response Task (SART). The SART is a type of Go/NoGo task in which the nogo stimulus is presented very infrequently, thereby leading to an autonomic tendency to press the go key if sustained attention is not present to detect and monitor responding (Robertson et al., 1997). Participants were presented with a single digit 1–9 in the middle of the screen in varying font sizes. The digit then disappeared and was replaced by a circle with an X. Next, participants were asked to press a predefined key if any digit other than 3 was presented and to withhold a response if digit 3 was presented. There were 225 trials and the digit 3 appeared in 11% (25) of the trials. Reaction time (RT) and accuracy were both recorded for later calculation of percent of errors in nogo trials, commonly referred to as commission errors,

and RT variability in correct go trials, which is the coefficient of variability in RT (CVRT), calculated by dividing the RT standard deviation by the mean RT.

Operation Span Task (OSPAN). The OSPAN is a standard task for measuring a form of working memory span by asking participant to perform simple mathematical operations while trying to remember the order of a list of letters (Conway et al., 2005). Participants were presented with a sequence ranging from three to seven letters that need to be recalled at the end. The presentation of each letter on screen was preceded by a math problem (“ $3*4-8 = ?$ ”) followed by a proposed solution (“5”), and participants needed to indicate if this answer is correct by clicking “True” or “False.” After presentation of all letters in the sequence, recall was assessed by asking participants to select, from a letter matrix, the letters that were originally presented, in the correct order of presentation. There were three practice trials, followed by 15 trials in the test session. The importance of accuracy in math calculation and recall order was stressed throughout the task by immediately showing the percentage of correct responses following each math problem and recalled set. Participants were also told beforehand that they need to solve these math problems as quickly and accurately as possible, and to maintain at least 85% of accuracy. The sum of all correctly recalled sets was recorded.

Data Analysis

Data were visually inspected for any outliers and violation of normality assumptions. Pairwise deletion was used for missing data and outliers were identified and removed from further analyses if values were two standard deviations above or below the mean. Two outliers in the mindfulness group were removed.

Independent samples t-tests were conducted for all questionnaires and task measures to examine if there were any baseline differences between the mindfulness seminar and the control seminar. Significant baseline difference ($t = 2.25, p < 0.05$) was only found in PHQ (depression) such that students in the mindfulness seminar had slightly more depressive symptoms than those in the control seminar. There was no significant baseline difference in any of the measures between women and men for the control group, while women in the mindfulness group had slightly higher levels of self-control ($t = 2.07, p < 0.05$).

Our primary goal was to test for any changes in cognitive task and self-report measures from pretest (beginning of class) to posttest (end of class) for both groups, then compare these changes between groups. Typically, repeated measures analysis of variance (RM-ANOVA) is conducted to examine between and within group differences for this type of design. Nonetheless, given the smaller sample size of the mindfulness seminar, as well as considerable differences in the sizes of the two groups, conventional tests of significance are less meaningful and less appropriate for the present study. Hence, for all behavioral assessments, we report and interpret the results in terms of effect sizes using Cohen’s d_z for both groups. A descriptive statistics table (Table 1) is provided below for all measures from both groups. Different sample sizes across questionnaires and tasks were due to failure of some students to complete them. In particular, seven participants had incomplete data for OSPAN and SART, and nine participants had incomplete data for ANT.

Results

Here, we present the more intuitive Cohen’s d_z , an effect size that is commonly used in paired t-tests, to compare changes in behavioral outcomes from baseline to conclusion of the class between these two groups. We compare the effect sizes between each group for differences

Table 1

Descriptive Statistics for Questionnaires and Cognitive Tasks

Tasks	Group	Session	N	Mean	SD	
Trait Mindfulness	Mindfulness	Pre	39	3.79	0.69	
		Post		4.00	0.58	
	Psychology	Pre	99	3.83	0.65	
		Post		3.83	0.69	
Anxiety (GAD)	Mindfulness	Pre	20	8.50	4.85	
		Post		5.55	3.47	
	Psychology	Pre	103	6.71	4.63	
		Post		6.46	4.37	
Anxiety (STAI) Fall 2017 & 2018 Mindfulness Class Only	State Anxiety	Pre	24	43.00	13.16	
		Post		37.83	12.47	
	Trait Anxiety	Pre		43.17	12.17	
		Post		41.46	10.12	
Satisfaction with Life	Mindfulness	Pre	46	12.87	5.27	
		Post		14.28	6.11	
	Psychology	Pre	105	13.84	5.78	
		Post		14.09	5.41	
Self-Control	Mindfulness	Pre	35	41.00	8.21	
		Post		38.80	8.97	
	Psychology	Pre	103	42.75	7.80	
		Post		41.15	8.53	
Self-Compassion	Mindfulness	Pre	45	2.87	0.67	
		Post		3.04	0.69	
	Psychology	Pre	100	2.88	0.64	
		Post		2.98	0.58	
Sleeping Quality	Mindfulness	Pre	39	6.10	2.63	
		Post		6.51	3.11	
	Psychology	Pre	97	5.36	2.56	
		Post		5.59	2.47	
Depression	Mindfulness	Pre	43	7.02	5.18	
		Post		7.93	4.47	
	Psychology	Pre	104	5.30	3.78	
		Post		6.81	4.21	
Operation Span	Total Span	Mindfulness	Pre	39	56.33	12.52
			Post		53.51	12.74
	Psychology	Pre	11	53.55	16.36	
		Post		48.18	17.95	

(continued)

Table 1

(Continued)

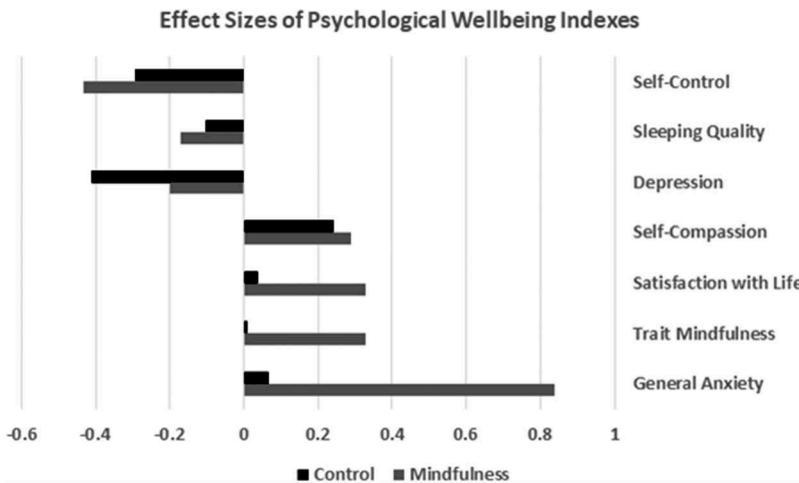
Tasks		Group	Session	N	Mean	SD
Sustained Attention to Response	% Commission Error	Mindfulness	Pre	39	52.21	26.72
			Post		47.28	27.57
		Psychology	Pre	15	31.73	22.70
			Post		28.00	25.21
	Coefficient of Variability	Mindfulness	Pre	39	0.274	0.097
			Post		0.261	0.113
Psychology		Pre	15	0.208	0.065	
		Post		0.183	0.066	
Attention Network Test	Alerting	Mindfulness	Pre	37	63.79	34.62
			Post		73.42	37.12
		Psychology	Pre	14	56.80	25.53
			Post		40.97	30.17
	Orienting	Mindfulness	Pre	37	25.39	20.07
			Post		15.99	33.99
		Psychology	Pre	14	22.05	11.93
			Post		20.00	16.70
	Executive	Mindfulness	Pre	37	74.01	27.83
			Post		61.37	35.87
		Psychology	Pre	14	78.49	19.09
			Post		61.05	23.93

in change, rather than using t-statistics and *p*-values. For ease of interpretation, we modified the direction of signs, such that positive values of effect sizes indicate better cognitive function, faster reaction times, and greater psychological well-being at the posttest assessment relative to pretest, whereas negative signs indicate the opposite. *P*-values for paired t-tests are also included along with effect sizes for references.

Psychological Wellbeing

Participants in the mindfulness seminar exhibited overall positive changes in most aspects of psychological well-being, consistent with previously observed benefits. Specifically, at post-assessment, students in the mindfulness seminar had small to moderate improvement in trait mindfulness (Cohen's $d_z = 0.328$, $p < 0.05$), symptoms of general anxiety (Cohen's $d_z = 0.839$, $p < 0.001$), state anxiety (Cohen's $d_z = 0.318$, $p > 0.05$), trait anxiety (Cohen's $d_z = 0.162$, $p > 0.05$), satisfaction with life (Cohen's $d_z = 0.329$, $p < 0.05$), and self-compassion (Cohen's $d_z = 0.288$, $p > 0.05$), compared to the control group. Interestingly, as shown in Figure 1, participants in both groups reported less self-control, poorer sleeping quality and more depressive symptoms (PHQ) at post-assessment.

Figure 1. Effect sizes of psychological wellbeing indexes for both groups. Positive effect sizes suggest improvement in psychological health, whereas negative effect sizes indicate the opposite trend.



Cognitive Measures

Compared to baseline, students in both groups exhibited small improvement in two indices of the sustained attention: commission errors and CVRT, with the control group showing slightly larger effect sizes than the mindfulness group. Similarly, small to moderate improvement was found in the efficiency of orienting attention network for mindfulness group (Cohen’s $d_z = 0.262, p > 0.05$), while no change was detected in the control group. Both groups exhibited small to moderate improvement in executive attention network, with the control group (Cohen’s $d_z = 0.836, p < 0.05$) showing a larger effect size than the mindfulness group (Cohen’s $d_z = 0.322, p > 0.05$). Nonetheless, an exception was found in alerting attention work, for which a small negative effect size was observed for mindfulness group, indicating a reduction in alerting network efficiency (Cohen’s $d_z = -0.318, p > 0.05$), whereas control group exhibited a small to moderate improvement in the same measure (Cohen’s $d_z = 0.615, p < 0.05$). Figure 2 below illustrates effect sizes of all cognitive measures for both groups.

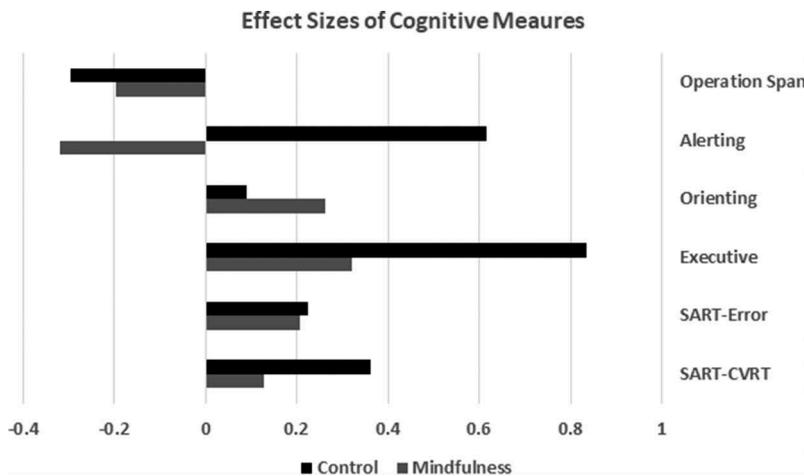
Practice Time

Students reported engaging in approximately 45 minutes of practice per week (outside of the classroom), but with quite a lot of individual variability (activities: $M = 16.77, SD = 23.59$; techniques: $M = 28.02, SD = 15.44$). Consequently, we tested whether this variation in duration correlated with any of our dependent measures. None of the correlations reached statistical significance ($p > 0.05$, uncorrected).

Discussion

We employed a quasi-experimental design comparing MT with an active control group to examine the feasibility and effectiveness of incorporating MT into standard college curriculum

Figure 2. Effect sizes of cognitive measures for both groups. Positive effect sizes suggest improvement in cognitive performance, whereas negative effect sizes indicate the opposite trend.



offerings. For psychological well-being, the findings were somewhat consistent with prior reports, indicating moderate to large positive effect on anxiety, and small to moderate effects on trait mindfulness, self-compassion and satisfaction with life. Nonetheless, somewhat inconsistent with a number of prior reports, we did not find evidence of cognitive function being differentially enhanced by MT.

Students in the mindfulness seminar showed evidence of improvements in mindfulness capacity and life satisfaction, as well as anxiety symptoms compared to control group, which are consistent with a previous study that showed improvement in anxiety after MT, using the same curriculum (Dvořáková et al., 2017). Surprisingly, poorer sleep quality and more depressive symptoms at post-assessment were observed for both groups. This could be due to our post-assessment being conducted toward the end of semester during finals period, a time that students were likely to have disrupted patterns of sleep, leading to possible depressive symptoms. Moreover, the mindfulness group had less increase in depressive symptoms than those in control group, suggesting that mindfulness practices may potentially have protective effects against stress-related depressive symptoms during an academic semester and prepare students to cope with stress (Dvořáková et al., 2018). Lastly, self-control also showed decline in both groups, which was also unexpected, since MT has been found to enhance self-control capacity as measured by objective cognitive tasks (Tang et al., 2007). Nonetheless, it is possible that students' perception of their own self-control ability may not have been accurate and that they may become more aware of their self-control abilities (in both groups, since the concept of self-control was a focus of both), resulting in a completely different perception of self-control relative to their original perception at the beginning of the semester.

For cognitive measures, the results did not provide strong evidence for differential enhancement in these two groups. The observed patterns were somewhat contrary to what has been found in prior studies (Jha et al., 2007; Tang et al., 2007; Van den Hurk et al., 2010), where MT

typically induced stronger changes in executive attention and orienting network efficiencies at post-assessment. The current results may not be that surprising, given that the amount of training students received in the present study is not comparable to previous studies that had a greater total number of hours of MT. Yet the lack of positive benefit observed in mindfulness group for alerting network efficiency does stand in stark contrast to previous studies that showed enhanced function after MT (Jha et al., 2007; Tang et al., 2007).

Another surprising aspect of the findings was that two indices of sustained attention in the SART task, as well as executive network efficiency measured by the ANT task, though showing improvement in mindfulness group, actually exhibited larger positive effects in the control group. These two indices of SART are thought to reflect the presence of mind-wandering (Bastian & Sackur, 2013). At least one prior report has also shown a strong relationship between reductions in mind-wandering and increased working memory function (Mrazek et al., 2012), so the weaker findings in both measures in the current study may also be related.

There are several additional possible explanations that might account for these deviant patterns in cognitive function. First of all, it is possible that testing environments were sub-optimal, in terms of time and distraction potential, reducing data quality. Additionally, for students in the control group, data analyses were only conducted on participants who completed the entire cognitive task battery. The reason was due to our compensation scheme, such that participants were only compensated if they completed all tasks, and we were required not to keep data from participants who were not compensated. As a result, it is plausible that those who persisted and finished all cognitive tasks may have had inherent differences in their level of motivation, which could all potentially contribute to the observed task outcomes to some extent. Conversely, measures of self-reported psychological well-being were likely less affected by these extraneous factors, since both classes had to complete the questionnaires as part of their class requirement and that questionnaires are less likely to be vulnerable to environmental distractions than cognitive tasks.

Finally, the effects of MT on cognitive function in healthy adults may actually be less reliable and consistent than it seems from a more cursory read of the prior literature. Indeed, more recent literature reviews have found that mindfulness effects on attention and executive control measures are actually fairly inconsistent (Lao et al., 2016). Hence, it may be the case that the observed effects in cognitive task measures are not so surprising, especially when considering that all students had above-average cognitive functioning (i.e. working memory capacity was between the 67th to 75th percentile on average) even at baseline (i.e., all participants were students enrolled at a highly selective private university). Likewise, the sample size was somewhat small, particularly for the cognitive tasks for both groups, due to some students in the mindfulness group not completing the entire task set and low responsive rate from the control group (for whom task completion was optional). Because the present study was primarily conducted as a pilot investigation, sample size was inevitably smaller than what would otherwise be desirable. Consequently, statistical power was low for detecting moderate effects and subtle differences between the two groups.

Conclusions

First-year college students belong to a special population that is constantly facing new challenges from the external environment. Our study provides some support for the proposition that incorporating MT into a standard college curriculum and setting is both feasible and potentially effective for promoting well-being. In particular, both public and private academic

institutions with residential hall programs or activities could model the setup of this study, making MT an active component of residential life, as well as part of college curriculum. This approach would also provide students with convenient access to resources that are tailored specifically to their needs and characteristics and could be promising for promoting mental health in college populations. For community colleges or colleges where residential programs and first-year electives are not available, MT could still be offered as a conventional elective course within the college curriculum for interested students to participate and benefit. This approach could still model the curriculum of the present study but would need to choose an appropriate location for the course, as MT involves actual practices that can be difficult to carry out in traditional classrooms. Although the cognitive benefits in this study were rather small and mixed, there was an overall improvement in psychological health for students who underwent MT. Additional data are needed in order to more conclusively determine the size of observed effects and confirm their statistical reliability.

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