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The Impact of Mindfulness Meditation on Students' Creativity

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The Impact of Mindfulness Meditation on Students' Creativity

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Abstract

Researchers have suggested a link between mindfulness meditation and increased creativity. Specifically, meditation seems to promote improved divergent thinking (Colzato et al., 2012). I sought to better understand mindfulness meditation and creativity by addressing the differential effects of brief meditation on divergent and convergent thinking, as well as investigating decreased anxiety and increased executive control as potential mechanistic mediators of this relationship. In a laboratory experiment 40 Butler University undergraduate students participated in either a sham or mindfulness meditation exercise, followed by several creativity assessments as well as measures of anxiety and executive control. The findings show that mindfulness meditation was significantly related to improved performance on a divergent thinking task, but the results regarding the proposed mechanisms were inconclusive, leaving open questions regarding what exactly is mediating this relationship.

Introduction

Creativity, or the capacity to generate novel, socially valued products and ideas, has not only allowed for many of civilization's major accomplishments, from Michelangelo's masterpieces to the invention of a wheel, but is also necessary for thriving in everyday life. Methods capable of improving creative functioning have the potential to profoundly increase well-being, both at the societal and individual level (Kaufman & Sternberg, 2010). In this context, I will consider the promising relationship between mindfulness meditation and creativity, illustrated by several converging lines of research indicating a significant causal association. Furthermore, the potential mechanisms allowing for this relationship will be considered including reduction of anxiety and improved executive function.

Creativity

The concept of creativity encompasses an array of definitions and representations in research, ranging from problem solving (Lubart, 1994) to problem finding, or "the self-initiated creation of problems."(Getzels & Czikszentmihalyi, 1976). Some have suggested that creativity is the ability to generate novel and socially valued ideas (Mumford, Reiter-Palmon, & Redmon, 1994), or the ability to think beyond the boundaries of available information to produce original ideas and apply them in a valuable way (Horan, 2007). However, according to Guilford (1967), creativity can best be understood by distinguishing between its two components: divergent and convergent thinking. Guilford suggested that these two styles of thinking represented different creative processes that

function independently of each other. Divergent thinking consists of thinking that supports the generation of many new ideas, such as the thought processes involved in brainstorming sessions. Guilford (1967) assessed this style of thinking with his Alternate Uses Task, in which participants are presented with an object and asked to generate as many uses for the object as possible. Divergent thinking has been consistently linked with the concept of the creativity. In 1987 McCrae published results that linked divergent thinking to self-reports of openness to experience as well as high scores on Gough's (1979) Creative Personality Scale, establishing its role in assessing creativity. Convergent thinking, then, is the process of generating one specific correct solution to a particular problem with an emphasis on accuracy and logic. Nonetheless, it is thought to be an important element of creativity, serving as a check to balance divergent thinking and remain focused on accuracy (Cropley, 2010). To evaluate convergent thinking, Mednick (1962) devised the Remote Associates Task, which involves presenting participants with three seemingly unrelated words (i.e. poke, down, motion) for which they must find a common associating word (slow).

Mindfulness Meditation

Mindfulness meditation is a relaxation technique utilizing mindfulness, or "the detached, non-judgmental witnessing of thoughts, feelings, and sensations," to promote self-awareness of one's own experiences (Horan, 2007). The traditional practice of mindfulness is historically based in Buddhism and Eastern traditions (Ostafin & Kassman, 2012). However, since its early origins in the Middle Ages, mindfulness has been spread around the world from Asia, to Europe, and beyond

(Knight, 2009). Modern mindfulness has developed into a practice with great potential for benefitting overall well-being (Davidson et al, 2003; Kabat-Zinn, 1982). The current practice can be defined as " paying attention on purpose, in the present moment, and nonjudgmentally, to the unfolding of experience moment to moment."(Baime, 2014). Perhaps the best way to understand mindfulness meditation is by experiencing it personally. As an illustrative example, take three minutes to focus on your breathing. If/when your thoughts begin to wander to things like “what will I eat for dinner?” or “this is silly and I’m bored,” do nothing but observe your thoughts, acknowledge them nonjudgmentally, and return your focus to breathing.

A recent increase in scientific attention to the psychological and health benefits of mindfulness meditation has allowed for a greater understanding of the practice. Amid the large and growing body of mindfulness research are findings that confirm its efficacy in stress management (Chiesa and Seretti, 2009), reduction of anxiety (Dekeyser et al., 2008), improved executive functioning (Temper et al., 2013), cancer related fatigue(Johns et al., 2015) and even balancing work and home life (Allen & Kiburz, 2011). Although many of the studies addressing the impact of mindfulness meditation employ extensive training programs to teach mindfulness to participants or lengthy meditation sessions, multiple studies have also shown significant effects from very brief exposure to mindfulness techniques (Hoge et al., 2014 & Lam et al., 2015).

Influence of Mindfulness on Creativity

Ostafin and Kassman (2012) found that individuals possessing greater trait mindfulness exhibit greater creative abilities, operationalized as high scores on insight problem solving tasks. Furthermore, Horan (2009) used electroencephalogram (EEG) imaging to show that mindfulness meditation could "activate weak or nonexistent associations leading to creative inspiration".

As research regarding the impact of mindfulness on creativity accumulates, it is becoming clear that the relationship is complex. Colzato (2012) and colleagues have done a considerable amount of work investigating the relationship between meditation and the two types of creative thinking defined previously: divergent and convergent thinking. They examined whether focused attention (i.e., subjects are directed to focus their attention on breathing in a certain way) and open monitoring meditation (i.e. mindfulness meditation) have differing effects on creativity. Open monitoring meditation induced a 'control state' that promoted divergent but not convergent thinking. Focused attention meditation did not affect divergent or convergent thinking, although the researchers had expected it to improve convergent thinking. In a follow up study, Liplett et al. (2014) addressed the influence of prior meditation practice on divergent and convergent thinking and found similar results: regardless of participants' level of meditation experience, those who meditated exhibited greater divergent but not convergent thinking.

Prior research suggests that mindfulness affects some aspects of creativity, like divergent thinking, more strongly than others. In a similar manner, individual mindfulness skills do not affect creative performance uniformly. Rather, different

specific aspects of mindfulness seem to be differentially related to creative skills (Baas et al., 2014). Observation, which refers to the ability to attend to various stimuli, and acting with awareness, which refers to focusing one's attention with complete awareness, both seem to promote creativity. Other aspects, like description and accepting without judgment, seem to have minimal impact on creative thinking. Baas et al. (2014) have suggested that observation and acting with awareness may be beneficial because they enhance cognitive flexibility, which then enhances executive function—a possible mechanism for the relationship between mindfulness meditation and creative thinking.

While the link between mindfulness mediation and creativity has been reliably established, prior research offers little insight into the specific mechanisms responsible for the relationship. One possible mechanism that might explain mindfulness' impact on creativity involves executive function. Executive function refers to a variety of interrelated processes involved in planning and carrying out a task (Flook et al., 2010). Executive functions encompass several processes including working memory, flexible thinking, and organization (Teper et al., 2013). Because of the emphasis on attention to the present and avoidance of judgment included in mindfulness meditation, it is reasonable to expect that practicing meditation fosters attentional control and executive control (Teper & Inzlicht, 2012). Research strongly suggests that mindfulness meditation practice is related to improved executive function, which allows for creative processing. For example, Horan (2009) found that two specific operations linked to executive control, transcendence and integration, help to explain why meditation increases creativity. Transcendence and

integration refer to the capacity for developing novel ideas and applying them in useful ways. Both of these specific executive function operations are crucial to successful creative processing, and were found to be linked to meditation. However, Horan (2009) also reported that activation of the prefrontal cortex, which is usually considered a physiological indicator of executive control, was actually observed less frequently in creative individuals.

Inhibition, or the ability to think before acting by evaluating one's situation and possible behavior, is an important executive function that allows for effective use of several other higher order functions (Dawson & Guare, 2004). Ostafin and Kassman (2011) demonstrated the positive effects of trait mindfulness on inhibition and creative processing using a paradigm involving insight problem solving. Ostafin and Kassman, when explaining their results, suggested "an aim of mindfulness is to limit the ability of automatically activated verbal-conceptual content derived from past experience to bias thoughts and behavior" (2011, p. 1032). This ability results in improved inhibition of distracting thoughts, implicating executive control as a potential cause of increased creativity resulting from mindfulness (Shapirio 2006; Baas et al., 2014).

Other recent research also supports a positive association between inhibition and creativity (Benedek et al. 2014). In fact, Benedek and colleagues looked at three different executive functions, including inhibition, and assessed their differential relations to intelligence and creativity. The researchers found that student's creative abilities could be predicted by inhibition, strengthening the idea that executive function could be a mechanism through which mindfulness influences creativity.

Notably, research has supported the idea that mindfulness meditation practice is related to improved executive functions including inhibition, transcendence, and integration, all of which have been associated with creativity (Horan, 2009 & Teper & Inzlcht, 2012). Executive control in relation to mindfulness meditation has historically been studied utilizing the Stroop test, a color identification task that specifically measures inhibition (Teper & Inzlicht, 2012). Another, relatively simple, measure of executive function with a particular emphasis on inhibition is the FAS verbal fluency test. Previous research has shown that this task is related to several key executive functions including shifting between mental states and operations, updating, and inhibition—similar to that of the Stroop test (Miyake et al., 2000). Updating refers to, "monitoring and coding incoming informaitno for relevance to the task at hand and then appropriately revising the items held in working memory" (Miyake et al., 2000).

Anxiety reduction also appears to be one of the more likely mechanisms. Mindfulness meditation is widely accepted as an effective method of anxiety reduction (Dekeyser et al., 2008). According to a meta-analysis of over 160 studies, one of the primary ways that mindfulness meditation improves general psychological well-being is by reducing and managing anxiety (Sedlmeier et al., 2012). Mindfulness meditation has also proven to be a successful therapeutic intervention for treating mood and anxiety disorders in clinical settings. One study reported that 90% of clinically anxious participants in a mindfulness mediation group experienced significant reductions in anxiety (Hoffman et. al, 2010). Recent research suggests that low levels of anxiety, in turn, are helpful for creative thinking

(Le et al., 2015). Researchers reported a positive correlation between mental health and creativity, and emphasized a negative correlation between negative emotional states such as anxiety and creative thinking (Le et al., 2015). Some evidence exists that the relationship may be bi-directional. Dobbins and Jaime (2014) found that engaging in divergent thinking tasks helped to reduce anxiety in situations involving art and writing therapy, suggesting that being creative may reduce anxiety as well as vice versa. However, several studies clearly demonstrated the beneficial effects that the reduction of anxiety has on creativity. Isen et al. (1987) found that manipulations that decrease anxiety resulted in increased positive affect, and that increased positive affect, in turn, facilitated creativity (see also Dekeyser et al., 2008).

In the following study, I examined the impact of a brief mindfulness meditation intervention on divergent and convergent forms of creativity. In keeping with prior work, I hypothesized that mindfulness will increase divergent but not convergent creativity. Then, to extend prior work, I examined whether the predicted effects on creativity were mediated by the occurrence of decreased anxiety and/or improved executive function.

Materials & Method

Participants:

Participants were recruited from the Butler University undergraduate student population. Students in psychology courses were given the opportunity to sign up for participation online with SONA, a research pool system managed by the

Department of Psychology. The software allows psychology students to obtain extra credit towards their psychology course of choice. Participants from Butler University ranged in age from 18-22, with various class standings, gender and ethnicity, and were generally representative of the Butler population. Although most participants were recruited through SONA, some were recruited through word-of-mouth. The sample consisted of 40 students.

Procedure:

Overview. Participants were randomly assigned to a brief mindfulness intervention exercise or to a control 'sham' meditation exercise, after which they were given a creativity assessment. Anxiety level was assessed before the meditation. Following meditation, anxiety level was again measured, followed by an assessment of executive function. (Because the executive function assessment was relatively time consuming, it was only performed once.) After the post-meditation assessment of anxiety and executive function, creativity was then assessed using three different measures. Changes in anxiety and post-intervention executive function were examined to determine whether they mediated the impact of condition on creativity. Participants were run in groups of 3-10 people at a time.

Baseline measure. Before being assigned to either the mindfulness or control (sham meditation) group, participants completed baseline measures of anxiety level. The anxiety assessment consisted of the 6-item form of the State-Trait Anxiety Inventory (STAI) (Marteau & Becker, 1993). The six-item STAI has been previously validated and was chosen for the current study because of its brevity. Because I expected the effects of the mindfulness mediation to be fleeting, I needed

measures that were relatively quick to complete. The measure focuses on anxiety specifically rather than general negative affect.

Mindfulness and control conditions. Participants were randomly assigned to either a mindfulness meditation or control condition, $N_{mindful} = 25$, $N_{sham} = 15$. Because participants were run in groups, and because each group was randomly assigned to condition, the sample sizes were not quite equivalent across the two groups. Participants assigned to the mindfulness condition listened to a 5-minute recording of a mindfulness meditation, an open monitoring form of meditation that has been used in prior work (A. O'Malley, personal communication, 2015). The meditation guides participants by asking them to release stress, focus on breathing, and acknowledge their thoughts and feelings. Alternatively, the participants in the control condition heard the same voice give them directions such as "simply think about whatever comes to your mind," and "let your mind wander freely" periodically for 5 minutes. Participants listened to MP3 files in an otherwise silent room.

Post-meditation anxiety measure. After listening to the recordings, all participants, regardless of condition, again completed the six-item STAI . (See appendix).

Post-meditation executive function measure. After the anxiety measure, executive function was assessed using the FAS Verbal Fluency test. This task consisted of asking participants to write as many words beginning with F, A and S as they could think of within a specific span of time, 60 seconds for each letter. Words

could not be repeated or proper nouns. To do well on the task, participants must recall the earlier instructions as well as their earlier responses in working memory, while suppressing irrelevant responses and repetition. It was also noted in scoring whether the participant included inappropriate or distasteful word responses. The FAS Verbal Fluency test is a widely used measure of executive function (Shao et al., 2014).

Post-meditation creativity assessment. After their meditation, all participants completed three creativity assessments, two focused on divergent thinking and one on convergent thinking (see appendix). Greater effects were expected for divergent thinking, in keeping with past work (Colzato et al., 2012). However, convergent thinking was also measured in order to replicate previous work. The order in which participants completed these three assessments was randomized in order to counterbalance the effect of varying time between the meditation condition and each task.

Divergent thinking measure. Alternate Uses Task (AUT). Participants were asked to list as many alternative uses for a newspaper as possible in 2 minutes. The results were scored according to originality and fluency. Fluency refers to the raw number of responses, while originality score was determined by granting one point for each response and two points for each response seen less than 10% of the time across the sample. Points were then summed to form an originality score (Colzato et al., 2012).

Divergent thinking measure: Real World Task (RWT). Participants were given two minutes to generate as many possible solutions to a 'real world'

problem that Butler University is experiencing. The exact wording of the problem can be found in the Appendix. Solutions were scored as described for the Alternate Uses Task. I developed this measure specifically for this investigation as an alternative measure of divergent creativity. Although it has not been validated, it parallels the AUT conceptually.

Convergent thinking measure: Remote Associations Task (RAT). Participants were presented with a series of three unrelated words (such as widow, bite, monkey) and asked to find a common associate (spider). Using stimuli from prior studies, a test was created including a series of these word association questions, each of which have a definite answer. The task includes both easy and difficult problems. Participants were given 2 minutes to complete as many of the 15 questions as they were able to in this task. The RAT produces two scores: number of answers and number of correct answers (Colzato et al., 2012).

Data analysis*.* All collected data were analyzed using IBM SPSS Statistics for Windows Version 22.0 software.

Results

Preliminary Results

Before computing the STAI scores, reliability analyses were conducted on the scale items. At baseline and especially at post-meditation, the items did not correlate as highly with each other as would be expected, Cronbach alpha's = .66 and .55,

respectively, but in keeping with prior work, items at each timepoint were averaged together to form STAI scores.

For the executive function measures, a composite fluency score was created by converting the three fluency scores into z-scores, then averaging them together (Cronbach alpha= .70). I combined the fluency scores because they were relatively highly correlated, and using a single summary score of cognitive fluency reduced the number of analyses, thus reducing the likelihood of Type I error. Because only four students actually generated words indicating poor inhibition, the inhibition scores were not used in any of the analyses.

Primary Results

The potential effects of mindfulness meditation on creativity were investigated using a series of one-way analysis of variance (ANOVA) tests, with condition (mindfulness meditation vs. sham meditation) as the independent variable and the creativity scores used as the dependent variables. Because I did not expect mindfulness to affect RAT scores, which reflect convergent creativity, I did not subject all six creativity scores to a multivariate analysis of variance (MANOVA). Instead, I conducted six separate ANOVA's. Recall that each measure of creativity used in the current study (i.e., the RAT, AUT and RWT) produced two scores, thus producing six dependent variables.

The RAT was scored according to both the number of attempted answers and the number of correct answers. A one-way ANOVA conducted to compare the effect of mindfulness meditation on the number of attempted RAT responses was not significant, $F\ (1, 38)= .111$, $p=.741$, partial $\eta^2=.003$, $M_{mindful} = 7.24$, $SD_{mindful} = 3.73$,

M_{sham} = 6.87, SD_{sham}= 2.85. Similarly, the effect on the number of correct responses to the RAT was not significant, F (1, 38)= .142, p= .708, partial η^2=.004, $M_{mindful}$ = 5.24, $SD_{mindful}$ = 3.54, M_{sham} =5.67, SD_{sham}=3.33.

The AUT was scored according to fluency (i.e., number of responses) as well as originality of responses. A one-way ANOVA determined that the effect of mindfulness mediation on AUT fluency was not significant, F (1, 38)= 1.803, p= .187, partial η^2=.05, $M_{mindful}$ =7.00, $SD_{mindful}$ =2.92, M_{sham} = 8.13, SD_{sham}= 1.88. Likewise, ANOVA showed that the effect of mindfulness meditation on the originality of alternative use responses was not significant, F (1, 38)= .968, p= .332, partial η^2=.03, $M_{mindful}$ = 9.60 , $SD_{mindful}$ =4.07, M_{sham} = 10.73, SD_{sham}= 2.31.

The RWT was also scored according to fluency and originality. A one-way ANOVA was used to determine that there was a significant effect of mindfulness meditation on the fluency of real world task responses, F (1, 38)= 10.763, p= .002, partial η^2=.22, $M_{mindful}$ =5.20, $SD_{mindful}$ =1.85, M_{sham} =3.33, SD_{sham}=1.54. See Figure 1. It was also shown that mindfulness meditation had a significant effect on the originality of real world task responses, F (1, 38)= 8.291, p= .007, partial η^2=.18, $M_{mindful}$ =6.16, $SD_{mindful}$ =2.37, M_{sham}= 4.07, SD_{sham}=1.94. See Figure 2. The influence of meditation conditions on anxiety will be discussed in the following section.

Mediational Results

To explain the differences between conditions on the RWT outcomes, two sets of mediational analyses were conducted using the traditional Baron and Kenney (1986) approach. One set focused on cognitive fluency as a potential mediator and the other focused on reductions in anxiety as a potential mediator. Because anxiety

was assessed both before and after meditation, I used change in anxiety (i.e., time 2 STAI score – time 1 STAI score) as a potential mediator. Negative values for this variable indicate reductions in anxiety. Because the RWT fluency and originality scores were highly correlated (r = .97), I chose to focus on the RWT originality score to simplify the analyses and reduce the number of tests, thereby reducing the risk of Type I error.

My hypothesis, regarding cognitive fluency as a mediator, was not supported. Although condition did indeed predict RWT originality, β = -.42, t(38) =-2.88 , p=.007, as previously established in the ANOVA analyses, condition did not predict cognitive fluency, β = -.08, p=.61, one of the critical paths needed to establish mediation. Cognitive fluency marginally predicted RWT originality when controlling for condition, β = .27, p=.06, but the relationship between condition and RWT originality remained virtually unchanged when controlling for cognitive fluency, β = -.40, t(37) =-2.80, p=.008, indicating lack of mediation.

My hypothesis, regarding reduced anxiety as a mediator, was also not supported. As before, condition did predict RWT originality, β = -.42, t(38) =-2.88 , p=.007, but unlike before, condition did predict changes in the hypothesized mediator (i.e., anxiety reduction) in the correct direction, β = .38, t(39) =2.52, p=.02, with the mindfulness group experiencing a significantly greater reduction in anxiety. Unfortunately, reduced anxiety did not predict RWT originality when controlling for condition, β = .24, p=.13, and the relationship between condition and RWT originality remained significant when controlling for reduced anxiety, β =

-.51, $t(37) = -3.29$, $p = .002$. Thus, changes in anxiety appear not to account for the observed increases in creativity experienced by the mindfulness group.

Discussion

The goal of this study was to extend previous research on the relationship between mindfulness meditation and creativity, in an attempt to identify the mechanism that mediates the relationship. Specifically, I sought to examine whether a brief mindfulness meditation affected creativity level by way of anxiety reduction or improved executive control.

The significantly higher RWT scores of the mindfulness group relative to the control group partially confirmed my hypothesis that mindfulness meditation leads to improved creativity. The RWT measures divergent thinking, which refers to the type of creativity that involves generating new or novel ideas. Unfortunately, mindfulness did not seem to affect AUT scores, which also rely on divergent thinking. The lack of relation may have been due to the relatively short meditation I used. It is also possible the AUT was less interesting to participants compared to the RWT and thus participants were not particularly motivated to perform well on the AUT.

Also in line with my hypothesis, I did not find a significant relationship between mindfulness meditation and the RAT, which measures convergent thinking. These findings parallel those of previous research, which demonstrated that open-monitoring meditation promoted divergent thinking, but not convergent thinking (Colzato, 2014). In their research, Colzato and his colleagues used either participants who were long-term meditation practitioners with an average of 2.2

years of experience or non-practicing participants who were exposed to 45-minute meditation sessions in their experimental protocol. The findings presented here extend this past work by demonstrating impact on creativity in inexperienced mindfulness meditators with a significantly shorter intervention.. This suggests the potential role of mindfulness in improving the ability to produce novel ideas in a very accessible way.

Though the findings of the present study confirmed the anticipated finding about the relationship between creativity and mindfulness meditation, the testing of my proposed mechanisms of both decreased anxiety and increased executive function did not yield significant results. Interestingly, mindfulness meditation did result in reduced anxiety, but the findings here do not support the suggestion that reduced anxiety can account for increased creative processing in the form of divergent thinking. This suggests that there is a different cause for the relationship in question. However, as noted previously, the internal reliabilities of the 6-item STAI used in the current study were relatively low. Measurement error may have reduced the validity of the scores produced by these measures. Although the brevity of the measure allowed me to assess anxiety twice, thus providing change scores, the advantages of assessing actual changes in anxiety were probably offset by the low reliabilities of the measures.

Similarly, executive function, as operationalized by scores on the FAS verbal fluency test, did not seem to mediate the relationship between creativity and meditation. Because the FAS verbal fluency test is commonly used to measure executive function, these findings contradict previous findings linking creativity to

various executive functions including inhibition (Benedek et al. 2014). However, despite my original hypothesis, these results are not entirely surprising. Not all-previous research reports a strong correlation between creativity and improved executive function. In fact, some suggests the opposite, especially in regards to inhibition. Carson, Peterson, and Higgins (2003) found that high creative achievers exhibit decreased latent inhibition compared to low creative achievers. Furthermore, Zabelina and Robinson (2010) found that divergent thinking and creative achievement are not related to inhibition as determined by a Stroop test, but rather to a more flexible form of cognitive control. It is also worth noting that the aspect of the FAS test most related to inhibition (i.e., the inhibition score), could not be used in the current study because so few participants made inhibition errors.

An additional factor that may have affected the results is that executive function, as operationalized by the FAS test, was assessed only once, after the meditation. This meant that change scores in executive function could not be computed. In essence, I was relying on random assignment to ensure that my two groups had equivalent levels of executive function at baseline. Using change scores, which would have controlled for individual differences, might have shown that mindfulness was indeed related to improved executive function, a necessary condition for mediation.

Several other limitations of the current research should be noted, which provide significant room for further investigation. First, I struggled to recruit enough participants to reach the intended sample of 30 per condition. This smaller sample limits the statistical power of my findings. The second limitation in

conducting this study was the relatively short mindfulness meditation exercise. This was used because of time constraints; keeping the study relatively short increased participation rate. However, it is possible that a five-minute meditation exercise was not sufficiently strong enough to generate effects on the AUT, one of the traditional measures of divergent creativity. For this reason, it may have been more beneficial to utilize a longer meditation exercise. However, as noted earlier, the shortness of the meditation exercise could also be viewed as a strength because it was sufficiently powerful to cause increased creativity, as measured by the RWT.

Another limitation is the validity of the RWT. Although the RWT has strong face validity, it is a novel measure of divergent creativity developed for this investigation. Though conceptually it fulfills the criteria for a creative task, future research should be devoted toward assessing its validity psychometrically. In the current study, although the correlations are not reported in the Results, RWT scores correlated positively with AUT and RAT scores, but the correlations were not significant or only marginally so. These findings are suggestive, and given the measure's direct application to real world problems, the RWT is worth pursuing in further work. Finally, an additional means for measuring executive control, such as the Trail Making Task or Stroop, would have likely yielded more easily interpretable results and helped to clarify some of the ambiguity about the role of inhibition in creativity (Tombaugh, 2004 & Teper & Inzlicht, 2012).

Generally, my findings confirm a significant relationship between mindfulness meditation and creativity, but leave several questions unanswered about the mechanism modulating this relationship. Therefore, future research on

this topic should focus on determining this unknown mechanism. One possibility for determining this mechanism would be to begin by identifying a neural basis and then work to find a cognitive mechanism based on those findings. There is little research available on the neuroscience of creativity, but there is a distinct possibility that it could strengthen our understanding of executive function (Haier & Jung, 2008). This could be especially helpful in clarifying the role of executive control and the prefrontal cortex with respect to creativity. While some researchers have found increased prefrontal activity in highly creative people (Horan, 2009), others suggest a less centralized network or even diminished prefrontal activity leads to increased creative output (Braun et al., 1997). The results of neuroimaging studies regarding creativity do not converge and beg for more research (Haier & Jung, 2008). If the results of further neuroimaging research indicate activation of a certain region such as the prefrontal cortex, such findings could provide insights into the mechanism, or more likely mechanisms, responsible for mindfulness-induced changes in creativity.

Conclusion

In my investigation into the relationship between mindfulness meditation and creativity, mindfulness promoted divergent thinking on one measure of creativity, the RWT. While mindfulness meditation also led to reduced anxiety, changes in anxiety did not predict higher scores on the RWT, indicating that anxiety did not function as a mediator. Similarly, executive control, as measured by the FAS test, also did not function as a mediating variable. Although the current study failed to shed light on the underlying processes, the results highlight the role of

mindfulness in fostering creativity, particularly the type of divergent thinking that can be used to solve real world problems.

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Name ..... Date .....

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the most appropriate number to the right of the statement to indicate how you feel right now, at this moment. *There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.*

	Not at all	Somewhat	Moderately	Very much
1. I feel calm	1	2	3	4
2. I am tense	1	2	3	4
3. I feel upset	1	2	3	4
4. I am relaxed	1	2	3	4
5. I feel content	1	2	3	4
6. I am worried	1	2	3	4

Please make sure that you have answered *all* the questions.

Alternate Uses Task- You have 2 minutes to come up with as many possible alternate uses as you can for the given object. For example, if the object were “brick” you might list doorstop, paperweight, step, etc.. Responses will be scored according to originality and fluency (how many responses).

List as many alternative uses for a **newspaper** as you can.

Real World Task-

Butler University's campus includes several important amenities, however students without cars have trouble accessing necessary items such as groceries, school supplies, and medication. While the bookstore offers some of these necessary items, there is typically a less expensive and more extensive selection elsewhere. How can this problem be solved?

You have 2 minutes to develop as many detailed solutions as you can.

Remote Associations Task:
Look at the three words and find a fourth word related to all three. Answer as many as you can in 2 minutes; feel free to skip to ones you know.
For example:
blue cake cottage—cheese

1. rocking wheel high _____
2. night wrist stop _____
3. puppy true letter _____
4. sense courtesy place _____
5. river note account _____
6. dust cereal fish _____
7. poison league creeping _____
8. right cat carbon _____
9. dress dial flower _____
10. property moral price _____
11. sake pet nick _____
12. sea home stomach _____
13. cracker fly fighter _____
14. dream break light _____
15. ruby glass bunny _____

Answers to RAT items

1. chair
2. watch
3. love
4. common
5. bank
6. bowl
7. ivy
8. carbon
9. sun
10. value
11. name
12. sick
13. fire
14. day
15. slippers

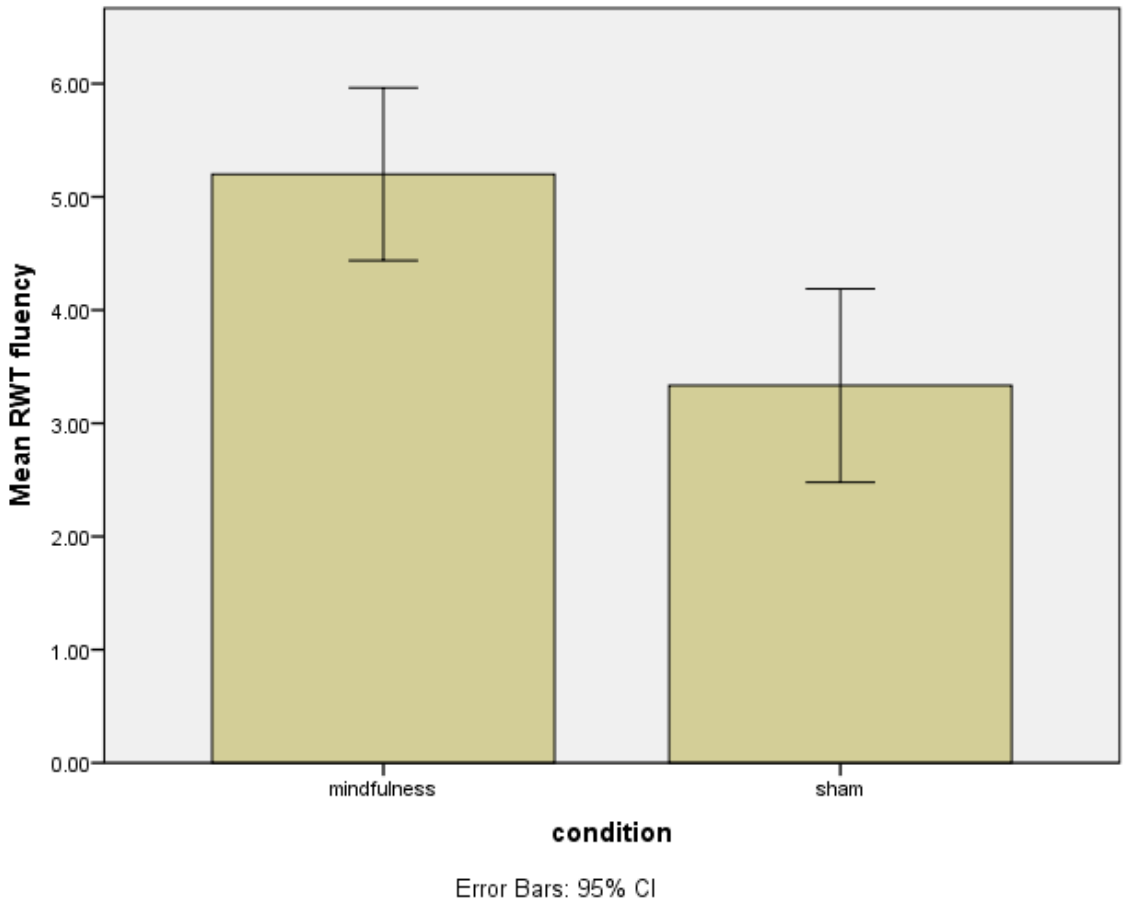

Figure 1. Participants who listened to the mindfulness meditation ($M_{mindful}$ =5.20, $SD_{mindful}$ =1.85) scored significantly higher on RWT fluency than those who listened to the sham meditation (M_{sham} =3.33, SD_{sham}=1.54).

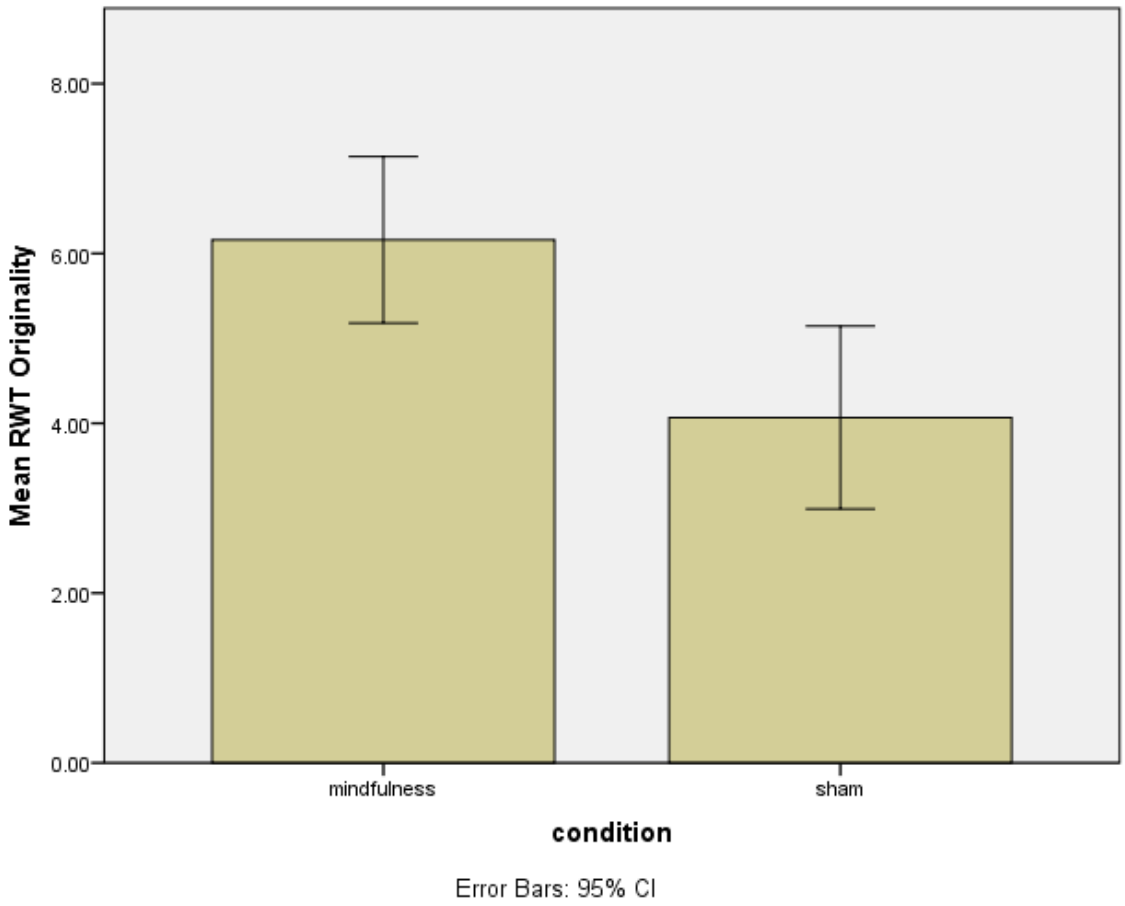

Figure 2. Participants who listened to the mindfulness meditation ($M_{mindful}$ =6.16, $SD_{mindful}$ =2.37) scored significantly higher on RWT originality than those who listened to the sham meditation (M_{sham}= 4.07, SD_{sham}=1.94).