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# PTSD's True Color; Examining the effect of a short-term coloring intervention on the stress, anxiety and working memory of veterans with PTSD.

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PTSD's True Color; Examining the effect of a short-term coloring intervention on the stress,  
anxiety and working memory of veterans with PTSD.

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in partial fulfillment of the requirements for the degree of

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### **Abstract**

The aim of this study was to explore the effect a coloring condition had on minimizing anxiety and stress experienced daily by veterans. The effect that coloring had on working memory was also explored.

A sample of 24 armed forces veterans were split into two coloring conditions, a mandala and a free draw condition, and asked to complete the Primary Care PTSD Screen, the Perceived Stress Scale and the Brief State Trait Anxiety Inventory. Working memory scores were established via a Backward Digit Recall task; pre-and posttest scores were evaluated for significant differences.

Our research suggests the act of coloring, not the coloring condition, resulted in significant decreases in stress and anxiety and an increase in working memory. We also found that participants who suffer from PTSD displayed significant decreases in stress and anxiety and significant increases in working memory when compared to individuals without PTSD.



## **Introduction**

### **What is PTSD?**

Post-Traumatic Stress Disorder (PTSD) is a debilitating mental disorder which can occur after someone has experienced a traumatic event in their lives, such as serious vehicular accidents, child abuse, natural disaster, or combat exposure. According to Ehrling et al. (2014), certain types of traumatic events, such as childhood abuse, can lead to high prevalence of PTSD in adults. PTSD stressors are characterized by the belief that someone's life is in danger, as well as the belief that the person has no control over what is occurring (Bisson et al., 2007). The probability of developing of PTSD depends on such factors as intensity of trauma, personal strength of reaction to the event, and the amount of control felt during the event. PTSD does not affect everyone who has experienced a traumatic event, but it can develop after just one exposure to trauma. This disorder can even become so severe that it prevents normal functioning.

The National Institute of Mental Health states that all individuals can develop PTSD. The prevalence rate for PTSD is approximately 7% to 8% for the general population, with certain populations being at greater risk due to genes, exposure or stressor type ("Post-Traumatic Stress Disorder," 2017; Prins et al., 2003). However, one population appears to be at particular risk: military combat veterans. Veterans appear to have PTSD rates ranging from two to almost four times higher than the general population, depending upon the war in which they served. A notable comparison between prevalence rates comes from veterans who were active during the Vietnam War as compared to those who were participants in the Gulf War; the lifetime prevalence rates of PTSD for men who participated in Vietnam is 30.9%, versus 12.1% for participants in the Gulf War (Gradus, 2016).

While PTSD does appear to affect veterans at particularly higher rates, they are not the only vulnerable group. The National Institute of Mental Health states that children and victims of sexual abuse are also more likely to develop PTSD (“Post-Traumatic Stress Disorder,” 2017). Risk factors which have been noted in these populations are feelings of horror, helplessness or extreme fear, seeing another person hurt, and having a history of mental illness. While children may express their symptoms in different ways than adults, such as acting out the traumatic event during playtime or by developing destructive behaviors, they still experience it at rates higher than the general population, as do veterans.

People who live with PTSD often face symptoms which can prevent normal functioning. Chronic PTSD, or PTSD which permeates into the everyday lives of those affected, can lead the individual to display negative symptoms such as re-experiencing the event through flashbacks, hyperarousal, avoidance of arousing stimuli, negative feelings and changes in beliefs after the trauma, with those affected having trouble concentrating or sleeping. PTSD also causes other negative issues, such as depression, anxiety, drinking or drug problems, and feelings of hopelessness, shame or despair (Aupperle, Melrose, Stein, & Paulus, 2012; Ford & Kidd, 1998; Miller, Wolf, & Keane, 2014).

A diagnosis of PTSD is made by a psychiatrist or psychologist, who makes note of the symptoms which are affecting the person. These symptoms usually appear within three months of the traumatic incident, but these can sometimes be delayed for several years. To be diagnosed with PTSD a person must experience at least one re-experiencing symptom, such as flashbacks, one avoidance symptom, such as depression, at least two arousal and reactivity symptoms, such as angry outbursts or feeling tense, and at least two cognition and mood symptoms, such as loss of interest in enjoyable activities and negative thoughts. These symptoms must persist for at

least a month in order to properly provide a diagnoses (Miller et al., 2014; “Post-Traumatic Stress Disorder,” 2017).

### **What triggers PTSD?**

While Post-Traumatic Stress Disorder stems from a feeling of loss of control in a dangerous or life threatening situation, there are several factors which can affect a person’s likelihood to develop PTSD. Research also suggests that there are certain traits and situations which can increase ones’ risk of PTSD. A meta-analysis found that there are seven significant factors that predict the likelihood of PTSD occurring in an individual: prior trauma, prior psychological adjustment, family history of psychopathology, perceived life threat during the trauma, post-trauma social support, peritraumatic emotional responses, and peritraumatic dissociation. These factors were all found to have a significant effect size, ranging from  $r=.17$  (family history, prior trauma and prior adjustment) to  $r=.35$  for peritraumatic dissociation (Ozer, Best, Lipsey, & Weiss, 2008). Peritraumatic dissociation involves disturbed awareness, impaired memory, or altered perceptions during and immediately after a traumatic experience, and is a common response to a traumatic event. The researchers believed that although a link was found between all seven factors and PTSD, peritraumatic dissociation is the variable which would be most useful to predict PTSD. They also noted that high levels of mental arousal at the time of the event seemed to increase the rates at which PTSD occurred.

Research also has shown that adult attachment styles can be a significant indicator and predictor of PTSD. A meta-analysis by Woodhouse, Ayers, and Field (2015), discovered that attachment style can influence both the development and severity of Post-Traumatic Stress Disorder in adults. The different attachment styles, which deal with how a person manages relationships, are secure, insecure, fearful, and dismissive. The researchers found that a secure

attachment style is associated with lower levels of PTSD following trauma. They also found that an insecure attachment style is associated with higher levels of PTSD symptoms, and that the fearful attachment style was most strongly associated with the prevalence of PTSD. Those with a fearful attachment style developed PTSD at a notably higher rate than other attachment styles.

### **What is the best way to treat PTSD?**

PTSD can be treated in several ways, and with varying effectiveness based upon how extreme the specific symptoms are, as well as how these symptoms effect the person's quality of life. When considering the treatment methods of individuals with PTSD, the most common way of assigning treatment appears to be by determining the symptoms which effect the person, as well as factors which may be considered 'exclusionary'. A study by Raza and Holohan, (2015) interviewed clinicians who utilized both Prolonged Exposure Therapy (PE), which is a form of behavior and cognitive behavioral therapy that involves examining the traumatic cause of PTSD and actively engaging in the memory rather than blocking it out. The researchers also focused on Cognitive Processing Therapy (CPT), which involves reducing avoidance of the previous trauma through understanding and evaluation of the events which resulted in PTSD. Clinicians are generally in agreement about which conditions and levels of severity warrant which treatment. They did however find that there was a preference for the PE method of treatment, indicating that thoughtful examination of the Trauma which caused PTSD as well as engagement in this memory is the preferred treatment for more people with PTSD.

Trauma-Focused Cognitive Behavioral treatments (TF-CBT) appear to show the greatest benefit as compared to other treatment types (see Bisson et al., 2007). The basis for Trauma Focused Cognitive Behavioral treatments, such as Prolonged Exposure Therapy and Cognitive Processing Therapy, is the mindful thought and discussion of the individual sources of the

person's PTSD, as well as the development of a new, positive way of thinking about this source. By examining the traumatic event that the individual experienced, the individual can develop a new way of thinking about it which can reduce the symptoms of PTSD. These features of TF-CBT are the basis for the current investigation's emphasis of mindfulness as a method of anxiety and stress reduction.

Another intervention of interest is Stress Management Therapy. Bisson et al. (2007) found Stress Management to not measurably reduce anxiety in individuals with PTSD. However, the lack of an effect size might be the result of the limited number of studies using Stress Management to treat PTSD. The researchers themselves indicated that "higher" quality studies (IE, better funded and with newer understanding of PTSD management) produced better outcomes. This shows that there is a definite need for more research in this area of treatment, and we hope to provide this research in our study.

### **Areas of the brain affected by PTSD.**

Traditional PTSD research has focused on two specific biological systems, the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system. These two areas were chosen due to the role that they play in stress response. These systems which are affected comprise areas such as the hippocampus and amygdala (subcortical structures) and the prefrontal cortex, the anterior cingulate cortex (ACC) and the orbitofrontal cortex (cortical regions). These areas play a specific role in recall and working memory, with enhanced glucocorticoid production being a specific byproduct of chronic stress / PTSD. Glucocorticoids, which improve memory of emotionally arousing events, cause an increase in hippocampal atrophy at high levels (Newport & Nemeroff, 2000).

Changes in amygdala activation which are present in individuals with PTSD play a role in establishing emotional significance of events. PTSD also causes changes in prefrontal cortical activity, which have been shown to explain the memory function deficits which are common in PTSD. Research has also found that veterans with PTSD show higher baseline cortisol levels than control subjects. These individuals also show elevated cortisol levels when compared to individuals with other anxiety disorders. Neurotransmitters which are involved in the flight-or-fight functions of the human body, such as norepinephrine, are also shown to be elevated in individuals with PTSD (Newport & Nemeroff, 2000). These changes in brain function primarily affect stress response and working memory capabilities; it is believed that these changes in functioning will be apparent during testing. It is also believed that due to the deficits which are presented in the typical individual with PTSD, an intervention which has been previously shown to cause positive changes in stress, anxiety and working memory will show a greater effect in these individuals. These deficits may allow any improvements to be better seen, and these changes will likely be of greater intensity than individuals who are neurotypical.

### **Mindfulness Theory.**

Mindfulness is an attribute of consciousness which is usually defined as being attentive and aware of what is currently occurring. Research has shown that mindfulness enhancement through training causes positive increases in well-being, including disengaging in automatic thoughts and unhealthy behavior patterns. Research has also shown that increased mindfulness is related to lower neuroticism, anxiety and depression. As well, mindfulness can benefit from training, which causes an increase in awareness and consciousness in the self (Brown & Ryan, 2003). The benefits which can occur from mindfulness are best expressed through mindfulness-based stress reduction (MBSR), which is a program of meditation and mindful awareness which

has been shown to be effective in treating a wide range of disorders and problems. This program, which focuses on activities that induce ongoing moment-to-moment awareness through meditative activities, has been shown to improve physical well-being, sensory pain and quality-of-life estimates (Grossman, Niemann, Schmidt, & Walach, 2004). By sustaining attention on the mental content which we experience daily, individuals can increase their perceptions which can lead to a greater sense of control.

The basic ideas underlying mindfulness theory is that the effects of stress can be countered by experiencing the current moment in an open and calm manner. This reduction even occurs in individuals with anxiety and depression, as mindfulness-based therapy (MBT), which includes mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR), works by changing the emotional and evaluative aspects which underlie many aspects of wellbeing (Hofmann, Sawyer, Witt, & Oh, 2010). Mindfulness training itself has been shown to be effective in increasing working memory capacity, as it enhances attention, improves visuospatial processing efficiency, and increases backward digit recall. A study by Mrazek, Franklin, Tarchin, Baird, and Schooler, (2013), found that a two week mindfulness training course led to a decrease in mind wandering and an increase in cognitive performance. These mindfulness practices create changes in the neural pathways, which affect cognitive functions such as attention and memory, as well as higher order cognitive processes such as comprehension and executive functioning. This allows the brain to better convert short-term memory into long-term memory. Quach, Jastrowski Mano, and Alexander, (2016), showed that short-term mindfulness practice improved working memory capacity in adolescents, which illustrates the ability of mindfulness to play a role in developing the various information pathways involved in working memory.

**Mindfulness to induce positive mental changes.**

Mindfulness is a way to recognize anxious feelings, clarify repetitive or maladaptive thoughts, minimize avoidant behaviors and self-monitor ones coping strategies. Mindfulness meditation also has been associated with relaxation and stress reduction (Carsley, Heath, & Fajnerova, 2015). Mindfulness techniques have been effective components of adult treatments for anxiety disorders, depression, borderline personality disorders and management of chronic pain. A study which sought to improve academic functioning and the internalization and externalization of problems involved teaching meditation to a group of students, with the results showing that the mindfulness induced by this activity caused an increase in positive behaviors, such as clear discrimination of thoughts and emotions, increased attention and relaxation, and enhanced attention regulation (Semple, Reid, & Miller, 2005).

Mendelson et al., (2010) ran a similar study, teaching mindfulness techniques and yoga intervention techniques to urban youth, with results showing enhancements in self-regulation and a reduction in activation and persistent or worrying thoughts. Support for the idea that coloring can induce a mindful state comes from a study by J. Lee, Semple, Rose, and Miller, (2008). Their investigation offered that structured drawing activities bring about an awareness that is inherent in mindfulness; this indicates that any activity which brings about moment-to-moment awareness can cause a state of mindfulness. The idea that coloring can induce a state of mindfulness has great support in the literature, as it increases positive behaviors associated with improved emotional and attentional thought (Semple et al., 2005). This in turn suggests that it can reduce stress and anxiety.

**Coloring as Mindfulness Therapy in the reduction of Stress and Anxiety.**



The present study builds on research which uses mindfulness as a therapy. As the patient is directed to think about the trauma which resulted in their disturbance, this then induces a state of mindfulness which could bring about an increase in the reduction of stress and anxiety. One emerging way to induce this state of mindfulness is through a coloring exercise. The research focused on college students without PTSD, and we hope to apply this reasoning to people who do have it. According to Curry & Kasser (2005), different types of art activities can result in a reduction of anxiety. A group of college students engaged in one of three coloring conditions; structured mandalas, structured plaid forms, or a free color activity on a blank sheet of paper. The researchers hypothesized that 20 minutes of coloring would result in a reduction in anxiety, with the largest reduction coming from the mandala condition. The idea that this condition would cause the greatest reduction comes from the very nature of the mandala; they are radial patterns with noted symmetry, designed to induce a calming, almost meditative state. Therefore, this condition was believed to have the largest effect. It was found that students in either the mandala or the plaid Condition experienced a significant reduction in anxiety, while participants in the free coloring condition did not. This study supports the idea that coloring in a structured condition can cause a significant reduction in anxiety, with the theory being that the complexity and structure of the designs induced a meditative-like state in the participants which helped reduce anxiety.

The findings that coloring can reduce anxiety are replicated in another study by Van Der Vennet & Serice, (2012). Van Der Vennet and Serice ran a replication of the original Curry and Kasser study, keeping many of the original conditions the same to determine if the previous results were true. The sample was varied and had state anxiety induced through a writing activity. The participants were then randomly divided into three groups, the participants being

placed once again in a mandala design scenario, a plaid design scenario, or a free color scenario. The researchers found that while their results closely mirrored the original study, there were some key differences, most notably in the anxiety reduction brought on by the Plaid Color Condition. While Curry and Kasser found that there was no significant difference in Anxiety reduction between the Plaid and Mandala condition as both reduced anxiety significantly, Vennet and Serice found that there was no significant difference in the reduction of anxiety in the Plaid and Free Draw Condition. But both studies showed that the Mandala consistently caused a reduction in anxiety, most likely due to the mindful and focused state that it induces.

The aim of the present study was to extend existing research and investigate effects of coloring in individuals with PTSD. As such, another focus in this study was to determine if coloring can induce mindfulness, which will then show a marked decrease in the state anxiety. A study by Carsley, Heath, and Fajnerova, (2015) was used to determine if anxiety could be reduced through a quick coloring activity. School age children were divided into two groups, with one group coloring a mandala, and the other group coloring in the “free” condition; Anxiety was then induced by telling the students they would be given a spelling test after coloring. The students were tested using the State-Trait Anxiety Inventory for Children State form (STAIC-S), at baseline and after coloring. This study had an almost even number of males to females, and seemed to indicate somewhat different results than the previous studies. While previous studies indicate that only the mandala condition results in the greater reduction of anxiety in subjects, this study seems to show that this reduction is stronger in females than males, and that at this age, males experience a greater anxiety reduction in the “free” condition. This study illustrates the idea that the Mandala is effective at reducing anxiety in children of both genders, but goes on to show that female children had a larger reduction of anxiety; this difference is believed to be

due to the disproportionate female samples in these previous studies, or possibly related to how the male motor skills develop. This study illustrates the need for comparison conditions in the current study, as factors such as gender caused a difference in the reduction of anxiety.

### **Coloring as Mindfulness Therapy in the increase of Working Memory.**

Working memory and coloring have previously been linked in several studies which examined working memory and drawing performance. A previous study by Panesi and Morra, (2016), showed that working memory capacity and executive functioning play an important role in the drawing ability of children. Working memory was shown to play a central role in cognitive development, with working memory capacity creating limitations on drawing performance. The researchers found that this significant relationship between working memory capacity and drawing occurred even when factors, such as age and motor coordination, were accounted for, indicating that there is a clear link between working memory and coloring. We hope to see if this connection can be strengthened through a coloring task.

A brief coloring task has been shown to cause a reduction in stress and anxiety; this task has also been shown to induce a state of mindfulness that can boost memory (Andrade, 2009). Andrade explored whether doodling while listening to information resulted in a mean increase in information recall on a memory test. She subjected randomly divided participants to a monotonous phone call and then asked them to recall as much information as possible in a surprise recall test. Participants were divided into a control group, and a doodling condition, which involved shading alternating squares and circles with a pencil. The participants were recruited immediately following another study was completed to induce maximum boredom, and were told they did not have to remember anything from the prerecorded tape, but that they should write down the names mentioned in the tape. The participants were then briefed on the

memory test, and half were then asked to recall the names, then the places, while the other half were asked to recall places and then names. Andrade found that monitoring performance in the doodling condition was significantly higher than in the control; in other words, doodling while listening to information may facilitate a deeper processing by reducing daydreaming, and may mean that a small attention task performed while learning can result in significantly higher test scores. It is from this previous research that we developed the idea that a coloring condition will invoke a state of mindfulness, which can then cause a reduction of stress and anxiety, as well as an increase in information recall.

We lastly come to the hypotheses of our proposed research. Based on previous research, we expect to see notable decreases in stress and anxiety as well as a notable increase in working memory in individuals who participate in 20 minutes of coloring. The second hypothesis of our study is that the presence of PTSD in an individual will affect the benefits seen by the coloring condition; we predict that individuals who suffer from PTSD will show greater decreases in stress and anxiety and greater increases in working memory as compared to those who do not suffer from PTSD.

## **Method**

### **Participants.**

Twenty-four veterans (15 men and 9 women; *M* age 32.25 years, *SD* = 8.481) from a public Florida university took part in this study, in exchange for extra credit or a 20-dollar incentive. Participants were between 21 and 49 years of age. These 24 participants were recruited through contacts at the University of North Florida Military Veterans Resource Center and the University of North Florida Disability Resource Center. The majority of participants were Caucasian (*n* =17), but there also were Hispanics (*n* =3), Native Americans (*n* =2), and an

Asian/African American participant (n =1). All participants were classified as individuals who have served in the armed forces and are current veterans, with only 8 participants responding positively to the PTSD measure. Half of the participants in the study served for less than or equal to 5 years (n = 12), 25% of the participants served between 5 and 10 years (n = 6), and the remaining quarter of participants served between 11 and 20 years inclusive. Participants met in person twice for a period of one hour, with a week between testing conditions. All participants who completed both hour-long sessions were compensated in the form of a \$20.00 gift card which were provided by an anonymous source.

### **Materials.**

*Primary Care PTSD Screen.* The Primary Care PTSD Screen is a four-item screen that was designed for use in primary care and other medical settings, and is currently used to screen for PTSD in Veterans at the VA. The screen includes an introductory sentence to cue respondents to traumatic events. Positive responses to three or more items indicates that the test taker has PTSD. This scale has a computed Cronbach's alpha of .78 (Freedly et al., 2010; Prins et al., 2003).

The PC-PTSD has good test retest reliability,  $r = .83$  ( $P < .001$ ), when they first developed the test, indicating good test-retest reliability (Prins et al., 2003). Furthermore, Freedly et al., (2010) demonstrated that the PC-PTSD had diagnostic efficiency of 85%, a sensitivity of 78%, and a specificity of 87%. An example item from this scale is: "Were constantly on guard, watchful, or easily startled?" In this case, an answer of "yes" would be counted as a positive response. The four-item scale was used due to the availability of previous research which provided support for this measures use in establishing PTSD; the PC-PTSD-5 would have been

used, but significant delays in study approval limited the researchers' ability to update the measures.

***Brief State-Trait Anxiety Inventory.*** The State-Trait Anxiety Inventory-State was administered to assess state anxiety levels. This inventory consists of six items with the highest item to item remainder correlations from the 20-question original inventory. All questions are measured on a four-point Likert Scale, where one is equivalent to almost never and four is equal to almost always. There is good internal consistency with Cronbach's alphas between .83 and .86 and it was also found to be highly correlated with the full 20-item State-Trait Anxiety Inventory (Tluczek, Henriques, & Brown, 2009).

***Perceived Stress Scale.*** We administered the Perceived Stress Scale to measure to what degree the individuals appraised their life situations as stressful. This scale consists of 10 questions in two areas, psychological competency and psychological vulnerability. Each question is rated on a five-point scale with zero being equal to never and four equaling very often (Lee, 2012). Scores in each area are then summed to obtain an overall score in each of the two areas, psychological competency scores range from zero to twenty and psychological vulnerability scores ranging from zero to thirty-five. Higher scores indicate a greater degree of the measured construct, psychological competency or psychological vulnerability. This scale measures the individuals current stress levels, and specifically asks questions regarding stressful situations and moods which have occurred over the previous month. Cronbach's alpha coefficients for these scales were .80 and .85, respectively and the correlation between these two factors was not statistically significant indicating that good discriminant validity exist (Lee, 2012).

***Backward Digit Recall.*** Working Memory was measured using a modified version of the Backward Digit Recall from a standardized assessment, the Automated Working Memory

Assessment (Alloway, 2007). The individual recalls a sequence of spoken digits in the reverse order. The test begins with recalling two numbers in backward order and increases by one item in each block, up to nine numbers per block. There were two trials in each block and the number stimuli were randomized for the different testing phases. Scoring was calculated based on the highest block (span) where they correctly recalled one of the two trials. Test reliability is reported as .86 (Alloway, 2007).

### **Procedures.**

Each participant completed testing in both mindfulness conditions (mandala and free draw) approximately one week apart. The experiment was a within participants design. The procedures for both sessions were the same, other than the different coloring activities. Regardless of the coloring activity, all participants colored for 20 minutes and were provided with 12 colored pencils. The participants completed these measures in person, using paper and pencil. The doodling group was included to establish if the difference in condition would result in different changes in the included measures; this condition could be considered the ‘control’ group. This was established as the control to mimic the natural doodling / drawing behavior which occurs in subjects when they are bored, as previous research has shown that individuals who doodle show a greater increase in working memory and greater decrease in stress and anxiety than those who do not. We hoped to compare this naturalistic behavior to one which was more structured, hence the mandala condition. A coloring time of 20 minutes was used to follow the studies by Curry and Kasser, (2005), and Van Der Vennet and Serice, (2012), who both used a coloring time of 20 minutes; this length of time has previously been demonstrated as effective in reducing stress and anxiety in participants.

During the first hour-long session, participants completed the informed consent form and a demographic questionnaire. Participants then entered phase 1, which was the pre-test phase, comprising completion of the Primary Care PTSD screening, a Perceived Stress Scale, the Brief State-Trait Anxiety Inventory-S and the Backward Digit Recall task. The working memory assessment was administered by asking the participants to repeat a string of numbers in reverse order. The researcher marked the participant's responses, and scores were calculated during testing; the measure was completed when the participant missed two strings in the same trial.

Phase 2 was the coloring condition, where the researcher provided a mandala-coloring sheet to the participant. The researcher directed the participants with written and verbal directions to use the provided colored pencils to fill in the provided image for a period of 20 minutes. Following the coloring activity, the participants entered phase 3, also known as the post-test phase, which consisted of completing the Perceived Stress Scale, the Brief State-Trait Anxiety Inventory-S and the Backward Digit Recall task.

The second hour long session took place roughly one week after the first session. During the second session, the procedures followed the same as in the first. The participants completed the same measures as in phase 1. In phase 2 (Coloring Condition), the researcher provided a blank 8.5" x 11" sheet of paper to the participant, rather than the mandala-coloring sheet; the only difference in instruction was indicating that the participant was allowed to draw anything they wanted. Time limit and number of pencils was not changed. The participants then completed the same measures in phase 3 as they did in the first session. The experiment concluded with the debriefing of the participants.

All testing was done in the same location, a research lab located on UNF's main campus. All participants were instructed in the same manner, and told specific instructions about what



was expected during the study. The participants were informed that they were only allowed to use the 12 colored pencils which were given, and that the testing phase would consist of 20 minutes. They participants were then allowed to work without distraction or interruption during the whole testing phase; they were informed when 20 minutes had ended, and were asked to stop drawing. Every effort was made to sure that the data which was collected was free from manipulation.

### **Results**

Wilcoxon analysis scores for coloring and PTSD condition are provided in Table 1 on the next page. A bar graph displaying all means for the PTSD x Coloring condition results are included in Graph 1. Descriptive Statistics for PTSD x Coloring condition are included in Table 2.

Table 1. Wilcoxon statistics of PTSD x Coloring Condition analysis.

Mandala, No PTSD	<i>p</i>	<i>Z</i>
Stress	.005	-2.839
Anxiety	.031	-2.162
Working Memory	.076	-1.774
Mandala, PTSD	<i>p</i>	<i>Z</i>
Stress	.733	-.341
Anxiety	.062	-1.866
Working Memory	.932	-.085
Free Draw, No PTSD	<i>p</i>	<i>Z</i>
Pretest Stress	.019	-2.347
Pretest Anxiety	.135	-1.495
Pretest Working Memory	.009	-2.62
Free Draw, PTSD	<i>p</i>	<i>Z</i>
Stress	.343	-.949
Anxiety	.344	-.946
Working Memory	.039	-2.06

Graph 1. Means of scores for PTSD x Coloring Condition results

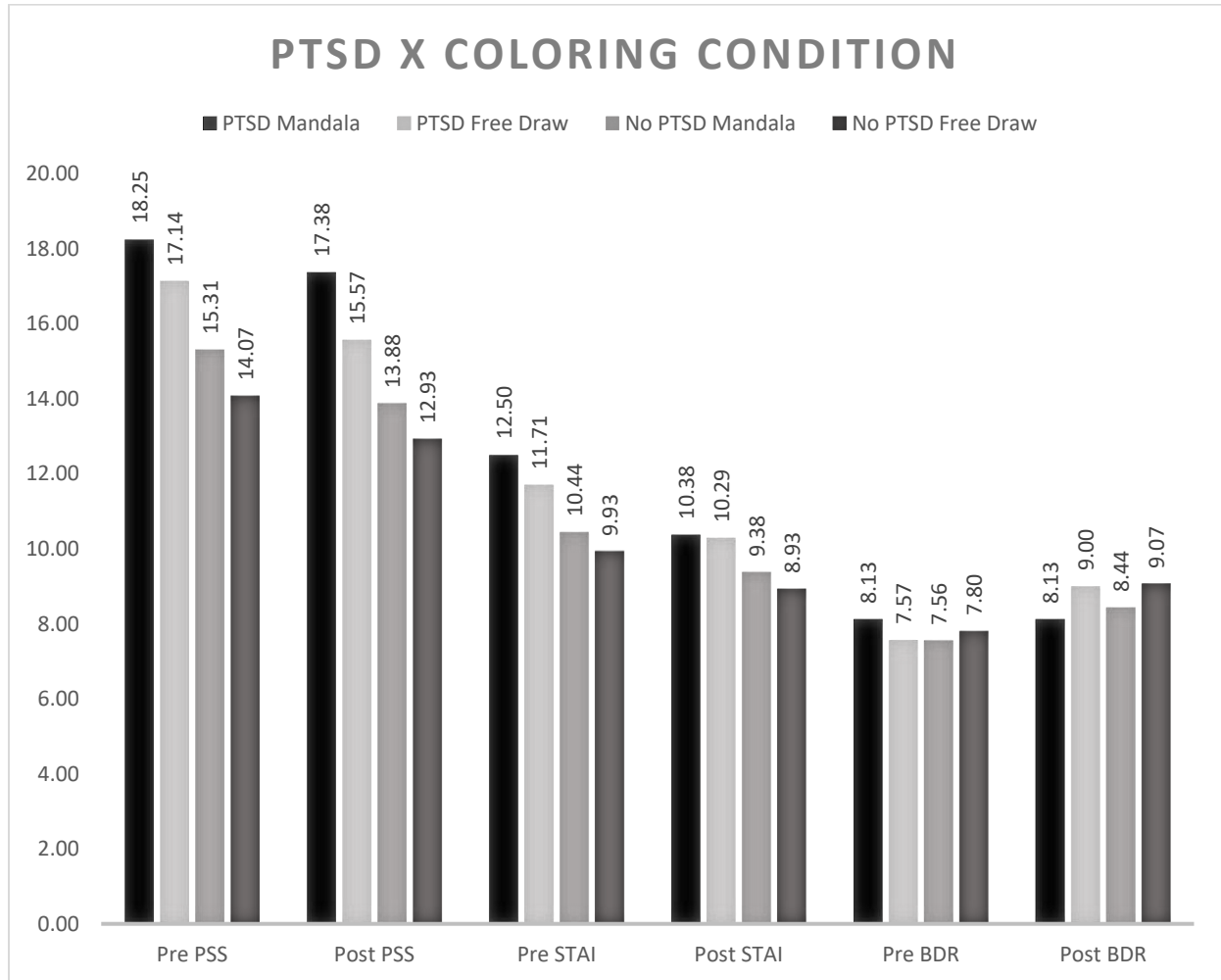


Table 2. Descriptive Statistics of pre-and posttest stress, anxiety, and backward digit recall trials scores for PTSD x Coloring Condition

Mandala, PTSD	Mean	Standard Deviation
Pre-Stress	18.25	3.854
Pre-Anxiety	12.50	2.204
Pre-Working Memory	8.13	2.416
Post Stress	17.38	6.675
Post Anxiety	10.38	2.774
Post Working Memory	8.13	2.997
Mandala, No PTSD	Mean	Standard Deviation
Pre-Stress	15.31	6.630
Pre-Anxiety	10.44	3.326
Pre-Working Memory	7.56	2.581
Post Stress	13.88	5.852
Post Anxiety	9.38	3.481
Post Working Memory	8.44	2.308
Free Draw, PTSD	Mean	Standard Deviation
Pre-Stress	17.14	4.018
Pre-Anxiety	11.71	3.352
Pre-Working Memory	7.57	.787
Post Stress	15.57	6.477
Post Anxiety	10.29	4.152
Post Working Memory	9.00	1.633

Free Draw, No PTSD	Mean	Standard Deviation
Pre-Stress	14.07	6.386
Pre-Anxiety	9.93	4.399
Pre-Working Memory	7.80	2.111
Post Stress	12.93	6.341
Post Anxiety	8.93	3.011
Post Working Memory	9.07	2.576

### **PTSD Screening.**

The Primary Care PTSD Screen was utilized during testing as a method of determining whether participants were displaying symptoms of PTSD. This measure was given at the beginning of both coloring sessions, and participants who answered positively to three or more questions in either session were included in the PTSD condition. It was determined that eight individuals were currently suffering from PTSD, while 16 individuals were not. Several individuals responded positively to multiple questions on the survey, but did not reach the cutoff criteria; they are currently included in the Non-PTSD condition.

### **PTSD Status.**

To determine the effect that PTSD condition had on the significance of the participant scores, the file was split by PTSD Status. The data was then analyzed using a Wilcoxon signed-ranked test. After being split by status of PTSD, non-PTSD did not show significance in the areas of stress ( $p = .341$ ,  $Z = -.953$ ) and working memory ( $p = .190$ ,  $Z = -1.310$ ), but did show significant decreases in anxiety ( $p = .046$ ,  $Z = -2.000$ ). In comparison, PTSD participants

showed significant decreases in stress ( $p = .000$ ,  $Z = -3.685$ ), anxiety ( $p = .011$ ,  $Z = -2.528$ ), and significant increases in working memory ( $p = .001$ ,  $Z = -3.185$ ).

### **Coloring Condition.**

To determine whether coloring condition played a role in the significant changes between testing, the data sample was split by coloring condition. After participant scores were split by coloring condition and then analyzed via Wilcoxon signed-ranked test, it was found that the mandala condition showed significant decreases in the areas of stress ( $p = .023$ ,  $Z = -2.281$ ) and anxiety ( $p = .008$ ,  $Z = -2.652$ ). But, working memory did not show significance ( $p = .193$ ,  $Z = -1.301$ ). Participant scores in the Free Draw condition showed significant decreases in the area of stress ( $p = .026$ ,  $Z = -2.226$ ) and significant increases in working memory ( $p = .001$ ,  $Z = -3.335$ ), but did not show significance in anxiety ( $p = .198$ ,  $Z = -1.286$ ).

### **PTSD x Coloring Condition.**

A Wilcoxon signed-ranked test was run on pre- and post- test scores of stress, anxiety and working memory scores from the target condition (Mandala) after the data set had been split based upon coloring condition and PTSD status. There was no significant difference in perceived stress across testing sessions for individuals without PTSD and in the mandala condition ( $p = .733$ ,  $Z = -.341$ ). There was not a significant difference between anxiety across testing conditions, although it was approaching significance ( $p = .062$ ,  $Z = -1.866$ ). Working Memory did not change significantly either ( $p = .932$ ,  $Z = -.085$ ). For individuals who did not have PTSD and were in the Free Draw condition, there was not any significant change between pre- and post-test scores for perceived stress ( $p = .343$ ,  $Z = -.949$ ) and state anxiety ( $p = .344$ ,  $Z = -.946$ ).

However, test scores for working memory were found to show significant increases ( $p = .039$ ,  $Z = -2.060$ ).

Individuals in the PTSD condition who were assigned the Mandala condition showed significant decreases in both stress and anxiety; with significance levels of ( $p = .005$ ,  $Z = -2.839$ ) and ( $p = .031$ ,  $Z = -2.162$ ) respectively. However, there was no difference between working memory scores, although it was approaching significance ( $p = .076$ ,  $Z = -1.774$ ). For individuals in the PTSD condition who were also in the Free Draw condition, there was a significant decrease in test scores on perceived stress ( $p = .019$ ,  $Z = -2.347$ ), as well as significant increases in working memory ( $p = .009$ ,  $Z = -2.620$ ). But, there was no significant difference in the scores for anxiety ( $p = .135$ ,  $Z = -1.495$ ).

## Discussion

The current results were somewhat dissimilar to findings from prior investigation. Several differences occurred in nearly every condition, which will be addressed and discussed in the following sections. Level of agreement with the hypotheses of this paper also will be addressed. Efforts which were made to reduce experimenter error appeared successful; every participant was handled in the same manner.

### Hypothesis 1.

**Mandala.** When examining the results of participant scores in the mandala coloring condition, it was found that these individuals showed a significant decrease in stress and anxiety. For an example of the mandala coloring condition, please refer to appendix 1. This was expected based on previous research, and adds further support to the idea that the mandala generates the calming, meditative state which is a key part of mindfulness. However, these individuals did not

show a significant increase in working memory. We can possibly attribute this to the inclusion of individuals with PTSD; individuals with PTSD show notably different neural activity as compared to individuals without PTSD, including in the brain regions associated with working memory and attention. It is therefore possible that while these individuals did show an increase in working memory, differences in total ability level created an effect which prevented this group from showing significance (Morey et al., 2009). This result is not in line with our hypotheses, as we believed the mandala condition would show a greater decrease in stress and anxiety, as well as a greater increase in working memory. This result shows that the differences were only significant for stress and anxiety, but not working memory.

***Free Drawing.*** The results of individuals in the free draw condition were somewhat different than what we expected; individuals in this group showed a marked difference in stress. These individuals did not display a significant decrease in anxiety. For an example of the free draw condition, please refer to appendix 2. It is believed that giving these individuals the ability to draw whatever they wanted allowed them to enter a mindful state. This is especially true of the stress condition; the ability to be creative and to determine their own design allowed them to enter a relaxed and calm state. Mindfulness itself has been shown to satisfy the need for autonomy in individuals, thereby increasing emotional and psychological well-being (Parto & Ali, 2011). However, the creative ability could be a double-edged sword; individuals in the free draw condition showed no significant decrease in anxiety. While the ability to govern their own creative path could have been a positive for some, it could have actually induced anxiety in others. This is supported by an individual who became frustrated during testing, and asked to finish early because they did not know what else to draw.



Individuals in this condition did display significant increases in working memory. The increase in working memory could have been due to the ability of the individuals to draw whatever they wanted; a notable example is that one individual drew a complete weekly schedule. This provides support to the previous assertion that a state of mindfulness was induced, and that the choice of what to draw was beneficial to some individuals. This result is also not in line with our hypotheses, as we believed the differences in stress, anxiety and working memory would all be significant. It appears that coloring condition does not significantly affect the changes in stress, anxiety and working memory.

## **Hypothesis 2.**

*Non-PTSD.* As noted in the results section, the Primary Care PTSD Screen was used to determine whether an individual was suffering from PTSD. While we did discover that eight individuals were clearly suffering from more than three symptoms of PTSD, several individuals met the criteria for less than three symptoms of PTSD, and were therefore not included in the PTSD group. When looking at the pre-and post-test scores of individuals who did not test positively for the presence of PTSD, it was found that they did not display notable differences in the areas of stress. The scores for these participants are therefore not what we expected to see, as previous research suggests that there would be a notable decrease in stress (Andrade, 2009; Curry & Kasser, 2005). We did see that these individuals noted a significant decrease in anxiety; this is what we expected based off previous research. We believe that these results occurred due to the nature of the testing conditions; while the mandala did induce the state of mindfulness, the lack of direction inherent in the free draw condition may have elevated stress levels. Another possibility is that the lack of direction did not allow the individual to filter outside stimuli, which should have caused an increase in working memory. These individuals did not display an

increase in working memory, which is the opposite of what we expected based upon previous research on neurotypical individuals (Andrade, 2009; Curry & Kasser, 2005). These results are somewhat in line with our hypothesis, as they indicate that the presence of PTSD could result in greater changes.

***PTSD.*** In direct opposition to the previous results, individuals who tested positive for the presence of PTSD showed significant decreases in both stress and anxiety, as well as significant increases in working memory. This could have been due to the nature of PTSD; this is a disorder which is noted for symptoms such as hyperarousal and hypervigilance, and any activity which allows for moment-to-moment control and the exclusion of external noxious stimuli may reduce these symptoms in these individuals (Liberzon et al., 1999).

Another possible explanation for the changes displayed is the nature of dissociation. Dissociation is a notable symptom of PTSD, which provides a type of avoidance in the individual that removes them from their stressful emotions. Approximately 76% of individuals with PTSD reporting higher dissociation scores than the general population, and higher dissociation scores are in turn related to higher PTSD severity (Kulkarni, Porter, & Rauch, 2012). Dissociation in individuals with PTSD has also been found to effect delta dipole density, with dissociative experiences being positively related to abnormal slow-wave generation in the anterior cortical structures and the left hemisphere, and negatively related to abnormal slow-wave generation in the right hemisphere (Ray et al., 2006). By utilizing this coloring technique, perhaps a further state of dissociation was induced in the individual. This then may have allowed for a quieting effect due to the removal of noxious stimuli. These results support our hypotheses, showing that individuals with PTSD show greater decreases in stress and anxiety, as well as greater increases in working memory.

**PTSD x Coloring.**

When the individual scores were split based upon both PTSD condition and coloring condition, results could be more closely examined.

***Mandala, No PTSD.*** Individuals who did not test positive for PTSD and were in the mandala condition displayed no significant changes in stress, anxiety or working memory across pre-and post-test scores. However, there was a trend in the direction of a decrease in stress and anxiety and increases in working memory.

***Free Draw, No PTSD.*** Individuals who did not test positive for PTSD and were in the Free Draw condition displayed less stress and anxiety after coloring; but, this was not significant. However, individuals in this group did display significantly higher working memory scores; this may have been due to the free-form nature of the drawing activity, which could have allowed for the individual to perform a task which was relaxing and yet cognitively stimulating to them.

***Mandala, PTSD.*** When we examined the results of individuals who tested positive for PTSD and were in the Mandala condition, we found that both stress and anxiety scores significantly decreased. This is in line with the previous research, and suggests that the mandala was successful in creating the expected state of mindfulness. However, there was no significant change in working memory, despite a trend towards improvement in scores. These results support our first hypothesis, as we noticed significant changes in two of the three areas measured based on coloring condition. As well, our second hypothesis is supported, as individuals with PTSD appear to have significantly decreased stress and anxiety.

***Free Draw, PTSD.*** Individuals who tested positive for PTSD and were in the Free Draw condition displayed significant changes in stress. It is believed that the meditative nature of

coloring was responsible for this significant change in stress. Anxiety did not show a significant change; this result could have also been due to the nature of the free-assignment, which did not offer direction and instead allowed for the individual to choose their own drawing. This lack of direction could have had the opposite effect, instead resulting in increased anxiety as compared to the mandala condition.

The individuals in this condition also displayed significant increases in working memory. The increases in working memory in this condition are more noticeable, perhaps due to the free-form nature of the condition. These results once again support both our hypotheses, as individuals with PTSD display significant changes based off coloring; these results may not be as substantial in every area measured as we had hoped, but still indicate support for our research.

### **Limitations.**

While our research was conducted on an appropriately sized sample as compared to other research in this area, sample size may have hidden possible effects. Several results were approaching significance, and with a larger sample size of both individual with PTSD and those without, we could have established stronger results. Another limitation is in the relatively brief nature of our research. The two sessions occurred over a period of roughly one week; this is a remarkably small time period within which to measure changes to stress, anxiety and working memory. A longitudinal study, done over a year long period, could have established whether any long lasting or permanent effects occurred. Furthermore, by implementing a regular schedule of reinforcement for the coloring behaviors, greater effects may be observed. A final limitation to this study is in the use of the PC-PTSD to measure PTSD status in individuals. While we managed to establish whether individuals were suffering from symptoms of PTSD, the actual diagnoses were not available to us. Partnering with either a mental health hospital or the U.S.

Department of Veteran's Affairs would afford us a solid sample of diagnosed individuals, which may serve to increase the differences seen in our results.

### **Future Directions.**

One future direction that this study may examine is in the long-lasting effects of this type of intervention. We hope to one day review the changes that this simple, cost-effective strategy may produce. Current results are very promising, showing increases in working memory as well as decreases in stress and anxiety; but we hope to determine whether these results are typical, as well as consistent over a period. Another future direction is in determining adherence to these behaviors. We would like to determine if this is a behavior which individuals such as veterans would be willing to adhere to, because without adherence these results cannot be applied effectively. The last area of future research is into the effect of coloring on dissociation. The current results indicate that we could induce a state of mindfulness in individuals with PTSD; but we are interested in determining how this will affect the individual over time. Dissociation allows for the individual to feel some control by removing themselves from the stressful emotions they experience, but research suggests that dissociation may in fact be related to maintenance of PTSD (Kulkarni et al., 2012). If coloring allows for the creation of dissociation in individuals with PTSD, it may in fact enable PTSD symptoms to continue. Any long-term harms which may come from coloring would be an important part of future research.

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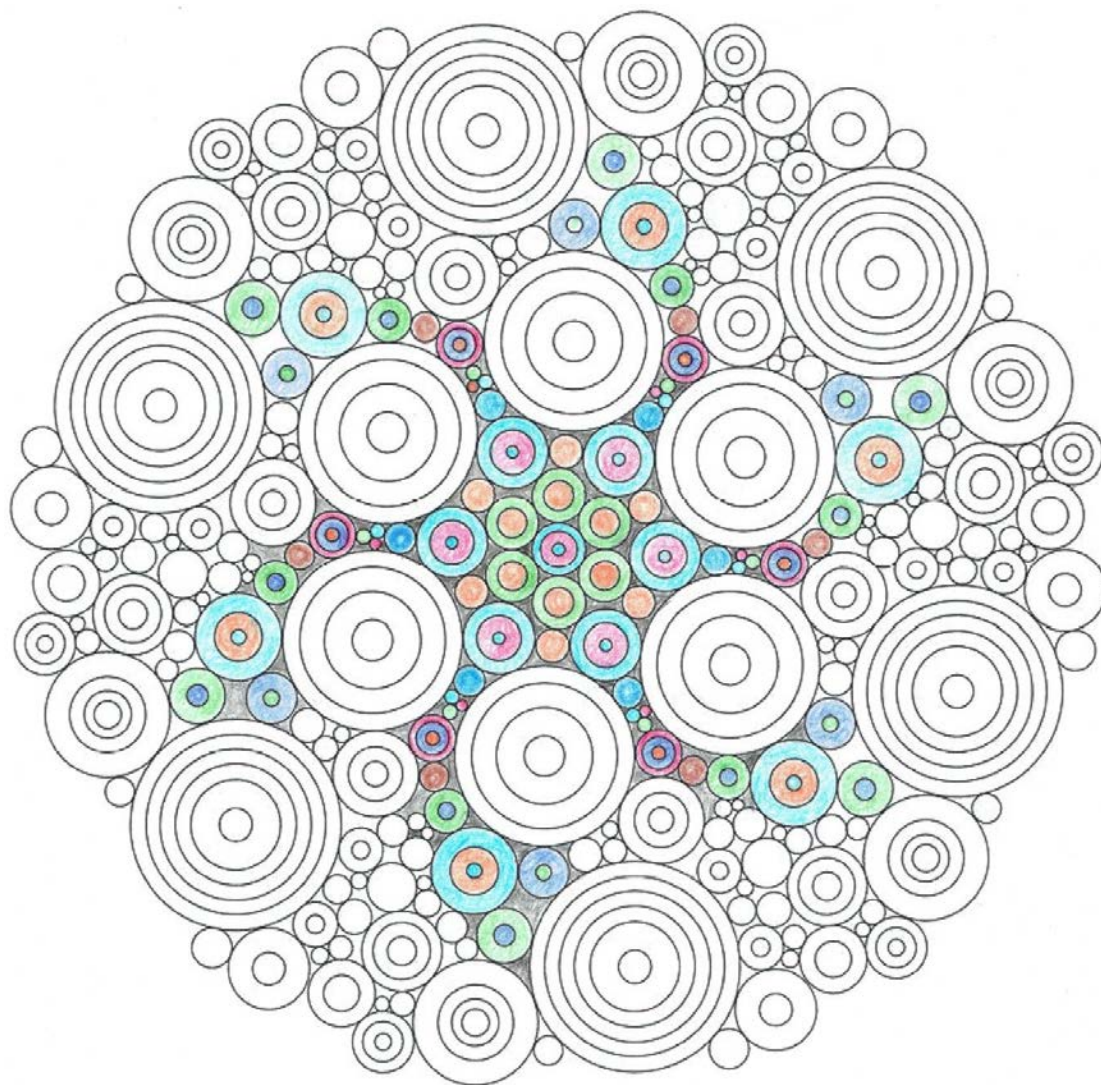
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### Vita

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Jourdan Rodak has presented his research at four conferences, including the annual convention of the Southeastern Psychological Association, as well as the annual Showcase of Osprey Advancements in Research & Scholarship. He is the first author of a chapter on Developmental Coordination Disorder and Working Memory in *Working Memory and Clinical Developmental Disorders: Theories, Debates and Interventions*, to be published in 2017 by the Taylor & Francis Group. He is currently employed as an interviewer for Social Security by Dr. Gabriel Ybarra, PhD.

**Appendix 1.**



Appendix 2.

