THE PHYSIOLOGY OF ART: THE EFFECT OF COLORING ON BLOOD PRESSURE AND HEART RATE AS MEASURES OF STRESS

by

Casey Yzquierdo, B.S.

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Committee Members:

Reiko Graham, Chair

Krista Howard, Co-Chair

Natalie Ceballos, Co-Chair

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LIST OF ABBREVIATIONS

Abbreviation	Description
STAI	State Trait Anxiety Inventory
PANAS	Positive and Negative Affective Schedule
ANS	Autonomic nervous system
HPA axis	Hypothalamic-pituitary-adrenal axis
BP	Blood pressure
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
HR	Heart rate
MB	Mindfulness-based
TM	Transcendental meditation
T1-T3	Time 1- Time 3
TP1-TP6	Time period 1- Time period 6
mm/Hg	Millimeters of mercury
DASS	Depression Anxiety and Stress Scale
HADS	Hospital Anxiety and Depression Scale

ABSTRACT

Claims have been made that certain forms of coloring may be efficacious in reducing stress. Coloring mandalas, in particular, has received attention because the repeating patterns and symmetry are thought to induce a meditative state (Curry & Kasser, 2005). The current study examined the effects of coloring on subjective and objective measures of anxiety. To this end, 110 participants completed baseline anxiety and mood measures, followed by an acute stressor, and were then randomly placed into one of three coloring groups (mandala, pre-drawn images, or free-draw) or a control group (choice of crossword, word search, or sudoku). They each completed their respective task for 15 minutes. Cardiovascular measures and self-reported anxiety were monitored throughout. State anxiety significantly decreased in all coloring groups (versus control), though there were no significant differences between the coloring groups. Blood pressure and negative moods decreased beyond baseline in all four groups after either coloring or control, while heart rate and positive moods returned to baseline. This finding did not support the hypothesis that mandalas and pre-drawn images are more beneficial at reducing anxiety than free-draw and control, but does provide evidence that coloring, in general, is conducive to lowering state anxiety.

I. INTRODUCTION

Recently, adult coloring books have risen in popularity and can be found everywhere, from checkout lines at the grocery store to newsstands and gas stations. An internet search using a popular search engine showed over 2.6 million results when searching for adult coloring books to purchase. Adult coloring books claim that coloring reduces stress, though empirical evidence of this claim is lacking. Art-making has been used for many centuries and many believe that creating art can help people meditate and alleviate the stress associated with day-to-day living. Art, coloring in particular, has been used to induce a relaxed state in individuals, which is correlated with lowered blood pressure (BP; Schrade, Tronsky, & Kaiser, 2011) and enhanced positive moods (Curl, 2008). The goal of the current research was to systematically examine the efficacy of coloring as a means of reducing stress via subjective (i.e., self-report) and objective (i.e., cardiovascular) measures. This study evaluated claims regarding the stress-reducing effects of coloring and its cardiovascular and subjective correlates. The results from this research help to inform whether coloring can effectively reduce stress, with implications for the treatment and prevention of anxiety.

II. LITERATURE REVIEW

II.1. Overview of Past Research

Few studies have examined art-making as it pertains to stress and anxiety, and even fewer have included objective methods of a physiological nature. A thorough review of the previous literature on art-making and stress follows, which has yielded little data regarding the physiological changes that occur while coloring, as many of these studies have only used self-report measures as a means of determining anxiety reduction. Since some studies have compared art-making to meditation, and since meditation has been studied with physiological measures, studies examining the effects of meditation on anxiety reduction are also incorporated into the literature review. This will serve as a bridge to help guide hypotheses for the current study about the physiological and subjective changes in anxiety that occur during art-making. First, a general overview of the proposed health benefits of art-making on stress will be discussed, followed by a critical review of the empirical evidence regarding the anxiolytic effects of coloring. The review focuses on coloring and/or creating mandalas (circular, symmetrical images with complex and repeating patterns) due to claims that these may be especially efficacious in reducing stress. Further information about stress and its effects on the cardiovascular system are provided, and studies will be discussed that examine how certain calming practices such as meditation affect cardiovascular reactivity in response to stress. The review ends with an overview of the purpose of the current research, which was to systematically examine the efficacy of adult coloring as a form of stress relief, with a focus on cardiovascular reactivity during and after an acute stressor.

II.2. Art and health

In recent years, artistic therapies have been used to help a variety of people and ailments, such as patients with chronic pain (Reynolds, Nabor, & Quinlan, 2000), patients with intellectual disabilities (Schrade et al., 2011), and emotionally disturbed children (Slayton, D'Archer, & Kaplan, 2010). As another example of the benefits of artistic therapies, people going through cancer and subsequent treatments undoubtedly deal with a tremendous amount of physical, emotional, and psychological stress. A meta-analysis conducted by Boehm, Cramer, Staroszynski, and Ostermann (2014) revealed that various artistic therapies can help in curbing anxiety in breast cancer patients. These therapies ranged from music to art to dance. The musical therapies used various self-report and physiological measures to assess anxiety, though the dance and art therapies only used self-report measures. For the studies that looked at the effects of arts therapies on anxiety, all showed significant reductions in anxiety scores (see Boehm et al., 2014 for a review). Although artistic therapies reduced anxiety and stress, they did not help with quality of life or depression levels in breast cancer patients, implying that another form of therapy would still need to be used alongside the artistic therapy in order to effectively treat depression and improve quality of life (Boehm et al., 2014).

Abbott, Shanahan, and Neufeld (2013) conducted a study examining the effects of artistic versus non-artistic tasks on stress reduction, as well as active versus passive coping approaches to each task. They stated that active coping is a physical action meant to lessen the effects of a stressor, whereas passive coping involves a minimal amount of physical action and more mental focus meant to reduce the mental aspects of a stressor. The researchers proposed that actively manipulating something with the hands is stress relieving, like squeezing a stress ball (Abbott et al., 2013). Part of what seems to be

helpful with art-making, according to this idea, is the physical nature of handling the tools that are being used and keeping the hands occupied. In their study, one of the ways they induced stress was with a mental arithmetic task that had participants count (aloud) backwards from 1,021 by thirteens as fast as they could for two minutes, starting over if they made a mistake (though the time would continue). The participants were then placed into one of four conditions: active artistic, passive artistic, active non-artistic, and passive non-artistic. Participants in the artistic conditions were shown artistic images before their task and told to let the images inspire them. Participants in the active artistic condition were then told to create a drawing of their own, and those in the passive artistic condition were told to rate a list of adjectives based on the images they viewed. Participants in the active non-artistic condition worked on a puzzle of U.S. maps, and those in the passive non-artistic condition used the same U.S. maps to make distance judgements of counties to the state capitals. After comparing self-reported stress scores throughout the study, Abbott et al. (2013) found that participants in the artistic conditions showed significant decreases in stress scores compared to those in the non-artistic conditions, though the coping approaches (active or passive) did not differ significantly. The benefits of the artistic conditions were thought to be due to the fact that artistic creation uses physical handling of materials (active coping) as well as mental creativity (passive coping) in order to make the art piece (Abbott et al., 2013). These data suggest that art-focused tasks may be a successful method to significantly reduce stress levels because it induces both kinds of coping mechanisms.

In accordance with this idea, Sandmire, Gorham, Rankin, and Grimm (2012) conducted a pilot study on the effects of art-making on anxiety in which the participants

in the experimental condition chose their desired art medium. The choices included coloring a mandala, painting on a blank page, making a collage, drawing a still life image, or sculpting clay (Sandmire et al., 2012). Participants in the control condition sat in a comfortable room for half an hour while the experimental group conducted their art-making. The measure used in this study to assess stress levels was the State Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1968), which was given before and after the activity (art-making or control). No stress induction method was used. This study revealed that the art-making group showed significant decreases in both state and trait anxiety levels compared to the control group, which did not show significant changes in anxiety levels. However, having the control group simply sit still and quiet could have induced boredom, or alternatively, simply having something to do for 30 minutes may be relaxing in and of itself, regardless of the activity. Unfortunately, no comparisons were conducted on the type of art chosen and reductions in anxiety; therefore, it is not known whether one form of art was more effective in reducing stress or if the different kinds of art-making had equal effects on anxiety. Although it is limited by the sole use of self-report and cannot make claims about what specifically is happening in the body during art-making tasks, the results from the Sandmire et al. (2012) study provide further evidence of the benefits of art-making, in general, as a means of reducing anxiety.

It has also been observed that one's mental focus during a task can play a role in the anxiolytic effectiveness of art-making. Curl (2008) had participants either draw or create a collage while focusing on either a positive or a negative (highly stressful) event they had experienced within the past two weeks. The positive focus was thought to create

a cathartic effect that would result in short-term reductions in stress. The negative focus was meant to create ruminating and stressful thoughts that were intended to cause short-term increases in stress. Stress levels were measured before and after the art tasks with the STAI (Spielberger et al., 1968) and with heart rate (HR) readings. Curl (2008) found that regardless of art condition, the positive-focus group showed significant decreases in state anxiety as indexed by the STAI after art-making compared to baseline scores. HR was monitored by measuring the pulse in the radial artery for 30 seconds before and after the art tasks, with no significant changes in HR for any of the conditions. However, the HR measure in this study was potentially unreliable because the researcher merely held participants' wrists and counted beats for 30 seconds instead of monitoring HR continuously during the task. Since HR was monitored before and after the art task, there were no data to examine how HR changed over time during the tasks. Nevertheless, this study provides evidence that specific types of art-making may not differ in their anxiolytic effects; however, if participants are ruminating over negative events, the anxiolytic benefits of art-making may be negligible.

The studies described thus far have shown that art-making can significantly reduce stress and anxiety in participants. However, while art-making and artistic therapies may help in reducing anxiety, they might not help to relieve all negative effects, such as depression or quality of life (Boehm et al., 2014). Keeping a positive focus during artistic tasks may be important in reducing anxiety (Curl, 2008). According to Abbott et al. (2013), it is possible that keeping the hands occupied with artistic tasks may be a major factor leading to stress relief. The type of art being created may not be very important (Curl, 2008), although this has not been systematically examined (Sandmire et

al., 2012). This lack of separation of art methods is a weakness in the research, as is the fact that self-report is the primary method of obtaining participant state anxiety scores. Furthermore, although stress was shown to reduce significantly as an effect of art-making, no data were collected about the time course of these reductions and the inclusion of physiological measures, such as HR and BP, is lacking. As mentioned, the studies reviewed above focused on art-making in general; therefore, it is not known whether certain kinds of art-making are superior to others with respect to anxiolytic effects. Studies examining the specific effects of adult coloring are outlined in further detail below.

With respect to adult coloring books, what is commonly seen in these books are images of mandalas and other similarly intricate patterns. Mandalas (circular, symmetrical images with complex and repeating patterns), in particular, have been used at least as far back as the 12th century, and have been used traditionally for meditative purposes by many, from Asian cultures to Native American cultures (The Mandala Project, 2010). Curry and Kasser (2005) examined whether there was something special about mandalas compared to free-drawing. They believed that the repeating patterns and symmetry of mandalas may help to induce a meditative state in those who color them. To test this, they first had the participants complete the State Anxiety Inventory (Spielberger et al., 1968), and then stress was induced by having the participants write for four minutes about a fearful event that they had experienced. After the stressor task, stress scores were measured again and then participants were placed in one of three coloring conditions; free-draw (blank paper), mandala, or a plaid design. The plaid design was used since it was equally geometrically intricate to the mandalas, and it was thought that

this would help to determine whether mandalas were special or if it was merely the intricacy level of the drawing to be colored that helped reduce stress. After coloring for 20 minutes, self-reported stress scores were measured again and changes in anxiety scores were analyzed over time as a function of condition. Curry and Kasser (2005) found that both the mandala and plaid conditions showed significant decreases in self-reported anxiety levels, whereas the free-draw condition showed no significant changes. These results suggest that coloring mandalas is no more special with regard to stress reduction than coloring an equally intricate pattern, as both seemed to provide enough complexity to distract participants away from the stressors.

Van Der Vennet and Serice (2012) replicated the study by Curry and Kasser (2005) to further examine the stress-relieving capabilities of coloring mandalas. All procedures were the same as the Curry and Kasser (2005) design, with the three coloring conditions (mandala, plaid design, and free-draw), a writing stressor, and State Anxiety Inventory (Spielberger et al., 1968) was administered before and after the stressor, as well as after the coloring task. Van Der Vennet and Serice (2012) found slightly different results than the original study, with significant reductions in stress levels being observed for those in the mandala coloring condition, but not for those in the free-draw or plaid coloring conditions. Van Der Vennet and Serice (2012) ultimately concluded that the most effective form of art-making with respect to reducing stress was to color mandalas.

Both the Curry and Kasser (2005) and the Van Der Vennet and Serice (2012) studies showed stress reductions during some forms of coloring and not others, but the difference in results of coloring mandalas versus plaid designs could simply be due to characteristics of the sample (age, sex or education): Curry and Kasser (2005) had

participants aged 18-22 (n = 84), they were all psychology students, and 65% of their sample was female; Van Der Vennet and Serice (2012) had participants aged 21-59 (n = 50), they were all psychology students (graduate and undergraduate), and 82% of their sample was female. An important limitation of both studies was that a control condition was not included in the design. It would have been very informative to see whether a simple non-artistic task (like a crossword or word search) had a similar effect as the free-drawing condition, or if free-drawing would actually have better anxiolytic effects than a non-artistic task.

All in all, the biggest limitation in the studies mentioned so far is their reliance on self-report measures of anxiety and the absence of more objective, physiological measures of stress, such as cardiovascular measures. In addition, many of the studies described did not include a non-artistic control condition that required focus and directed activity. Although it is important to know how people feel (self-report) about their subjective anxiety during art-making, this method can be flawed in that it is subject to social desirability effects and other demand characteristics. Furthermore, participants may not truly understand their own stress levels, which can lead to greatly varying responses across participants. Therefore, measuring the body's physiological responses to stress when art-making can provide richer information about how art-making contributes to reductions in anxiety and the time course of these effects. Physiological measures, such as HR and BP, provide an objective measure of stress levels, yielding additional information about how anxiety levels change throughout the task. Understanding this can help to either strengthen or weaken the claims that adult coloring books can reduce a person's stress. The data regarding how stress changes over time during art tasks can help

physicians to recommend a minimum time of coloring or art-making required in order to show beneficial anxiolytic effects. The next section will help to explain physiological stress systems, as well as some of the effects that stress can have on the human body.

II.3. Stress and the cardiovascular system

Stress is a prevalent issue in today's world and is impossible to avoid completely; nevertheless, we must manage it in order to maintain quality of life. Lazarus (1966) defines stress as a state that occurs when the anticipated requirements of a situation will take more coping ability than the person believes they can handle or requires more effort than they are prepared to expend. When people are under stress, other parts of their life may suffer, such as relationships or physical health. Juster, McEwen, and Lupien (2009) state that stress can lead to negative health outcomes, as shown by a faster aging process and less active immune system, making it easier to contract diseases and illnesses. If the stress is not remedied and continues throughout life, the negative health impacts increase drastically. This is in part due to the neural changes that take place as a result of chronic stress, making it increasingly more difficult to cognitively and physiologically process ongoing and future stressors (Juster et al., 2009). The American Psychological Association (APA, 2014) lists the health impacts of stress as causing problems with muscle tension, breathing, the heart and liver, and gastrointestinal and reproductive systems. It is important to study treatments for stress because excessive stress can lead to changes in certain behaviors as well, including altered eating habits, irritability, depression, anxiety, social withdrawal, and alcohol or tobacco use (Pruthi, 2016). These behavioral changes can then ultimately lead to further poor health outcomes, though the Mayo Clinic states that physical activity, participating in personal hobbies, and relaxation

techniques can help to combat the effects of stress (Pruthi, 2016).

The system activated during times of stress is the autonomic nervous system (ANS), specifically the sympathetic nervous system, which is important for the preparatory "fight-or-flight" responses (Olpin, 2010). Continuous activity of the sympathetic system inhibits the complimentary arm of the ANS, the parasympathetic nervous system, which is meant to return the body back to a state of homeostasis (Olpin, 2010). The ANS regulates functions like HR, respiration, and BP that, when elevated by the sympathetic nervous system, are key in giving the body increased strength and power to handle the stressor. This stress process is governed by the HPA axis (hypothalamic-pituitary-adrenal axis) and begins when a danger signal is received by the hypothalamus and then sent to the endocrine system (pituitary and adrenal glands), which sends hormones (mainly cortisol, but also epinephrine and norepinephrine) throughout the body to alert other systems of the potential danger (Olpin, 2010). When cortisol levels remain high in the body, feedback systems that are meant to get the body back to its normal state of rest are interrupted (Randall, 2011).

From an evolutionary standpoint, the stress response was meant to protect people from harm by preparing them to either fight for their life or flee from a dangerous situation. Today, that kind of physical danger is much less imminent in daily life and the more common stressors we face include more chronic stressors such as bills, upcoming deadlines, academic and professional pressures, and family or social strains. When people are stressed, their bodies are flooded with stress hormones that raise BP and HR, which is the body's attempt to increase physical energy and mental awareness for the pressing situation at hand (Krantz, Thorn, & Kiecolt-Glaser, 2012). The problem with this,

however, is that this process is only designed to be temporary. Prolonged exposure to stress (and the resulting hormonal and autonomic stress response mechanisms) can lead to negative health outcomes, such as chronic headaches, increased risk of cardiovascular disease, and depression (Krantz et al., 2012). A better understanding of the various methods that aim to reduce stress and their psychological and subjective effects is necessary in order to determine healthy ways of coping. Some people may turn to drugs or alcohol to manage their stress, but these are maladaptive coping behaviors that can create additional health problems (liver and heart problems, for example). It is important to implement healthy and adaptive coping mechanisms, like exercise or meditation, though it may be difficult to maintain adherence to these practices. Healthy lifestyle changes to increase coping can be difficult to adapt to in the long-term, but maladaptive alternatives can be detrimental over time. Furthermore, it is possible that behavioral adaptive coping mechanisms may be effective enough to control stress to avoid turning to medications.

As mentioned above, the stress response has hormonal and autonomic correlates, and cardiovascular measures can be a reliable and objective method for quantifying the effects of a stressor. HR is a common measure of stress and arousal; as stress increases, the sympathetic nervous system becomes activated and releases norepinephrine into the bloodstream, increasing HR (Lumma, Kok, & Singer, 2015). BP is another commonly used measure of stress, which consists of two numbers measured in millimeters of mercury (mm/Hg). There are two indices of note with respect to BP. The first is systolic BP (SBP), which is the maximum amount of pressure that is exerted on the vessel walls when the heart pumps. The second is diastolic BP (DBP), which is more of a “resting”

pressure, representing the minimum amount of pressure within the blood vessels that occurs when the heart is relaxed (Kate, Poonam, Sehgal, & Jasuja, 2016). The normal BP score for adults is considered to be approximately 120/80, and stress can raise these numbers drastically because a larger volume of blood is pumping more swiftly through the body. When given an acute stressor task of mental addition, participants showed significant increases in both SBP and DBP, as well as increases in HR (Phillips, Der, & Carroll, 2009).

Based on a comprehensive literature search, the only study to look at art-making on a physiological basis in terms of stress was done on a very specific population but is still informative with regard to the topic of art-making and stress. Schrade et al. (2011) tested the effects of art-making on BP in 15 people with intellectual disabilities (who can experience times of high psychophysiological stress due to living with their disabilities, including communication and coping difficulties), aged 55-74. There were two coloring conditions (mandala-making or free-draw) and a control condition (table activities like puzzles or games), each lasting 15 minutes. This study was a repeated measures design, with each person participating in each of the three conditions and acting as their own controls. The researchers counterbalanced the conditions to reduce any order effects. BP and pulse readings were taken before and after the tasks. The researchers did not examine HR in this study, but they found that SBP and DBP were significantly reduced after mandala-making. Decreases seen in the free-draw and control conditions were not significant (Schrade et al., 2011). What these data ultimately suggest is that mandala-making could be beneficial in producing physiological changes, although results may not be generalizable to other populations. Bodily stress, as indexed by BP, could be

significantly reduced with calming, noninvasive, non-drug therapies like art, which could potentially become a first-line defense against stress.

Despite lack of research on the anxiolytic effects of art-making, Slayton et al. (2010) suggest that art-making is a type of meditative practice that appears to show significant improvements in mood, self-esteem, and basic well adjustment, just as other meditations do. The results of the meta-analysis by Slayton et al. (2010) that analyzed the effectiveness of art therapies (including individual and group settings) imply that some types of relaxing practices could be a good therapeutic alternative to medications or expensive therapies. When it comes to the adverse effects of stress, it has been seen in many studies that certain meditative practices, like mindfulness training and yoga, can lower stress, increase sleep quality, and improve overall HR (Wolever et al., 2012). The effects experienced greatly depend on the type of stress relief being utilized (e.g., mindfulness meditation, art-making, Buddhist meditation, etc.), how often the particular form of stress-relief is applied, and general experience level with the chosen form of meditative practice (Britton, Lindahl, Cahn, Davis, & Goldman, 2014). Art-making could potentially be considered as a type of meditative practice (Slayton et al., 2010). It may not have the same long-term effects of meditation, as certain mindfulness factors in meditative practices contain general methods of looking at the world in a more positive manner (additional studies comparing art-making and meditation should be conducted to determine the differences on stress levels). However, the study by Curl (2008) showed increases in positive moods when focusing on positive events, and the study by Schrade et al. (2011) showed mandalas to induce a relaxing, meditative state. Along with these (Curl, 2008; Schrade et al., 2011), studies examining different meditations and their

effects on self-reported and physiologically-measured stress levels were used to guide the hypothesis in the current research that art-making would reduce stress as shown by BP and HR decreases.

II.4. Meditation and cardiovascular reactivity

Meditation has been shown to reduce stress in several studies, which is discussed in further detail below. Lumma et al. (2015) conducted an investigation of different forms of meditation to infer whether the meditative methods produced physiological improvements in responses to stress. They looked at breathing, loving-kindness, and observing-thoughts meditations, which are extremely common in Buddhism. These practices involve breathing, cognitive, and redirective thought processes that are indicative of typical meditative thoughts. Participants attended weekly training sessions and were told to practice their respective meditations at home for 13 weeks. HR measurements were taken at week 3 and week 13. Subjective measurements were also obtained each week (participants were asked how enjoyable the task was and how much effort was required). Lumma et al. (2015) found that the breathing meditation was much more anxiolytic (shown by decreased HR) than the other meditation types, probably due to the fact that it required much less effort from the participants than the other two forms of meditation. These findings further support the ideas of Britton et al. (2014) that meditation type is key to an individual's stress reduction.

A study conducted by Solberg et al. (2004) compared the effects of a single session of long-lasting meditation (up to three hours) versus rest (for one hour) on HR and BP to assess any potential hemodynamic changes that occur during meditation. The people recruited for the meditation condition were experienced meditators who meditated

regularly. Participants had BP readings taken before and after the activities, and HR was measured continually throughout the activities. HR showed a steady decline over the first two hours for the meditation condition compared to the resting condition, but no significant differences in BP were shown in either condition. The researchers speculated that this was possibly due to the experienced meditators having an already lowered baseline BP compared to the national average, as they regularly practice these calming techniques (Solberg et al., 2004). This may give insight into what meditation can do for some individuals' long-term physiology. If a clinician has a patient with high anxiety (regular periods of elevated HR without any actual external threats), they may be able to recommend meditation for 1-2 hours per day over an extended period of time in attempts to get the patient's regular HR to a healthier level. An important weakness of this study, however, is the fact that the participants were already experienced meditators who practice this method regularly. This gives little information of what can be seen for people who are beginners in meditative practices and trying to lower stress.

Goldstein, Josephson, Xie, and Hughes (2011) conducted a meta-analysis of studies that looked at various types of meditation on participants who exhibited BP within the pre-hypertensive and hypertensive range. These participants all had SBP above 120 mm/Hg and DBP above 80 mm/Hg, and the types of meditations studied included mindfulness-based (MB) approaches, transcendental meditation (TM), and other relaxation-based meditations. Goldstein et al. (2011) found that participants who were classified as having high baseline BP showed greater drops in their BP than those who were classified as having lower baseline BP. This was seen across the MB, TM, and relaxation techniques in this meta-analysis. This could suggest a target population

(individuals with higher BP) for artistic stress reduction, as those with higher BP readings in this analysis showed the greatest reductions in BP scores. This suggests that meditative methods like these may be beneficial to patients diagnosed with hypertension or pre-hypertension, either before turning to medications or in concert with medication.

Many studies have specifically targeted college students (and college-aged young adults) and aimed to find anxiolytic methods to help them in everyday university life. These young adults are particularly apt to be stressed, especially if they are attending college and are away from home for the first time (Mahmoud, Staten, Hall, & Lennie, 2012). College students are constantly trying to handle to the stress of exams, project deadlines, financial concerns, and interpersonal relationships. These experiences are generally stressful in themselves, and if other poorly developed habits are co-occurring, such as poor eating and sleeping habits, stress can have a much bigger impact on the health of that individual. It is imperative for students to be able to find healthy ways of coping with stress, rather than unhealthy coping behaviors like alcohol and cigarette use that are common in young adults (Pritchard, Wilson, & Yamnitz, 2007).

One meditation study that used self-report measures of stress examined the effects of mindfulness training on state anxiety and mood in college students (Shearer, Hunt, Chowdhury, & Nicol, 2015). Shearer et al. (2015) state that mindfulness is a particular way of paying attention to the present while suspending any judgments. Holding judgments for things one cannot change or control can increase one's mental stress and suspending those judgments (with practice) would be expected to lower that mental stress. Participants completed the State Anxiety Inventory (Spielberger et al., 1968) to measure stress and the Positive and Negative Affect Scale (Watson, Clark, & Tellegan,

1988) to measure mood. They were then placed into one of three conditions; a mindfulness intervention condition (with yoga-like instruction), a condition of interacting with therapy dogs, and a no-treatment control (they did not participate in mindfulness instruction or interact with dogs, but still completed the stress and mood questionnaires). Participants completed four sessions, with stress and mood measures administered after each session. The researchers found that mindfulness training elicited the greatest significant improvements on the stress and mood scales compared to the other two groups (although the therapy dog group also showed significant improvements). According to Shearer et al. (2015), these changes were likely due to the awareness the students had on their own internal changes (from the training in mindfulness procedures). A weakness of this study is the lack of physiological measures to examine stress levels, which could have produced a more accurate analysis of bodily changes during mindfulness exercises.

Another study was conducted by Nidich et al. (2009) that looked at TM (a common mind-body meditation) and how it affects SBP, DBP, psychological distress (Profile of Mood States; McNair, Lorr, & Droppleman, 1971), and coping ability (Constructive Thinking Inventory; Epstein, 2013) in students compared to a wait-list control group (these participants received the meditation treatment after acting as controls for the first meditation group). Participants who were considered to be at higher risk of developing hypertension (higher BP scores or stressful life events) were put into a separate group from the lower-risk participants, allowing for separate conditions of high-risk and low-risk subgroups. This study used a pre/post-test design, measuring stress scores at baseline before meditation treatment and then after treatment was complete (the TM was employed for three months). The researchers found significant drops in self-

reported psychological distress and coping ability for the meditation group compared to the wait-list control. However, the only significant decreases in SBP and DBP were seen in the high-risk subgroup compared to the rest of the experimental condition, suggesting that the benefits of this type of meditation may be specific to higher risk candidates. This evidence of meditation showing greater improvements specifically for those with higher stress levels compared to those with mild stress was also observed in the Goldstein et al. (2011) study.

Overall, these studies consistently suggest that certain meditative practices may help to lower blood pressure and heart rate, which can lower the risk of cardiovascular problems later in life. This is important because methods like these can be used in everyday life and are not harmful to the body like smoking, alcohol, or even some medications. Studies examining meditation and the cardiovascular system (Goldstein et al., 2011; Lumma et al., 2015; Nidich et al., 2009; Shearer et al., 2015; Solberg et al., 2004), as well as studies examining the effects of stress and the cardiovascular system (Britton et al., 2014; Schrade et al., 2011; Slayton et al., 2010; Wolever et al., 2012) and those investigating the effects of art-making on health and well-being (Abbott et al., 2013; Boehm et al., 2014; Curl, 2008; Curry & Kasser, 2005; Reynolds et al., 2000; Sandmire et al., 2012; Van Der Vennet & Serice, 2012) suggest that art-making and meditation both lead to lower stress levels in participants. This knowledge can be (and was) used to predict the anxiolytic effects of art-making on stress.

Much of the research regarding the effects of art-making on stress does not effectively include objective measures, like HR or BP, relying largely on self-report (Abbott et al., 2013; Boehm et al., 2014; Curl, 2008; Curry & Kasser, 2005; Sandmire et

al., 2012; Van Der Vennet & Serice, 2012). Nevertheless, these studies converge insofar as they all showed that art-making can significantly lower stress. Most art-making studies have not used any physiological measures of stress (although these measures are often used in meditation studies); therefore, the current research was to extend our understanding of the changes that occur in the cardiovascular system while participating in art-making, rather than only utilizing self-report measures. Judging by the larger collection of studies that focus on various meditations and their effects on physiology, and the fact that studies on art-making have shown anxiolytic effects in participants via self-report, it was presumed in the current study that art-making would show similar anxiolytic effects as mediation.

II.5. Rationale for the proposed research

Over 12 million copies of adult coloring books were sold in the United States in 2015 (BookScan, 2015), and the objective of the current research was to assess the validity of the stress-relieving claims of adult coloring. Self-report measures of stress can be flawed (Bergomi, Tschacher, & Kupper, 2013), so the current study also utilized BP and HR measures of stress levels in participants. The purpose of this study was to determine whether coloring does, in fact, lower stress in those who participate; specifically, whether there was a particular form of coloring (mandalas, pre-drawn images, or free-draw) that was best in reducing stress relative to a non-artistic control. A control condition (working their choice of a crossword, word search, or sudoku puzzle) was also included in this study to determine if time alone could be lowering the stress levels, rather than the art-making itself. The current research consisted of a pre-test/post-test design. Participants had baseline stress levels determined (BP, HR, and self-report)

and then completed a mild stressor. The mental arithmetic task used as the stressor in the Abbott et al. (2013) study was used to induce stress in the current research. The participants had two minutes to count backwards from 1,021 by thirteens, starting back at 1,021 if a mistake was made. After the arithmetic task, stress levels were again determined. Next, the participants either colored a mandala, pre-drawn image, blank page, or chose a non-artistic control task (crossword, word search, or sudoku). BP and HR were measured continually during the coloring and control tasks, and self-report measures were taken once more after completion of these tasks.

Both the Abbott et al. (2013) study and a study by Fechir et al. (2008) showed the arithmetic stressor to be significantly effective in raising stress levels in participants, measured by self-report and HR respectively. It was hypothesized that this arithmetic task would increase self-reported levels of stress, negative mood states, BP, and HR in this study as well, while positive mood states were hypothesized to decrease. The pre-drawn images used in the current study were similar to mandalas in their intricacy level, but they differed only because they were not specifically round like mandalas. Curry and Kasser (2005) showed significant decreases in self-reported stress scores (STAI) for both the mandalas and intricate plaid designs. Because of this, it was hypothesized that participants who were in both the mandala and pre-drawn image conditions would show significantly decreased self-reported stress levels, negative mood states, BP, and HR after coloring, compared to post-stressor levels, and increased positive mood states. In both the Curry and Kasser (2005) and Van Der Vennet and Serice (2012) studies, no significant changes were observed for self-reported stress scores (STAI) in the free-draw conditions. Because of these findings, it was hypothesized that those in the group who colored a

blank page would not show markedly lower self-reported stress levels, negative mood states, BP, or HR compared to their post-stressor scores, as well as no increases in positive mood states. The participants in the control condition (who simply completed a crossword, word search, or sudoku puzzle) were hypothesized to show decreases in self-reported stress, negative mood states, BP, and HR, and increases in positive mood states after their task due to the factor of time alone; however, this change was not expected to be as dramatic as those observed in the coloring conditions (Sandmire et al., 2012).

The results of this study will help in gaining an understanding of the claims that coloring reduces stress. Many studies have tried to validate the anxiolytic claims made by adult coloring books. However, these studies have relied primarily on self-reported stress, whereas the current research systematically examined changes in both self-reported stress and cardiovascular correlates of the stress response. If this coloring does in fact reduce BP and HR, this will provide objective evidence regarding the stress-relieving qualities of adult coloring books and inform our understanding of how coloring affects the cardiovascular system.

III. METHOD

III.1. Participants

Participants (N = 110; mandala, n = 28, pre-drawn, n = 28, blank page, n = 27, control, n = 27) were recruited from Introductory Psychology courses at Texas State University via the SONA system maintained by the Department of Psychology. Demographic data is listed in *Table 1* below (two participants in the control condition failed to answer any demographic questions). One participant had their physiological data excluded due to machine malfunction. Study protocol and procedures were approved by the Institutional Review Board at Texas State University.

Table 1: Demographic data by condition

	Mandala	Pre-drawn Images	Free-draw	Control
Age range	18-20	18-22	18-25	18-23
Male	3	3	8	11
Female	25	24	19	14
Hispanic	10	14	13	16
Non-Hispanic	18	13	14	10
Freshman	18	18	14	17
Sophomore	8	8	8	4
Junior	2	1	2	3
Senior	0	0	3	2

III.2. Self-report measures

Participants were asked to provide basic demographic information (age, ethnicity, gender, and education level). Self-reported state and trait anxiety were measured by Form Y of the State Trait Anxiety Inventory (STAI) questionnaire (Spielberger et al., 1968). This questionnaire consists of 20 questions to measure state anxiety and 20 questions to measure trait anxiety, with all responses given on a four-point Likert scale. The STAI Form Y-2 (trait anxiety) was given only at baseline. The STAI Form Y-1 (state anxiety) was given before and after the stress induction, and after the coloring or control task to determine stress levels at Time 1 (T1, baseline), Time 2 (T2, post-stressor), and Time 3 (T3, post-task). The STAI questionnaire has been used in most of the articles reviewed above and is widely used as a method of assessing self-reported stress levels. The STAI has shown high test-retest reliability (accounting for normal state-related changes), and when compared to other stress/anxiety scales, the STAI showed high content validity as well (Spielberger et al., 1968).

In order to measure changes in emotional states other than anxiety, the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) was used. This scale consists of 20 words (10 positive and 10 negative moods) that the participants indicated the extent to which they felt each mood at that particular moment using a 5-point Likert scale. The PANAS was given before and after the stress induction, and after the coloring or control task to determine moods at Time 1 (T1, baseline), Time 2 (T2, post-stressor), and Time 3 (T3, post-task). Crawford and Henry (2004) tested the reliability of the PANAS questionnaire by administering it to 1,003 participants and comparing it to their responses on two other known scales: Depression Anxiety and Stress Scale, DASS

(Lovibond & Lovibond, 1995) and Hospital Anxiety and Depression Scale, HADS (Zigmond & Snaith, 1983). The Positive Affect portion was negatively correlated with depression, with the Negative Affect portion correlating more positively with depression scores. They analyzed the data with Cronbach's α, showing the Positive Affect portion as having .89 reliability, and the Negative Affect portion as having .85 reliability. This demonstrates the convergent validity and internal consistency of this measure.

III.3. Physiological measures

The physiological measures consisted of SBP, DBP, and HR. SBP and DBP were measured with a NIBP100D continuous BP meter and the Biopac MP150 Data Acquisition System (Biopac; Goleta, CA). A pneumatic finger cuff was positioned on the index and middle fingers of the non-dominant hand of the participant (the dominant hand was used for coloring or control tasks) with a standard pneumatic arm cuff placed over the upper non-dominant arm over the radial artery (for calibration purposes). Due to the fact that these kinds of monitors also record "noise" from excessive muscle movements (movement artifacts), the participants were instructed not to make unnecessary movements and to move only as needed with their art-making. BP measurements were recorded continuously using Acknowledge 4.3 (Biopac, Goleta, CA). After recording, raw BP data were cleaned (to remove any movement artifacts), and SBP, DBP, and HR were computed. Summary mean values for SBP, DBP, and HR were computed over 5 minute intervals to determine physiological stress levels at six time points: initially for a 5-minute baseline reading (Time Period 1, TP1), for 5 minutes after stress induction (Time Period 2, TP2), and for the first (0-5 minutes), second (5-10 minutes), and third (10-15 minutes) 5-minute intervals during the coloring or control task (Time Period 3,

TP3; Time Period 4, TP4; and Time Period 5, TP5), and for 5 minutes after completing the task (Time Period 6, TP6).

III.4. Materials

The mandalas used in this study were taken from *Stress Less Coloring: Mandalas* (Gogarty, 2015). The pre-drawn pages were taken from *The Calm Coloring Book* (Coster, 2015). These designs had a medium-to-high level of intricacy. Participants in the coloring conditions chose one from a selection of 15-20 possible images that had previously been selected due to their level of intricacy. Free-drawing consisted of coloring on a blank piece of paper (8.5" by 11"). Coloring materials included colored pencils and graphite pencils. For the control condition, participants chose from 3 options of puzzles: crosswords of easy to medium difficulty (www.word-game-world.com; Fisher, 2009), word searches (www.superwordsearchpuzzles.com), or sudoku puzzles (www.krazydad.com/sudoku/; Bumgardner, 2017). After choosing which type of puzzle they preferred, they were handed 2-3 pages in case they finished with any before the time expired.

III.5. Stress induction

An arithmetic task (Abbott et al., 2013; Fechir et al., 2008) was used to induce acute, mild stress in participants. Participants were instructed to count backwards by thirteens out loud, as quickly as possible, starting from 1,021. If the participant made a mistake in counting, they were instructed to start again. The researcher had a sheet with the correct answers to ensure that participants completed the task without errors. The entire stressor task lasted two minutes (time did not start over if the participant made a mistake), measured via stopwatch.

III.6. Procedure

Participants came into the lab and were given the informed consent form to fill out. All participants filled out the questionnaires (T1) and the recording equipment was applied. Next, baseline cardiovascular measures were monitored for 5 minutes (TP1). Participants were then given a mild stress induction via arithmetic task while BP and HR were monitored. After the stressor, participants completed questionnaires (T2) and had their BP and HR monitored for an additional 5-minute period (TP2). The participants who were randomly assigned to the coloring conditions (mandala, pre-drawn image, or blank page) were instructed to color their chosen coloring or puzzle page(s) for 15 minutes while HR and BP were monitored (TP3-TP5). After the coloring activity, participants answered the questionnaires (T3) and had BP and HR levels monitored for a final 5-minute interval (TP6; see *Table 2*).

Table 2. Example of approximate timeline of procedures (total time: about 45 minutes)

12:00pm	12:10pm	12:15pm	12:25pm	12:30pm	12:35pm	12:40pm	12:45pm
Consent	BP (5 m.)	Stressor	STAI	Coloring or	Coloring or	Coloring or	STAI
STAI	HR (5 m.)	BP (5 m.)	PANAS	Control	Control	Control	PANAS
PANAS		HR (5 m.)	BP (5 m.)	BP (0-5 m.)	BP (5-10 m.)	BP (10-15 m.)	Exit lab
			HR (5 m.)	HR (0-5 m.)	HR (5-10 m.)	HR (10-15 m.)	

A control group with no art-making was used to assess whether time alone being distracted by another non-demanding task plays a significant role in stress reduction. Participants who were randomly assigned to this group were instructed to sit quietly in a room for 15 minutes and fill their choice of a crossword, word search, or sudoku puzzle. During the task, they had BP and HR monitored continuously (TP3-TP5). After the 15

minutes was complete, they also completed the questionnaires (T3) and had BP and HR monitored for a final 5-minute interval (TP6; see *Table 2*). It was imperative that participants in all conditions (the three coloring groups and the control group) did not have any reading materials, music, cell phones, or other items that could confound results, so they were instructed to put any of these items away during the study.

III.7. Analytic strategy

Trait anxiety scores were compared across groups to confirm group equivalence prior to performing further analyses to determine whether this variable should be included as a covariate in subsequent ANOVAs. Six mixed ANOVAs were conducted. STAI (Form Y-1) responses, PANAS responses (positive and negative subscales represent two separate variables), SBP, DBP, and HR served as dependent variables in these ANOVAs. For all ANOVAs, time served as the within-subjects factor (T1-T3 STAI and PANAS scores for self-report variables; TP1-TP6 BP and HR scores for cardiovascular measures). Condition (mandala, pre-drawn images, free-draw, and control) served as the between-subjects factor for all ANOVAs. Where necessary, Greenhouse-Geisser corrections to degrees of freedom were applied for within-subjects factors where the assumption of sphericity was violated. A priori hypotheses were confirmed with two-tailed *t*-tests.

IV. RESULTS

All participants in the 4 conditions were equivalent regarding trait-anxiety prior to any manipulations; $F(3, 104) = 0.91$, $p < .001$. The arithmetic stressor significantly increased state anxiety (mandala, $t(27) = -6.75$, $p < .001$; pre-drawn, $t(26) = -4.41$, $p < .001$; blank page, $t(26) = -3.52$, $p = .002$; control, $t(25) = -7.09$, $p < .001$), negative moods ($t(107) = -6.78$, $p < .001$), SBP ($t(107) = -6.79$, $p < 0.001$), DBP ($t(107) = -7.96$, $p < 0.001$), and HR ($t(107) = -5.24$, $p < 0.001$), and significantly decreased positive moods ($t(107) = 6.55$, $p < .001$). ANOVAs were run on all dependent measures. *T*-tests were run to determine any significant differences between time points.

The ANOVA on state anxiety scores (measured with the STAI Form Y-1) showed a significant effect of time, $F(1.76, 182.98) = 108.88$, $p < .001$, and a significant time x condition interaction, $F(5.28, 182.98) = 2.39$, $p = .037$. State anxiety significantly increased from T1 (baseline) to T2 (post-stressor) in all groups (mandala, $t(27) = -6.75$, $p < .001$; pre-drawn, $t(26) = -4.41$, $p < .001$; blank page, $t(26) = -3.52$, $p = .002$; control, $t(25) = -7.09$, $p < .001$). State anxiety significantly decreased from T2 (post-stressor) to T3 (post-task) in all groups, (mandala, $t(27) = 7.39$, $p < .001$; pre-drawn, $t(26) = 6.13$, $p < .001$; blank page, $t(26) = 5.83$, $p < .001$; control, $t(25) = 5.76$, $p < .001$). State anxiety significantly decreased from T1 (baseline) to T3 (post-task) in the mandala group, $t(27) = 3.05$, $p = .005$; pre-drawn group, $t(26) = 2.38$, $p = .025$; and blank page group, $t(26) = 3.88$, $p = .001$; but not the control group, $t(25) = 0.03$, $p = 0.97$. See *Table 3* for means; see also *Figure 1* for a graphic representation of the data.

Table 3: Means for STAI scores over time per condition

GROUP	*TIME*	*MEAN*	*N*	*SD*
Mandala	STAI T1	34.86	28	9.09
	STAI T2	48.54	28	12.56
	STAI T3	30.75	28	7.64
Pre-drawn	STAI T1	37.44	27	9.56
	STAI T2	44.96	27	11.54
	STAI T3	32.78	27	7.21
Blank Page	STAI T1	39.15	27	12.16
	STAI T2	47.37	27	11.45
	STAI T3	31.70	27	9.32
Control	STAI T1	34.58	26	8.20
	STAI T2	45.19	26	9.65
	STAI T3	34.54	26	8.44

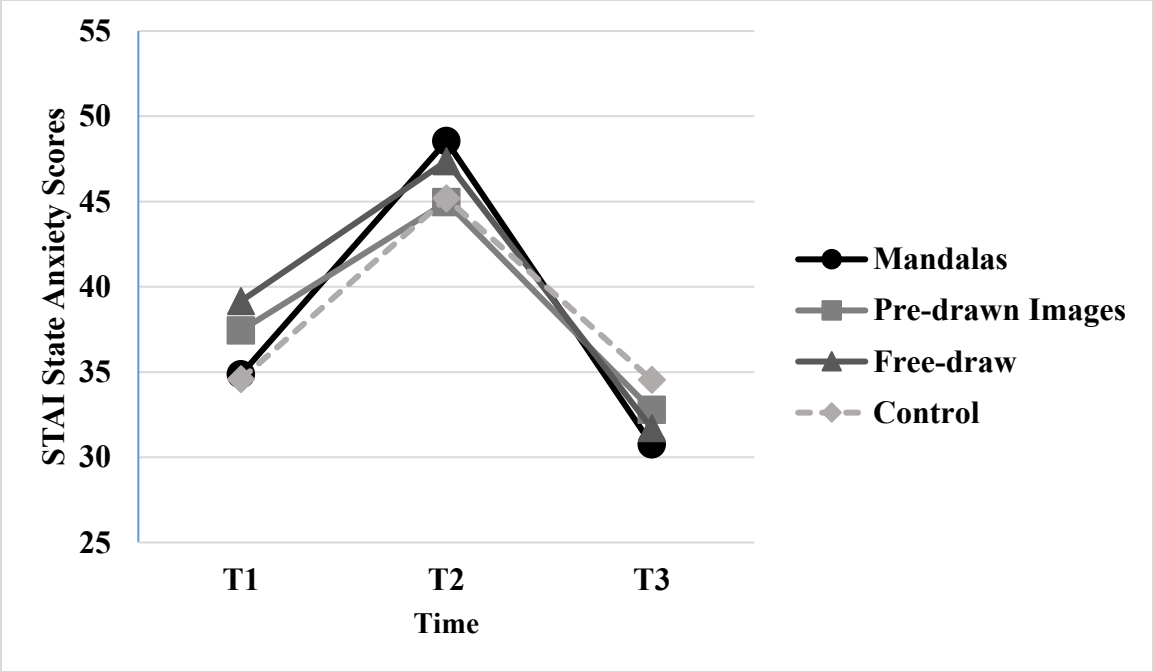

Figure 1: Graph of means for STAI scores over time by condition

Table 4: Means for PANAS positive mood scores over time (no significant differences between groups)

TEST	*TIME*	*MEAN*	*SE*
PANAS Pos.	T1	29.27	0.81
	T2	25.68	0.81
	T3	28.00	0.90

Positive moods were measured by the positive portion of the PANAS, which showed a significant effect of time, $F(2, 208) = 20.02$, $p < .001$, but no significant time x condition interaction, $F(6, 208) = 1.72$, $p = .117$. *T*-tests of the PANAS showed a significant decrease in positive mood from T1 (baseline) to T2 (post-stressor), $t(107) = 6.55$, $p < .001$, a significant increase in positive mood from T2 (post-stressor) to T3 (post-

task), $t(107) = -3.70$, $p < .001$, and a significant decrease in positive mood from T1 (baseline) to T3 (post-task), $t(107) = 2.28$, $p = 0.025$ (this was not significant after Bonferroni correction). See *Table 4* for means; see also *Figure 2* for a graphic representation of the data.

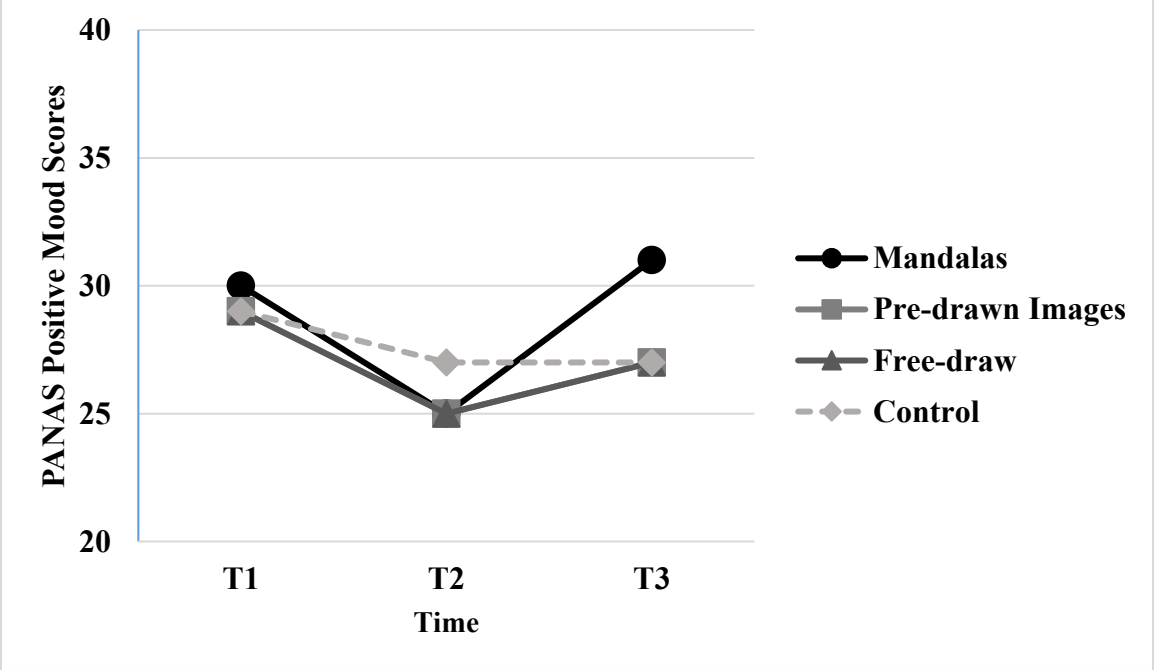

Figure 2: Graph of means for positive mood scores over time (no significant differences between groups)

Table 5: Means for PANAS negative mood scores over time (no significant differences between groups)

TEST	*TIME*	*MEAN*	*SE*
PANAS Neg.	T1	13.99	0.45
	T2	17.38	0.64
	T3	12.21	0.33

Negative moods were measured by the negative portion of the PANAS, which showed a significant effect of time, $F(1.52, 158.44) = 59.78$, $p < .001$, but no significant time x condition interaction, $F(4.57, 158.44) = 0.95$, $p < .448$. The PANAS showed a significant increase in negative mood from T1 (baseline) to T2 (post-stressor), $t(107) = -6.78$, $p < .001$, a significant decrease in negative mood from T2 (post-stressor) to T3 (post-task), $t(107) = 9.10$, $p < .001$, and a significant decrease in negative mood from T1 (baseline) to T3 (post-task), $t(107) = 5.30$, $p < .001$. See *Table 5* for means; see also *Figure 3* for a graphic representation of the data.

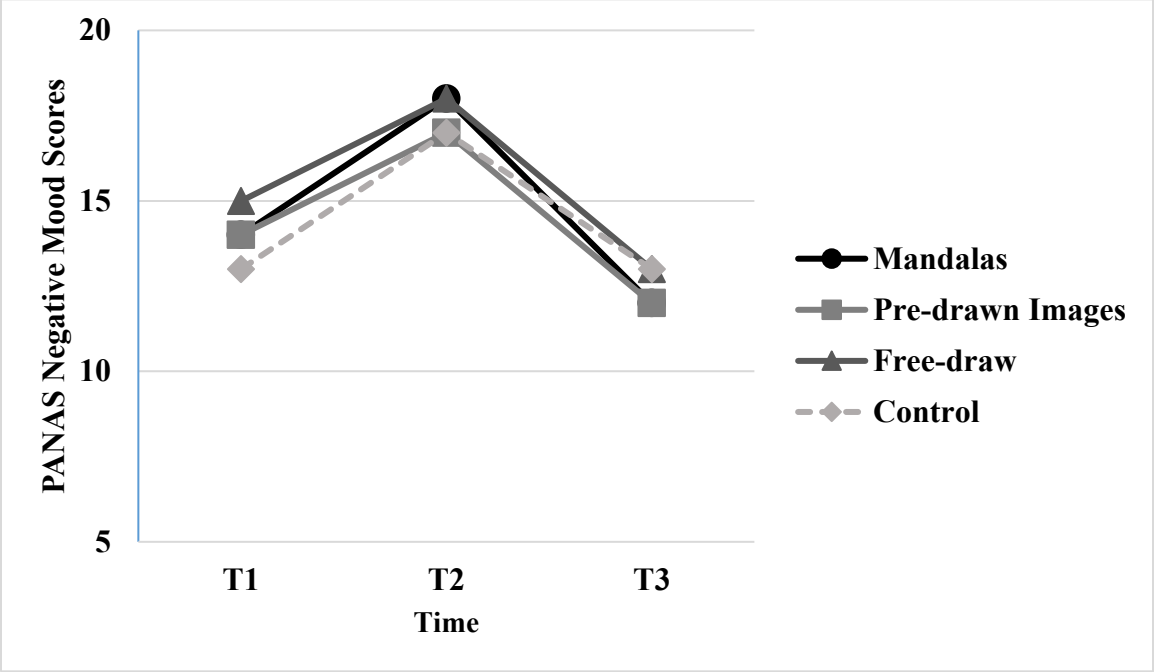

Figure 3: Graph of means for negative mood scores over time (no significant differences between groups)

Table 6: Means for physiological measures over time; SBP, DBP, and HR scores (no significant differences between groups)

PHYSIOLOGICAL MEASURE	*TIME*	*MEAN*	*SE*
SBP	TP1	120.05	1.32
	TP2	125.87	1.62
	TP6	114.07	1.57
DBP	TP1	78.27	0.84
	TP2	82.59	1.01
	TP6	74.45	0.84
HR	TP1	90.41	1.69
	TP2	96.93	1.78
	TP6	89.83	1.70

Though the physiological data were recorded six times during the procedure, only three time periods (TP1, TP2, and TP6) were analyzed in order to directly compare with the self-report data that were measured at the same time points. SBP showed a significant effect of time, $F(1.51, 157.05) = 43.51$, $p < .001$, but no time x condition interaction, $F(4.53, 157.05) = 0.71$, $p = .603$. *T*-tests of SBP showed a significant increase from TP1 (baseline) to TP2 (post-stressor), $t(107) = -6.79$, $p < 0.001$, a significant decrease from TP2 (post-stressor) to TP6 (post-task), $t(107) = 7.83$, $p < .001$, and a significant decrease from TP1 (baseline) to TP6 (post-task), $t(107) = 4.49$, $p < .001$. See *Table 6* for means;

see also *Figure 4* for a graphic representation of the data.

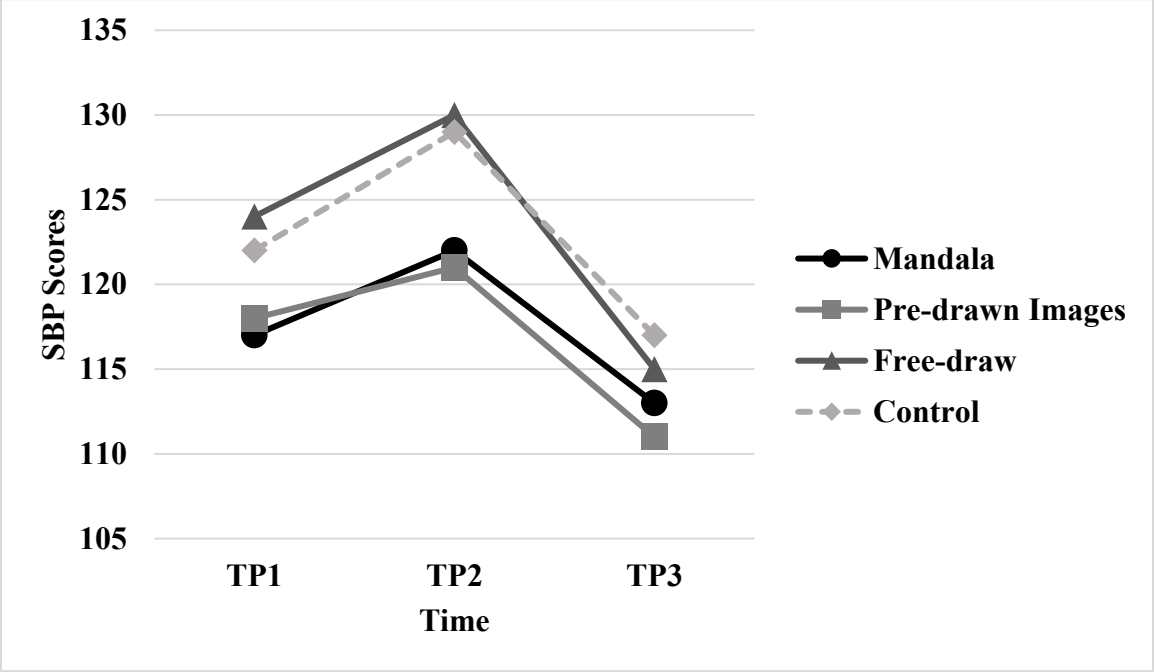

Figure 4: Graph of means for SBP scores over time (no significant differences between groups)

DBP showed a significant effect of time, $F(1.37, 142.87) = 41.21$, $p < .001$, but no significant time x condition interaction, $F(4.12, 142.87) = 1.86$, $p = .12$. *T*-tests of DBP showed a significant increase from TP1 (baseline) to TP2 (post-stressor), $t(107) = -7.96$, $p < 0.001$, a significant decrease from TP2 (post-stressor) to TP6 (post-task), $t(107) = 7.27$, $p < .001$, and a significant decrease from TP1 (baseline) to TP6 (post-task), $t(107) = 3.89$, $p < .001$. See *Table 6* for means; see also *Figure 5* for a graphic representation of the data.

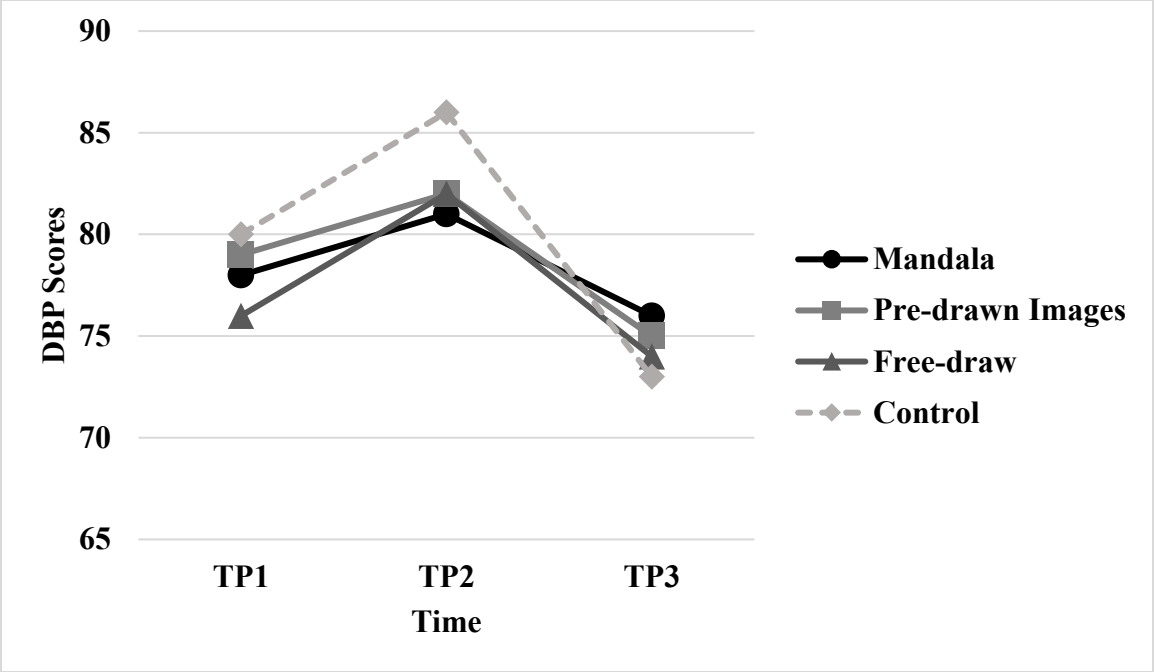

Figure 5: Graph of means for DBP scores over time (no significant differences between groups)

HR showed a significant effect of time, $F(1.81, 188.46) = 14.79$, $p < .001$, but no significant time x condition interaction $F(5.44, 188.46) = 0.62$, $p = .696$. *T*-tests of HR showed a significant increase from TP1 (baseline) to TP2 (post-stressor), $t(107) = -5.24$, $p < 0.001$, a significant decrease from TP2 (post-stressor) to TP6 (post-task), $t(107) = 4.37$, $p < .001$, but no significant change from TP1 (baseline) to TP6 (post-task), $t(107) = 0.43$, $p = .671$. See *Table 6* for means; see also *Figure 6* for a graphic representation of the data.

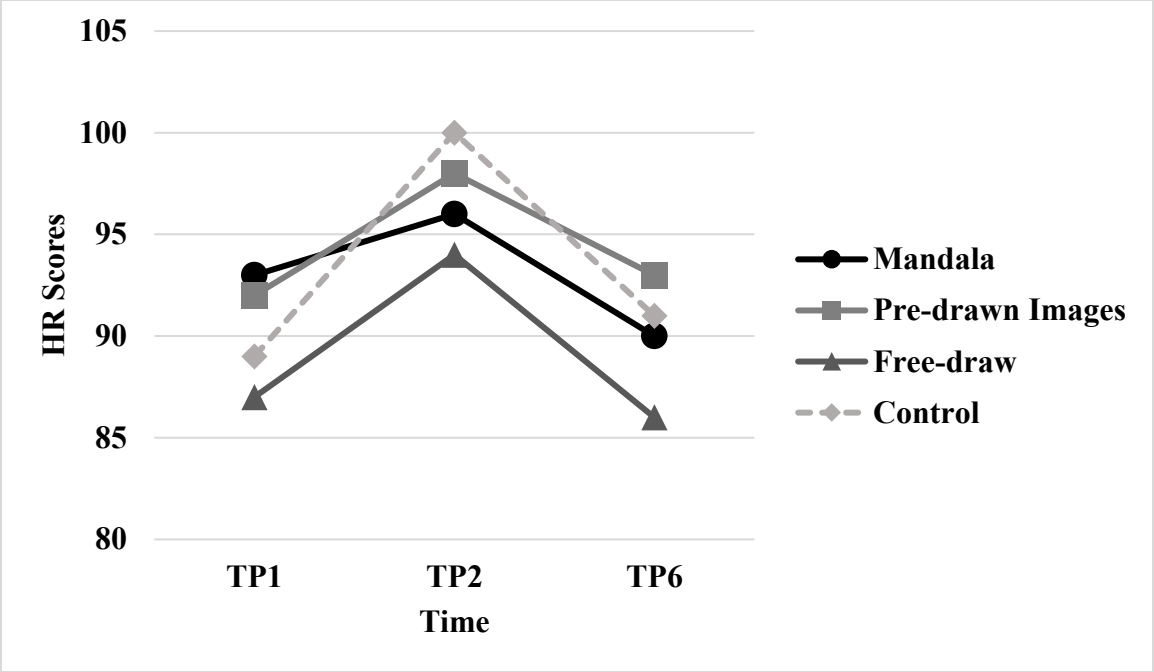

Figure 6: Graph of means for HR scores over time (no significant differences between groups)

V. DISCUSSION

Art-making and coloring are widely believed to reduce stress levels, but little research has studied the specifics of these claims using objective measures like cardiovascular reactivity. The purpose of this study was to fill some of the research gaps by examining the effects of coloring on both subjective and objective measures of stress. To this end, participants were monitored prior to and after an acute stressor (mental arithmetic) and either colored (mandalas, pre-drawn images, or free-drawing) or participated in a control condition (crossword, word search, or sudoku) while self-reported anxiety and mood, as well as cardiovascular variables (SBP, DBP, and HR) were monitored. The hypothesis was that certain forms of coloring would be more efficacious than others in reducing stress levels (induced by a mild arithmetic stressor, hypothesized to significantly increase stress levels). Specifically, it was thought that coloring mandalas and equally intricate pre-drawn images would produce the largest decreases in stress, whereas free-draw and control tasks would elicit smaller, if any, reductions in stress.

These hypotheses were not entirely supported by the data. The self-report measure of state anxiety (STAI Form Y-1) did increase due to the arithmetic stressor, but showed all coloring tasks to be beneficial to lowering anxiety compared to the control task. No differences were observed across coloring conditions (free-draw, mandalas, intricate pre-drawn images; see *Table 3* and *Figure 1*). The self-report measure of moods (PANAS) showed that positive moods decreased, and negative moods increased due to the arithmetic stressor. However, positive moods were not higher than baseline in any of the four groups at post-task readings (see *Table 4* and *Figure 2*), though negative moods significantly lowered from baseline after the tasks in all four groups at post-task readings

(see *Table 5* and *Figure 3*). SBP, DBP, and HR were all significantly increased as a function of the arithmetic stressor. SBP (see *Table 6* and *Figure 4*) and DBP (see *Table 6* and *Figure 5*) significantly lowered from baseline in all groups, but HR only returned to baseline levels in all groups (see *Table 6* and *Figure 6*). These findings will be discussed in further detail below.

The arithmetic stressor was hypothesized to increase stress levels from baseline in all participants, regardless of condition. This hypothesis was supported by the data, which revealed increases from baseline to post-stressor readings on state anxiety, negative mood states, SBP, DBP, and HR, while positive mood states decreased from baseline to post-stressor readings. These finding suggest that the arithmetic task was effective in inducing both psychological and physiological stress. The hypothesis that coloring mandalas and pre-drawn images would lead to lower stress levels in participants compared to free-draw and control tasks was not entirely supported. Self-reported state anxiety decreased from T2 (post-stressor) to T3 (post-task) in all four groups but decreased from T1 (baseline) to T3 (post-task) only in the coloring groups and not the control group; see *Table 3* and *Figure 1*. This suggests that coloring mandalas, pre-drawn images, and free-drawing were all superior to the control tasks in lowering state anxiety after an acute stressor. However, all other stress measures revealed no differences between the four conditions.

The current study was based largely on the Curry and Kasser (2005) study, as well as a replication of that study by Van Der Vennet and Serice (2012), but the results of the current study did not converge with these studies. Curry and Kasser (2005) found that coloring mandalas and plaid designs yielded significant reductions in state anxiety compared to free-drawing, and Van Der Vennet and Serice (2012) found that only

coloring mandalas yielded significant reductions in state anxiety when compared to coloring plaid designs and free-drawing. Results of the current study showed that coloring mandalas, pre-drawn images, and free-drawing were all beneficial to lowering state anxiety (*Table 3* and *Figure 1*) and that coloring was no more effective at reducing stress than doing puzzles. Additionally, it was believed that state anxiety, negative mood states, BP, and HR would concurrently increase in response to the stressor and decrease due to coloring, with positive mood states showing the opposite pattern (decreasing after stress and increasing due to coloring). This was supported when comparing baseline measurements to post-stressor measurements, but not when comparing baseline measurements to post-task measurements. When analyzing final post-task scores, it was observed that state anxiety scores were lower than baseline scores in all coloring groups versus control, positive mood states and HR returned to baseline in all four groups, and negative mood states, SBP, and DBP decreased from baseline in all four groups. It was expected that, regardless of condition, if one measure returned to baseline, the other measures would return to baseline as well (or below baseline, respectively). This was not the precise pattern observed. The changes in the individual measures did not match one another, and the changes in subjective measures (STAI and PANAS) did not match changes in objective measures (SBP, DBP, and HR). The fact that some stress measures reacted differently than others in this study provides no insight for whether coloring is an effective means of anxiety reduction; however, the overall pattern of results suggests that coloring does not confer any special benefits beyond distraction, since coloring was not superior to the control condition except with respect to self-reported anxiety.

An examination of more recent research on coloring may yield some insight into

why self-reported anxiety did not track with cardiovascular variables. A review of recent research, as well as older studies, suggests that there may be a dissociation between subjective and objective measures of stress. For example, Keogh and Creaven (2017) compared the differences between free-drawing, coloring, and text copying on perceived stress, task enjoyment, BP, and HR. While they found that participants enjoyed the free-drawing and coloring tasks more than the control task, no significant differences were seen between any of the groups on perceived stress, BP, and HR. Similarly, Haiblum-Itskovitch, Czamanski-Cohen, and Galili (2018) hypothesized that art-making with gouache paint would create the highest emotional response and higher heart rate variability (both associated with enjoyment and relaxation) in participants compared to art-making with oil pastels and pencil, based on the fluidity of the art materials. In fact, they actually found higher emotional response to the oil pastels compared to gouache paint and pencil; however, no significant differences between art materials were found for heart rate variability. Consistent with the dissociation between subjective and objective measures, Sandmire et al. (2016) compared coloring mandalas to clay modeling, painting, and a control condition (non-artistic tasks of identical tests, timelines, and group sizes) on state anxiety and heart rate variability. State anxiety was reduced in all four conditions, but heart rate variability decreased in only the control. Additionally, Lee (2018) and Ashlock, Miller-Perrin, and Krumrei-Mancuso (2019) both tested various art materials and their effects on stress measures and found no specific art material to be most efficacious in reducing stress on either subjective or objective measures, converging with the results of this study. In conjunction with those of the current study, these results indicate that there does not seem to be a particular form of art-making that is superior to

others for stress reduction. Rather, many forms of art-makings can be beneficial. In addition, there appears to be a disconnect between psychological (subjective) and physiological (objective) data when studying the effects of art-making on stress.

While there may be no ready explanation for the dissociation between physiological and psychological results found in this and other studies, there are several possibilities that may be worthy of future consideration. First, physiological measures are influenced by a large number of factors, such as diet, genetics, psychosocial factors (relationships, work, school, etc.), and socioeconomic status (Smith et al., 2017), which may have differed systematically across groups. Furthermore, individuals may have had idiosyncratic differences in subjective feelings of enjoyment, creativity, engagement, meditation, and even boredom with the tasks, which could also have contributed to the physiological processes measured in the current study (Muthard & Gilbertson, 2016). These factors were not examined in the current study and future studies would benefit from closer examination of individual differences in physiological and personality differences to determine whether the anxiolytic benefits of art-making are universally beneficial or if they are best suited toward specific individuals (e.g., on the basis of physiological or psychological differences).

It was thought that the effects of art-making would be similar to those observed during meditation due to Slayton et al.'s (2010) claim that art-making has meditative qualities and could produce the same effects as meditation. However, the data from the current study did not match many of the meditation studies that were discussed above, suggesting that Slayton et al.'s (2010) claim is not supported. It may be the case that meditation is not the appropriate model to explain art-making and its effects on anxiety.

Meditation and art are different activities that require different foci. Those practicing meditations tend to focus inward, paying close attention to aspects of their mind and body (Nidich et al., 2009). Art-making, on the other hand, involves more of an outward focus. When people make art, they must interact with items in the environment in order to express their creative ideas. This outward process can allow for a range of emotions within the creator, however, which could have ultimately occurred in the current study and varied systematically across the conditions. These emotions, whether positive or negative, could have had differential effects on subjective and objective markers of stress. Since the current study failed to monitor participants' specific emotions (other than the rigid self-report questions), these were not able to be factored into any hypotheses of how stress scores were affected by coloring or control tasks. It would have been informative to ask participants open-ended questions about their thoughts and emotions during the current study. Moreover, adding a meditation condition in the current study that could have been compared to the coloring and control tasks would have helped to confirm or refute the claim that art-making is meditative (Slayton et al., 2010). These inclusions could have informed the research of what factors led to the conflicting patterns observed throughout the subjective and objective measures and may provide a fruitful direction for future research into the anxiolytic effects of coloring.

After a review of similar studies involving art therapy and art-making as they pertain to stress reduction, it is clear that there are inconsistences between subjective and objective measures of stress (including the current study). Although previous research was used to guide study hypotheses and experimental designs, no clear picture regarding the efficacy of art in reducing stress emerges. Rather, the literature is replete with

inconsistencies. There is little to no converging evidence that a particular art medium or coloring type was most efficacious in reducing stress, a finding that is also supported by the current study. Nevertheless, a review of relevant studies suggests that several factors may be responsible for this lack of convergence, including tactility, creativity, and flow.

The first theme that emerged from the literature review is the role of tactility in art-making; it seems important to be keeping the hands busy, as Abbott et al. (2013) suggested. Haiblum-Itskovitch et al. (2018) mentioned the importance of interacting with the art materials and handling them as a crucial process in art therapy. Since all art-making involves a tactile element, the varying claims of previous studies that any particular art form is more beneficial (or not) to stress reduction than others can simply be explained by the fact that people are using their hands. The results of the current study also support this concept, since all four conditions were tactile in nature and yielded similar anxiolytic effects (aside from state anxiety, which was significantly lowered in the coloring versus control groups). However, this is not the only factor involved in successful stress reduction with art therapy. When tactility was tested with a stress ball compared to clay-working in stress reduction, the clay-working outperformed the stress ball in as little as five minutes (Kimport & Robbins, 2012). This suggested that it is not simply the manipulation of items with the hands that is helping people relax when they are engaged in art-making. Although art-making and squeezing a stress ball are both tactile activities, art-making additionally involves a great deal of planning and creative thinking. However, since the control condition also included a tactile component, this possibility requires further examination.

It is possible that in addition to tactility, the planning and creative process of art

may also have contributed to inconsistencies across studies. Creativity alone has been shown to be effective in reducing stress, but not conclusively across multiple studies. For example, Abbott et al. (2013) showed stress reductions in participants who viewed artwork, whether they drew their own picture after viewing, were inspired by the artwork to create their own art piece, or merely rated adjectives about the artwork they had viewed. These results suggested that art exposure alone may be involved in stress reduction. However, Bolwerk, Mack-Andrick, Lang, Dörfler, and Maihöfner (2014) found that evaluating art produced no changes in psychological resiliency among participants, but that creating art did lead to significant improvements. These two studies tested the effects of creative tasks on psychological measures but did not produce the same results. This is another example to show how studies of a similar nature do not converge on a definitive conclusion in this field, just as the current results did not align with those produced by Curry and Kasser (2005) or Van Der Vennet and Serice (2012).

According to the studies evaluated that include tactile and creative tasks, it is possible that creativity and tactility, when applied together in art therapy, could provide the most efficacious means of reducing subjective and objective measures of stress. This may inform the results of the current study, since negative moods and BP both decreased below baseline after the coloring and control tasks (the control tasks were not inherently creative, but did involve some aspect of creative thinking in order to solve crosswords or sudoku puzzles). However, Kapitan (2013) states that some people show beneficial increases in arousal when creating, which acts as an intrinsic motivation to move forward in their artistic projects. For others, this arousal could be stressful, and art could potentially have a harmful impact. If this is the case, then the premise that creativity and

tactility are sufficient means to reducing stress would not be supported, at least not across all individuals. Not only do people need to use their hands and their creative minds when art-making, but they also need to be mentally involved to an extent that they are distracted from the stressors affecting them. If this is the case, the results of this study (which showed no consistent differences between coloring and doing puzzles) suggests that creativity might not be as important for stress relief as distraction or engagement in a pleasurable activity. Because participants in the control condition were able to choose an activity that they preferred (vs. an obligatory activity), this question awaits further scrutiny.

One theory of this mental distraction during a task is the concept of "flow," which was the final theme that emerged from the current literature on art-making. Csíkszentmihályi (1991) describes "flow" as a state of consciousness in which people can lose track of time due to complete involvement in a task, pure enjoyment, creativity, and a focus on life. It is the act of being in the "here-and-now" or "the zone" (Chilton, 2013). Flow can be experienced in many tasks, such as sports, conversation, work, play, and art. It is achieved whenever one's skill level is met with a challenge that is tough, yet attainable (Csíkszentmihályi, 1991). When it is experienced in art-making, people tend to feel enjoyment, mental relaxation, and a stronger sense of self (Kaimal, Ray, & Muniz, 2016). Though state anxiety significantly reduced from baseline in the coloring versus control tasks in the current study, all other stress measures were not affected differently by the separate conditions (positive mood states and HR returned to baseline in all conditions, negative mood states and BP reduced below baseline in all conditions). These results do not support the premise that participants achieved a state of flow during the

coloring tasks. Alternatively, doing puzzles (control condition) may have also induced a flow state, since participants were allowed to choose a preferred control activity. It is possible that participants in the control condition also achieved a flow state. However, the current study did not monitor this possibility, since participants were never asked about their thoughts during the tasks. It is possible that participants were not challenged enough by the coloring tasks to be distracted from their stressors. Alternatively, it is possible that some participants were able to achieve a flow state, but not others. If the art tasks had been more complex and challenging and if more time to create was allowed, it is possible that the coloring conditions would have produced significantly different results than the control condition. Additionally, if participants had been asked about their thoughts during the tasks, it could have been determined whether they achieved a state of flow and were distracted from their stressors by the coloring or control tasks. This also could have helped to support whether or not combining tactility, creativity, and flow was a beneficial means to reducing stress levels.

V.I. Limitations and future directions

There are several limitations of the current research. Although the study included 110 participants, they were split into four separate groups of 27-28 participants each. This, along with small effect sizes, may have underpowered the study and not allowed for subtle differences between participants to be detected, which could provide less generalizability to the overall population. In addition, the sample consisted of Psychology students from an introductory course, which also hinders generalizability. Individual differences between participants (health, artistic experience, skill level, socioeconomic status, illness, etc.) were not accounted for in this study. In order to increase the

generalizability of results, future studies should include a more representative sample of the population.

It was assumed that the sample in the current study was relatively healthy, since they were young college students, but this may have not been accurate. Participants were not screened for any abnormal BP scores or medication usage before participation, which easily could have influenced the findings. Additionally, the stressor used in the current study was an artificial method to increasing stress, but a generally healthy sample would naturally show improved stress scores over time from such a mild stressor. This may not have been the most effective way to show how coloring can reduce stress. Including participants who have experienced chronic stress would have been useful in comparing the effects of coloring to those with acute stress, as the results from these two subsamples could be analyzed and compared to determine if the stressor was effective and if there were any differences between acute vs. chronic stress samples.

Related to this, although differences were not seen between groups on measures of mood, BP, or HR, future studies could incorporate much larger sample sizes from various settings and backgrounds (rather than only college students) to determine if the current findings were potentially due to sample size and individual differences. Researchers could work together from different locations around the country to conduct a much larger art study that contained a large variety of participants. Due to the fact that physiological measures are affected by a wide array of factors, it would be important to separate people based on these individual differences. These groups could consist of normal versus high BP/HR, acute versus chronic stress, special populations (illness/injury), age group, experienced versus novice artists, etc. This could help to

pinpoint the specific types of people who benefit most from art therapy and whether the inconsistencies across studies are due to sampling biases. It could also be helpful in identifying those who could have negative attitudes or experiences during art-making, contraindicating the use of art therapy (Kapitan, 2013).

Another limitation of the current study was that the participants only had 15 minutes to complete their tasks, which is quite a short time when trying to induce an anxiolytic state. The length of time spent conducting art may not be as important in stress reduction as the quality of time spent art-making, but it may have been too brief to fully engage creative processes and to allow participants to enter a flow state. Various time durations have been employed by different studies in the field, but the duration or "dosage" of coloring has not been systematically compared within a single study. The current study produced some anxiolytic changes in 15 minutes, with state anxiety reducing below baseline in coloring groups and BP and negative moods reducing below baseline in all four groups. However, future studies could vary the duration of time participants spend on artistic tasks, for example, ranging from a single 15-minute session to multiple two-hour sessions. Future studies could conduct longitudinal research to track participants' progress over time and determine the best routine for stress reduction.

The lack of any follow-up questions for participants during debriefing in the current study is another limitation. This could have enlightened the research by providing a sense of participants' thoughts and feelings during and after the coloring and control tasks and whether participants achieved a flow state. It was not possible to determine whether positive or negative thoughts during the tasks helped to produce the results that were observed in the current study. If it is the quality of time that is most important,

rather than the length of time, future studies could benefit from asking participants about their thoughts and feelings while art-making. These data could be analyzed and compared throughout the different conditions and provide more clarity into what types of thoughts and feelings lead to higher or lower stress scores.

Another beneficial topic for future study is further examination of the differences between the stress-relieving effects of art-making and meditation. The current study did not include any conditions or variables that would have allowed for this comparison, and results did not support any claims that art-making is meditative. Curry and Kasser (2005) claimed that coloring mandalas induces a meditative state, and Slayton et al. (2010) claimed that art-making produces the same stress-reducing effects as meditation. These claims informed the hypothesis in the current study that coloring would reduce BP and HR, though this was not ultimately supported. If art-making is believed to be meditative (Curry & Kasser, 2005; Slayton et al., 2010), then the research should produce supporting evidence of this. The current study produced state anxiety scores that match with prior meditation research, but the other measures do not match the anxiolytic effects of meditation (Slayton et al., 2010). Examining the effects of meditation versus coloring could aid in systematically comparing the differences observed on subjective and objective measures of stress during these activities.

It would be highly beneficial for a future study to directly compare meditation tasks to art tasks. For example, a study could include two or three types of meditation (mindfulness, transcendental, breathing, guided, etc.) that are compared along psychological and physiological measures to two art-making groups; one of art-making alone, the other of art-making while guided by meditative thought processes. This would

be extremely informative as to whether it is the meditation, the art, or a combination of the two that leads to the greatest stress reductions.

Lastly, based on the major themes that emerged from a review of previous research (tactility, creativity, and flow), the most interesting direction in art research could be to include these concepts as factors during art-making and examine whether they have an effect on emotional or stress-related changes. The current study did not include any of these as factors; nevertheless, their inclusion in future studies might yield a more nuanced explanation of how coloring can be used to reduce stress. Since all conditions included some form of creativity and tactility, it is possible that the measures that reduced below baseline in the current study, regardless of condition, could have been altered by a state of flow.

It has been noted above that any one of these factors alone was not always sufficient to reduce stress levels but combining them could produce much greater anxiolytic effects. Future research could test varying combinations of these factors, with conditions that include each factor individually along with combinations of these factors: creativity (planning an activity); tactility (copying shapes or words); flow (interesting conversation); creativity + tactility (listing thoughts or writing about art that was viewed); creativity + flow (planning an activity with another participant, allowing for the flow of conversation); flow + tactility (jigsaw puzzle); and creativity + tactility + flow (art-making with guidance to assure a state of flow is achieved). Since the current study, and number of other previous studies (Abbott et al., 2013; Ashlock et al., 2018; Boehm et al., 2014; Curry & Kasser, 2005; Haiblum-Itskovitch et al., 2018; Keogh & Creaven, 2017; Kimport & Robbins, 2012; Lee, 2018; Sandmire et al., 2016; Schrade et al., 2011; Van

Der Vennet & Serice, 2012) did not show a specific form of art-making to be best for reducing stress, the art-making condition could allow participants to choose their desired medium. Comparing data from subjective and objective measures of stress in these conditions could provide very important information in the literature of stress reduction and help to reconcile the inconsistencies observed in the current study and the general literature on the therapeutic effects of art.

VI. CONCLUSION

The objective of this study was to characterize the subjective and objective correlates of the stress response and to examine the efficacy of different kinds of coloring as a means of stress reduction. Based on previous research (Curry & Kasser, 2005; Van Der Vennet & Serice, 2012), it was hypothesized that coloring mandalas and pre-drawn images would elicit significant decreases in stress levels compared to free-drawing and a control task (choice of crossword, word search, or sudoku). This was not supported in this study. State anxiety showed a main effect of condition, with all coloring tasks leading to significant reductions from baseline scores compared to the control tasks (crossword, word search, or sudoku), suggesting that any coloring task is beneficial to lowering state anxiety. However, positive mood states and HR returned to baseline in all four groups, suggesting that coloring and control tasks do not lead to significant reductions of those measures. Additionally, negative mood states, SBP, and DBP decreased below baseline in all four groups, suggesting that coloring and control tasks are equally beneficial to lowering these stress measures. Ultimately, the hypothesis that mandalas and pre-drawn images would be most effective at reducing stress was not supported, suggesting that there is no particular form of coloring that elicits the greatest stress reductions and that coloring might not be any more effective than doing puzzles.

The current study looked at various types of coloring and their effects on reducing stress levels but found no solid answer of which is most efficacious. This is likely because the type of art that one engages in may not be an important factor in stress reduction. Instead, it appears that simply having a distraction of tasks such as coloring,

crosswords, word searches, and sudoku helps one to reduce stress. Based on the research reviewed, which revealed inconsistencies in results across studies, it is clear only further research can determine whether coloring is a superior method for stress reduction. Including larger sample sizes that are categorized by individual differences (i.e., health, artistic experience, skill level, socioeconomic status, illness, etc.) could help to explain the effects of art on various populations. Varying the length of time that people conduct art, even conducting longitudinal studies, could help to show whether particular durations of conducting art are more beneficial to others. It is also important to directly compare art and meditation in order to examine the similarities and differences between the two, and to determine if a meditation model is appropriate in explaining the anxiolytic effects of art. Lastly, it is believed that a promising future direction in art-related stress research is to examine the role of flow states among participants, and whether creative and tactile activities are important to stress reduction.

Stress will always return to people in some form, but if future research can find a successful method of reducing stress and anxiety with art, people could practice this on an as-needed basis in their daily lives. Prior artistic experience and ability do not seem to be an issue, as participants lacking experience and skill still find art therapy useful (Kaimal, et al., 2017; Keogh & Creaven, 2017). Art is readily available to the public, inexpensive, and produces no side effects for much of the population. Everyone can access a pencil and paper, at the very least, but not everyone has access to doctors, therapists, and medications. There are programs that provide art materials and studio time to people who may not have other healthy methods of relieving their stress. Art From The Streets (AFTS) is one such program that allows the homeless to come in, create art, and

even sell their work, which provides a positive distraction from the challenges of living on the street (https://artfromthestreets.org/; Art From The Streets, 2019). This is why it is so important to continue studying art and its beneficial effects. It is true, however, that certain special populations may need more guidance and therapeutic attention, and art-making alone may not be directly beneficial to them. For example, people with posttraumatic stress disorder and traumatic brain injuries find some help with art therapy, but they tend to have a multitude of symptoms that may need prolonged therapy and a focus on other specific areas of improvement (Kaimal, Jones, Dieterich-Hartwell, Acharya, & Wang, 2019). Additionally, those dealing with an illness, such as cancer, may benefit more when they have a higher sense of control over their artistic work, such as free-drawing or coloring compared to text copying (Keogh & Creaven, 2017).

Art-making and its perceived effects on the reduction of stress can pave the way for a multitude of research. It is important to study art-making and its potential to benefit many in their daily lives because stress is something everyone experiences and art is an easily accessible form of coping that can be done at almost any time or place. Kaimal et al. (2017) show that changes can occur in the brain with training and practice with art. This suggests that the more people participate in art-making and art therapy, the more likely they are to make permanent changes that can help them create a better, more stress-free life.

The results of this study showed that coloring, in any form, was efficacious in reducing state anxiety, though there was no main effect of condition on mood states, BP, or HR. The hypothesis that coloring mandalas and pre-drawn images would yield greater stress reductions than free-drawing or control tasks was not supported. However, these

results are still important, as they reveal that the anxiolytic claims made by adult coloring books are lacking supportive evidence. State anxiety may be reduced to a greater degree while coloring versus doing word or number puzzles, but the evidence of the current study does not show that coloring is more beneficial to relieving moods or physiological stress compared to word or number puzzles. Overall, these results suggest that any form of distraction (e.g., coloring or puzzles) is beneficial in decreasing BP and negative mood states, and that coloring does not confer any special advantage for improving HR or positive mood states. However, any method of reducing stress is beneficial and the results of the current study support the idea that coloring reduces state anxiety. These results attest to the stress-relieving benefits of coloring, although they do not support the notion that coloring is somehow special with respect to its stress-reducing effects.

APPENDIX SECTION

SELF-EVALUATION QUESTIONNAIRE STAI Form Y-1

Please provide the following information:

Name_____Date_____S_____

Age_____ Gender (*Circle*) **M** **F** T_____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *right* now, that is, *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 SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I feel strained	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel satisfied	1	2	3	4
9. I feel frightened	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel indecisive	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel confused	1	2	3	4
19. I feel steady	1	2	3	4
20. I feel pleasant	1	2	3	4

Figure 7: STAI (Form Y-1); State anxiety measure (Spielberger et al., 1968)

SELF-EVALUATION QUESTIONNAIRE

STAI Form Y-2

Name_____ Date_____

DIRECTIONS

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel. 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 how you generally feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	1	2	3	4
22. I feel nervous and restless	1	2	3	4
23. I feel satisfied with myself	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I feel like a failure	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I have disturbing thoughts	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I make decisions easily	1	2	3	4
35. I feel inadequate	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

Figure 8: STAI (Form Y-2); Trait anxiety measure (Spielberger et al., 1968)

State-Trait Anxiety Inventory for Adults Scoring Key (Form Y-1, Y-2)

Developed by Charles D. Spielberger in collaboration with R.L. Gorsuch, R. Lushene, P.R. Vagg, and G.A. Jacobs

To use this stencil, fold this sheet in half and line up with the appropriate test side, either Form Y-1 or Form Y-2. Simply total the scoring **weights** shown on the stencil for each response category. For example, for question # 1, if the respondent marked 3, then the **weight** would be **2**. Refer to the manual for appropriate normative data.

Form Y-1	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1.	4	3	2	1
2.	4	3	2	1
3.	1	2	3	4
4.	1	2	3	4
5.	4	3	2	1
6.	1	2	3	4
7.	1	2	3	4
8.	4	3	2	1
9.	1	2	3	4
10.	4	3	2	1
11.	4	3	2	1
12.	1	2	3	4
13.	1	2	3	4
14.	1	2	3	4
15.	4	3	2	1
16.	4	3	2	1
17.	1	2	3	4
18.	1	2	3	4
19.	4	3	2	1
20.	4	3	2	1

Form Y-2	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21.	4	3	2	1
22.	1	2	3	4
23.	4	3	2	1
24.	1	2	3	4
25.	1	2	3	4
26.	4	3	2	1
27.	4	3	2	1
28.	1	2	3	4
29.	1	2	3	4
30.	4	3	2	1
31.	1	2	3	4
32.	1	2	3	4
33.	4	3	2	1
34.	4	3	2	1
35.	1	2	3	4
36.	4	3	2	1
37.	1	2	3	4
38.	1	2	3	4
39.	4	3	2	1
40.	1	2	3	4

Figure 9: STAI Scoring key (Spielberger et al., 1968)

Worksheet 3.1 The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988)

PANAS Questionnaire

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. **Indicate to what extent you feel this way right now, that is, at the present moment *OR* indicate the extent you have felt this way over the past week (circle the instructions you followed when taking this measure)**

1	2	3	4	5
Very Slightly or Not at All	A Little	Moderately	Quite a Bit	Extremely

_____ 1. Interested	_____ 11. Irritable
_____ 2. Distressed	_____ 12. Alert
_____ 3. Excited	_____ 13. Ashamed
_____ 4. Upset	_____ 14. Inspired
_____ 5. Strong	_____ 15. Nervous
_____ 6. Guilty	_____ 16. Determined
_____ 7. Scared	_____ 17. Attentive
_____ 8. Hostile	_____ 18. Jittery
_____ 9. Enthusiastic	_____ 19. Active
_____ 10. Proud	_____ 20. Afraid

Scoring Instructions:

Positive Affect Score: Add the scores on items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Scores can range from 10 – 50, with higher scores representing higher levels of positive affect. Mean Scores: Momentary = 29.7 (*SD* = 7.9); Weekly = 33.3 (*SD = 7.2)*

Negative Affect Score: Add the scores on items 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20. Scores can range from 10 – 50, with lower scores representing lower levels of negative affect. Mean Score: Momentary = 14.8 (*SD* = 5.4); Weekly = 17.4 (*SD* = 6.2)

Figure 10: PANAS Worksheet and scoring key (Watson et al., 1988)

LITERATURE CITED

Abbott, K. A., Shanahan, M. J., & Neufeld, R. W. J. (2013). Artistic tasks outperform nonartistic tasks for stress reduction. *Art Therapy: Journal of the American Art Therapy Association, 30*(2), 71-78.

American Psychological Association (2014). *Stress effects on the body.* Retrieved from http://www.apa.org/helpcenter/stress-body.aspx.

Art From The Streets. (2019). Retrieved from https://artfromthestreets.org/.

Ashlock, L. E., Miller-Perrin, C., & Krumrei-Mancuso, E. (2018). The effectiveness of structured coloring activities for anxiety reduction. *Art Therapy: Journal of the American Art Therapy Association, 35*(4), 195-201.

Bergomi, C., Tschacher, W., & Kupper, Z. (2013). The assessment of mindfulness with self-report measures: Existing scales and open issues. *Mindfulness*, *4*(3), 191-202.

Boehm, K., Cramer, H., Staroszynski, T., & Ostermann, T. (2014). Arts therapies for anxiety, depression, and quality of life in breast cancer patients: A systematic review and meta-analysis. *Evidence-Based Complementary & Alternative Medicine*, 1-9.

Bolwerk, A., Mack-Andrick, J., Lang, F. R., Dörfler, A., & Maihöfner, C. (2014). How art changes your brain: Differential effects of visual art production and cognitive art evaluation on functional brain connectivity. *PLoS ONE*, *9*(7), 1–8.

BookScan, Nielsen. (2015). *Unit sales of selected adult coloring books in the United States from January to November 2015.* Retrieved from https://www.statista.com/statistics/531105/adult-coloring-books-sales-usa/.

Britton, W. B., Lindahl, J. R., Cahn, B. R., Davis, J. H., & Goldman, R. E. (2014). Awakening is not a metaphor: The effects of Buddhist meditation practices on basic wakefulness. *Annals of the New York Academy of Sciences, 1307*(1)*,* 64-81.

Bumgardner, J. (2017). *KrazyDad Sudoku Printables.* Retrieved from https://krazydad.com/sudoku/.

Chilton, G. (2013). Art therapy and flow: A review of the literature and applications. *Art Therapy, 30*(2), 64-70.

Coster, P. (2015). *The Calm Coloring Book.* New York, NY: Chartwell Books.

Crawford, J., & Henry, J. (2004) The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal Of Clinical Psychology, 43*(3), 245-265.

Csíkszentmihályi, M. (1991). *Flow: The psychology of optimal experience.* New York, NY: Harper Perennial.

Curl, K. (2008). Assessing stress reduction as a function of artistic creation and cognitive focus. *Art Therapy: Journal Of The American Art Therapy Association*, *25*(4), 164-169.

Curry, N. A., & Kasser, T. (2005). Can coloring mandalas reduce anxiety? *Art Therapy: Journal of the American Art Therapy Association, 22*(2), 81-85.

Epstein, S. (2013). Cognitive-experiential self-theory: An integrative theory of personality. In Tennen, H., Suls, J., & Weiner, I. B. (Eds.), *Handbook of psychology: Personality and social psychology, 5*(2), 93–118. Hoboken, NJ: John Wiley & Sons Inc.

Fechir, M., Schlereth, T., Purat, T., Kritzmann, S., Geber, C., Eberle, T., Gamer, M., & Birklein, F. (2008). Patterns of sympathetic responses induced by different stress tasks. *The Open Neurology Journal, 2,* 25-31.

Fisher, A. (2009). *Word Game World*. Retrieved from http://www.word-game-world.com/.

Gogarty, J. (2015). *Stress Less Coloring: Mandalas.* Avon, MA. Adams Media.

Goldstein, C., Josephson, R., Susan, X., & Hughes, J. (2012). Current perspectives on the use of meditation to reduce blood pressure. *International Journal Of Hypertension*, 1-11.

Haiblum-Itskovitch, S., Czamanski-Cohen, J., & Galili, G. (2018). Emotional response and changes in heart rate variability following art-making with three different art materials. *Frontiers in Psychology*, *9*.

Juster, R. P., McEwen, B. S., & Lupien, S. J. (2010). Allostatic load biomarkers of chronic stress and impact on health and cognition. *Neuroscience & Biobehavioral Reviews, 35*(1), 2-16.

Kaimal, G., Ayaz, H., Herres, J., Dieterich-Hartwell, R., Makwana, B., Kaiser, D. H., & Nasser, J. A. (2017). Functional near-infrared spectroscopy assessment of reward perception based on visual self-expression: Coloring, doodling, and free drawing. *The Arts in Psychotherapy*, *55*, 85–92.

Kaimal, G., Jones, J. P., Dieterich-Hartwell, R., Acharya, B., & Wang, X. (2019). Evaluation of long- and short-term art therapy interventions in an integrative care setting for military service members with post-traumatic stress and traumatic brain injury. *The Arts in Psychotherapy*, *62*, 28–36.

Kaimal, G., Mensinger, J. L., Drass, J. M., & Dieterich-Hartwell, R. M. (2017). Art therapist-facilitated open studio versus coloring: Differences in outcomes of affect, stress, creative agency, and self-efficacy. *Canadian Art Therapy Association Journal*, *30*(2), 56–68.

Kaimal, G., Ray, K., & Muniz, J. (2016). Reduction of cortisol levels and participants' responses following art making. *Art Therapy: Journal of the American Art Therapy Association*, *33*(2), 74–80.

Kapitan, L. (2013) Art therapy's sweet spot between art, anxiety, and the flow experience. *Art Therapy: Journal of the American Art Therapy Association, 30*(2), 54-55.

Kate, T., Poonam, S., Sehgal, P., & Jasuja, N. (2016). *Systolic vs diastolic blood pressure*. Retrieved from http://www.diffen.com/difference/Diastolic_vs_Systolic.

Keogh, K., & Creaven, A. (2017). Evaluating the impact of a brief artistic intervention on cardiovascular recovery from acute stress. *Art Therapy: Journal of the American Art Therapy Association*, *34*(4), 167–175.

Kimport, E. R., & Robbins, S. J. (2012). Efficacy of creative clay work for reducing negative mood: A randomized control trial. *Art Therapy: Journal of the American Art Therapy Association, 29*(2), 74-79.

Krantz, D., Thorn, B., & Kiecolt-Glaser, J. (2012). *How stress affects your health*. Retrieved from http://www.apa.org/helpcenter/stress.aspx.

Lazarus, R. S. (1966). *Psychological stress and the coping process.* New York, NY: McGraw-Hill.

Lee, S. (2018). Why color mandalas? A study of anxiety-reducing mechanisms. *Art Therapy: Journal of the American Art Therapy Association, 35*(1), 35-41.

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales*. Sydney, Australia.

Lumma, A., Kok, B. E., & Singer, T. (2015). Is meditation always relaxing? Investigating heart rate, heart rate variability, experienced effort and likeability during training of three types of meditation. *International Journal Of Psychophysiology*, *97*(1), 38-45.

Mahmoud, J. S. R., Staten, R., Hall, L. A., & Lennie, T. A. (2012). The relationship among young adult college students' depression, anxiety, stress, demographics, life satisfaction, and coping styles. *Issues in Mental Health Nursing, 33,* 149-156.

Mandala Project, The (2010). *What is a Mandala?* Retrieved from www.mandalaproject.org.

McNair, D. M., Lorr, M., & Droppleman, L. (1971). Manual for the Profile of Mood States. San Diego, CA: Educational and Industrial Testing Service.

Muthard, C., & Gilbertson, R. (2016). Stress management in young adults: Implications of mandala coloring on self-reported negative affect and psychophysiological response. *Psi Chi Journal of Psychological Research, 21*(1), 16-28.

Nidich, S. I., Rainforth, M. V., Haaga, D. F., Hagelin, J., Salerno, J. W., Travis, F., ...Schneider, R. H. (2009). A randomized controlled trial on effects of the Transcendental Meditation program on blood pressure, psychological distress, and coping in young adults. *American Journal Of Hypertension*, *22*(12), 1326-1331.

Olpin, M. (2010). *The science of stress*. Retrieved from http://faculty.weber.edu/molpin/healthclasses/1110/bookchapters/stressphysiologychapter.htm.

Phillips, A., Der, G., & Carroll, D. (2009). Self-reported health and cardiovascular reactions to psychological stress in a large community sample: Cross-sectional and prospective associations. *Psychophysiology*, *46*(5), 1020-1027.

Pritchard, M. E., Wilson, G. S., & Yamnitz, B. (2007). What predicts adjustment among college students? A longitudinal panel study. *Journal of American College Health*, *56*(1), 15-22.

Pruthi, S. (2016). *Stress symptoms: Effects on your body and behavior.* Retrieved from http://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/stress-symptoms/art-20050987.

Randall, M. (2011). The physiology of stress: Cortisol and the hypothalamic-pituitary-adrenal axis. *Dartmouth Undergraduate Journal of Science.* Retrieved from http://dujs.dartmouth.edu/2011/02/the-physiology-of-stress-cortisol-and-the-hypothalamic-pituitary-adrenal-axis/#.VykIYY-cG1y.

Reynolds, M. W., Nabors, L., & Quinlan, A. (2000). The effectiveness of art therapy: Does it work? *Art Therapy, 17*(3), 207-213.

Sandmire, D. A., Gorham, S. R., Rankin, N. E., & Grimm, D. R. (2012). The influence of art making on anxiety: A pilot study. *Art Therapy: Journal of the American Art Therapy Association, 29*(2), 68-73.

Sandmire, D. A., Rankin, N. E., Gorham, S. R., Eggleston, D. T., French, C. A., Lodge, E. E., … Grimm, D. R. (2016). Psychological and autonomic effects of art making in college-aged students. *Anxiety, Stress & Coping*, *29*(5), 561–569.

Schrade, C., Tronsky, L., & Kaiser, D. H. (2011). Physiological effects of mandala making in adults with intellectual disability. *The Arts In Psychotherapy*, *38*(2), 109-113.

Shearer, A., Hunt, M., Chowdhury, M., & Nicol, L. (2015). Effects of a brief mindfulness meditation intervention on student stress and heart rate variability. *International Journal Of Stress Management.*

Slayton, S., D'Archer, J., & Kaplan, F. (2010). Outcome studies on the efficacy of art therapy: A review of findings. *Art Therapy: Journal of the American Art Therapy Association, 27*(3), 108-118.

Smith, J. A., Zhao, W., Yasutake, K., August, C., Ratliff, S. M., Faul, J. D., … Needham, B. L. (2017). Gene-by-psychosocial factor interactions influence diastolic blood pressure in European and African ancestry populations: Meta-analysis of four cohort studies. *International journal of environmental research and public health*, *14*(12), 1596.

Solberg, E. E., Øivind, E., Holen, A., Ingjer, F., Sandvik, L., Standal, P. A., & Vikman, A. (2004). Hemodynamic changes during long meditation. *Applied Psychophysiology & Biofeedback*, *29*(3), 213-221.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1968). State-Trait Anxiety Inventory for adults: Self-evaluation questionnaire. Redwood City, CA. Mind Garden Publishing.

Super Word Search Puzzles. Retrieved from http://www.superwordsearchpuzzles.com/.

Van Der Vennet, R., & Serice, S. (2012). Can coloring mandalas reduce anxiety? A replication study. *Art Therapy: Journal of the American Art Therapy Association, 29*(2), 87-92.

Watson, D., Clark, L. A., & Tellegan, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070.

Wolever, R. Q., Bobinet, K. J., McCabe, K., Mackenzie, E. R., Fekete, E., Kusnick, C. A., & Baime, M. (2012). Effective and viable mind-body stress reduction in the workplace: A randomized controlled trial. *Journal Of Occupational Health Psychology*, *17*(2), 246-258.

Zigmond, A. S., & Snaith, R. P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica, 67*, 361–370.