

**Cognitive and affective benefits of coloring: Two randomized controlled crossover studies**

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**Abstract**

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The current research sought to replicate and extend work suggesting that coloring can reduce anxiety, asking whether coloring can improve cognitive performance. In two experiments undergraduates ( $N = 47$ ;  $N = 52$ ) colored and participated in a control condition. Subjective and performance measures of mood and mindfulness were included: an implicit mood test (Experiment 1) and a selective attention task (Experiment 2) along with a divergent thinking test. In both experiments coloring significantly reduced anxiety and increased mindfulness compared with control and baseline scores. Following coloring participants scored significantly lower on implicit fear, than the control condition, and significantly higher on selective attention and original ideation. Coloring may not only reduce anxiety, but also improve mindful attention and creative cognition.

*Keywords:* Coloring, anxiety, mindfulness, selective attention, divergent thinking

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Research on the therapeutic benefits of coloring has burgeoned in recent years (e.g. Sandmire et al., 2016; Powell, Alcorn & Lindsay, 2017), driven by the popularity of coloring amongst the general population, as evidenced by increased sales of adult coloring books (Quartz, 2016). Coloring for well-being is frequently advocated in community settings, for example as a stress-reduction tool for University students (Independent, 2016). As such, it is important to build an evidence base for coloring as a well-being intervention. Previous research supports claims that coloring reduces state anxiety (e.g., Eaton & Tieber, 2017) and improves mindfulness (Carsley & Heath, 2018). However, there are methodological problems with this body of work, including a reliance on self-report data and a lack of control groups. The current research sought to build on previous research by assessing the impact of coloring on well-being using both self-report and performance measures of mood and mindfulness, and by using a randomized controlled crossover design with an active control condition. Theoretically, the research sought to extend understanding of the benefits of coloring to cognitive functioning, focusing on selective attention and creative thinking.

While the evidence base for the therapeutic benefits of the arts more widely is compelling (Clift & Camic, 2016), research on coloring is in its early stages. Nevertheless, a reduction in anxiety, pre- to post coloring is consistently reported (e.g., Eaton & Tieber, 2017). For example, the first study of this kind, by Curry and Kasser (2005), reported that, following an anxiety induction, coloring for twenty minutes (either a mandala or a grid-like design) led to a reduction in anxiety, to levels significantly below that of baseline anxiety for the mandala condition, and to a significantly greater degree than ‘free form’ drawing for both coloring conditions. Subsequent studies have replicated this anxiety reduction effect, both with (Carsley, Heath & Fajnerova, 2015; Carsley & Heath, 2018; van der Venet & Serice, 2012) and without (Eaton & Tieber, 2017; Mantzios & Giannou, 2018; Sandmire et al., 2016; Small, 2006) an anxiety induction; some finding significant reductions in anxiety irrespective

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of the art activity assigned (e.g. coloring and ‘free drawing’) (Carsley et al., 2014; Carsley & Heath, 2018; Drake, Searight Olson-Pupek, 2014; Mantzios & Giannou, 2018; Sandmire et al., 2016). Mindfulness (focusing attention on one’s current activity) has been postulated as a mechanism for the reduction in anxiety following coloring (Curry & Kasser, 2005), but has only been included as an outcome variable in two recent studies (Carsley & Heath, 2018; Mantzios & Giannou, 2018). Only Carsley and Heath (2018) reported a significant effect, where mindfulness significantly increased pre- to post-coloring (and after ‘free drawing’). Hence, further research is required to explore the impact of coloring on mindfulness.

Overall, these findings support the efficacy of coloring as a stress reduction technique, both to repair and to improve mood, but emphasize the need for non-art-based control conditions to test whether extraneous factors, such as time, distraction from stressful activities or experimenter effects, explain the reductions in anxiety.

Only two coloring studies have used a control condition (Powell et al., 2017; Sandmire et al., 2016). Both compared coloring with sitting passively in groups, although participants were allowed to socially interact. Interestingly, both studies reported a statistically significant anxiety reduction in both the control and coloring conditions. Only Powell et al. reported that coloring reduced self-reported anxiety to a significantly greater degree than the control, necessitating further controlled research. Consideration of the type of control condition is important (Karlsson & Bergmark, 2015). A passive control consists merely of the absence of potential therapeutic elements and enables variation in activities in which participants engage, whereas an active control group, where a specific activity is assigned, seeks to homogenize experience. Hence in the current research, coloring was compared with reading (about time management), an activity that requires focused attention, like coloring, and which represents a typical student experience. In order to better control for confounding variables (such as

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social interaction) a crossover design was used, so that all participants were in the same environment at the same time.

Another important methodological consideration is the reliance of previous research upon self-report measures, which are sensitive to response bias, including demand characteristics (where participants form expectations about an experiment that unconsciously influence their behavior) (Davidson & Kaszniak, 2015; McCambridge, De Bruin, & Witton, 2012). For example, Eaton and Tieber (2017) reported reduced scores on all mood scales following coloring, including positive affect, which may be indicative of acquiescence bias. Only Sandmire et al. (2016) have used an objective measure in coloring research, measuring vagal tone as an inverse physiological index of anxiety. Although vagal tone did not correlate significantly with self-reported anxiety, it indicated lower levels of physiological stress following coloring compared with the control condition (to a significant degree), better supporting the hypothesis that coloring reduces anxiety. Objective and subjective measures may assess different aspects of affect (Campbell & Ehlert, 2012). Indeed, given discrepancies between physiological and self-report data in mindfulness research, Davidson and Kaszniak (2015) recommend that a range of outcome measures be included, including cognitive measures, since these may be differentially responsive to demand characteristics.

In light of the call for more objective measures in coloring research (Sandmire et al., 2016), the current research included both self-report and performance measures of mood (implicit mood) and mindfulness (selective attention). Measures of implicit mood seek to avoid response bias in mood reports (Paulhus & Reid, 1991) by masking the mood measure as an evaluative task, where ambiguous stimuli are judged according to affective qualities (Bartoszek & Cervone, 2017), and have been used efficaciously in mindfulness interventions (Remmers, Topolinski & Koole, 2016). A selective attention task was included as a performance measure of mindfulness (Robertson, Ward, Ridgeway & Nimmo-Smith, 1994).

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Selective attention improves concentration by orienting attention, and appears to be increased following both mindfulness meditation (Jha, Krompinger & Baime, 2007) and reductions in state anxiety (Fernández-Castillo & Caurcel, 2015).

In addition to assessing performance measures of mood and mindfulness, the current research tested further cognitive benefits of coloring: creative cognition. Moderate positive moods facilitate creativity (Baas, Dreu & Nijstad, 2008). Fredrickson's (2004) broaden-and-build theory explains this by proposing that positive mood widens attention, promoting the discovery of novel ideas, aligning with associative models of creative cognition (Benedek et al., 2012). Mindfulness has likewise been associated with improved creativity (Lebuda, Zabelina & Karwowski, 2016). Extrapolating from this body of work, if coloring is associated with both improved hedonic tone and mindfulness, one would predict that coloring would also improve creative thinking, in particular, originality, facilitating the making of remote associations (Baas et al., 2008; Benedek et al., 2012; Fredrickson, 2004). Figural divergent thinking was included as an outcome measure, which requires making original responses to stimuli, and which has been found to be resistant to expectation effects (Rozenkrantz, et al., 2017).

### **Experiment 1**

Experiment one aimed to replicate previous research showing a reduction in state anxiety following coloring, including both self-report and performance measures of mood. Self-report measures of mindfulness (focused attention) and the flow state (feeling immersed in and enjoying an activity) were included to examine the impact of coloring on attention. It was hypothesized that participants would score significantly higher on mood (hedonic tone, calmness and energetic arousal), mindfulness and the flow state following coloring, compared with both control and baseline scores. Secondly, it was hypothesized that

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participants would score significantly differently on implicit mood (with reduced fear, anger and sadness, and increased happiness) compared with the control condition.

### **Participants**

47 year one undergraduate psychology students (36 females) with a mean age of 20.62 (ranging between 18 and 37) were recruited through opportunity sampling. Participants were invited to take part in order to learn about how interventions are designed and evaluated as part of a module on applied psychology. Participation was not compulsory, rewarded or part of assessment on the module.

### **Design**

A randomized controlled crossover MANOVA design, with two factors: a repeated measures factor (condition) with three levels (baseline, coloring and control [reading]); and a between-participants factor (order) with two levels (reading first and coloring first). The order in which conditions were taken was randomized ( $n = 25$  completed reading first). Dependent variables consisted of: mood (hedonic tone, energetic arousal and tense arousal); the flow state; mindfulness; and implicit mood (happiness, anger, fear and sadness). The presentation of measures, and the order of alternate forms, was counterbalanced.

### **Measures**

*Short Mood Scale, SMS* (Wilhelm & Schoebi, 2007). A six-item scale measuring three dimensions of mood: valence, calmness and energetic arousal. Each item is presented on a dipole with a seven-point scale between two ‘opposites’ (e.g., calm and agitated). This scale was designed to repeatedly sample individual’s mood and has been found to be reliable and sensitive to individual change (Kanning et al., 2015).

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*Flow Short Scale, FSS* (Engeser & Rheinberg, 2008). A ten-item scale designed to measure phenomenological features of the flow state, including being absorption and experiencing a balance between challenges and skills. Items are responded to on a 7-point Likert scale and include “I am totally absorbed in what I am doing”. The scale has excellent psychometric properties.

*Mindful Attention Awareness Scale, MAAS* (Brown & Ryan, 2003). A five-item scale to measure the features of a mindful state, including focusing attention without being preoccupied. An example item (reversed) is: “I was rushing through something without really paying attention to it”. Items are responded to on a 7-point Likert Scale. The MAAS has demonstrated good reliability, concurrent and predictive validity (MacKillop & Anderson, 2007).

*Implicit Emotion Assessment Task* (Bartoszek & Cervone, 2017). 20 abstract expressionistic images (14 greyscale; 6 color) are rated according to the emotion expressed: ‘anger’, ‘fear’, ‘happiness’, ‘sadness’ or ‘none’. Bartoszek and Cervone (2017) report that the measure adequately detects changes in distinct emotions following appropriate mood inductions, for example an increase in the rating of ‘fear’ alone following exposure to fearful stimuli. Alternate forms of this test were created, randomly selecting 7 monochrome and 3 colored images for each form.

### **Procedure**

Participants registered interest in taking part online after receiving an email invitation. This enabled researchers to adequately prepare for the sample size. Participants were tested in a group setting in a large teaching room at the University of the West of England (UWE).

Rectangular study tables were arranged in two circles. Each table had ample space for two participants. Participant information forms, consent forms, booklets of measures (placed face



down), copies of the reading (a chapter on time management by Lee-Davies [2007]), coloring sheets (a mandala), and 12 felt tip pens, each of a different color were set out on every table.

A random point was selected on each circle of tables, from which instructions to read and color first were alternated. At the start of the session participants were welcomed and invited to take a seat where they chose. Participants were reminded that the purpose of the study was to examine the effects of different activities (coloring and reading) on experience.

Participants were asked to read an information sheet about the study, reminded of their ethical rights, invited to ask questions and to sign a consent form if they wished to participate.

Participants were informed that they each had a booklet that guided them through the stages of the study. Participants were asked to begin by completing the baseline measures in this booklet, and then to turn a page to see whether they were coloring or reading first.

Participants either read or colored for twenty minutes. Following this, they completed the self-report measures again, and rated ten abstract images according to the emotions they appeared to represent. Participants then participated in the crossover condition (reading or coloring) for twenty minutes. Finally, they completed the self-report measures and rated another ten abstract images. Participants were then debriefed about the aims of the study and thanked for their time. This research received ethical approval from the UWE's Research Ethics Committee.

### **Results and discussion**

#### **The effect of coloring on self-report measures (mood, flow and mindfulness)**

There were significant differences between mean levels of all dependent variables across conditions (baseline, coloring and reading): hedonic tone ( $F_{2,86} = 38.25, p < .001$ ); tense arousal ( $F_{2,86} = 21.65, p < .001$ ); energetic arousal ( $F_{2,86} = 29.84, p < .001$ ); flow ( $F_{2,86} = 55.17, p < .001$ ); and mindfulness ( $F_{2,86} = 26.06, p < .001$ ) (please refer to Table 1 for

descriptive statistics). Post-hoc analyses revealed significantly higher levels after coloring than the control condition for all state dimensions: contentment (means = 8.62 and 7.27;  $F_{1,43} = 20.29, p < .001$ ), calmness (means = 9.44 and 7.18;  $F_{1,43} = 38.31, p < .001$ ), energy (means = 6.22 and 4.33;  $F_{1,43} = 30.76, p < .001$ ), flow (means = 41.95 and 27.29;  $F_{1,43} = 88.34, p < .001$ ) and mindfulness (means = 20.90 and 12.95;  $F_{1,43} = 52.82, p < .001$ ). Further, participants had significantly higher scores after coloring than at baseline on all measures apart from energetic arousal, where they were significantly less energetic after coloring: hedonic tone (means = 8.62 and 5.02;  $F_{1,43} = 59.83, p < .001$ ); tense arousal (means = 9.44 and 8.11;  $F_{1,43} = 15.32, p < .001$ ); energetic arousal (means = 6.22 and 7.98;  $F_{1,43} = 12.71, p < .001$ ); flow (means = 41.53 and 32.02;  $F_{1,43} = 66.20, p < .001$ ); and mindfulness (means = 20.90 and 16.62;  $F_{1,43} = 16.19, p < .001$ ). There were no significant order effects, suggesting that the order in which participants took part in conditions did not significantly impact upon reported experience.

The hypothesis that participants would report improved mood and attention following coloring, compared with both baseline and control was met for all variables except energetic arousal. This replicates previous research reporting a reduction in anxiety following coloring (e.g. Curry & Kasser, 2005). It further suggests that coloring may improve positive affect, and reduce both energetic arousal (alertness) and tense arousal (anxiety). The experiment also supports previous work where coloring affected attentional state (Carsley & Heath, 2018), since participants reported being more focused and engaged while coloring. However, only self-report measures of attention were used, leaving open the influence of demand characteristics.

### **The effect of coloring on an implicit mood task**

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Participants rated abstract images as being ‘happy’ more often after coloring than the control condition ( $F_{1,42} = 2.28, p = .139$ ), less angry ( $F_{1,42} = 1.93, p = .172$ ), and more sad ( $F_{1,42} = 1.44, p = .236$ ), but none of these effects were statistically significant (means are reported in Table 2). The only significant effect was for fear, where participants were less likely to rate pictures as representing fear after coloring (means = 1.78 and 2.02;  $F_{1,42} = 4.25, p = .046$ ). The hypothesis that participants would show improved hedonic tone following coloring (compared to the control group) using an implicit measure was only partially met, for fear only. Nevertheless, this suggests that the reduction in anxiety (an overlapping construct, Reiss, 1991) reported previously (e.g. Curry & Kasser, 2005) may not be due to response bias.

### Experiment 2

Experiment two sought to further understand the impact of coloring on cognition, including performance measures of attention and creativity, firstly, to help assess the impact of demand characteristics on self-report measures of attention, and secondly to test whether coloring improves creative cognition. It was hypothesized that participants would score significantly differently on self-report measures of anxiety (lower) and mindfulness (higher) following coloring, compared with both control condition and baseline scores. Secondly, it was hypothesized that participants would score significantly higher on selective attention and divergent thinking (in particular originality) following coloring compared with reading.

### Participants

52 psychology undergraduate students (40 females) with a mean age of 21.04 (ranging between 18 and 32), were sampled through opportunity sampling, using the department’s participant pool. Participants were rewarded course credit.

### Design

A randomized controlled crossover MANOVA design, with two factors: a repeated measures factor (condition) with three levels (baseline, coloring and control [reading]); and a between-participants factor (order) with two levels (reading first and coloring first). The order in which conditions were taken was randomized ( $n = 24$  completed reading first). Dependent variables included anxiety, mindfulness, figural divergent thinking (fluency, flexibility and originality) and selective attention. The presentation of these measures, and the order of alternate forms, was counterbalanced.

### Measures

Short state form of the *Spielberger State-Trait Anxiety Inventory, STAI* (Marteau & Bekker, 1992). A six-item scale where higher scores indicate greater levels of anxiety. An example item is “I feel calm”, with a 4-point Likert Scale. The scale has adequate concurrent validity and reliability (Marteau & Bekker, 1992).

*Mindful Attention Awareness Scale, MAAS* (Brown & Ryan, 2003). Please refer to Experiment 1 for a description.

Figural divergent thinking activity from the *Torrance Tests of Creative Thinking, TTCT* (Goff & Torrance, 2002; Torrance, 1990). The figural activity chosen consists of nine identical shapes on a sheet of A4 paper (triangles or circles on the parallel form), with the request to “see how many objects you can make from the triangles/circles below”. Responses are scored according to fluency (number of responses), flexibility (how many different ideas are represented) and originality (how rare responses are compared with normative responses). The TTCT have good reliability and predictive validity (Kim, 2006; Torrance, 1990).

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*Map Search*, from the *Test of Everyday Attention, TEA* (Robertson et al., 1994). A measure of visual selective attention, requiring the location of an everyday symbol repeatedly printed on a colored map. The TEA has adequate concurrent and predictive validity and reliability, including test-retest reliability (Robertson et al., 1996). Two parallel forms were used (locating either a knife and fork or a screwdriver and spanner symbol).

### **Procedure**

Participants took part individually in a small research room in the psychology laboratory. After being greeted by the researcher participants read an information sheet describing the study and their ethical rights and signed a consent form if they wished to participate. Participants then completed baseline state measures (STAI and MAAS), before being informed whether they were either to color or read first. Participants either colored in a mandala design, using 12 Crayola coloring pencils, or read the chapter ‘Effective Time Management’ (Bird, 2011), for twenty minutes. Subsequently, participants completed the MAAS and STAI followed by both the Map Search test and the TTCT. Map Search involved locating (and circling) a symbol on a printed map as many times as possible in two minutes (out of a possible 80). The TTCT involved drawing on nine identical shapes in order to transform them into something else (e.g., a clock face or a pyramid), in three minutes. After completing the first condition, participants were offered a short break before completing the cross-over condition (reading or coloring). They then completed the same state measures and alternate forms of the cognitive tasks. At the end of the study, participants were debriefed and any questions answered. This research received ethical approval from the UWE’s Research Ethics Committee.

### **Results and discussion**

#### **The effect of coloring on self-report measures (mood and mindfulness)**

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Significant differences across conditions (baseline, coloring, reading) were found for both state anxiety ( $F_{1,51} = 26.388, p < .001$ ) and mindfulness ( $F_{1,51} = 13.770, p < .001$ ) (mean scores can be seen in Table 3). Post hoc analyses demonstrated that state anxiety was significantly lower after coloring compared with the control condition (means = 9.27 and 12.58;  $F_{1,51} = 30.042, p < .001$ ) and mindfulness was significantly higher (means = 22.29 and 17.54;  $F_{1,51} = 39.717, p < .001$ ). Anxiety was also significantly lower after coloring than at baseline (means = 9.27 and 12.06;  $F_{1,51} = 13.924, p < .001$ ) and mindfulness increased significantly (means = 22.29 and 18.42;  $F_{1,51} = 34.052, p < .001$ ). There were no significant effects for the order in which conditions were completed. The hypothesis that coloring would lead to reduced anxiety and focused attention, compared with both baseline and the control condition was accepted. The results of experiment two replicate those of Experiment 1, and previous research (e.g. Carsley & Heath, 2018), suggesting that coloring for twenty minutes can improve self-reported anxiety and mindfulness.

### **The effect of coloring on performance measures of attention and divergent thinking**

After coloring, compared with the control condition, participants scored significantly higher on originality (means = 3.10 and 2.42;  $F_{1,51} = 5.221, p = .027$ ) but neither fluency ( $F_{1,51} = .097, p = .756$ ) nor flexibility ( $F_{1,51} = 1.393, p = .243$ ) (mean scores can be seen in Table 4). Participants located significantly more symbols on the selective attention task following coloring compared with the control (means = 71.92 and 67.46;  $F_{1,51} = 17.187, p < .001$ ). There were no significant effects for the order in which conditions were taken. Hypotheses were met for selective attention, but were only partially met for creativity – participants did not produce *more* ideas, but the ideas that they did produce were more original. Importantly, Experiment 2 provides predictive validity for the mindfulness effect, since performance on a test of selective attention following coloring was also improved (Jha et al., 2007). Further, it suggests that coloring has cognitive benefits, improving original ideation, in line with

previous research supporting greater originality after positive mood inductions (Baas et al., 2008). As such, this research suggests that coloring can not only benefit one's wellbeing by reducing anxiety, but by improving one's ability to focus attention and generate original responses to problems.

### **General discussion**

Previous research, using pre-post designs had reported a significant reduction in anxiety after coloring (e.g., Eaton & Tieber, 2017; van der Venet & Serice, 2012). However, two studies using a control condition reported equivocal results (Powell et al., 2017; Sandmire et al., 2016). The two experiments reported in the current paper provide needed support for the hypothesis that coloring is a useful tool for reducing anxiety in a university student population, using controlled comparisons, and based on both self-report and objective measures. However, mood consists of distinct dimensions (Baas et al., 2008), and while coloring improved hedonic tone and reduced 'activating moods' (anxiety and alertness) on self-report measures, performance measures of mood only supported the reduction of anxiety. This might suggest that coloring only affects negative mood, alternatively a more statistically powerful study may be required to detect small effect sizes, or alternate objective measures of mood employed (Quirin, Kazén & Kuhl, 2009; Sandmire et al., 2016).

Coloring is often described in popular culture as a mindfulness activity (Mantzios & Giannou, 2018), however, only two studies previously assessed this claim, obtaining conflicting results (Carsley & Heath, 2018; Mantzios & Giannou, 2018). The current research was the first to compare mindfulness coloring both with a control condition and with a performance measure of mindful attention. The findings support those of Carsley and Heath, that coloring can improve mindfulness. Interestingly, both the current research and Carsley and Heath used the MAAS, which measures focused attention, while Mantzios and Giannou

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used a measure of global attention to the present moment (including bodily awareness and transitioning feelings). Hence, further research into the attentional state generated through coloring is required – it may simply be that coloring engages attention, acting as a temporary distraction from daily stresses, rather than developing ‘open’ mindfulness, for example. That coloring led to the flow state supports this interpretation, since this measures active enjoyment and engagement in one’s current activity, and is thought to arise when skills are balanced with challenges and tasks enable choice and expression (de Sampaio Barros et al., 2018), rather than merely concentrating attention.

The most novel outcome from the current research was that coloring for a short period of time might improve one’s ability to make original associations to stimuli. Hence, coloring might not only affect wellbeing by improving hedonic tone, but also by increasing one’s capacity to solve problems in daily life (Fredrickson, 2004). However, future research could seek to better understand the mechanism involved (e.g. positive affect and/or attentional networks), especially since some mindfulness research suggests that focused attention (measured by the MAAS) can inhibit divergent thinking (Lebuda et al., 2016). It is not clear why in the current research both divergent thinking and selective attention were increased. Explanatory factors might include: reduced anxiety (since anxiety can impede attention and creativity [Eysenck & Derakshan 2011]), increased motivation to engage in cognitive tasks following coloring (Jensen et al., 2012); or neurocognitive factors, since both original ideation and mindfulness have been associated with alpha synchronization (Lomas, Ivtzan & Fu, 2015; Schwab et al., 2014), which may improve both selective attention and cognitive processing that efficiently locates (original) concepts in memory (Schwab et al., 2014).

Future research could further consider problems with control groups and expectation effects (Boot, Simons, Stothart & Stutts, 2013). The current research attempted to select outcome measures that are not influenced by demand characteristics, but measuring and manipulate



expectation effects to examine their import would be useful (Davidson & Kaszniak, 2015), especially since there is limited evidence to suggest that expectation affects cognitive performance (Oken et al., 2008).

The results of the research support suggestions made by previous authors (e.g. Sandmire et al., 2016) that University wellbeing centers might profitably offer coloring as a method to help reduce student anxiety as an adjunct to other treatments, especially since they are increasingly under pressure to help students deal with stress (Novotney, 2014). However, caution is required, since research to examine the efficacy of such interventions is necessary. Further, it is not clear how useful coloring is for high levels of anxiety, what the duration of any effects are, or how best to maintain any beneficial effects (e.g., duration and frequency of coloring, or the need for accompanying instructions [Mantzios & Giannou, 2018]). Future research on coloring as a wellbeing intervention could examine these issues.

In conclusion, the current research supports the hypothesis that coloring for twenty minutes not only has affective consequences, reducing anxiety and improving positive mood, but also has cognitive consequences, improving one's ability to focus attention and produce original responses to problems, which in turn could improve one's wellbeing and performance. However, further research is required to explore the role of expectation effects, and examine the longitudinal impact of coloring on mood and cognition.

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## COGNITIVE AND AFFECTIVE BENEFITS OF COLOURING

Table 1

*Descriptive statistics (mean scores and standard deviations) for self-report measures at baseline, following coloring and following reading*

Dependent variables	Baseline	Coloring	Reading
Hedonic tone (content)	5.02 (2.42)	8.62 (2.28)	7.27 (2.22)
Energetic arousal (full of energy)	7.98 (2.38)	6.22 (2.48)	4.33 (2.39)
Tense arousal (calm)	8.11 (2.21)	9.44 (1.89)	7.18 (2.54)
Flow	32.02 (7.12)	41.53 (8.47)	27.29 (8.03)
Mindfulness	16.62 (5.92)	20.90 (4.08)	12.95 (6.21)

*Note.* SDs are indicated in parentheses.



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Table 2

*Descriptive statistics (mean scores and standard deviations) for implicit mood ratings after reading and coloring*

	Coloring	Reading
Happiness	2.72 (1.41)	2.39 (.95)
Anger	1.94 (1.02)	2.34 (1.34)
Fear	1.78 (.78)	2.02 (.99)
Sadness	2.12 (1.22)	1.92 (1.14)

*Note.* SDs are indicated in parentheses.

## COGNITIVE AND AFFECTIVE BENEFITS OF COLOURING

Table 3

*Descriptive statistics (mean scores and standard deviations) for self-report measures at baseline, following coloring and following reading*

Dependent variables	Baseline	Coloring	Reading
State anxiety	12.06 (3.27)	9.27 (3.24)	12.58 (3.10)
Mindfulness	18.42 (6.42)	22.29 (5.21)	17.54 (5.99)

Note. SDs are indicated in parentheses.

## COGNITIVE AND AFFECTIVE BENEFITS OF COLOURING

Table 4

*Descriptive statistics (mean scores and standard deviations) for cognitive performance measures following coloring and following reading*

Dependent variables	Coloring	Reading
Fluency	5.54 (2.28)	5.42 (2.17)
Flexibility	2.57 (0.98)	2.42 (1.04)
Originality	3.10 (1.99)	2.42 (1.88)
Elaboration	11.62 (4.49)	10.06 (4.91)
Selective attention	71.92 (7.63)	67.46 (8.36)

*Note.* SDs are indicated in parentheses.