

The Potential of a Mindfulness-Based Coloring Intervention to Reduce Test Anxiety in Adolescents

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ABSTRACT— Test anxiety is prevalent among adolescents. Some potentially successful mindfulness-based coloring interventions have been identified in previous research, however, conclusions have been based on self-report measures only. In the current study, 150 17- to 18-years-olds taking final school exam completed measures of state anxiety (STAI) and Mindfulness (SMS) prior to and directly after completing 12 min of either (1) free drawing, (2) mandala coloring, (3) mandala coloring paired with pre-recorded mindfulness instructions. Heart rate (HR) was recorded prior to and directly after the 12-min coloring intervention.

Test anxiety is located at the disciplinary boundaries of both psychology and education and recent interest has increased coinciding with the sharp increase in using tests as instruments of accountability both at organizational and individual level (Cizek & Burg, 2006; Marszalek, 2009). Test anxiety is a situation-specific form of trait anxiety (Spielberger & Vagg, 1995) characterized by aversive cognitions (feelings of apprehension and worrisome thoughts) and physical symptoms (feelings of tension and activation of the autonomic nervous system) in response to tests and exams (Liebert & Morris, 1967; Zeidner, 2007). It has become an increasingly common experience of adolescence with prevalence rates of 33% among high school pupils reported (Methia, 2004) with female students reporting higher test anxiety than male students (Putwain, 2007; Rosário et al., 2008; Putwain

& Daly, 2014). The prevalence of test anxiety is worrying as reviews have consistently found that those who experience higher anxiety are more likely to have poor academic performance (Hembree, 1988; Seipp, 1991; von der Embse, Jester, Roy, & Post, 2018). Furthermore, experimental research suggests that this relationship is likely to be, at least in part, causal as high levels of anxiety have been found to have a negative impact on both learning (Bisaz, Conboy, & Sandi, 2009), memory (Smeets, Giesbrecht, Jelicic, & Merckelbach, 2007; Schwabe & Wolf, 2010), and performance (Cassady & Johnson, 2002). Consequently, it is vital that successful methods of test-anxiety reduction are identified.

Although interventions to reduce test anxiety among university students have been successful (Ergene, 2003), success rates for interventions with high school pupils have been more modest and fewer studies have considered this age group (Von der Embse, Barterian, & Segool, 2013). Furthermore, most of the early interventions were lengthy (3 hr+) and delivered by researchers or specialists rather than a teacher (Von der Embse et al., 2013). This reduces the applicability of these findings as in many settings it is likely that curriculum demands, lack of funding to pay specialists and staff time would make including such interventions as standard problematic.

Recent interventions to reduce test anxiety among adolescents have found some success at reducing anxiety using internet-based programmes (Putwain, Chamberlain, Daly, & Sadreddini, 2014), expressive writing tasks (Shen, Yang, Zhang, & Zhang, 2018), structured Mandala coloring (Carsley & Heath, 2018), and an auditory training technique (AAT) consisting of differentially attending to prerecord auditory stimuli for approximately 12 min, regardless of internal experiences that may become present (Fergus & Limbers, 2019). Two of these, structured mandala coloring

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and AAT have been linked to controlling attention. While ATT encourages an external focus of attention, structured mandala coloring has been linked to mindfulness (Carsley & Heath, 2019; Carsley, Heath, & Fajnerova, 2015; Curry & Kasser, 2005; Sandmire et al., 2012) which encourages self-focused attention. Despite the conceptual differences, both ATT and mindfulness appear to be promising in reducing anxiety through improved attentional processes in both clinical and nonclinical samples (Kallapiran, Koo, Kirubakaran, & Hancock, 2015; Knowles, Foden, El-Deredy, & Wells, 2016; Haukaas, Gjerde, Varting, Hallan, & Solem, 2018; Fergus & Limbers, 2019).

Although definitions of test anxiety refer to physical symptoms (feelings of tension and activation of the autonomic nervous system), only one previous intervention study has been found which collected physiological data (Bradley et al., 2010); all others have relied on self-report data most commonly Spielberg's State Trait Anxiety Inventory (STAI) and Test-Anxiety inventory. This is similar to evaluations of the effectiveness of mindfulness-based interventions among school pupils, with a recent review (Maynard, Solis, Miller, & Brendel, 2017) of 61 studies identifying only six including physiological measures. Consequently, although interventions for test anxiety show potential, as do mindfulness-based interventions, there has been an overreliance of self-report measures which are susceptible to demand characteristics and do not provide objective measurement of activation of the autonomic nervous system.

CURRENT STUDY

The aim of the current study was to assess the potential of a short mindfulness-based intervention to reduce test anxiety among 17- to 18-year-old high school pupils. Previous research in this area has tended to focus on pupils in early- to mid-adolescence or University students (Von der Embse et al., 2013). Therefore, to address the current gap in the literature, the focus of the current study was older adolescence. To increase the ecological validity of this study, pupils preparing to sit final school examinations were sampled. This differs to much of the previous work on reducing test anxiety where spelling tests or Stroop tasks have been frequently used to induce test anxiety. Therefore, using actual upcoming exams increases validity as anxiety has been found to increase among undergraduates prior to final examinations but not prior to mock examinations (Lotz & Sparfeldt, 2017).

A further criticism of much of the research in this area, both on test anxiety and mindfulness, is that interventions have often failed to include an active control group. Therefore, in the current study, the effectiveness of spending 12 min free coloring will be compared to structured mandala coloring (as used by Carsley & Heath, 2018), with and

without mindfulness-based instructions. These activities were chosen as although Carsley and Heath found structured mandala coloring successfully increased state mindfulness and decreased test anxiety, this finding has not been replicated (Mantzios & Giannou, 2018). Therefore, building on mindfulness theory and previous successful interventions to reduce test anxiety, which included audioinstructions encouraging focusing of attention (Bradley et al., 2010; Mantzios & Giannou, 2018; Fergus & Limbers, 2019), mindfulness instructions were pre-recorded and played through headphones to one of the three groups of participants. Should the intervention be successful the use of pre-recorded instructions will increase the accessibility of the intervention as it could be accessed by pupils either at school or at home.

A suitable measure of state test anxiety does not exist, therefore in accordance with previous research assessing the effectiveness of mandala coloring on reducing test anxiety (Franco Justo, 2009; Beauchemin, Hutchins, & Patterson, 2015; Mantzios & Giannou, 2018; Carsley & Heath, 2019), state anxiety was assessed directly prior to and directly after completing the coloring activity. To encourage participants to focus on their anxiety in relation to the upcoming exams, pupils were instructed at the beginning of the questionnaire to report how they are feeling at that moment in time when they think of the upcoming exams. To control for pre-existing differences in trait-test anxiety, all participants completed the short form five-item Test Anxiety Inventory (TAI) (Taylor & Deane, 2002) prior to the coloring activity. To assess the efficacy of the intervention to promote a mindful state, state mindfulness was assessed prior to and after the coloring activity.

Research using mandala coloring in other contexts has found some indication that physiological markers of anxiety, typically heart rate (HR), decrease after mandala coloring (Schrade, Tronsky, & Kaiser, 2011; Stinley, Norris, & Hinds, 2015). The only test anxiety intervention found which assessed physiological markers of anxiety also assessed HR (Bradley et al., 2010). Therefore, HR was measured during two rest phases, prior to any questionnaires being completed and directly after the intervention. It was anticipated that the greatest reduction in HR and state anxiety would be observed in those who had engaged in the mandala coloring with mindfulness instructions, followed by those in the mandala coloring only and those in the free drawing group. For state mindfulness it was expected that the increase would be greatest among those who have done the mandala coloring with mindfulness instruction compared to those who had colored the mandala or engaged in free drawing. To explore the extent to which pupils' current and previous experience of drawing and mindfulness might affect the generalisability of the findings they were asked the extent to which they had enjoyed the task, followed the instructions, previously

practiced mindfulness or used drawing for relaxation. Furthermore, gender differences were explored as previous research has suggested that test anxiety is higher among females (Putwain & Daly, 2014), mindfulness interventions are more beneficial for females (Rojiani, Santoyo, Rahrig, Roth, & Britton, 2017; Kang et al., 2018) and there is some, albeit inconsistent, evidence for females finding mandala coloring more beneficial than males (Carsley et al., 2015).

METHOD

Participants

Effect sizes for reductions in test anxiety in previous studies comparing mandala coloring and free drawing range from large ($d = .8$, Curry & Kasser, 2005) to small/very small ($.07 > d < .019$, Carsley et al., 2015; Mantzios & Giannou, 2018). The only study which has previously compared mandala coloring with guided mandala coloring found a large effect size ($d = 0.74$) for reduction in state anxiety and a small/medium effect size for increase in mindfulness (Mantzios & Giannou, 2018). A study (Stinley et al., 2015) investigating the potential of mandala coloring to reduce heart rate (HR) has found a medium effect size ($d = .52$). Taking these previous effect sizes into consideration, it was decided to design the current study to detect a medium effect ($\eta^2 = 0.059$) with a power of 0.8. Therefore, 150 participants were recruited, with 50 participating in each condition.

Participants were recruited through contacting state-funded, mainstream schools and colleges with 17- to 18-year-olds preparing to take final exams within the local area. The final sample consisted of (x) city based and (x) semirural educational establishments (number of participating schools will be confirmed at Stage 2 submission). All participating pupils were within 5 weeks of taking a final examination. Once approval was gained from the educational establishment, a letter was shared with all pupils with upcoming exams, this provided information about the research and what would be involved in participation. Alongside this a letter with information for parents/guardians was provided, this included an opt-out consent form so that parents of 17-year-olds could notify the researcher if they did not wish their child to take part. The project was granted ethical approval.

Materials

Trait Test Anxiety

The five-item short form TAI, based on Spielberger, Gonzalez, Taylor, Algaze, and Anton (1978) TAI that has been validated on a university (Taylor & Deane, 2002) and adolescent sample (Marszalek, 2009), was used. This contains items such as “I feel very panicky when I take an important test” to

which participants respond on a 4-point scale from “not at all” to “very much so.”

State Test Anxiety

To assess state anxiety before and after the drawing session an adaption of the STAI's (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used. This consisted of the 20 statements from the original STAI State Anxiety Scale (e.g., “I feel calm”, “I feel worried”) that participants rated on a 4-point scale from “not at all” to “very much so” with the additional instruction directing participants to reflect on how they are feeling, at that moment in time, when they think of the upcoming exams. The STAI has good reliability and validity (Marteau & Bekker, 1992; Spielberger et al., 1983) and is appropriate for those who have at least the reading level of an average 11- to 12-year-old (Spielberger et al., 1983).

State Mindfulness

The 21-item State Mindfulness Scale (SMS) (Tanay & Bernstein, 2013) consisting of two subscales: bodily sensations (e.g., “I noticed some pleasant and unpleasant physical sensations”) and mental events (e.g., “I noticed emotions come and go”) was used. Participants rate each statement on a 5-point scale from “not at all” to “very much so” to reflect how much the statement relates to them at that moment in time. Strong internal consistency reliabilities ($\alpha = .90-.95$), strong positive correlations with other state mindfulness measures and sensitivity to change have been demonstrated (Tanay & Bernstein, 2013).

Heart Rate

HR was recorded using electrocardiogram (ECG) waves detected by a Biopac MP36 system and HR was calculated based on the R-R interval. Separately for the pre- and postdrawing tasks 3 min rest phases the mean of the relevant series of beats per minute ($BPM = f \times 60$ where f is the frequency, frequency = $1/T$, where T is the time period between R peaks) was calculated. Disposable circular electrodes with a 6 cm diameter and cloth backing, prefilled with low chlorin gel were used. These were placed by participants on both inner ankles and on their right wrist.

Materials for the Intervention

The coloring interventions involved either a plain A4 piece of paper for the free drawing condition or a piece of A4 paper with a mandala design, as used by Carsley and Heath (2018) and Mantzios and Giannou (2018), for the mandala conditions. In all condition's, participants were equipped with 10

different colored pencils and a pair of headphones. The script of the guided mindfulness instruction used by Mantzios and Giannou (2018) was read and recorded by the second author. These instructions focused on relaxation, concentration on the coloring, and nonjudgmental acceptance of self. A copy can be obtained by contacting the corresponding author.

Procedure

Participants took part in small groups between two and six pupils in classrooms at their schools. Prior to participation the group was randomly assigned to one of the three intervention conditions. After gaining informed consent the researcher demonstrated the application of the disposable electrodes. Participants placed these on themselves and the researcher made sure that stable readings were being recorded by the BioPac prior to the experiment commencing.

The experiment consisted of five phases (1) baseline, (2) prequestionnaires, (3) intervention, (4) rest period, and (5) postquestionnaires. The baseline phase required participants to sit quietly for 3 min while an initial HR measure was taken. After this, participants completed the TAI, STAI, and SMS electronically using iPads. Participants were then provided with a sheet of A4 paper (in the mandala conditions this contained the mandala) and 10 colored pencils. Those in the free drawing condition were instructed to draw whatever they liked for 12 min and those in either of the mandala conditions were instructed to color in the mandala for 12 min. All participants were instructed to wear the headphones, in the free coloring and mandala without instruction conditions, it was explained that this was to reduce noise distraction, in the guided mindfulness condition, it was explained that it was to reduce noise distraction and to enable them to receive some instructions. All groups were informed that the drawings would be theirs to keep and that no assessments of them would be made. After 12 min had elapsed participants were asked to stop coloring and to remove the headphones. Participants then entered the 3-min rest period where again they were required to sit in silence and do nothing, during this time their HR was recorded. The researcher then handed out iPads again for the participants to complete STAI and SMS for a final time. After completing these participants responded to four additional statements on 5-point Likert type scales (1 = *strongly agree* to 5 = *strongly disagree*): (1) "I enjoyed the task that I took part in," (2) "I fully understood and followed the instructions for the task," (3) "I have previous experience of practicing mindfulness," and (4) "I use drawing or colouring for relaxation." Finally, participants entered details of their age (year and month of birth) and sex before removing the electrodes and receiving a verbal and written debrief.

Data Analysis

Only participants who had fully completed all phases of the study were included in the final analysis. The data set was analyzed to determine the extent and randomness of missing data. No data imputation was used, instead pairwise deletion was used. Data were screened for outliers (z -score cut off $-3/+3$) and the presence of an approximately normal distribution was checked. If outliers are found, then analysis will be conducted with and without outlying data points to check the robustness of the findings. If the distribution of data is not approximately normal, appropriate transformations of the data will be carried out and if these are not successful then nonparametric tests will be used to check the robustness of any conclusions made.

A one-way analysis of variance (ANOVA) will be used to compare pre-existing levels of trait test anxiety between the three intervention groups. If these are found to differ, subsequent analysis will include trait test anxiety as a covariate. Three separate 2 (time: pre- vs. post-test) \times 3 (condition: free vs. mandala vs. guided mandala coloring) ANOVAs will be carried out for the three dependant variables of state anxiety, state mindfulness, and HR. Significant two-way interactions will be followed up with simple effects in which condition will be held constant and the precompared with postintervention responses compared using within group t -tests. To control for type 1 error, without substantially increasing the risk of a type 2 error, Bonferroni corrections will be used within each family of tests. For state anxiety, total scores only will be analyzed as this measure includes no subscales. For state mindfulness, the overall score will be analyzed followed by separate ANOVAs (and if appropriate post-hoc tests) being carried out for the two subscales independently. For HR, average measures for each of the resting periods (pre- and postintervention) will be used in the ANOVA (and if appropriate post-hoc tests).

If significant effects of the intervention are not identified for one or more of the dependant variables, Bayesian analysis using JASP will be used to test the null (i.e., no difference between conditions) hypothesis. Therefore, the Bayes factors will be calculated to evaluate evidence in favor of the null hypothesis.

Exploratory analysis will be used to investigate whether the effectiveness of the interventions differ for males and females. For this difference, scores (post minus pre-test scores) for state anxiety, HR, and mindfulness will be calculated. Three separate 2 (gender: female vs. male) \times 3 (condition: free vs. mandala vs. guided mandala coloring) ANOVAs will be carried out for the three sets of difference scores. Significant two-way interactions will be followed up with simple effects with condition held constant and the responses of males and females compared using within group t -tests with a Bonferroni correction made. Furthermore, separately

for each of the three groups, correlations will be calculated to establish whether there are any associations between change in pre- to post-test anxiety and (1) participants' liking of the intervention, (2) the extent to which they reported understanding and following the instructions, (3) their previous experience of practicing mindfulness, and (4) using drawing or coloring for relaxation.

Timeline to Completion

Ethical approval for this study has been gained and the researchers have current disclosure and barring service (DBS) checks. As the data are to be collected in the United Kingdom and the main examination period is May–June, each year it is planned that data will be collected April–June 2021 depending on the stage 1 review process. On this basis, it is anticipated that if the stage 1 submission is successful then the stage 2 submission will take place during October 2021.

Acknowledgments—The authors wish to thank Paul Galimore for technical support relating to the measurement of physiological responses. This work was funded through a British Psychology Society Undergraduate Research Assistantship award made to the authors. Authors declare that they have no conflicts of interest.

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