The effect of colouring-in tasks on heart rate and classroom behaviour: An in-depth single-subject study

A thesis submitted in partial fulfilment of the requirements of the degree of Master of Science (Child and Family Psychology)

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2018
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Abbreviations

ACTH – Corticotropic Hormone

ANOVA – Analysis of Variance

ANS – Autonomic Nervous System

BPI – Behaviour Problem Index

BPM – Beats per minute

CBT – Cognitive Behavioural Therapy

CCQS – California Child Q Set

CES-D – Center for Epidemiological Studies Depression Scale

CORS – Child Outcome Rating Scale

CRF – Corticotropin Releasing Factor

CRIES-13 – Children’s Revised Impact of Event Scale

DSM – Diagnostic and Statistical Manual of Mental Disorders

DTC – Daily Teacher Checklist

EMDR – Eye Movement Desensitization and Reprocessing

GSR – Galvanic Skin Response

HPA - Hypothalamic Pituitary Adrenal Axis

HRV – Heart Rate Variability

IAPS – International Affective Picture System
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PANAS – Positive and Negative Affect Schedule

PBS – Positive Behaviour Scale

PNS – Parasympathetic Nervous System

POMS – Profile of Mood States

PSS – Perceived Stress Scale

PTSD – Post Traumatic Stress Disorder

PTSS – Post Traumatic Stress Symptoms

RCMAS – Revised Children’s Manifest Anxiety Scale

SAM – Self Assessment Manikin

SCID1-CV – Structured Clinical Interview for DSM-IV Axis 1 Disorders: Clinical Version

SCL – Skin Conductance Level

SNS – Sympathetic Nervous System

STAIC – State-Trait Anxiety Inventory

STAIC-S – State-Trait Anxiety Inventory for Children State Form

TSC – Teacher Selection Criteria

TSST – Trier Social Stress Test

WDQ – Worry Domains Questionnaire
Abstract

Background

Earthquakes are found to have lingering post-disaster effects on children that can be present for months or years after the disaster, including hyperarousal symptoms. Young children have the most difficulties in regulating their emotions, especially when they are highly aroused. Colouring-in mandala designs have been found to reduce hyperarousal symptoms of stress in young adults. The purpose of this study was to determine if the same effects of colouring-in mandalas would be seen with children showing signs of hyperarousal.

Research Question

To identify what effect colouring-in mandala designs would have on the heart rate in a young child showing signs of hyperarousal.

Method

Following approved procedures for informed consent, two 6-year-old girls from a Christchurch primary school were chosen for the study. Heart rate was measured using a Fitbit in a single subject design. The baseline, colouring-in and a second baseline phase were conducted during mathematics. The participants and their teacher reported on arousal, enjoyment, and positive and problem behaviours. The study took 26 school days to complete.

Results

Compared with baseline, the average heart rate data showed no decrease in heart rate (i.e., calming effect) during the mandala colouring-in task phase.
Conclusions

The participants enjoyed colouring-in the mandalas, but the average heart rate data did not show that colouring-in pre-drawn designs reduced heart rate, a measure of arousal. Major study limitations included; not having suitable participants or a suitable setting for the colouring-in task, and not being able to observe both participants.
Chapter 1

Introduction

Following a natural disaster, there is a high risk for children to present with post-traumatic stress symptoms (PTSS) which could lead a child to Post-Traumatic Stress Disorder (PTSD). These symptoms appear when a person experiences an event that created fear and anxiety, or that was life-threatening. After the traumatic event behaviours that are possible indicators of PTSD are most likely to appear. These include; repetitive behaviours, terrifying dreams, physiological hyperarousal, and avoidance from stimuli linked to the event, such as not doing things or not going to places that might make them anxious and bring back memories of the traumatic event they experienced (American Psychiatric Association, 2013; Dyregrov & Yule, 2006).

On September 4, 2010, the city of Christchurch was hit by a 7.1 magnitude earthquake at 4:35 am. Only about 100 people were injured because the streets were empty, and the epicentre of the earthquake was 37km west of Christchurch (Gledhill, Ristau, Reyners, Fry, & Holden, 2011). Unfortunately, six months after this earthquake on February 22, 2011, Christchurch was hit with a 6.2 magnitude aftershock at 12:51 pm. This aftershock was more disastrous than the 2010 earthquake because it was quite shallow, the epicentre was only 10km south-east of Christchurch City, and it struck during lunchtime which was a time of high activity. It caused the destruction of many buildings, took the lives of 185 people, and injured thousands (Kaiser, Holden, Beavan, Beetham, Benites, Celentano, Collett, Cousins, Cubrinovski, Dellow, Denys, Fielding, Fry, Gerstenberger, Langridge, Massey,
Motagh, Pondard, McVerry, Ristau, Sterling, Thomas, Uma, & Zhao, 2012). Between September 4, 2010, and September 3, 2014, there have been 4341 earthquakes with 271 aftershocks between the 2010 earthquake and the devastating aftershock that followed in 2011 (GNS Science, 2013; 2015). Like all natural disasters some people’s reactions to natural disasters can vary, but other people start to present with trauma-related outcomes including anxiety disorders, depression and most commonly PTSD (Fergusson & Boden, 2014). The 2013 New Zealand Census figures show that out of the 438,744 people living in the Canterbury region in 2013, 74,622 people were 10 years or younger when the earthquake struck Christchurch in 2010 (Statistics New Zealand, 2013). A significant proportion of young children from that census statistic were present during the first earthquake, and even some of these children could still be struggling because of interventions ineffectively reducing the presentation of trauma-related outcomes.

In the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013) children younger than 6 years of age have been given different diagnostic criteria for PTSD. Children must be exhibiting symptoms in the following diagnostic criteria. Firstly, exposure to sexual violence, serious injury, or threatened or actual death should happen in one or more ways, either by witnessing the event(s), in person, as it happened to others, understanding the traumatic event(s) occurred to a parent or guardian, and/or experiencing the traumatic event(s) directly. Secondly, one or more intrusion symptoms connected to the traumatic event(s) must be present after the occurrence of the traumatic event(s). These include, prolonged or intense psychological distress when exposed to external or internal cues resembling or symbolising a part of the traumatic event(s),
dissociative reactions such as flashbacks where the child acts or feels comparable to that of the traumatic event(s) reoccurring, distinct physiological reactions to traumatic event(s) reminders, frequent distressing dreams related to the traumatic event(s), or intrusive, involuntary, and recurrent distressing memories about the traumatic event(s). Thirdly, one or more symptoms that either exhibit constant avoidance of stimuli or negative alterations of mood and cognitions and mood modifications linked to the traumatic event(s), must be displayed, presenting after or worsening after the event(s). The symptoms of constant avoidance of stimuli include efforts to avoid or avoidance of places, activities, or other physical reminders that could trigger recollections of the traumatic event(s) and efforts to avoid or avoidance of conversations, people, or interpersonal scenarios that could trigger recollections of the traumatic event(s). Symptoms of negative modifications in cognition include withdrawn social behaviour, distinctively reduced participation or interest in notable activities such as play, steady reduction of expressing positive emotions, and significant increases in the number of negative emotional states (e.g., sadness, confusion, fear, shame, guilt). Fourthly, two or more symptoms regarding modifications in reactivity and arousal linked to the traumatic event(s), must be displayed, presenting after or worsening after the event(s). These symptoms include hypervigilance, concentration problems, exaggerated startle response, sleep disturbances, and angry outbursts and irritable behaviour generally expressed as physical or verbal aggression towards objects or people. Fifthly, the disturbance duration must last more than a month. Sixthly, clinically significant impairment or distress in relationships with peers, siblings, parents, or guardians or with school behaviour due to the disturbance. Lastly, symptoms cannot be attributed to the
physiological effects of another medical condition or substance (American Psychiatric Association, 2013).

Another major problem is that most children who present with symptoms of PTSD after a traumatic event, like a natural disaster, could still show signs of these symptoms a few years later. The persistence of PTSS is usually seen with people who have experienced an earthquake as there are many reoccurring adversities and negative events that keep levels of anxiety high, mainly from not knowing when another earthquake or aftershock will strike, how strong it will be, and how long it will last (Galea, Nandi, & Vlahov, 2005; Goenjian, Steinberg, Najarian, Fairbanks, Tashjian, & Pynoos, 2000).

The Christchurch earthquakes produced many other post-disaster problems. Most families living in Christchurch had to find new places to live and some needed to move multiple times. These moves were mainly due to the unsafeness of the house or land, although some were driven by emotional reasons (Freeman, Nairn, & Gollop, 2015). Reopening schools was another problem that had to be solved quickly. Some schools did not reopen until several weeks, months, or even a year later. Schools that were permanently closed had to merge and share sites with other schools (Brown, 2011). For a child under the age of 8 years being exposed to these types of disruptions during their childhood can cause persistence of PTSS. Children are usually affected by a combination of factors, which some have been mentioned, such as unpredictable aftershocks, and house and school relocations which could lead to a drastic change in a child’s life, especially the prevalence of psychological problems (Kiliç, Aydin, Taşkintuna, Özçübüz, Kurt, Eren, Lale, Özel, & Zileli, 2006; Wang, Gao, Zhang, Zhao, Shen, & Shinfuku, 2000).
With Christchurch, many more significant problems were created as a cause of being struck by a large aftershock only six months after the big earthquake in 2010. This consistent damage on all the suburban and urban communities in Christchurch is what makes the Christchurch earthquakes unique compared to the other disastrous earthquakes around the world (McColl & Burkle, 2012). By adding to the damage already caused by the previous earthquake, schools were having more difficulties reopening, and some had to be shut down permanently (Brown, 2011). As mentioned, some families moved houses due to emotional reasons which created more disruptions for children in those situations. For example, there were disagreements within some families whether they should stay in Christchurch or move to a new place. This led to situations where one parent moved to another city while the other parent stayed in Christchurch (Caldwell & Maynard, 2012). The allocation of children could create new problems where a child might have to learn to live in a new city or live in a single parent household. These persistent symptoms can be quite problematic with children under the age of 8 years as they are still developing the skills to regulate their own emotions adaptively.

Self-regulation is the ability to focus one’s attention and actions to meet various goals. This could relate to self-discipline, delay-of-gratification, executive function, and conscientiousness (Flouri, Midouhas, & Joshi, 2014). These constructs all have the idea of self purposefully acting to modify emotions, behaviours, and thoughts. The ability to modify these areas allows a person to either trigger or maintain a required response or suppress an inappropriate response (Lengua, 2003; Posner & Rothbart, 2000). Self-regulation development in children is dependent on exposures from the environment and biology (Flouri et al., 2014; Eisenberg, Valiente,
& Eggum, 2010). If these exposures negatively affect the child, such as increasing their stress levels, then this can impair the development of self-regulation. Young children who are exposed to stressful events have problems with self-regulation, especially emotion regulation, as they are still learning the skills required to understand their emotions, control their behaviour when they are under emotional distress, and modulating the intensity and/or duration of unpleasant emotional experiences (Gratz & Roemer, 2004; Weiss, Tull, Viana, Anestis, & Gratz, 2012). This is the primary reason why children have problems with reducing physiological arousal after they have experienced a negative event as their emotional regulation skills have not fully developed.

Emotion regulation is the learnt skill of observing, assessing, and adjusting one’s emotions relating to a situation usually one that is arousing or stressful (Cicchetti, Ganiban, and Barret; 1991; Eisenberg and Morris; 2002; Thompson, 1994). Regulating one’s emotions to a situation can happen before, during, or after the emotion has been expressed. Over time people can learn what situations illicit negative emotions and prepare themselves beforehand to prevent it from happening or modifying it in a way to reduce its effect, which is known as proactive coping (Aspinwall & Taylor, 1997). Young children are still developing skills for regulating their emotions so, if it is possible, children will avoid or withdraw from situations that are emotionally arousing for them (Barrett, Rapee, Dadds, & Ryan, 1996; Suveg & Zeman, 2010).

Arousal or physiological arousal is the level of activation or alertness that can range from being extremely drowsy to being extremely wakeful and attentive (Humphreys & Revelle, 1984). Young children who experienced the earthquake
might show abnormally high levels of arousal, also known as hyperarousal, which creates difficulties in regulating physiological arousal. Physiological arousal levels are controlled by the Autonomic Nervous System (ANS) and the Hypothalamic-Pituitary-Adrenal axis (HPA axis), which are affected by experiencing traumatic events and responding to stress. The role of the ANS is to help a child adjust to physical environments, the regulation of anger, fear and anxiety, and the management of threats (e.g., the activation of the ‘fight or flight’ response; Rees, 2014). Responding to stress changes on the two ANS branches, the parasympathetic (PNS) and sympathetic nervous systems (SNS). When the body responds to stress the SNS normally prepares the body by producing many ‘fight or flight’ responses which target certain organs, such as the brain, the heart, and the lungs (Cacioppo, Berntson, Malarkey, Kiecolt-Glaser, Sheridan, Poehlmann, Burleson, Ernst, Hawkley, & Glaser, 1998). Minutes or hours after responding to the stressor the SNS increases the heart and respiratory rate (Bertram, Jamison, Slightman, Kim, Roth, & Roth, 2014). After a while, the ANS should deactivate the SNS and activate the PNS and stop the production of these fight or flight responses to restore homeostasis on the target organs.

The brain regions that also have a large part in responding to stress comprise the hippocampus, medial prefrontal cortex, amygdala, and the HPA axis. The HPA axis is the series of interactions between the hypothalamus, pituitary gland, and the adrenal glands that occur during stress regulation (Bear, Connors, & Paradiso, 2007). When a child responds to stress the ANS activates the SNS branch sending information to the brain, specifically the amygdala, to release corticotropin-releasing factor (CRF) from the hypothalamus which in turn releases an adrenocorticotropic
hormone (ACTH) from the pituitary gland and causes glucocorticoids (e.g., cortisol) to be released from the adrenal glands that are found on top of the kidneys. The primary function of the amygdala is to evaluate incoming stimuli for emotional significance which is the reason why the amygdala will activate these processes if it decides the stimulus is a stressor (Davis & Whalen, 2001). When responding to stress, CRF also activates additional neurochemical responses including the noradrenergic system where neurotransmitters from noradrenergic neurons are released all around the brain. Epinephrine and norepinephrine that is released from the adrenal medulla of the adrenal glands causes an increase in vigilance and alerting behaviours which are crucial for coping with stress (Bremner, 2006; Turner-Cobb, 2014). Once enough cortisol is produced a negative feedback loop begins on the HPA axis by the hippocampus, and hypothalamus to stop the production of cortisol, epinephrine, and norepinephrine. At this time the ANS activates the PNS and deactivates the SNS to lower the heart and respiratory rate and restore homeostasis in the affected organs. In children with PTSD autonomic activity is higher, so the time it takes for the body to get back to resting heart rate and respiratory rate levels after a stressor is much longer than in healthy children (Pole, 2007). This is due to the dysregulation of the ANS and the inhibition of the negative feedback loop in the HPA axis seen in children with PTSD (Yehuda, Hoge, McFarlane, Vermetten, Lanius, Nievergelt, Hobfoll, Koenen, Neylan, & Hyman, 2015). The HPA axis of children with PTSD responds differently to stress, where over time the amount of CRF secreted by the hypothalamus is increased, and the baseline levels of cortisol released by the adrenal glands are reduced. This reduction keeps the negative feedback loop and SNS active. The constant levels of lower than normal cortisol and high CRF keep
children with PTSD alert and vigilant for much longer than when a healthy child responds to a stressor (Yehuda et al., 2015). Without the deactivation of the SNS, levels of heart rate, respiration rate, and physiological arousal remain higher for much longer than in healthy children.

Sometimes the PNS can deactivate which in turn amplifies the responses of the SNS (McEwen, 1998; Taylor, Lerner, Sage, Lehman, & Seeman, 2004). These two ANS branches are studied when researchers want to see physiological arousal levels and the possible reasons for why some children have high levels of arousal. Children respond to stress differently because of the variations in coordination between the SNS and PNS. The way the HPA axis acts with the SNS also determines the level of arousal. These combinations are the reasons for children responding to stress differently. Berntson, Cacioppo, and Quigley (1993) developed a model which listed a variety of responses a person can have to stress due to a pattern of several responses. From the model, the patterns are either complementary or opposing. The two complementary patterns are coactivation when the activation of SNS is combined with the activation of the PNS and coinhibition when the deactivation of the SNS is combined with the deactivation of the PNS. While the two opposing patterns are reciprocal sympathetic activation when by combining the activation of the SNS and deactivation of the PNS induces heightened arousal and reciprocal parasympathetic activation when the combining of the activation of the PNS and the deactivation of the SNS induces low arousal (Quas, Yim, Oberlander, Nordstokke, Essex, Armstrong, Bush, Obradović, & Boyce, 2014). If both branches of the ANS could be measured, then researchers would be able to see what pattern a participant would have activated.
Traumatic events experienced by a child can cause problems with ANS regulation, which can produce intrusive thoughts, nightmares that are more generalised than trauma specific, create problems with managing emotions, and the re-enactment of trauma-specific content in play (Imran, Haider, & Azeem, 2017). It is believed that traumatic events create fragmented and disorganised memories of those events (Feldner, Monson, & Friedman, 2007). Strong associations with cues of the traumatic event make these encoded memories overly accessible. During a traumatic event, high levels of arousal produce vivid memories that are remarkably impervious to forgetting and post-traumatic arousal causes the over-consolidation of the traumatic memories, which leads to constant re-experiencing of the traumatic event (McCleery & Harvey, 2004). Consolidation of these intrusive thoughts or traumatic memories are thought to occur when the cortisol levels are low, norepinephrine is still being produced, and the SNS is still active during the time of the traumatic event (Jehuda, 2002; Jehuda et al., 2015). Also, failing to keep the stress response during the time of the trauma can cause alterations in the biological systems that lead to children re-experiencing those intrusive thoughts or memories (Jehuda, 2002). For younger children, these issues are more problematic as their neurobiological systems are not highly developed. The trauma can negatively affect their neurobiological development which damages their ability to regulate emotions, create relationships and impair their memory and learning (Kruczek & Salsman, 2006; Perry, 1994; van der Kolk, 2003).

Usually, young children who are still learning skills needed for emotion regulation mainly learn these skills through observing and modelling others, especially their parents or guardians (Dowrick, 2012). Since young children with PTSD
have difficulties with learning because of having a dysregulated ANS and HPA axis, they cannot learn skills for regulating emotions through observational learning. This limits young children with PTSD in ways to learn the necessary skills to regulate their emotions when they respond to a stressor and could cause the young child to present with PTSS for longer (Yehuda, 2002). Without having learnt the skills for emotion regulation young children with PTSD need to find activities that will help them reduce their arousal levels when responding to a stressor.

In New Zealand earthquakes are quite common, and one of the most significant problems is that they are unpredictable and uncontrollable. This has been found to cause higher adrenergic activity which affects the regions of the brain that are involved in attention, arousal, and emotion (Donnelly, Amaya-Jackson, & March, 1999). Therefore, interventions have been created and studied to help adults, adolescents and children, who are more sensitive to stress, find effective ways to regulate the cortisol and CRF levels in their body (Curry and Kasser, 2005; Bronner, Beer, van Eldik, Grootenhuis, & Last, 2009; Zhu, Wang, Kao, Zong, Liu, Tang, Xu, Liu, & Lam, 2014).

The risk of presenting with PTSS is increased in children because their developing behavioural repertoire and cognitive schema make them more vulnerable (Zhu et al., 2014). This increased risk in children promotes creating or finding various effective treatments or therapies that could work for a variety of children who have been affected by a natural disaster as one single therapy might not be effective for every child. For example, Cognitive Behaviour Therapy (CBT) is an effective treatment used in helping people with PTSD and other anxiety disorders onset by trauma. Studies have varying results on the effectiveness and suitability of
CBT with younger children as the cognitive abilities needed to complete CBT tasks usually develop between the ages of 7 and 12 years. This means that even though CBT can be an effective intervention, it does not mean that it will be effective for everyone (Beck, 1976; Cohen, Mannarino, Berliner, & Deblinger, 2000; Dyregrov & Yule, 2006; Jones-Smith, 2012; Stallard, 2002; Verduyn, 2000). Children only start to develop the understanding and skills needed for effective emotion regulation in late childhood and adolescence, which highlights the importance of discovering various ways in which young children could reduce their arousal or stress levels in certain situations when they have not developed all the necessary skills yet.

For this study, non-verbal activities were researched that have been used in reducing arousal in young children presenting with PTSS. Specific treatments, like CBT, have been found to help children with PTSD, but this does not guarantee that these treatments will be effective for all children. The reasoning is that CBT programs use different cognitive and behavioural techniques and sometimes these chosen techniques do not focus on the developmental stage of the children they are treating. As CBT programs for children are mainly modified adult programs, it is difficult to know what is causing a significant decrease in PTSD symptomatology, whether it is the cognitive or behavioural techniques or maybe a combination of the two. Some researchers say that CBT would not be suitable for young children under the age of 8 years as there are still in the preoperational stage of development as proposed by Jean Piaget (1936; Grave & Blissett, 2004).

The inability of thinking logically about concrete ideas and perception dominated thinking are two main reasons it is believed that CBT techniques would not work with young children in this developmental stage. The cognitive portion of
CBT uses a few techniques to help a person change their way of thinking about a traumatic event they experienced. The main techniques used are; causal reasoning, metacognition, and perception changing. These techniques are also used to challenge or change a person’s irrational thinking about their everyday life or other situations (Grave & Blissett, 2004).

Causal reasoning is the ability to understand the cause and effect of one’s thoughts on their behaviour. This ability will allow people to decide whether a cause was accidental or intentional (Shirk, 1988). Regarding a traumatic event, children who can use causal reasoning can determine the reasoning for their behaviour, whether it be due to thinking about the event or being in a similar situation. There are conflicting arguments on whether young children can infer internal causation (Garber, Frankel, Herrington, 2016). Those opposing state that young children need the ability to view the world from another person’s point of view which young children do not possess as they are characterised as being egocentric (Grave & Blissett, 2004; Piaget, 1936). Without these main skills being fully developed, children will struggle to infer causation with more complex or subtle emotions (e.g., embarrassment or guilt). However, some studies have said that if the internal cause and effect information is provided in a simple and clear way, then young children should be able to use this information accurately during causal reasoning (Miller, 1985).

The process of being able to think about thinking, which is referred to as metacognition, is a key ability that is used in CBT. Metacognition develops around three to four years old in healthy children from basic theory of mind and allows the child to understand that a person’s behaviour is influenced by their desires, beliefs
or from experiencing emotions (Bartsch & Estes, 1996). At around eight years of age, children develop the ability to understand that different situations can cause different reactions and that people can experience more than one emotion at the same time (Friend & Davis, 1993; Gnepp & Klayman, 1992). Self-evaluation and self-observation are also required to think about thinking, as the child needs to understand the concept of self in relation to others. This is needed so they can infer from their own experiences to help them identify the reason for another person’s behaviour. Since these two abilities are deemed important when metacognition is used in CBT, children younger than 8 years of age will have difficulty with metacognition and affective perspective taking tasks used in CBT.

The problem of using perception changing techniques with young children is that they struggle to process new information that conflicts with the information they already have about the perception of themselves or other people (Bierman, 1998). This all or nothing approach, known as dichotomous thinking, or centration by Piaget (1936), is likely to hinder the child’s ability to challenge and alter their irrational thinking about an event or situation that is creating problems for them. If this ability is impeded, then changing one’s perception would be difficult and thus reduce the effectiveness of CBT (Piaget, 1936).

From what has been written each cognitive technique used in CBT have similar cognitive skills that are needed for CBT to be effective in reducing PTSD symptomatology. All techniques require a contribution of those various skills mentioned, such as perception changing skills to understand why a child might be behaving or feeling a certain way, and metacognitive skills to know how one’s thoughts are influencing their behaviour. With these skills, children can view their
world in various ways to help them understand the different ways a single person can react to a particular situation (Grave & Blissett, 2004). This reiterates the importance of these cognitive skills as they are essential for CBT to be effective with young children.

As stated with metacognition, it is important that children can understand how other people think about an event as perception changing is one of the key skills needed in CBT. Children are much better at changing their perceptions when they get older and stop thinking dichotomously (Leahy, 1995). Healthy young children also have limited attention spans, memory capacity, general mental organisational ability, and experiential knowledge which would impact their functioning in the cognitive therapeutic domain used in CBT (Crick & Dodge, 1994; Miller, 1989). The attention span in children rapidly changes from 8 to 10 years of age which means that children younger than this age range are still learning to focus on tasks given to them. Young children with PTSD are found to have additional attentional and memory problems, which means that interventions given to children with PTSD must consider these issues, especially if the tasks require a child’s full attention for the task to be effective (Kingery, Roblek, Suveg, Grover, Sherrill, & Bergman, 2006). CBT programs have been modified and created with these cognitive issues in mind, but the child-focused programs that were found to be effective at reducing specific symptoms (e.g., anxiety) have difficulties in distinguishing what part of the program made it successful (Grave & Blissett, 2004; Monga, Young & Owens, 2009).

Although not all children show PTSS after 1 or even 5 years after a traumatic event, by teaching children ways to regulate their emotions through applied
strategies could aid those who have not developed these strategies for themselves because of adverse circumstances or physiological dysregulation. This study will look at interventions that are aimed and developed for younger children to help them reduce their high levels of physiological arousal, so they can focus on important tasks, like doing school work and listening and following the teacher’s instructions. (Zeman, Cassano, Perry-Parrish, & Stegall, 2006). Rydell, Berlin, and Bohlin (2003) found that young children are more likely to show high levels of externalising behavioural problems (e.g., aggression) at school and home if they have poor emotional regulation skills. Children who show high levels of arousal and an inability to regulate their emotions have a higher chance of showing internalising behaviour problems (e.g., anxiety), which could lead to problems for the child in multiple settings in the future (Rydell et al., 2003; Zeman et al., 2006).
Chapter 2

Literature Review

With children, the difficulty of helping them after a traumatic event is finding an effective treatment or therapy that considers their level of cognition. For young children, verbal communication is limited, which creates problems when they are asked to explain how they are feeling. This issue has led researchers and therapists to find forms of non-verbal therapies or activities that could be used to reduce PTSD symptoms, like hyperarousal, in children who have difficulties understanding or answering questions asked by a therapist (Skybo, Ryan-Wenger, & Su, 2007).

Art has been found to be effective as a type of therapy. Various art activities including; drawing, colouring, working with clay, writing, and calligraphy have been studied (Toyoshima, Fukui, & Kuda, 2011). Therapists have often used drawing as a screening tool to understand how a young child might be feeling without the need for verbal communication. All these non-verbal activities can be used to allow the young child to express how they are currently feeling, reduce their arousal levels, or help them reduce the negative effects of thinking about the stressful event.

For this study, art activities that could reduce arousal in young children and that were suitable for their current level of cognition were researched. Mandala studies undergone with adults found that colouring-in these certain designs helped reduce their anxiety levels. Since there are uncertainties of whether CBT is suitable for young children under the age of 8 years, it would be beneficial if more treatments or activities were found that would be suitable and effective for young children who are presenting with PTSS. Harter (1988), noted that children between
the ages of 4-12 years chose strategies that were active rather than thought focused when dealing with negative or stressful emotions. If young children prefer more active therapeutic activities, then, in theory, the colouring-in activity chosen should be better at reducing PTSD symptoms in young children. These mandala colouring studies will analysed in detail in this chapter.

This part of the literature review will also examine interventions that have been developed to reduce various trauma-related behaviours in children such as hyperarousal, anxiety, stress and fear. Cohen’s d ($d$) effect sizes will be reported, if possible, to provide a better understanding of how large an effect a therapy or activity had on the participants in the studies below.

One therapy that has found to be effective in reducing PTSD symptoms is eye movement desensitisation and reprocessing (EMDR). This therapy is like CBT and other exposure therapies where therapists try to cognitively distort or distance the traumatic memory in the participant’s mind. The difference is that with EMDR the therapist asks the patient to focus on the target traumatic memory while they follow orders on a bilateral sensory stimulation (Fernandez, 2007). As an example, a study by Fernandez (2007) had 22 children aged 7-11 years, who experienced the 2002 Molise earthquake in Central Italy and were at risk of presenting with PTSS 1 month after the event. These children were rescued from under the rubble of a primary school that was destroyed by the earthquake. The children had to wait for hours amongst their dead classmates until they were rescued. This experience had met all the PTSD criteria and was why these children who were at risk were chosen for the study. Three cycles of EMDR treatment was administered to the children 1 month, 3 months, and 12 months after the event took place with the children having an
average of 6.5 EMDR sessions. EMDR sessions varying from 30 to 90 minutes in length, depending on the response and developmental level of each child (Fernandez, 2009). For each session, the children could have a parent present to provide support and aid them in understanding the experience of processing. The researcher wanted to know whether PTSS would be reduced across the three PTSD clusters, hyperarousal, avoidance, and intrusiveness by interviewing the children a week before and a week after each EMDR cycle using the Structured Clinical Interview for DSM-IV Axis 1 Disorders, Clinical Version (SCID1-CV, First, Gibbon, Spitzer, & Williams, 1997).

All 6.5 sessions of EMDR in the study were modified from the adult protocol by Shapiro (2001) to be suitable for the children, and the sessions were completed individually with each child. Before each session, the child was informed of what they would be doing and asked whether they understood what was said. Next, the child was asked questions to help them provide details on an enjoyable memory they have, which was known as the “safe place.” The child was then asked to think about this enjoyable memory while following the therapist’s fingers with their eyes. If the child could not follow the fingers, eye movements were either replaced with the therapist clicking their fingers in front of the child’s ears or by tapping on thighs or hands (Ahmad & Sundelin-Wahlsten, 2008). Next, the child was asked to think about a terrifying memory related to the traumatic event and explain how it makes them feel, whether they had any trauma-related thoughts, and how they would like to think instead about the memory. Pictures of emotions were given to the child to help them choose how they are feeling about the memory if they are not able to verbalise it. The chosen terrifying memory was known as the “traumatic memory.” Next was
the EMDR reprocessing where the child thought about the traumatic memory while focusing on a suitable stimulus as was accomplished in the safe place exercise. The child was given a relaxation exercise using the enjoyable memory, and then the child was asked to talk about how they are feeling about the traumatic memory. Then EMDR reprocessing and relaxation exercises were repeated until the child had nothing left to say about the traumatic event (Ahmad & Sundelin-Wahlsten, 2008). Lastly, the child was asked to think about their safe place to end the session thinking about an enjoyable memory (Fernandez, 2007).

After a year of EMDR sessions, statistically significant reductions were found for all symptom clusters of hyperarousal, avoidance, and intrusiveness. EMDR was also effective in reducing the number of children who met the criteria for PTSD, which at one month after the event, 61% of children met the criteria compared to 9% of children one year later. This supports the statistically significant reductions across the three symptom clusters of PTSD and the effectiveness of using EMDR with children who are a risk or are diagnosed with PSTD.

The effectiveness of EMDR has been studied looking at the psychophysiological on adults and children. It is theorised that the dual task of eye movements and having a memory in mind causes a disruption in the working memory, which creates psychological distancing from the recalled memory. This distancing is found to reduce heart rate and skin conductance by increasing the activation of the PNS (Gunter & Bodner, 2009). PNS activation is supported by the reduction of cortisol levels seen in Gerardi, Rothbaum, Astin and Kelley’s (2010) study where cortisol levels were significantly lower in the adult participants who had
a greater than 50% reduction in PTSS. This theory explains why young children with dysregulated ANS’s can be given EMDR to reduce their PTSS.

This study was reviewed to determine whether EMDR would be more suitable than CBT for young children presenting with PTSS. One main benefit of EMDR is that young children do not require many cognitive skills as with CBT. The only skill required is for the child to focus on a target traumatic memory and follow a bilateral sensory stimulation. This could be difficult for young children and is why other EMDR studies working with young children have asked them to draw the enjoyable and terrifying memories (Jarero, Artigas, & Hartung, 2006; Jarero, Artigas, Montero, & Lena, 2008).

Although exposure therapies, especially CBT, are effective they also have a few issues providing high-grade services. The issues with CBT are: its effectiveness is dependent on the practitioner’s skill level, high-skill levels need to be taught to patients, CBT is quite complex, and it could make it difficult for a practitioner to implement it competently after learning it. Also, teaching CBT is expensive which reduces the number of practitioners who know how to use CBT making the access to CBT limited (Rhodes, Richards, Ekers, McMillan, Byford, Farrand, Gilbody, Hollon, Kuyken, Martell, O’Mahen, O’Neill, Reed, Taylor, Watkins, & Wright, 2014). These issues provide more of the reasons for why interventions other than CBT should be researched, especially interventions that would be suitable for young children at risk or presenting with PTSS.

Another intervention that has been used with children affected by natural disasters or other traumatic events is bibliotherapy (Pola & Nelson, 2014). In bibliotherapy, children are given books to read that are related to the specific
traumatic event. For example, if a child were to be traumatised after experiencing an earthquake, a book would be given that has a story about a person overcoming their fears of earthquakes. As the child reads the book, they can relate to the character in the story and hopefully feel that if the character can overcome their fears so can they (Berns, 2004). Reading these types of relatable books can also help the child understand more about stressful situations and how to cope with them (Heath, Sheen, Leavey, Young, & Monday, 2005). For bibliotherapy to be effective, a comprehensive reading assessment of the participant needs to be made, so the right book is selected that is suited to their reading level and the traumatic event they experienced (Goddard, 2011).

One study by Schneider, Peterson, Gathercoal, and Hamilton (2013) tested to see whether bibliotherapy given to children with cancer could help reduce their anxiety and perceived physiological arousal caused by having the chronic illness. Twenty-one children (12 boys, nine girls), which the majority were diagnosed with acute lymphoblastic leukaemia, aged 4-12 years participated in the study. Schneider et al. (2013) created a book called “Nikki’s Day at Chemo” which talked about a child diagnosed with cancer using coping strategies to cope with being given a diagnosis and having treatments. The Child Outcome Rating Scale (CORS; Miller, Duncan, Brown, Sparks, & Claud, 2003) was chosen to measure the child’s perceptive functioning across four areas: school, intrapersonal, family, and global functioning. The CORS is known to be effective in measuring children’s self-esteem, quality of life, and quantifying anxiety and depression as a whole. Two symptom-specific items were added to the CORS to assess physiological arousal. These items assessed the
children’s perceived relaxing ability and their perceived ability to regulate nervousness.

The book was read to each child by the child’s caseworker, and afterwards, the children filled out the CORS. Once the book was read, the children were asked questions about the book to evaluate their comprehension level. The children were then asked how they would apply, in their own lives, the coping strategies that the character from the story used. After approximately 15 minutes of listening to the book and answering the questions, the children were given another CORS to fill out. The child’s guardians were asked to complete these steps again one month after the book was read to the child for the first time. No statistically significant differences were found before and after the book reading in perceived relaxing ability, perceived ability to regulate nervousness, and in school, intrapersonal, family, and global functioning. Small effect sizes for perceived ability to regulate nervousness ($d = 0.26$) and intrapersonal functioning ($d = 0.31$) were found which means that even though a statistically significant difference was not found, the book had some effects on arousal and intrapersonal functioning. Also, the data was compared to when the book was initially read to the child and when the child was read the book 1 month later. Similar results were seen, but a statistically significant difference in intrapersonal functioning was found and supported by a large effect size ($d = 1.02$). All the other outcome measures did not show statistically significant differences, but there were large effect sizes for perceived relaxing ability ($d = 0.95$), school ($d = 1.00$), and global functioning ($d = 0.94$). Moderate to small effect sizes were found for perceived ability to regulate nervousness ($d = 0.34$) and family functioning ($d = 0.50$). These results show that even though not all outcomes measures were found to have
significant differences, various effect sizes were found. This shows that bibliotherapy was affecting arousal and intrapersonal functioning immediately and 1 month after the book was read to the child. This was supported by how the children were still recalling the coping strategies from the book and tailoring the strategies to work with their own lives. This result shows promise for creating books about traumatic events that children have experienced. The only issue with this study was not knowing how often the book was read to the child during the 1-month period after the book was read for the first time. According to the researchers, the increase in effect sizes could have been due to other variables rather than the effect of the book (Schneider et al., 2013). Pola and Nelson (2014) stated that there are not many studies about the effect of using bibliotherapy to help children cope with having experienced a traumatic event, which means that more studies, like Schneider et al.’s (2013) study, need to be completed before bibliotherapy can be considered an effective intervention.

Mindfulness is the act of intentionally focusing on things that are either external or internal to oneself, like feelings or body functions (e.g., breathing), to help reduce stress, anxiety, or even arousal (Whitehead, 2011; Zoogman, Goldberg, Hoyt, & Miller, 2015). The most common mindfulness exercises used in programs and studies are breathing exercises. These involve teaching the child to focus on all the physical and sensory changes involved in breathing, like focusing on their chest rising and lowering and the air coming in and out of the body. Since breathing is a function connected with the ANS, SNS, and PNS, when responding to a stressor, then a child focusing on their breathing to reduce the breathing rate could help children with a dysregulated ANS to deactivate the SNS and activate the PNS to lower arousal.
levels and the HPA axis from creating higher levels of CRF and lower levels of cortisol (Jerath, Crawford, Barnes, & Harden, 2015). Other exercises include physical exercises where the child is told to focus on certain body parts or complete specific yoga stretches. The exercises could be sensory like focusing on a smell and explaining it, or it could be a thought exercise where they can be asked to be aware of their thoughts when asked a question or lead through guided imagery (Napoli, Krech, & Holley, 2005).

One study used mindfulness exercises to create a stress management intervention for healthy 8-year-old children who were in the third grade (Bothe, Grignon, & Olness, 2014). The sessions included diaphragmatic breathing for a minute, deep breathing for a minute, simple movements and stretches for 4 minutes, deep breathing for one more minute, and lastly a guided imagery exercise for four minutes. Children in the control group were read a story for their 10-minute session. These sessions were completed daily for four months. To see whether the exercises reduced symptoms of anxiety in the children, heart rate variability (HRV) was measured for 3 minutes using a computer with biofeedback software and a finger sensor to measure heart rate. HRV is an ANS measure as the heart rate variations from beat-to-beat have elements included in the SNS and PNS (Bothe et al., 2014). HRV scores were added to create the total percentage of time the child was in a state of relaxation. The other measure included a child self-report called the Revised Children’s Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1978) that measured anxiety and a teacher self-report to see how effective they thought the intervention was. The children were also asked whether they enjoyed the
intervention and whether they used the exercises elsewhere. Data were collected before and after the intervention and one year later.

From the results, there were no improvements in HRV immediately after the intervention which was supported by the small to moderate effect size \( (d = 0.30) \), Although, there were significant improvements shown in the HRV of the children from the experimental group one year after the intervention with a moderate effect size \( (d = 0.65; \text{Bothe et al., 2014}) \). For the self-reported anxiety scores, there was a significant decrease in anxiety before and after the intervention within the experimental group, which is supported by the large effect size \( (d =0.93) \). No changes in anxiety were found in the control group. This was also seen in the experimental group after one year where anxiety scores were significantly lower compared to the control group, and there was also a moderate effect size \( (d =0.63) \). The problem with this finding is that it would be difficult to attribute the improvement to the intervention as one year of development had taken place (Bothe et al., 2014). From looking at results, the stress management intervention was effective in decreasing self-reported anxiety, but not with lowering the percentage of time children were relaxed. Since scores of the physiological and psychological measures varied, it is difficult to state whether the stress management intervention is considered effective in reducing anxiety.

Calligraphy training was used in the study by Zhu et al. (2014). Calligraphy is the act of using ink from black ink sticks, made from soot and animal glue, and a brush to write Chinese characters on a piece of paper. This study investigated whether teaching calligraphy to a cohort of Chinese children who were affected by the China earthquake in 2008 could reduce PTSD symptoms, especially hyperarousal
A long-held belief is that Chinese calligraphy integrates the body and mind. This integration with the planning, spatial structuring, visual perception, and the movement of the brush when drawing a Chinese character is said by the researchers to enhance concentration and attention, which will help with relaxation and emotional regulation (Kao, 2006).

Practising calligraphy provides sensory, biomotional, and cognitive feedback. Sensory feedback is received from the graphical record and movement of calligraphy practice, biomotional feedback arises from the movement of the body as the child regulates and guides their movement, and lastly, cognitive feedback comes from the individualised experiences of increased alertness, attention and accelerated responses when writing. This feedback should help the children with self-monitoring, altering of cognitive deficits, and the change of arousal levels. (Xu, Kao, Zhang, Lam, & Wang, 2013). This study used a sample of 210 children (105 boys, 105 girls) for the first experiment and a sample of 80 children (38 boys, 42 girls) for the second experiment. The children were a mixture of fourth and fifth-grade students aged between 9 and 11 years old from the areas that were affected by the earthquake. To measure hyperarousal levels, the Children’s Revised Impact of Event Scale (CRIES-13; Horowitz, Wilner, & Alvarez, 1979) was used to measure the psychological results, and salivary cortisol was taken to measure the physiological results. The children were measured before the intervention, halfway through the intervention (15 days), and at the end of the 30-day intervention (Zhu et al., 2014). In each session, the children were given an hour to trace 40 characters with brushes from 5 books. The sessions were completed five days a week for 30 days with guidance from a teacher when the children were at school or from a parent if the children were at home.
It was found that there was a statistically significant decrease in both the arousal scores from the CRIES-13 and salivary cortisol levels. Calligraphy training had a small effect size ($d = -0.32$) on the arousal levels of the experimental group in the first experiment. Even though the effect size was small, the experimental group showed statistically significant changes in arousal levels compared to the control group which did not have any significant changes. A large effect size ($d = -1.39$) and a statistically significant difference was found for the experimental group in the second experiment for the reduction in salivary cortisol. Salivary cortisol levels showed no statistically significant changes in the children of the control group. These findings support the hypothesis that the calligraphy training was found to reduce hyperarousal symptoms in the child survivors of the China earthquakes in 2008.

It is interesting to see the effects of calligraphy training in reducing arousal, but it would be much better to see whether this intervention is suitable and effective for children under 8-years-old, especially as young as 6-years-old. Younger children have shorter attention spans, so an hour-long session of calligraphy training might be too long for them to focus on tracing 40 characters. Also, fine motor skills in children are developing through the ages of 6 and 7 years and handwriting skills typically become organised and automatic around the ages of 8 and 9 years (Feder & Majnemer, 2007). Not having these fine motor skills could lead to difficulties in using the brush and ink to trace the characters. Since New Zealand children between the ages of 6 and 7 are not taught cursive handwriting, this might cause more difficulties for younger children in New Zealand to similarly trace those Chinese characters or letters from the English alphabet as the child needs to know the specific ways the characters or letters need to be traced (Ministry of Education, 2008).
In a study by Betts, Mckay, Maruff, and Anderson (2006), healthy children aged 5 to 12 years old were tested on their sustained attention skills by performing attention tasks with varying complexities. The 57 children (28 boys, 29 girls) were split into three age groups, 5 to 6-year-olds, 8 to 9-year-olds, and 11 to 12-year-olds. Each group were given nine neuropsychological subtests to complete on computers. These included a counting game, a simple reaction time task, a congruent reaction time task, and a matching task. The counting game called “Score!” required the children to listen to a recording and count the number of tones heard. Scores were calculated by how many correct responses were given on the number of tones heard. This task was chosen as it shows how alert the child needs to be to count and monitor the tones heard. The simple reaction time task involved the children pressing a button on a keyboard when the face of a card is shown on the computer screen. This task was chosen to measure sustained attention processes as it would require concentration to be maintained on the stimulus that is monotonous. The next two tasks were chosen to see how attention can differ between two different tasks varying in complexity. For the congruent reaction task, the children had to decide whether two playing cards were the same colour. This task was referred to as the “low load” task as the children did not need to use many attentional processes as they only had to focus on two cards and differentiate them with one feature of a card, the colour.

For the matching task, the children had to match a pair of cards with one of the other six pairs of cards shown by three features, colour, suit, and number. Since this task required more attentional processes and much more features to focus on, the task was known as the “high load” task. Each reaction task had an interstimulus
interval that varied from 1000 to 1500 milliseconds (ms), and each stimulus was presented for only 5 seconds. The simple reaction tasks were given three times during the 9 subtests and were scored by speed (reaction time), errors (amount of times responded when card was still face down), accuracy (amount of correct responses), variability of reaction times, and max outs (amount of times child responded after the 5 second stimuli time limit). Both “high load” and “low load” tasks were scored on speed (reaction time), errors (amount of incorrect card matches), variability of reaction time, and max outs.

From the results, the children from the 5 to 6-year-old group made more errors on the sustained attention and “high load” tasks than the other age groups 8 to 9 and 11 to 12 years old. On the “high load” tasks there were no differences in accuracy between the 8 to 9 and 11 to 12-year-old children. The only difference was that the 8 to 9 years olds were slightly longer in finishing the tasks. This supports the theory from other studies that there must be a significant improvement in sustained attention in children around the age of eight years. It also shows that children under the age of 8 years have problems with sustained attention due to their limited attention spans.

Having this in mind, it is not certain whether the calligraphy training would be suitable for children younger than 8 years of age, as they could get distracted more easily than older children and possibly become bored with the task (Lin, Hsiao, & Chen, 1999; Rebok, Smith, Pascualvaca, Mirsky, Anthony, & Kellam, 1997).

Carl Jung and Sigmund Freud thought art was a way of expressing oneself (Eisdell, 2005). They believed, especially Carl Jung, that creating art can be used to interpret how someone is feeling without the need of verbal communication or to
focus the attention to the creation of art rather than the stress they might be feeling.

Carl Jung (1954, 1972) specifically found that creating mandalas helped him calm down when he felt stressed (Bair, 2003). The features of a mandala, such as the complexity, circular shape, and repeating patterns, supposedly helps put an individual into a mental state comparable to meditation (Bair, 2003; Eisdell, 2005; Small, 2006; Smith, 1975). In this case, colouring-in or creating a mandala should help a child focus more on the task and less on the arousing intrusive thoughts thus reducing the stressful effects of those intrusive thoughts such as having high levels of arousal or anxiety (Curry & Kasser, 2005).

Curry and Kasser (2005) were the first to research whether colouring a complex design, specifically a mandala, could reduce stress in healthy adults. A sample of 84 undergraduate students (29 males, 55 females) aged between 18 to 22 years was separated into three groups for one session of colouring. One group had to colour a mandala pattern, the other group had to colour a plaid design, and the last group had to colour a blank white page any way they wanted. Before they got to colour, an anxiety-inducing task was performed which consisted of the participants writing about an anxious event they had experienced for 4 minutes. After this, each group had 20 minutes to colour their given design with any of the six coloured pencils (orange, red, yellow, purple, blue, and green) provided to them.

To measure levels of state anxiety, the participants were asked to fill out a 14 item State Anxiety Inventory adapted by Goolkasian (n.d.) from the State-Trait Anxiety Inventory (STAI; Spielberger, Gorusch, & Lushene, 1970) before and after they had coloured in their design (Curry & Kasser, 2005). The researchers wanted to see whether colouring-in a mandala design was an effective way to reduce state
anxiety, which is the temporary reaction to a stressful situation that increases arousal and discomfort (Drake, Searight, & Olson-Pupek, 2014). Their results showed that the reduction of state anxiety after the intervention was significantly more effective when colouring-in a mandala than colouring-in a blank white page, which was supported by the large effect size \( (d = -1.40) \) between these two groups. This supported the result that the blank white page group showed no reduction in the participant’s anxiety levels. There was no statistically significant anxiety reduction found between the mandala design group and the plaid design group after the intervention, as was shown by the small effect size \( (d = -0.27) \) between these groups. The researchers concluded that the reason that there was no difference between colouring-in a mandala or a plaid design is that both designs are abstract designs that have similar complexities and, compared to the free-form colouring, the participants had some direction to follow when doing the task. This direction caused them to stay attentive on the task rather than having to think about what to colour, which helped with the reduction of anxiety (Curry & Kasser, 2005).

Another researcher wanted to see whether colouring mandalas was effective in reducing anxiety in normally developing adults ranging from 18 to 56 years of age for one session of colouring (Small, 2006). This study differed to Curry and Kasser’s (2005) study with the addition of an extra group where participants were given a mandala as well as a synopsis that included short descriptions of mandala practices in five different religions (Buddhism, Nichiren Buddhism, Hinduism, Discordianism, and Vajranya) and how the effects of mandalas were linked to spirituality. The reason for adding this new condition was that Miller (1993) found that confidence was improved in adults who were given directions when they had to create a piece
of art. This increase in confidence lead them to spend more time on the task and in the end, helped reduce their anxiety. The researchers also measured two different types of anxiety, concreteness in worry and reduced-concreteness of worry (Stöber & Borkovec, 2002), to see whether colouring-in mandalas had any effect on the two types of anxiety. Anxiety was measured using the Worry Domains Questionnaire (WDQ; Tallis, Eysenck & Mathews, 1992), which measures how much non-pathological worry a person has (Small, 2006). Small’s (2006) study separated their 75 participants (35 males and 40 females) into four groups; colour a mandala design with a synopsis, colour a mandala design without a synopsis, colour a plaid design, and colour a blank white page. The participants were given six colouring pencils (orange, red, yellow, purple, blue, and green) to colour-in their designs. For this experiment, the participants were not given a time limit to finish colouring their given designs.

The results of this study were quite different as compared to Curry and Kasser’s (2005) study. Small (2006) found that the plaid condition was the most effective in reducing anxiety, but there were no statistically significant differences compared with the mandala group as seen by the very small effect size (d = 0.09). Also, there were no statistically significant differences in the reduction of anxiety between the mandala and blank white page groups, which was supported by the very small effect size (d = -0.09). Another thing that was found is that there was no statistically significant difference found between the two mandala groups. This means that the addition of a synopsis did not significantly improve the effects of the mandala in reducing anxiety as only a small effect size (d = 0.21) was found.
Overall this study shows that all three types of designs can reduce anxiety in healthy adults and it does not matter if synopsises were given about the designs. Small’s (2006) study did not manage to replicate the same results as the previous study. Firstly, the participants did not always colour in the same settings\environments and secondly, the amount of time the participants coloured was not consistent. The researcher thought that the length of time given for the participants to colour in a design would change the effectiveness of the activity. Small (2006), purposed that a statistically significant effect in reducing anxiety would be seen from having a time limit or a more extended time given to colour a design. Previous mandala studies did not state their reasons for giving their participants only 20 minutes to colour in, so it is unknown whether the effectiveness of colouring-in a mandala is also due to the duration of colouring-in.

Researchers did not stop trying to replicate Curry and Kasser’s (2005) study. Van der Vennet and Serice (2012) learnt from Small’s (2006) study by using the same measures, following the same procedures and using a sample of participants that were like Curry and Kasser’s (2005) study. The only difference was this study had a sample of 50 participants (9 males, 41 females) consisting of a mixture of healthy postgraduate and undergraduate students from the ages of 21 to 59 years. The participants were split into three colouring groups; a mandala group, a plaid design group, and a blank white page group. For the 20-minute colouring-in task, the participants were given six colouring pencils (yellow, orange, red-orange, blueberry, navy blue, and green) to use. The participants performed an anxiety-inducing task where they were asked to write about a fearful scenario from their past for 4 minutes before the colouring task was given. The participant's anxiety levels were
measured by having asked the participants to fill out a 20-item form from the STAI before the anxiety-inducing task and after the colouring task. This was completed for one session. Van der Vennet and Serice (2012) found similar results to the original study by Curry and Kasser (2005) which showed that participants in the mandala group had a greater reduction in anxiety compared to the group who had to colour a blank white page as seen by the small effect size ($d = -0.16$). The researchers also found no statistically significant differences and only moderate to small effect sizes between the mandala and plaid group ($d = -0.45$), and between the plaid and blank white page group ($d = 0.33$) in the reduction of anxiety. Even after closely following Curry and Kasser’s (2005) study, the results were not similar, especially how there were no statistically significant reductions in anxiety between the plaid and blank white page groups. These differing results could be the reason why more studies about colouring mandalas were performed to try and support Curry and Kasser’s (2005) original findings.

Drake et al. (2014) were also trying to replicate previous mandala studies with 44 healthy undergraduate students (8 males, 36 females) aged 18 years and over. The researchers wanted to see if colouring mandalas could reduce three negative mood states; anxiety, tension, and depression. The participants were split into three groups; a mandala group, plaid design group, and a blank white page group. For the colouring task, they were given 10 colouring pencils to use. Before and after the task, the participants were asked to fill out the 20 item STAI form and the Mini Profile of Mood States (Mini-POMS; Shacham 1983). The Mini-POMS is the shortened version of the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1992) which was developed to assess a variety of mood states such as,
anxiety, depression, anger, and tension. Drake et al. (2014) gave the participants one session to colour in their given design for 20 minutes. The researchers found similar results to van der Vennet and Serice’s (2012) study, where colouring a mandala or a plaid design were both found to significantly reduce anxiety in undergraduate students but compared to the previous study the plaid group had lower anxiety levels than did the mandala group. Within groups, the effect sizes were large for the mandala group ($d = -0.74$) and the plaid group ($d = -0.78$), while the blank white page group had a moderate effect size ($d = -0.55$). These effect sizes support the statistically significant differences found within the three different colouring groups in state anxiety before and after the colouring tasks. No statistically significant differences between the three colouring groups were found for the reduction of state anxiety, which can be seen by the small to moderate effect sizes between the mandala group and plaid group ($d = -0.11$), the mandala group and the blank white page group ($d = -0.57$), and the plaid design group and the blank white page group ($d = -0.42$). These two other studies support Curry and Kasser’s (2005) hypothesis that colouring a mandala design is quite effective in reducing anxiety in people who are feeling anxious. However, as the reduction in anxiety varies between the mandala studies, especially the effects of a plaid design, it is still difficult to state that mandala designs are the best in reducing a person’s anxiety than any other pre-drawn design.

Since the other colouring conditions were found to reduce stress the reductions in stress and anxiety could have been due to the act of colouring-in rather than doing so with a particular design (Spiegel, Malchiodi, Backos, & Collie, 2006; Dalebroux, Goldstein, & Winner, 2008).
Researchers were still curious about the effects of colouring-in mandalas to reduce stress, but they also wanted to see whether the same effects found in previous mandala studies could be seen in elementary school children. Carsley, Heath, and Fajnerova (2015) wanted to determine whether colouring-in mandalas could reduce test anxiety in 52 normally developing children (24 boys, 28 girls) who were 9-12 years old. The children were put into either the mandala or blank white page group. Instead of having three different conditions, as seen in the previous studies, the act of colouring-in was split between structured and unstructured colouring. Plaid designs were not included in the structured condition as not all previous mandala studies found statistically significant differences between the plaid and mandala groups in stress reduction (Curry & Kasser, 2005). The groups who coloured in blank white pages were found to show some stress reduction and was the reason why Carsley et al.’s (2015) study included the unstructured colouring condition. The primary goal of their study was to see whether the child’s score on the State-Trait Anxiety Inventory for Children State form (STAIC-S), changed before and after a spelling test was given and whether it was due to the structured colouring-in task before the test. Results showed a statistically significant decrease in anxiety for both groups as seen by the moderate individual effect sizes of the structured group \((d = -0.45)\) and the unstructured group \((d = -0.57)\), but statistically significant differences in the effectiveness of reducing anxiety between the two colouring groups differed between the genders (Carsley et al., 2015). The blank white page group was more effective with the boys while anxiety was significantly reduced when the girls were in the mandala group.
The outcome differed from what previous mandala studies found about the effectiveness of colouring-in mandalas in reducing stress. Carsley et al. (2015) stated that these differences were found because the participants could have been too young for the mandalas to create the same effect as what was seen with the adult participants. Since gender differences were found across the two conditions, the effectiveness of the mandalas could be linked to their stage of development. This was theorised as the girls in Carsley et al.’s (2015) study kept within the lines when colouring the mandalas while 45% of the boys coloured over the lines and shapes of the mandalas. A motor development meta-analysis by Thomas and French (1985), supports this theory as girls develop fine motor skills earlier and their performance on fine eye-motor coordination are consistently better than boys, which is important for colouring, especially colouring-in complex designs and staying within the lines (Ruble, Martin, & Berenbaum, 2006).

Researchers have also been examining mandalas due to the increase in popularity of adult colouring-in books. These colouring-in books include pre-drawn designs (e.g., mandalas) that have more detail than designs in colouring-in books for children. Flett, Lie, Riordan, Thompson, Conner, and Hayne (2017), wanted to whether adults colouring-in pre-drawn designs seen in adult colouring-in books would create temporary improvements on a variety of psychological outcomes including, anxiety, stress, flourishing, resilience, mindfulness, and symptoms of depression. One hundred and four healthy female psychology students participated in the study. A control group was added to compare the art activity with a non-art activity to see whether stress was due to engaging in an art-based activity rather than the specific act of colouring a detailed pre-drawn design.
Anxiety was measured using the seven anxiety items from the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). Conscious stress was measured using the 10-item Perceived Stress Scale (PSS10; S. Cohen & Williamson, 1988). Flourishing, which is an individual’s perceived achievement in a variety of areas including; purpose, optimism, self-esteem, and relationships, was measured with the 8-item Flourishing Scale (Diener, Wirtz, Tov, Kim-Prieto, Choi, Oishi, & Biswas-Diener, 2010). Resilience was measured using the 6-item Brief Resilience Scale (B. W. Smith, Dalen, Wiggins, Tooley, Christopher, & Bernard, 2008). Mindfulness was measured using the 12-item Cognitive Affective Mindfulness Scale- Revised (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007). Depressive symptoms were measured using the 20-item Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). The students were asked to participate in the study for seven days. A 10-page adult colouring book with a pencil sharpener and 12 colouring pencils (black, brown, light green, dark green, light blue, dark blue, peach, pink, purple, orange, yellow, and red) were given to the students in the experimental group. The booklet included a variety of pre-drawn designs such as mandalas, nature and animal motifs, and abstract zentangle images. Participants in the control group were given a book filled with logic puzzles, a pencil sharpener, a 2.5HB pencil, and an eraser. The logic puzzles included in the booklet were word searches, reverse word searches, and sudoku puzzles. Each group completed one of their tasks for 10-minutes daily for seven consecutive days (Flett et al., 2017). The psychological measures were assessed before and after the intervention was given.

Results of the study showed that for the experimental group there was a statistically significant decrease in symptoms of stress, depression, anxiety, and
mindfulness. These reductions were supported by the small effect sizes found in the symptoms of stress ($d = .19$), depression, ($d = 0.32$), anxiety ($d = .28$), and mindfulness ($d = -0.21$). Significant differences were not found within the control group on any of the symptoms. This was supported by the moderate effect sizes when the two groups on stress ($d = -0.51$), depression ($d = -0.49$), anxiety ($d = -0.57$), and mindfulness ($d = -0.25$) outcomes were compared. No significant improvements in flourishing or resilience were found. These results demonstrate that colouring-in complex pre-drawn designs found in adult colouring books are effective in reducing symptoms of stress, depression, and anxiety as seen in previous colouring studies (Flett et al., 2017). Even though the effect sizes for the experimental group were small, the results showed the psychological benefits of colouring-in especially the ease of implementation and how inexpensive it is to buy all the necessary materials. Both groups did show an increase in symptoms of mindfulness, which explains that the improvements found were not governed by being mindful (Flett et al., 2017). Since colouring-in does not encourage novel creation due to following rules such as keeping within the lines, then colouring-in could be considered a mindless activity rather than being mindful (Bercovitz, Pagnini, Phillips, & Langer, 2017).

There are a few differences between this and the other mandala studies. Firstly, there were several designs given to the experimental group not just mandalas, which creates issues with deciphering whether there was a specific design or just the act of colouring that produced reductions in the psychological outcomes. All designs that were included had similar complexities which could have been the reason for why improvements were found rather than from what type of pre-drawn design was coloured in. It is also unknown what designs were coloured in and if one
specific design was coloured in more than once. This idea has been tested in previous mandala studies, but the other design was abstract as well. Other studies would need to compare abstract and figurative designs to determine whether stress reduction is caused by colouring-in a specific design, whether abstract designs are more effective than figurative ones, or whether it is due to the complexity of the pre-drawn design. Secondly, environments, where the participants did the tasks, were not consistent, so it is difficult to know whether certain environments changed the effectiveness of the task. It is a possibility that quieter environments would have increased the participant's attention on the task, thus producing a better feeling of stress relief (Lee & Brand, 2010). Lastly, since the psychological symptoms were measured before and after the seven days of the intervention, it is difficult to know whether the improvements in stress, anxiety, and depressive symptoms were due to the daily colouring-in task rather than some event that happened in their life during that week. Having one session, like the other colouring studies, might have controlled for this and given the researchers a stronger result about the effectiveness of the complex pre-drawn design seen in adult colouring books.

Another study examined the effects of creating mandalas to reduce stress responses. DeLue (1999) had 33 healthy children (15 boys, 18 girls) aged from 5 to 10 years participate in the study. The children were split into two groups: an experimental group and a control group, as the study was an experimental pre-test post-test control group design. To see whether creating a mandala reduced a child’s stress levels, heart rate, peripheral skin temperature, and autonomic arousal were measured using a physiological monitor. Children in the experimental were asked to draw lines, shapes, and symbols with any colours in a 26.67cm diameter circle.
Thirty-six oil pastels were given to the children to colour in their mandalas (DeLue, 1999). Those in the control group were asked to complete problem-solving activities (e.g., hidden picture puzzles, matching, and dot-to-dot). Problem-solving activities were chosen as they did not require creative input, were not emotionally simulating due to the children’s familiarity with the activities, and they were suitable for the age range of the children.

The beginning of the study included telling the children what each instrument measured before the physiological measures were recorded. Next, each child was asked general questions for 2 minutes about themselves to make the child more comfortable. Then the children either engaged in colouring-in a circle or completing puzzles for 12 to 14 minutes in a room separate to the classroom with only the researcher present. Lastly, heart rate was measured for the second time, the children were asked about the activity they did, and they were also asked the same list of general questions again that was used at the beginning of the study (DeLue, 1999). Skin temperature was recorded before, during, and after the activities were completed. The results showed a statistically significant decrease in heart rate in the children who were in the experimental group which was seen by the moderate effect size ($d = -0.54$). A small effect size ($d = 0.03$) was found in the group of children in the control group as a statistically significant difference was not found in heart rate before and after the activity. No statistically significant differences were found between the two groups on peripheral skin temperature, but a moderate effect size was found ($d = -0.51$) suggesting a larger sample size could have shown a statistically significant difference on peripheral skin temperature. This decrease in heart rate
indicates that creating mandalas can significantly reduce autonomic arousal in young children, which supports DeLue’s (1999) hypothesis.

The only issue with DeLue’s (1999) study was that the young children drew their mandalas within a circle rather than colouring-in pre-drawn mandalas as seen in previous mandala studies. Also, a statistically significant effect in DeLue’s (1999) study could have been attributed to Carl Jung’s thoughts on the circular nature of a mandala (Jung, 1973). Another study would need to be developed to discover whether the effectiveness of mandalas in stress reduction is due to colouring or drawing a mandala.

One other study combined a known stress-reducing exercise with the activity of colouring-in mandalas to see whether combining the two would create a more significant reduction in anxiety, negative affect, and psychophysiological stress response when stressed. Muthard and Gilbertson (2016), recruited 37 healthy undergraduate students (7 males, 30 females) between the ages of 18 and 22 years for the study. A focused breathing exercise was paired with colouring-in mandalas to test their effectiveness in reducing psychological and physiological anxiety.

The participants were split into two groups, an experimental and control group. Participants in the control group did not receive the focused breathing or colouring-in exercise for comparison purposes. Positive and negative affect was measured using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellagan, 1988). This self-report measure indicates whether the participant is feeling pleasurable or energetic or if the participant is feeling aversive or nervous. State anxiety was measured using the STAI form Y-1 which measures an individual’s current state of anxiety by evaluating subjecting feelings of tension, apprehension,
worry, nervousness, arousal, and activation of the autonomic nervous system (Julian, 2011).

Physiological measures were also recorded including, heart rate, pulse, blood pressure, and skin conductance levels. The equipment used to record all the physiological data included a plethysmograph which measured pulse and heart rate, two electrodes that were connected to measure skin conductance levels, and a blood pressure monitor to measure systolic blood pressure, diastolic blood pressure, and mean arterial pressure. The effectiveness of the exercises in state anxiety and negative mood reduction were tested by giving a stress-inducing task to all the participants to increase their psychosocial stress before the group-specific exercises were started. The stress-inducing task was chosen to see whether the psychological and physiological measures were significantly reduced after the single session of exercises were completed. The Trier Social Stress Test (TSST; Kirschbaum, Pirke, Hellhammer 1993) increases psychosocial stress by giving participants two public speaking tasks. These tasks required participants to prepare for two 3-minute public speeches, with only 2 minutes of preparation for each speech and without having the ability to write anything down.

For the mandala colouring-in exercise, participants were given 7 minutes to colouring-in a pre-drawn mandala design using any of the following items; markers, coloured pencils, or crayons. While colouring-in, the participants were focusing on their breathing especially how their stomach and lungs moved through each inhalation and exhalation (Muthard & Gilbertson, 2016). Participants in the control group were asked to sit for 7 minutes quietly without using their mobile phones instead. Baseline measures were recorded before the stress-inducing task. After
filling out the two self-report forms, the participants were asked to sit for 3 minutes and stand for 3 minutes while physiological measures were recorded. The STAI Y-1 and PANAS forms were filled out before the stress-inducing task for baseline measures, after the stress-inducing task, and after the stress-reducing exercises were completed. Measures of blood pressure were recorded before the stress-inducing task, after each speech, and immediately after the stress-reducing task. Heart rate, pulse and skin conductance levels (SCL) were measured at 30-second intervals during each of the phases.

The results showed that there were no statistically significant differences in the physiological measures of heart rate, systolic blood pressure, diastolic blood pressure, skin conductance levels, and pulse between the experimental and control group. These measures showed a marginal decrease in the experiment group between speech 2 and after the colouring and focused breathing exercise. This shows that the two exercises did not have a large effect on the physiological measures, which can be seen by the small effect size of mean heart rate after the intervention between the two groups ($d = 0.16$). Marginally significant differences were found between the two groups when comparing the measures of negative affect and state anxiety from speech 2 to after the colouring and focused breathing exercise. The moderate effect sizes for mean negative affect ($d = -0.66$) and mean state anxiety ($d = -0.60$) support the significant differences between the two groups on these self-report measures. This finding shows that the exercise given to the experimental group did provide a stress-reducing effect but compared to Muthard and Gilbertson’s (2016) hypothesis, the pairing of a mandala colouring activity with a
focused breathing exercise was only found to reduce self-reported negative affect and state anxiety significantly.

One interesting finding was that heart rate was higher for the experimental group than the control group at the end of the study. The researchers had a couple of reasons why these were seen. Firstly, having a task to complete could have been more arousing than sitting down doing nothing. Secondly, it has been suggested that since mindfulness requires attentional processes to focus on moment-to-moment experiences, then this could increase rather than decrease arousal in an individual (Epstein, 1995). This finding shows that psychological and physiological measures can differ even if the task given is used to reduce anxiety in an individual (Muthard & Gilbertson, 2016). The only other issue with this study was not knowing how much the colouring task and breathing exercise individually attributed to the reduction in state anxiety and negative affect. Other studies would need to examine each part of the combined task individually to see what part attributed more to the reduction of those psychological and physiological measures of anxiety.

Combing the results of all the mandala studies analysed shows that mandalas can either be coloured in or drawn to be effective in reducing stress, which also supports Carl Jung’s ideas about the benefits of mandalas. One similarity found between a few of the studies was that colouring plaid designs had similar or slightly better effects at reducing stress, arousal, or anxiety when compared to the mandala design groups. Both mandala and plaid designs are abstract rather than figurative designs, which could be why they were shown to have similar effects in reducing stress in adults. The reason could be that since the designs have no representational forms, the brain might not need to pass through certain brain centres, such as the
prefrontal cortex, language areas, and visual processing areas, to analyse and understand the pre-drawn design. Thus, the effects of the activity could go directly to the ANS, specifically the SNS, and the HPA axis (Lusebrink, 2004). By doing so, the colouring activity should help deactivate the SNS, activate the PNS, and reduce the psychophysiological effects created by a stressor.

The present study looked to see whether the activity of colouring-in a mandala design could be used to effectively reduce physiological arousal in young children as seen in previous mandala studies with older children and adults. The hypothesis is: By colouring-in mandala designs, the child should feel less aroused due to a reduction in heart rate and an increase in positive behaviour.

**Research Question**

What effect would colouring-in mandala designs have on the heart rate in a young child showing signs of hyperarousal controlling for the temperature and noise levels in the classroom?
Chapter 3

Methods

Research Design

This study used a single subject ABA case study design (Bailey & Burch, 2002) with a baseline (Phase A1), a mandala colouring-in intervention (Phase B1), and a return to baseline (Phase A2). The researcher chose a single subject ABA case study design to determine the individual effects of colouring in mandalas on the arousal levels of two young children. This design is suitable for determining the functional relationship between an intervention and a behaviour, in this case, the relationship between colouring-in a mandala and heart rate. By introducing and removing the colouring-in intervention, the participant's heart rate during the intervention phase should show a different trend compared to the two baseline phases.

The participant's heart rate during the colouring-in intervention phase would need to be lower than the two baseline phases to demonstrate that the colouring-in intervention was calming. The intervention could also be removed without having any harmful effects on the participant, which was a requirement for this type of design (Bailey & Burch, 2002). This type of design is also suitable for two participant studies, as each participant would act as their own control for observing changes in heart rate, thus not requiring more participants or the creation of separate experimental and control groups (Bailey & Burch, 2002). A single subject ABA case study design was chosen as this study fits with the design criteria. Also, due to time constraints, a more extended reversal study would not have been possible, so this shorter reversal design was selected. This design should provide evidence on
whether the mandala colouring-in task reduced the participants’ heart rate when it was introduced by visually analysing the changes on a graph. Visually analysing the data allows researchers to identify subtle and abrupt changes in the observed behaviour over time and it does not require any statistical analyses to be calculated (Lane & Gast, 2014). Each phase was planned to consist of at least five sessions for five school days.

**Ethics**

The University of Canterbury Human Ethics Committee approved the study and its procedures for informed written consent to be obtained from the participants, their parents, the teachers, and the school (2016/32/ERHEC; see Appendix A). Approved information sheets and consent forms were provided to all the parties who were involved in the study (see Appendix B). All the information sheets and consent forms were written using age-appropriate language to help each person understand what was written. The Chair of the School’s Board of Trustees, principal, teachers, the parents/guardians, and children were informed about the study itself, the instruments and measures that would be used, and the study procedures before giving informed written consent. Additionally, the participants were asked for daily assent to wear the Fitbit.
Recruitment

The researcher approached the school by sending an email to the Principal to set up a meeting to discuss the study and whether there was a possibility to complete the study at their school. The Principal was asked to meet with the teachers to explain their roles in nominating children they thought would be suitable for the study.

Participant inclusion criteria. The teachers were told by the principal to nominate children who fit the study’s criteria set by the researcher. Children who were suitable for this study had to have lived in Christchurch during the earthquakes, reported by their teacher to have trouble focusing on tasks, demonstrating frequent angry outbursts, difficulty doing what the teacher asked, and had trouble staying in their seat.

Teacher nomination. The nomination of children was dependent on the items of the Teacher Selection Criteria (TSC) that was given to the teacher by the researcher via the principal. The TSC is a 5-item checklist explicitly constructed for this study to determine if a child displayed symptoms of hyperarousal and had been living in Christchurch during the earthquakes (see Appendix C). Items for the TSC were chosen and adapted from the Behaviour Problem Index (BPI; Peterson & Zill, 1986) to identify children who were displaying symptoms of hyperarousal. Due to time constraints, this 5-item checklist was constructed to shorten the nomination process as other behaviour checklists would have taken too long to complete. The BPI (Peterson & Zill, 1986) was chosen for its suitability and demonstrated reliability and validity. In Zill’s (1990) report the BPI for children aged 4 to 11 years had an
internal consistency of ($\alpha = .89$), and the reliabilities of the subscales ranged from ($\alpha = .54$) to ($\alpha = .73$).

The five items of the TSC included; ‘Lived in Christchurch during the earthquakes’, ‘Mostly has trouble focusing on tasks’, ‘Frequently has angry outbursts’, ‘Mostly has trouble doing what the teacher asks, and ‘Mostly has trouble staying in their seat’. For each item, the teacher scored either “Yes” or “No.” The nomination process continued until two children were chosen that fit the study’s criteria and for whom parent and child consent was obtained.

Setting

School. The study was conducted at a decile five state full primary school in Christchurch. It has 16 classrooms for children who are 5 to 13 years of age. The school had not previously introduced colouring-in as an activity to reduce stress. Each day the school started at 9:00 am with classes until morning break began at 10:30 am to 11:00 am. Classes resumed from 11:00am until lunch started at 12:00pm to 12:20pm. Then the classes resumed from 12:20 pm to 1:20 pm followed by an afternoon break from 1:20 pm to 2 pm. Classes resumed from 2:00pm until school ended at 3:00pm. The school has two separate playgrounds and a sports field.

Participants. Participants were two girls aged 6-years-old from a primary school in Christchurch. Children were chosen who had experienced the Christchurch earthquakes and met the criteria of the TSC. Sarah was six-years-old and nine months, year 3 in school, and the teacher answered yes to all the items of the TSC. Nikki was six-years-old and three months, year 3 in school, and met all the criteria of the TSC. Both participants were found to have frequent angry outbursts and
difficulty with focusing on tasks and listening to the teacher. For their participation in the study, both children kept the colouring pencils and eraser that they used in the study as a koha (gift).

**Classrooms.** The school has structured their learning environments to be open plan. Children aged between six and seven years have been divided between three classrooms all connected by doorways which allowed for student and teacher movement between each room. Each participant was from a different classroom. Sarah’s classroom had 26 children while Nikki’s classroom had 22 children. Each classroom had one wall with windows that looked out onto the sports field, an office for the teachers and storage, and a sink with a bench.

**Maths.** The study occurred across the participants’ two classrooms during their 50 minutes of mathematics. Both participants had maths at the same time. This curriculum area was chosen as the teachers thought it would be convenient to implement the study during mathematics. Mathematics occurred after lunch from 12:20 pm to 1:20 pm from Monday to Wednesday. On Thursdays, mathematics was scheduled from 9:45 am to 10:45 am, while on Fridays mathematics occurred after morning break, from 11:00 am to 12:00 pm.

The 50-minute-long mathematics lesson had three main segments; lesson preview, group learning with a teacher, and workstation time. Lesson preview involved the children sitting on the carpet in the middle of the room facing the teacher. The teacher would explain to the children what was planned for the entire mathematics class and what would be taught in group learning. Group learning occurred on small tables and chairs in a semi-circle surrounding the teacher who was
seated in the middle. Group learning involved students being taught about a mathematics topic in more detail and learning how to use their mathematics skills (e.g., addition and subtraction) by doing tasks or worksheets set by the teacher. Groups for group learning were created by separating the students in each classroom into small groups. Each teacher was assigned three groups, one from each of the three classrooms to teach throughout mathematics after the lesson preview ended. Once the first set of groups from each classroom finished learning with their group teacher, the teachers moved between the classrooms to teach their next group of students. These groups were generally the same, which meant that the children were with the same group of children and with the same teacher each day.

On some of the days there was no group learning, and instead, there was another segment called group instruction. This segment was similar to group learning, but each teacher taught the children from their classroom while the children were seated on the mat facing the teacher. The teachers taught the children new mathematics topics and skills and gave the children worksheets to complete. The group instruction would usually last for the entire mathematics lesson. If there was neither group learning or group instruction scheduled, then all the children had workstation time after the lesson preview ended.

Before or after the lesson preview, the teacher assigned around six to eight maths activities at different places around the classroom. These assigned places were known as workstations and were where children would go to practice their math skills when they did not have group learning. The maths activities at these workstations were completed either on small tables and chairs or the floor. This decision was dependent on the activity, for example, creating equations were
completed on the small tables as it was easier for the children to write sitting at a table. What workstation each child chose to work at and for how long was decided by the child. Each child would work independently at the workstations unless the activity requires more than one person (e.g., an equation solving game). The time when the students were working at the workstations was dependent on when their group learning was scheduled. This meant that if the students did not have group learning with a teacher, then they were working at the workstations. Group learning started after the lesson preview, and once one group ended group learning, the teachers moved between classrooms to teach the next scheduled group for group learning.

On average the lesson preview was 10 minutes long, group learning time was 11 minutes long, and workstation time was 19 minutes long. The order in which these segments of mathematics occurred was different for each study participant, depending on the schedule set by the teacher for their respective group. For example, Sarah and the other students in her group had the lesson preview; then group learning with a teacher, and then workstation time, while Nikki and the other students in her group had the lesson preview, then workstation time, and then group learning with a teacher. The only differences between the participants during mathematics were when their group learning with a teacher was scheduled and when each student was working at the workstations, as the lesson preview was always at the beginning of mathematics for both participants. During the intervention phase, the participants coloured-in the mandalas with the children from their group learning group at one of the tables not being used as a workstation.
**Equipment**

The equipment used for the present study was non-intrusive and included an optical heart monitor that was attached to the wrist that measured heart rate (i.e., a Fitbit), a room sensor that measured the temperature in the classroom, and a sound meter which measured the noise levels in the classroom.

**Fitbit Charge 2.** The Fitbit Charge 2 is a fitness monitor that was attached to the wrist to measure heart rate (Figure 1). A smartphone was paired with this device using the Fitbit mobile application software (Fitbit Inc., 2015). It has a sync range of up to 6.1m, a battery life of up to 5 days, and is water and sweat resistant. With the optical heart rate monitor, the Fitbit Charge 2 records at 1 and 5-second intervals dependent on the mode that is chosen for monitoring heart rate (Fitbit Inc., 2015).

*Figure 1. Two photos of the Fitbit Charge 2 (left: front of Fitbit Charge 2 showing display screen, right: back of Fitbit Charge 2 showing optical heart rate monitor).*
This device was chosen as it was non-intrusive, and the measurements could be collected quickly and efficiently, which made it suitable for the young children in the study. Other kinds of heart rate monitors were researched, but this wrist-worn instrument was the most suitable for the study and was practical to purchase with the fund available. An oximeter was not chosen as it cannot measure heart rate continuously while other exercise trackers that measure heart rate require an extra sensor to be worn around the chest which would be uncomfortable for a young child to wear.

One study tested wrist-worn instruments to determine how reliable they are in measuring heart rate. The participants were given a treadmill walking task for 15 minutes and a treadmill running task for 10 minutes, followed by a 10-minute cycling task on an exercise bike, while they wore as much as four of the devices simultaneously. The researchers found that these types of heart rate monitors can reliably measure heart rate as the median heart rate errors during the walking tasks were within an error range of 5%, which is acceptable (Shcherbina, Mattsson, Waggott, Salisbury, Christle, Hastie, Wheeler, & Ashley, 2017). The Fitbit Surge used in Shcherbina et al.’s (2017) study, had a median heart rate error below the threshold of 5% during the cycling task, and a heart rate error below the 10% threshold during the walking task. A Fitbit was chosen to measure heart rate in this present study, since a Fitbit was found to be within an acceptable error for measuring heart rate. The Fitbit website and smartphone application were used to
collect and move the recorded heart rate data from the Fitbit to the computer (Fitbit Inc., 2015).

Smartphone and tablet applications that measured heart rate using the devices camera and flashlight or microphone were also examined, but they were found to be inaccurate and not designed for young children (Ho, Fu, Lin, Chan, Hwang, & Jan; 2014). The inaccuracies were due to how each application measured heart rate and their difficulties with measuring levels of heart rate of 120bpm (beats per minute) or higher. Some applications require covering a finger over the device's camera and flashlight which with young children could be problematic as their fingers might not be large enough to do so (Ho et al., 2014). These inaccuracies and recording issues with smartphones and tablet applications were the reasons for not choosing them for the present study.

**Elgato Eve.** The Elgato Eve is an environmental sensor that was used to measure the temperature of the classroom. It was paired with an Apple iPad using the Elgato Eve tablet application software to record the classroom temperature every 10 minutes. It has a temperature reading accuracy of ± 0.3°C (see Figure 2 on the next page; Elgato Systems GmbH, 2016).
Figure 2. A picture showing the Elgato Eve room sensor (right) and the Elgato Eve mobile application software (left) Retrieved from https://www.elgato.com/en/eve/eve-room. Copyright 2016 by Elgato Systems GmbH.

Decibel 10th – Professional Noise Meter. The Decibel 10th is a mobile application software which was used with an Apple iPad to measure the noise levels
in the classroom (see Figure 3 below; SkyPaw Co. Ltd., 2011).


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Materials for the Intervention

Uncoloured mandalas with black lines indicating the interior shapes, 24 coloured pencils in a box and an eraser were provided. Fifteen different mandala designs were prepared for the study (see Figure 4 below and Appendix D). The participants were allowed to choose between 2 mandala designs each time they needed a new mandala to colour in. Each mandala design given to the participants were different in every experimental session and the participants only coloured-in
the same design if they did not manage to finish it the day before.


Coloured pencils were chosen instead of crayons, felts, or paints as they can be quickly erased with an eraser if the child needs to do so (e.g., if they go over the line when colouring). Children who made a mistake that was not correctable (e.g., made with a felt pen) may find colouring-in to be stressful or frustrating, which could affect their heart rate and the results of the study. Coloured pencils were therefore chosen for this reason, because coloured pencils allow the children to fix any mistake they thought they made, such as using the wrong colour or colouring over the lines, to prevent additional stress. The pencils were stored in one of the teachers’ offices, so the coloured pencils did not need to be transported to the school each day during the intervention phase. The colouring-in pencils and the eraser used in the study was given to the participants as a koha (gift) at the end of the study to thank them for participating in the study.
Coloured pencils chosen for the study included the colours orange, red, yellow, green, purple, and blue as these specific colours were used in two of the previous mandala studies (Curry & Kasser, 2005; Small, 2006). Another reason for choosing this assortment of colours is that Burkitt, Barrett, and Davis (2003) found that children ages 6-12 prefer and like using these colours when they had to colour-in outline designs.

**Measure of Physiological Arousal**

Physiological arousal was measured by recording the child’s heart rate.

**Heart rate.** Heart rate is a measure of arousal that was chosen for this study, as it was better suited for recording the arousal levels of the participants compared to the other measures of physiological arousal. Heart rate has also been a measure in other studies which examined methods to reduce stress in children. In one study, the heart rate variability in 8-year-old children was recorded to see whether various mindfulness exercises would reduce their arousal levels (Bothe et al., 2014). In the present study, heart rate was measured using a heart rate sensor known as the Fitbit Charge 2. This heart rate sensor was attached to the wrist of each participant to continuously measure their heart rate for the entirety of mathematics classes, which was about 50 minutes.

Collecting precise, sensitive measures of heart rate is less complicated than the other physiological measures, for example, salivary cortisol (Roscoe, 1992). It takes at least 30 minutes for cortisol to reach peak levels, which would take too much time for the participants to be measured during the baseline or following colouring in intervention. Also, they would need to be frequently measured to have
a better look at whether there were any significant changes in their cortisol over time (Gunner, 1992). For this reason, salivary cortisol was not chosen to be one of the physiological measures for this study.

The measures were only chosen if they could show the various patterns of the ANS and the two branches, the PNS and SNS, as these nervous systems control physiological arousal. The control of oxygen levels and rate of respiration are modified by chemical and neural factors facilitated through the ANS from the hindbrain’s respiratory centre (Roscoe, 1992). Likewise, heart rate is also controlled by these nervous systems as the stimulation of the PNS decreases heart rate while the stimulation of the SNS increases heart rate. Heart rate data are relatively simple to collect and a good indicator of stress and physiological arousal (Bertram et al., 2014). A difficulty with measuring heart rate is that the activity of the PNS and SNS cannot be observed separately. However, for this study recording heart rate will be sufficient to determine the efficacy of the colouring-in intervention in reducing physiological arousal in young children.

Galvanic skin response (GSR), also known as skin conductance, and electrodermal activity, is another physiological measure of arousal that was determined not to be a useful measure in the present study. When an individual becomes physiologically or psychologically aroused, the glands of the skin produces ionic sweat which causes the skin’s electric conductivity to change. Since the SNS controls sweating, if the SNS becomes highly aroused, then this increases the release of sweat from the glands of the skin, thus increasing the electrical conductance of the skin (Carlson, 2013; Marieb & Keller, 2018). Therefore, the level of arousal can be determined by measuring a child’s skin conductance (Aubert-Khalfa, Roques, & Blin,
2008; Storm, Myre, Rostrup, Stokland, Lien, Ræder, 2002; Wilson, Barnes-Holmes, & Barnes-Holmes, 2014). However, the temperature of the room can affect the accurate recording of skin conductance. Differences in skin conductance would be observed as a hotter room would cause a participant to sweat more thus increasing their levels of skin conductance, regardless or if they are aroused (Doberenz, Roth, Maslowski, Wollburg, & Kim, 2011; de Santos Sierra, Ávila, Casanova, & del Pozo, 2011). The GSR was not selected as a physiological measure for this study since it would have been too complicated or impossible to keep the classroom temperature the same throughout the study.

**Measures of Child Behaviour**

This study had three different measures of child behaviour: on-task behaviour, arousal, positive and problem classroom behaviour, and enjoyment.

**On-task behaviour.** The researcher observed and recorded on-task behaviour for 30 minutes during mathematics (Church, Tyler-Merrick & Hayward, 2006). An interval schedule for on-task behaviour was used (Church, Tyler-Merrick & Hayward, 2006). The researcher scored on-task behaviour every two minutes for 30 minutes from the beginning of the participant's maths group. If the participant was found to have been on task for at least 30 seconds during a 2-minute interval, the researcher marked that they were on task. Also, 12 codes were used to record observed behaviour (see Appendix E).

**Arousal.** The self-assessment manikin (SAM; Lang, 1980) is a pictorial scale with pictures of manikins that was used to measure each participant’s self-reported level of arousal (Figure 5). The SAM was designed for young children as they do not
have to verbalise their emotions or understand specific questions, which was found to be problematic with the other child self-reports that were reviewed for the present study (e.g., CRIES-13; Horowitz et al., 1979).

Figure 5. The arousal scale from the Semantic Assessment Manikin (SAM), adapted to have 5 points (Bradley & Lang, 1994).

This study used a modified arousal scale from the SAM to measure self-reported arousal (see Appendix F). The scale was modified by reducing the point scale from 9 to 5 as young children might find it challenging to score how they feel if there are too many options for them to choose from (Mellor & Moore, 2013). A review by Mellor and Moore (2013) compared various Likert scales developed for assessing children and found that the Likert scales are usually 3 to 5 points. It was noted by Chamber and Johnston (2002) that children respond similarly to 3 and 5-point scales, which is why the scale was adapted to 5 points as there are five images in the arousal scale of the SAM (Mellor & Moore, 2013). Likert scales with more than 5 points have been said not to provide any extra benefits in improving the accuracy of the scale (Lissitz & Green, 1975).
Cognitive levels of children completing these scales were considered when choosing the self-report scales. It was decided to use a pictorial scale as children around the age of seven years have troubles with understanding what each labelled point represents on a Likert scale. Understanding these labelled points requires the child to have a high enough reading level to read and comprehend them and to have an understanding of a variety of concepts. The pictures of the SAM were designed to help the participants understand the scale better and in turn choose the more appropriate response (Tischer & Lang, 1983; Wright & Asmundson, 2003).

Participant-reported arousal levels were measured at the end of the mathematics class by giving each participant a paper form to complete while the researcher stood nearby. The participants marked on the arousal scale with pencils to communicate how aroused they thought they felt after each of the sessions of the study. The researcher recorded the arousal scale scores daily onto a Microsoft Excel spreadsheet.

**Positive and problem classroom behaviour.** The teachers of the participants were given a 5-item checklist, known as the Daily Teacher Checklist (DTC), constructed with questions about the participant’s behaviour which they completed daily at the end of each session. This measure was included to investigate how the participants behaved for the rest of the day after maths and whether their behaviour changed during the mandala colouring phase. The teachers reported the participants’ positive and problem behaviours, which included their concentration on and attention to tasks, their reactions to potential stressors in the classroom, their instruction following, and whether they were in a positive or negative mood (e.g., cheerful or nervous).
The five items on the DTC were sourced from the BPI and the Positive Behaviour Scale (PBS; Quint, Bos, & Polit, 1997). The first item was ‘Has difficulty concentrating, cannot pay attention for long’, the second item was ‘Can get over being upset quickly (relative to the situation)’, the third item was ‘Is cheerful, happy’, the fourth item was ‘Does what the teacher asks’, and the fifth item was ‘Is rather high strung, tense, and nervous’ (Peterson & Zill, 1986; Quint et al., 1997). These items were scored on a scale from 1 to 5, one was ‘never’, two was ‘sometimes’, three was ‘about the same as others’, four was ‘more frequently than others’, and 5 was ‘often’ (see Appendix G).

The teacher was also asked to write down on the report form any time they thought the participants experienced a potentially stressful event (e.g., an argument with another classmate or an event that was upsetting for the child). These are essential pieces of information as a stressful event could affect the scores on the teacher report form, and it could provide a reason for why a participant was given a particular score for their behaviour. The teachers were asked to complete the report form at the end of the school day, and the completed report form was collected from the teacher on the next school day. After the data was obtained, positive and problem behaviour scores were calculated. Positive behaviour scores were calculated by adding the scores of items two, three, and four together, while problem behaviour scores were calculated by adding the scores of items one and five together.

Similar to the other scales and checklists used in this study, the DTC is cost-effective, short, and easy to complete. It was developed from two, freely available questionnaires. The positive questions were from the Positive Behavior Scale (Quint
et al., 1997) and the negative questions were from the BPI (Peterson & Zill, 1986). The PBS (Quint et al., 1997) was chosen due to its suitability for the study, but especially for its demonstrated reliability and validity. It had been used in other studies, and it was reliable at reporting behaviour problems in young children (Huston, Gupta, Thornton Walker, Dowsett, Epps, Imes, & Mcloyd, 2011; Quint et al., 1997).

In Quint et al.’s. (1997) study the PBS had an internal consistency of ($\alpha = .94$) and the reliabilities of the subscales ranged from ($\alpha = .77$) to ($\alpha = .88$). Some teacher reports were researched and the recurring issue found with them was the amount of time needed to complete (Quint et al., 1997). Items were chosen from the BPI to measure the participants’ problem behaviours as well (Peterson & Zill, 1986; Quint et al., 1997), as previously described. For the teacher to complete all the PBS and BPI reports daily would have been too time-consuming, which is why this 5-item teacher report was constructed specifically for this study (See Appendix G).

**Enjoyment.** The pleasure scale from the SAM was chosen to determine whether the children enjoyed colouring-in mandala designs during the intervention phase. The pictures of this scale were modified by the researcher to include faces with more evident emotions as the ones included on the SAM were too small, which could have made it more difficult for children to differentiate between the faces. Labels were added to help communicate what each face is emoting (Figure 6; Bradley & Lang, 1994; Lang, 1980). The point scales were also changed from 9 to 5 points because, as previously stated, young children might have difficulties scoring how much they enjoyed the task if there are too many options to choose from (Mellor and Moore, 2013). Participant-reported enjoyment with regards to the
colouring-in task was measured at the end of the mathematics class by giving each participant a form to fill out while the researcher stood nearby.

![Image of emotion scale](http://images.flatworldknowledge.com/wrenchorgcomm-27115/wrenchorgcomm-27115-fig094.jpg)

*Figure 6.* The enjoyment scale from the Semantic Assessment Manikin (SAM) modified with faces of emotion and 5 points going from I really did not enjoy it to I really enjoyed it (Bradley & Lang, 1994). Retrieved from http://images.flatworldknowledge.com/wrenchorgcomm-27115/wrenchorgcomm-27115-fig094.jpg

The present study chose to use the SAM’s pleasure scale for its suitability and reliability for asking young children about how they are enjoying the intervention. One study selected the scales from the SAM to measure how a person feels about a variety of pictures. Pleasure was rated on 9-point scale. Backs et al. (2005) measured how reliable the SAM is by analysing the scores given to the 90 affective pictures by younger adults with a mean age of 20 years. The pictures were taken from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997), which includes images that range from being emotionally pleasing (e.g., a baby) to emotionally arousing (e.g., a spider). (Backs et al., 2005). Their study chose pictures from each of the categories of the IAPS; unpleasant-aroused, unpleasant-calm,
neutral, pleasant-calm and, pleasant-aroused. The Cronbach’s alpha for valence was (α = .63) for the young group. The coefficient alphas for valence were significantly greater than p < 0.001. This statistically significant result was why the SAM was chosen for this study to determine whether the children disliked or enjoyed the procedure of colouring-in the mandalas.

**Environmental Controls**

Data collected about the environment was used to interpret changes in heart rate to control for the effects of the environment on any changes associated with the mandala colouring-in intervention.

**Room temperature.** Room temperature was chosen to be measured as it can affect work performance and learning. Environments, where room temperature is above 23.3 degrees Celsius (°C), have been found to decrease work efficiency, increase physiological stress, and affect reading and math skills (Lackney, 2000; Lei, 2010; Leung & Fung, 2005; Seppänen et al., 2006). The Ministry of Education requires that the room temperature of classrooms be maintained between 18-20°C (Ministry of Education & Building Research Association of New Zealand, 2007). Since room temperature can affect heart rate, it would be necessary to determine room temperature to control for any effect on the other measures of the study. The Elgato Eve, paired with its mobile application software on a smartphone, recorded the classrooms’ temperature in Celsius (°C) every 10 minutes of the 30 minutes of observation (Elgato Systems GmbH, 2016). This device was placed on a shelf on the left side of the classroom next to the teacher’s chair. All the data recorded by the
software was exported to Microsoft Excel by transferring the files from the smartphone to the computer via email.

**Room noise levels.** Classroom noise was measured using a mobile application software called Decibel 10th – Professional Noise Meter. This was to control for the impact of noise in the learning environment on heart rate (SkyPaw Co. Ltd., 2016). Evans, Lercher, Meis, Ising, and Kofler (2001) studied the effects of noise exposure and stress in children. It was found that children who were exposed to higher levels of noise had higher heart rate reactivity to a stressor like a test, slightly greater resting systolic blood pressure, and higher overnight cortisol levels. Evans et al. (2001) concluded that even though the physiological levels did not reach levels evidential of pathology, children are subject to stress in noisier places. It has also been found that classroom and environmental noises affect learning in the classroom. For example, in one study, the noise from road traffic reduced attention in children at a level of 70dB (Sanz, García, & García, 1993). Since noise could affect the participant’s heart rate and that heart rate was the only physiological measure in this study, it was necessary to measure noise for this reason alone. Classroom noise was recorded during the 30 minutes of observation across all the phases. The monitoring device was placed on a shelf on the left side of the classroom next to the teacher’s chair, but, as the teacher did not sit there during the lesson, it was not felt that the teachers’ voice unduly affected the measurement of classroom noise levels. All the data recorded by the software was exported to Microsoft Excel by transferring the files from the smartphone to the computer via email.
Procedures

**Pre-baseline.** Following informed consent, the researcher met with the participants so that they could become familiar with the Fitbit. It was important to let the participants know what the Fitbit Charge 2 was since they were wearing them on their wrists during every mathematics class for 25 school days. Both participants were given a verbal explanation from the researcher about the Fitbit they wore throughout the study and how it wrapped around their wrist, “like a wristwatch.”

The researcher also met with the head teacher and the two-other year 3 teachers and reviewed the study procedures. Two of the regular year 3 classroom teachers, one for each participant, were provided with booklets with all the DTC forms they would need to complete throughout the study and another explanation of how and when they were required to complete the forms each day. These two teachers completed the forms for the same participant throughout the study.

**(A) Baseline.** When each participant arrived into their respective classroom for mathematics, the researcher fitted a Fitbit Charge 2 onto one of their wrists, after asking for a verbal assent or permission from the participant. The baseline sessions involved the participants engaging in their usual mathematics class for 50 minutes. Measures during this phase were implemented. The participants were informed about the intervention phase one day before the end of the baseline phase, so they understood what was planned for the next five school days. The most stressful part of mathematics for Sarah was during her workstation time after group learning.
(B) Mandala colouring-in intervention. The planned intervention involved the researcher giving the participants a mandala and coloured pencils, and participants colouring-in for 5 minutes when the most stressful part of the maths lesson began, as identified during baseline. Measurement procedures used in the first baseline phase continued.

If they did not finish colouring-in their design in the allotted time, they continued colouring it in at the next session. A new design was given to them if they finished colouring-in the design before the time ran out. The researcher was in the room with the participants and only gave feedback if the participants had a question. The researcher sharpened their colouring-in pencils when they were needed. The participants were informed one day before the end of the intervention phase before the return to baseline began so they understood what was required of them for the next five school days. Measurement procedures used in the first baseline phase continued.

(A) Baseline 2. The return to baseline phase followed the same procedures as the first baseline phase. Measurement procedures used in the first baseline phase continued.

Data Summarisation and Analysis

All the data collected was charted using Microsoft Excel and visually analysed following the procedures for single-subject designs (Bailey & Burch, 2002). Any statistical analyses that were conducted below were accomplished using IBM SPSS Statistics Version 25.
Social validity. Social validity is the satisfaction and acceptability of the interventions outcomes, procedures, and goals according to the researchers and participants of the study (Foster & Mash, 1999). It can be determined by asking the participants who are taking part in the study their thoughts about the intervention (Luiselli & Reed, 2011). This was another reason why the participants were asked to mark down how much they enjoyed the colouring-in task as the scores from the enjoyment scale was chosen as a measure of social validity.
Chapter 4

Results

Study Description

Participant differences. The recruitment of participants differed from what was planned due to difficulties with participant recruitment, teacher identification of suitable children, and obtaining parent consent. The children were from different classrooms, which limited the possibility of both being observed. In addition, they did not exhibit any symptoms of hyperarousal at the time the study started.

Teacher differences. The regular classroom teachers were not always present throughout the study. Sarah’s teacher was absent on the ninth day on the 29th of May, the 24th day on the 19th of June, and the 25th day on the 20th of June. Nikki’s teacher was absent on the 10th day on the 30th of May. Each classroom had one teacher during mathematics that would carry out the lesson previews and group instructions. If group learning was scheduled, the three teachers would move between the classrooms to teach their groups. A teacher helper was present during day 11 and 12 of the study to help children who were working at the workstations. The same teacher helper was there on both days.

Study length differences. The study lasted for a total of 25 school days. Baseline had a total of 12 days, the intervention had a total of 9 days, and baseline 2 had a total of 5 days. Sarah was absent on day 6 and day 10 of baseline and day 14 of the intervention. Nikki was absent on day 9 of baseline and day 14 of the intervention. These absences were due to sickness, being away on a field trip, and a
New Zealand public holiday. The total days of data for Sarah were 10 in the baseline phase, 8 in the intervention phase, and 5 in the baseline 2 phase. For Nikki, the total days of data were 11 in the baseline phase, 8 in the intervention phase, and 5 in the baseline 2 phase.

**Observation differences.** Both study participants could not be observed at the same time due to being in separate classrooms, so the head teacher chose Sarah to be observed during mathematics. Sarah’s on-task behaviour was observed during group learning and workstation time. Mathematics was not scheduled at the same time for all days of the week, which may have changed how the children might have behaved, as some days they would have either eaten or played before maths. From Monday to Wednesday, mathematics occurred after lunch, from 12:20 pm to 1:20 pm. On Thursdays mathematics was scheduled from 9:45 am to 10:45 am, and on Fridays, mathematics was after morning break, from 11:00 am to 12:00 pm. Day 3 and day 13 were also Fridays, but mathematics was from 12:30 pm to 1:30 pm to prevent clashing with a school event earlier that day.

The teachers changed the sequence of the mathematics lesson components after the study was planned but before data collection. Sarah’s mathematics lesson started with the lesson preview, followed by group learning with a teacher, and then workstation time, while Nikki’s started with the lesson preview, followed by workstation time, and then group learning with a teacher.

**Implementation of intervention differences.** It was planned for all the children to be able to colour-in at the same time. However, once the sequence of the math lesson components changed, this was not possible. Instead, the children in the
same maths group all coloured in at the time that the participants coloured-in. Sarah did the colouring-in task after her group learning, during the first 5 minutes of her workstation time. Nikki was given the colouring-in task before her group learning, as Nikki’s group teacher wanted to see how she behaved during group learning after she had coloured-in a mandala. The colouring-in intervention involved the participants colouring-in as much of a mandala design as they could for 5 minutes. The length of time was changed from the planned 10 minutes in consideration with the teacher’s mathematics lesson plan, as if it was longer than 5 minutes, it would have disrupted the children’s mathematics time.
Changes in Dependent Variables

**Sarah’s daily heart rate.** Graphs of heart rate changes during maths sessions were created. These graphs were visually analysed. In addition, graphs were annotated to show specific activities or events during each lesson.

**Day 1.** The first day of the study and baseline phase was on a Wednesday after the children had lunch. This was also the first day the children wore their Fitbit and for the researcher to be present during Sarah’s mathematics class. A visual analysis showed a decreasing heart rate during group learning followed by an increasing heart rate during the workstation component of the class (Figure 7).

![Graph showing heart rate changes during mathematics](image)

**Figure 7.** Sarah’s heart rate (bpm) during mathematics on Wednesday, May 17, 2017. The time of observation started at 12:45:09 pm and finished at 13:15:01 pm.
**Day 2.** The second day of the study was on a Thursday. The children had a fruit snack before mathematics began. A visual analysis showed a decreasing heart rate during group learning, except when Sarah was playing with the Fitbit. As Sarah participated in the workstation component, her heart rate increased over time (Figure 8).

*Figure 8. Sarah’s heart rate (bpm) during mathematics on Thursday, May 18, 2017.*

The time of observation started at 9:57:00 am and finished at 10:28:03 am.
**Day 3.** The third day of the study was later than normally scheduled for a Friday, due to a school assembly. This lesson also had a different schedule to the regular mathematics lesson plan. The whole class first worked on a geometry worksheet which was completed at the workstation tables. This was followed by a group instruction. A visual analysis showed a decrease in heart rate while Sarah was completing the worksheet and waiting for the other children to finish. There was an increase in heart rate when Sarah was playing with the Fitbit and a decrease in heart rate while she was waiting for the group lesson to start. Sarah’s heart rate increased during the group lesson and after she was told by the teacher to stop playing with the Fitbit (Figure 9).

![Graph of heart rate data](image)

*Figure 9.* Sarah’s heart rate (bpm) during mathematics on Friday, May 19, 2017. The time of observation started at 12:42:12 pm and finished at 13:12:13 pm.
**Day 4.** The fourth day of the study was on a Monday after lunch, and the mathematics class was back to its regular lesson plan. Sarah’s math group did not start straight away as the teacher had to resolve a disagreement between two classmates. A visual analysis showed a steep drop in heart rate followed by an increase in heart rate throughout group learning. Sarah’s heart rate showed an increase when she was focusing on a task during the workstation component, except when her heart rate decreased when she was working with a classmate (Figure 10). The whole class were told to line up again outside as they were not following the teacher’s instructions.

*Figure 10.* Sarah’s heart rate (bpm) during mathematics on Monday, May 22, 2017. The time of observation started at 12:46:04 pm and finished at 13:17:06 pm.
Day 5. The fifth day of the study was on a Tuesday after lunch. Mathematics followed the regular lesson plan of lesson preview, group learning, and workstation time. An increase in heart rate, beginning after group learning, was shown (Figure 11).

Figure 11. Sarah’s heart rate (bpm) during mathematics on Tuesday, May 23, 2017. The time of observation started at 12:40:12 pm and finished at 13:11:03 pm.

Day 6. Sarah was absent from school on Wednesday, so no classroom observations were made. The teacher explained that Sarah was feeling unwell.
**Day 7.** The seventh day of the study was on a Thursday. The children had a fruit snack before mathematics began. Sarah maths group was asked to work on a maths activity to give the teacher time to prepare for the maths group. The maths group started later than usual for this reason. A slight upward trend was identified, beginning after the math group ended (Figure 12).

![Heart Rate Graph](image)

*Figure 12. Sarah’s heart rate (bpm) during mathematics on Thursday, May 25, 2017.*

The time of observation started at 9:53:01 am and finished at 10:24:02 am.
**Day 8.** The eighth day of the study was on a Friday before lunch, and the lesson was planned to begin at the usual time of 11:00 am. Morning tea was longer today, so the mathematics lesson started at 11:30 am. During this lesson, Sarah’s mathematics class had group instruction during which the teacher taught them about geometric shapes. Several minutes after the start, Sarah left the group to sit next to and comfort an upset friend. This lesson did not include time to work independently at workstations. A visual analysis showed an increase in heart rate during the group instruction over time. (Figure 13).

![Graph showing heart rate increase during group instruction](image)

*Figure 13.* Sarah’s heart rate (bpm) during mathematics on Friday, May 26, 2017. The time of observation started at 11:32:10 pm and finished at 12:01:36 pm.
**Day 9.** The ninth day was on a Monday after lunch. The class teacher was away, so a relief (substitute) teacher was present. There was no group learning component. The heart rate was relatively consistent (Figure 14).

![Heart rate graph]

*Figure 14. Sarah’s heart rate (bpm) during mathematics on Monday, May 29, 2017.*

The time of observation started at 12:42:03 pm and finished at 13:12:04 pm.

**Day 10.** Sarah was absent on a field trip on Tuesday, May 30, 2017, so no classroom observations were made.
**Day 11.** The 11th day was on a Wednesday after lunch. Sarah’s regular math teacher had returned, and mathematics was back to its usual lesson plan. The heart rate was relatively consistent throughout the maths lesson. Sarah’s heart rate slowly decreased when she stopped working at the workstations and participated in tasks not related to maths (Figure 15). A teacher helper was present during mathematics on this day. The teacher helper worked with Sarah when she was creating and answering equations.

![Heart Rate Graph]

*Figure 15.* Sarah’s heart rate (bpm) during mathematics on Wednesday, May 31, 2017. The time of observation started at 12:42:07 pm and finished at 13:13:04 pm.
Day 12. The 12th day was the last day of baseline and was on a Thursday. The children had a fruit snack before mathematics began. Teacher helper was present again to help children who were working at the workstations. Heart rate began slowly increasing during part of the workstation component but reduced during a card game in the final minutes (Figure 16).

Figure 16. Sarah’s heart rate (bpm) during mathematics on Thursday, June 1, 2017. The time of observation started at 9:54:04 am and finished at 10:25:04 am.
**Day 13.** Intervention day 1. The 13th day, a Friday, was the first day of the mandala colouring-in intervention. It was decided to insert the colouring-in segment before the workstation component. This was because many of the baseline recordings indicated that heart rate began to rise at the start of the workstation component. Sarah’s heart rate slowly decreased before the colouring-in task. After the colouring-in task, Sarah’s heart rate was relatively consistent with a slight increase at the beginning of the workstation component (Figure 17).

![Figure 17. Sarah’s heart rate during mathematics on Friday, June 2, 2017. The time of observation started at 12:31:01 pm and finished at 13:15:05 pm.](image)

**Day 14.** There was no school on Monday, June 5, 2017, due to a public holiday, so no observations were made.
**Day 15.** The 15th day, day 2 of the intervention, was on a Tuesday after lunch. A visual analysis showed that there was an upward trend in heart rate during group learning. After the colouring-in task, Sarah’s heart rate increased when she was observing her peers complete tasks, and her heart rate decreased when she was playing a maths game on a tablet until the end of the observation. Sarah’s maths group were unsettled when their lesson started (Figure 18).

*Figure 18. *Sarah’s heart rate (bpm) during mathematics class on Tuesday, June 6, 2017. The time of observation started at 12:41:01 pm and finished at 13:11:02 pm.
**Day 16.** Day 3 of the intervention. The 16th day was on a Wednesday after lunch. A visual analysis showed a decrease in heart rate during group learning, except when the heart rate increased when Sarah was working on a new task set by the teacher. After the colouring-in task, Sarah’s heart rate showed an upward trend when she was making shapes with rubber bands at an assigned workstation and playing ‘snap’ with a classmate. ‘Snap’ was an approved maths game for mathematics (Figure 19).

*Figure 19.* Sarah’s heart rate (bpm) during mathematics on Wednesday, June 7, 2017. The time of observation started at 12:34:14 pm and finished at 13:06:04 pm.
**Day 17.** Day 4 of the intervention was a Thursday. The children had a fruit snack before mathematics began. A visual analysis showed a relatively consistent heart rate during group learning. After the colouring-in task, Sarah’s heart rate showed a steep upward trend when she was independently moving around observing her peers play approved maths games and activities. Sarah’s heart rate decreased after she started playing an equation game with her peers (Figure 20).

*Figure 20. Sarah’s heart rate (bpm) during mathematics class on Thursday, June 8, 2017. The time of observation started at 9:56:04 am and finished at 10:26:14 am.*
Day 18. The fifth day of the intervention was on a Friday after morning tea. Heart rate was relatively consistent before and after the colouring-in task. Sarah’s heart rate showed an increase during group learning when the teacher was explaining the task again to her. After the colouring-in task, her heart rate was reasonably the same, except when Sarah’s heart rate increased when she played the maths game with a classmate (Figure 21).

Figure 21. Sarah’s heart rate (bpm) during mathematics on Friday, June 9, 2017. The time of observation started at 11:20:04 am and finished at 11:50:00 am.
Day 19. The sixth day of the intervention was a Monday after lunch. A visual analysis showed a downward trend in heart rate during group learning. After the colouring-in task, Sarah’s heart rate increased and then decreased after she started playing ‘snap’ with a classmate (Figure 22).

Figure 22. Sarah’s heart rate (bpm) during mathematics on Monday, June 12, 2017. The time of observation started at 12:37:02 pm and finished at 13:07:03 pm.
Day 20. The seventh intervention day was a Tuesday after lunch. A visual analysis found that Sarah’s heart rate was relatively consistent before the colouring-in task, with a few increases in heart rate when Sarah was working on a task during group learning. After the colouring-in task, heart rate showed a downward trend as her heart rate decreased while she was playing ‘snap’ with a classmate (Figure 23).

Figure 23. Sarah’s heart rate (bpm) during mathematics on Tuesday, June 13, 2017. The time of observation started at 12:35:02 pm and finished at 13:05:13 pm.
**Day 21.** The eighth and final day of the mandala colouring-in intervention was a Wednesday after lunch. A visual analysis showed a downward trend in heart rate, as Sarah’s heart rate steadily decreased during group learning. After the colouring-in task, Sarah’s heart rate increased while she was reading a book unrelated to maths. Heart rate started to drop after Sarah was told to participate in a maths related activity (Figure 24).

![Figure 24](image-url)

*Figure 24.* Sarah’s heart rate (bpm) during mathematics on Wednesday, June 14, 2017. The time of observation started at 12:37:01 pm and finished at 13:17:03 pm.
**Day 22.** The 22nd day was the first day returning to baseline and was a Thursday. The children had a fruit snack before mathematics began. A visual analysis showed that heart rate was reduced during group learning and was increased when Sarah went to create equations at the assigned workstation. Sarah’s heart rate decreased when she made equations alongside another classmate. Heart rate increased while Sarah was moving between workstations until deciding to play an equation game with a classmate (Figure 25).

![Heart Rate Graph](image)

**Figure 25.** Sarah’s heart rate (bpm) during mathematics on Thursday, June 15, 2017.

The time of observation started at 10:00:03 am and finished at 10:30:09 am.
**Day 23.** The 23rd day was on a Friday after morning tea. Heart rate was relatively consistent heart rate, except when Sarah’s heart rate showed a steep increase at the beginning of the workstation component (Figure 26).

*Figure 26.* Sarah’s heart rate (bpm) during mathematics on Friday, June 16, 2017. The time of observation started at 11:27:09 am and finished at 11:57:00 am.
**Day 24.** The 24th day was on a Monday after lunch. Sarah’s regular teacher was absent, so a relief (substitute) teacher was present. The researcher was informed that the children were unsettled after having returned from a presentation they were given before mathematics. A visual analysis showed a downward trend in heart rate during group learning and an upward trend during the workstation component (Figure 27).

*Figure 27. Sarah’s heart rate (bpm) during mathematics on Monday, June 19, 2017. The time of observation started at 12:32:02 pm and finished at 13:02:14 pm.*
Day 25. The 25th day was on a Tuesday after lunch. Sarah’s regular teacher was still absent, so a relief teacher was present again. Heart rate was relatively consistent with a slight increase in heart rate during group learning and a slight increase in heart rate near the end of the observation during the workstation component. Heart rate showed an increase when Sarah was making maths equations with a classmate (Figure 28).

Figure 28. Sarah’s heart rate (bpm) during mathematics on Tuesday, June 20, 2017. The time of observation started at 12:33:06 pm and finished at 13:03:04 pm.
**Day 26.** The 26th and final day of the study was on a Wednesday after lunch. Sarah’s regular teacher had returned and was able to teach the class. A visual analysis showed that heart rate was relatively consistent during the workstation component. There was a decrease in heart rate during the middle of group learning and an increase in heart rate by the end of group learning (Figure 29).

![Graph showing heart rate changes](image)

**Figure 29.** Sarah’s heart rate during mathematics on Wednesday, June 21, 2017. The time of observation started at 12:37:04 pm and finished at 13:07:00 pm.
Sarah’s daily heart rate summary.

**Baseline.** A visual analysis of baseline showed that Sarah’s heart rate was lower during group learning and higher during workstation time. Heart rate began to increase after group learning ended, and Sarah went to participate in the individual maths activities. The mandala colouring-in task was implemented after group learning and before the workstation component. There was an overall upward trend shown on 70% of the days during baseline. An upward trend was not shown on days 7, 9, and 11.

**Intervention.** A visual analysis of intervention showed that an upward trend after the workstation component was only observed for 37.5% of the days. Only days 16, 17, and 21 showed an upward trend in heart rate during the workstation component. A drop in heart rate during the colouring-in task was only seen on days 16 and 21, but after these tasks, Sarah’s heart rate was shown to increase again.

**Baseline 2.** A visual analysis showed that an upward trend was observed on 40% of the days during the workstation component. A clear upward trend was seen on days 22 and 24 only. The return to baseline phase did not show any changes in heart rate levels during mathematics compared to the first baseline phase.
**Nikki’s daily heart rate.** Nikki was not observed during mathematics, so there are not many details about what Nikki did each day to support her heart rate data. Since Nikki’s colouring-in task was completed after Sarah, it could be determined when Nikki had her colouring-in task thus the researcher could label when she was colouring-in on the days of the intervention.

**Day 1.** The first day of the study was on a Wednesday after the children had lunch. This was also the first day Nikki wore her Fitbit. The heart rate was quite variable as is seen by the frequent moderate increases and decreases in the heart rate (Figure 30).

![Heart rate graph](image)

*Figure 30.* Nikki’s heart rate during mathematics on Wednesday, May 17, 2017. Heart rate data was taken from 12:57:03 pm until 13:27:00 pm.
**Day 2.** The second day of the study was on a Thursday. The children had a fruit snack before mathematics began. A visual analysis showed a downward trend in heart rate during the first half of the 30 minutes and an upward trend in the heart rate during the second half of that time (Figure 31).

![Figure 31. Nikki’s heart rate during mathematics on Thursday, May 18, 2017. Heart rate data was taken from 10:07:02 am until 10:37:03 am.](image-url)
**Day 3.** The third day was on a Friday after morning tea. Mathematics class was moved 1 hour and a half later to avoid clashing with a whole school event. Heart rate was relatively consistent throughout the whole lesson, but there was a decrease in heart rate several minutes before the end of the 30 minutes (Figure 32).

![Heart Rate Graph](image)

*Figure 32. Nikki’s heart rate during mathematics on Friday, May 19, 2017. Heart rate data was taken from 12:47:09 pm until 13:17:05 pm.*
Day 4. The fourth day was on a Monday after lunch. A visual analysis showed an increasing heart rate at the beginning of the 30 minutes and a steep decrease in heart several minutes before the end of the 30 minutes (Figure 33).

Figure 33. Nikki’s heart rate during mathematics on Monday, May 22, 2017. Heart rate data was taken from 12:54:04 pm until 13:24:00 pm.
Day 5. The fifth day was on a Tuesday after lunch. Heart rate was relatively consistent during the 30 minutes, except for an increase in heart rate halfway through (Figure 34).

Figure 34. Nikki’s heart rate during mathematics on Tuesday, May 23, 2017. Heart rate data was taken from 12:52:05 pm until 13:22:00 pm.
**Day 6.** The sixth day was on a Wednesday after lunch. A visual analysis showed that the heart rate was quite variable with a decrease in heart rate halfway through the 30 minutes (Figure 35).

![Heart rate graph](image)

*Figure 35. Nikki’s heart rate during mathematics on Wednesday, May 24, 2017.*

Heart rate data was taken from 12:54:02 pm until 13:24:02 pm.
Day 7. The seventh day was on a Thursday. The children had a fruit snack before mathematics began. Heart rate was relatively consistent during the first half of the 30 minutes, but then it showed an increase near the end of the 30 minutes (Figure 36).

Figure 36. Nikki’s heart rate during mathematics on Thursday, May 25, 2017. Heart rate data was taken from 10:07:03 am until 10:37:08 am.
**Day 8.** The eighth day was on a Friday morning after morning tea at the regularly scheduled time. A visual analysis showed a decrease at the start of the 30 minutes and an increase in heart rate halfway through the 30 minutes (Figure 37).

![Heart Rate Graph](image)

*Figure 39.* Nikki’s heart rate during mathematics on Friday, May 26, 2017. Heart rate data was taken from 11:38:01 am until 12:08:13 pm.

**Day 9.** Nikki was absent on Monday, May 29, 2017, due to a school field trip.
**Day 10.** The 10th day was on a Tuesday after lunch. A visual analysis showed evident increases and decreases in the heart rate at the beginning of the 30 minutes. Heart rate increased near the end of the 30 minutes (Figure 38).

*Figure 38.*** Nikki’s heart rate during mathematics on Tuesday, May 30, 2017. Heart rate data was taken from 12:46:05 pm until 13:16:07 pm.
**Day 11.** The 11th day was on a Wednesday after lunch. A visual analysis showed a downward trend in the heart rate data (Figure 39).

*Figure 39. Nikki’s heart rate during mathematics on Wednesday, May 31, 2017.*

Heart rate data was taken from 12:57:00 pm until 13:27:02 pm.
Day 12. The 12th day and last day of baseline was on a Thursday. The children had a fruit snack before mathematics began. A visual analysis showed a decrease in heart rate at the beginning, and a few minutes before, the end of the 30 minutes (Figure 40).

![Figure 40. Nikki’s heart rate during mathematics on Thursday, June 1, 2017. Heart rate data was taken from 10:05:53 am until 10:32:52 am.](image-url)
**Day 13.** Intervention day 1. The 13th day, a Friday, was the first day of the mandala colouring-in intervention. A visual analysis showed a decreasing heart rate before the colouring-in task. After the colouring-in task, Nikki’s heart rate showed a downward trend (Figure 41).

![Heart rate graph](image)

Figure 41. Nikki’s heart rate during mathematics on Friday, June 2, 2017. Heart rate data was taken from 12:54:01 pm until 13:24:02 pm.

**Day 14.** Nikki was absent on Monday, June 5, 2017, due to a Public Holiday.
**Day 15.** Day 2 of the intervention was on a Tuesday after lunch. A visual analysis showed that heart rate was relatively consistent before the colouring-in task. Heart rate was quite variable after the colouring-in task (Figure 42).

*Figure 42.* Nikki’s heart rate during mathematics on Tuesday, June 6, 2017. Heart rate data was taken from 12:48:14 pm until 13:18:05 pm.
Day 16. Day 3 of the intervention was on a Wednesday after lunch. Heart rate was relatively consistent before the colouring-in task. After the colouring-in task, Nikki’s heart rate showed a reduction in heart rate, followed by an increase in heart rate (Figure 43).

Figure 43. Nikki’s heart rate during mathematics on Wednesday, June 7, 2017. Heart rate data was taken from 12:54:06 pm until 13:24:02 pm.
**Day 17.** Day 4 of the intervention was on a Thursday. The children had a fruit snack before mathematics began. A visual analysis showed a small, steady increase in heart rate before the colouring-in task. Nikki’s heart rate showed a steep increase in heart rate after the colouring-in task. Her heart rate showed a decrease in heart rate a few minutes before the end of the 30 minutes (Figure 44).

![Heart Rate Graph]

**Figure 44.** Nikki’s heart rate during mathematics on Thursday, June 8, 2017. Heart rate data was taken from 10:05:03 am until 10:35:00 am.
Day 18. Day 5 of the intervention was on a Friday after morning tea. A visual
analysis showed an increase in heart rate followed by a reduction in heart rate
before the colouring-in task. Nikki’s heart rate dropped a few minutes after the
colouring-in task, but her heart rate slowly increased after the reduction (Figure 45).

Figure 45. Nikki’s heart rate during mathematics on Friday, June 9, 2017. Heart rate
data was taken from 11:36:00 am until 12:06:12 pm.
**Day 19.** Day 6 of the intervention was on a Monday after lunch. A visual analysis showed a decreasing heart rate before the colouring-in task. Nikki’s heart rate was increased after the colouring-in task, but her heart rate was quite variable until the end of the 30 minutes (Figure 46).

*Figure 46.* Nikki’s heart rate during mathematics on Monday, June 12, 2017. Heart rate data was taken from 12:54:00 pm until 13:24:11 pm.
Stage 20. Day 7 of the intervention was on a Tuesday after lunch. A visual analysis showed a decreasing heart rate before the colouring-in task. Heart rate showed a downward trend after the colouring-in task (Figure 47).

Figure 47. Nikki’s heart rate during mathematics on Tuesday, June 13, 2017. Heart rate data was taken from 12:46:04 pm until 13:16:11 pm.
Day 21. The 21st and last day of the colouring in intervention was on a Wednesday after lunch. A visual analysis showed an increasing heart rate before the colouring-in task. Nikki’s heart rate showed a downward trend after the colouring-in task (Figure 48).

Figure 48. Nikki’s heart rate during mathematics on Wednesday, June 14, 2017. Heart rate data was taken from 12:54:05 pm until 13:24:01 pm.
Day 22. The 22nd and first day of the second baseline was on a Thursday. The children had a fruit snack before mathematics began. Heart rate was relatively consistent during the 30 minutes of maths (Figure 49).

![Heart Rate Graph](image)

Figure 49. Nikki’s heart rate during mathematics on Thursday, June 15, 2017. Heart rate data was taken from 10:07:01 am until 10:37:05 pm.
**Day 23.** The 23rd day was on a Friday after morning tea. A visual analysis showed a small downward trend in heart rate throughout the 30 minutes of maths (Figure 50).

*Figure 50.* Nikki’s heart rate during mathematics on Friday, June 16, 2017. Heart rate data was taken from 11:34:04 am until 12:04:01 pm.
**Day 24.** The 24th day was on a Monday after lunch. A visual analysis showed an upward trend in heart rate throughout the 30 minutes of maths (Figure 51).

*Figure 51.* Nikki’s heart rate during mathematics on Monday, June 19, 2017. Heart rate data was taken from 12:50:06 pm until 13:20:02 pm.
Day 25. The 25th day was on a Tuesday after lunch. A visual analysis showed an upward trend in heart rate for most of the 30 minutes of maths, except for the decrease in heart rate near the beginning (Figure 52).

Figure 52. Nikki’s heart rate during mathematics on Tuesday, June 20, 2017. Heart rate data was taken from 12:54:05 pm until 13:24:02 pm.
Day 26. The 26th and final day of the study was on a Wednesday after lunch. Heart rate was quite variable during the 30 minutes of maths as the heart rate did not show a particular trend (Figure 53).

Figure 53. Nikki’s heart rate during mathematics on Wednesday, June 21, 2017. Heart rate data was taken from 12:50:00 pm until 13:20:01 pm.
Nikki’s day to day summary. Nikki’s heart rate data was analysed daily to see if any trends were observed during the different phases of the study. There were not many common trends seen during the baseline phases of the study. Some days Nikki’s heart rate was low or reduced when she had group learning with a teacher while other days her heart rate was higher or showed an increase during this time. On most of the study days across the three phases, Nikki’s heart rate increased or was higher after group learning with a teacher until the end of the mathematics class.

After visually analysing the sessions of the mandala colouring-in intervention phase, it was noticed that Nikki’s heart rate was reduced while she was partaking in the mandala colouring-in task in a few of the sessions, however not in all of them. Since the effects of colouring-in mandalas in reducing Nikki’s heart rate was inconsistent, it is difficult to determine that the mandala colouring-in task was effective in reducing Nikki’s heart rate.
Self-Report, Teacher-Report and Observation Data

Participant self-reported arousal. The participants were given a 5-point arousal self-report after each session where it ranged from 1 meaning ‘calm’ to 5 which meant ‘energetic’. Sarah’s and Nikki’s self-reported arousal scores were individually graphed for all three phases of the study (Figure 54 and Figure 55). Any missing data was due to the children being absent because of feeling unwell, away on a field trip, or because it was a public holiday. The graphs below show that each child reported the same score for most of the study.

![Graph showing self-reported arousal scores across three phases of the study](image)

*Figure 54. Sarah’s self-reported arousal scores across the three phases of the study.*

A score of 1 means ‘calm’ and a score of 5 means ‘energetic’. The X-axis includes the date and day number for each of the data points. Missing data was due to the child being absent.
Figure 55. Nikki’s self-reported arousal scores across the three phases of the study. A score of 1 means ‘calm’ and a score of 5 means ‘energetic’. The X-axis includes the date and day number for each of the data points. Missing data was due to the child being absent.
**Teacher report on classroom behaviour.** Classroom behaviour in the hours following the mathematics lesson was observed and recorded by the participant’s regular classroom teacher using a 5-item strengths and weaknesses self-report. The self-reports were filled out at the end of each school day. Scores from items 1 and 5 were added together to create the total problem behaviour scores, while scores from items 2, 3, and 4 were added together to create the total positive behaviour scores for each of the completed teacher self-reports. Sarah’s and Nikki’s total positive behaviour scores were graphed across each phase (Figure 56 and Figure 57), and their total problem behaviour scores were graphed across each phase as well (Figure 58 and Figure 59).

**Figure 56.** Sarah’s total positive behaviour scores across the three phases of the study. The X-axis includes the date and day number for each of the data points. Missing data was due to the child being absent and for teacher report forms having not been completed.
Figure 57. Nikki’s total positive behaviour scores across the three phases of the study. The X-axis includes the date and day number for each of the data points. Missing data was due to the child being absent and for teacher report forms having not been completed.

All phases were visually analysed to identify the effects of the colouring-in task on positive behaviour. For Sarah, baseline scores showed an upward trend, while Nikki’s baseline scores showed an almost flat downward trend. Sarah’s intervention scores showed a downward trend, while Nikki’s intervention scores showed an upward trend. For Sarah, baseline 2 scores showed a downward trend, while Nikki’s baseline 2 scores showed a downward trend. Both participants showed a downward trend in their total positive behaviour scores across the three phases. Both children’s total problem behaviour scores on the graphs below are too variable to identify a trend (Figure 58 and 59).
Figure 58. Sarah’s total problem behaviour scores across the three phases of the study. The X-axis includes the date and day number for each of the data points. Missing data was due to the children being absent and for teacher report forms having not been completed.
Figure 59. Nikki’s total problem behaviour scores across the three phases of the study. The X-axis includes the date and day number for each of the data points. Missing data was due to the child being absent and for teacher report forms having not been completed.
On-task behaviour. Sarah’s on-task behaviour was observed to determine whether her time on task during workstation time increased after the colouring-in tasks were given. Sarah was observed to be on-task, was graphed across the three phases of the study (Figure 60). The graph demonstrates that Sarah was on-task in mathematics for most of the study with an average time-on-task of 79%. The average percentage of time-on-task during baseline was 76%, intervention was 82%, and return to baseline was 82%.

Figure 60. Sarah’s percentage of time-on-task during the workstation component of mathematics across the three phases of the study. The X axis includes the date and day number for each of the data points. Missing data was due to the child being absent.
Environmental Controls

**Environmental influences on the average heart rate data.** Average heart rate and average classroom temperature across the three phases were graphed together (Figure 61), and average heart rate and average classroom noise levels across the three phases were graphed together (Figure 62). These graphs were created to visually analyse whether the classroom temperature and noise levels had any effect on Sarah’s heart rate.

![Figure 61. Sarah’s average heart rate (bpm) and the average classroom temperature (°C) across the three phases during mathematics. Heart rate is in black and temperature is in grey. The X-axis includes the date and day number for each of the data points. Missing data was due to the child being absent and the researcher having forgotten the Elgato Eve to measure temperature (Elgato Systems GmbH, 2016).](image-url)
A visual analysis of the effects of temperature on Sarah’s heart rate was completed, and the data showed similar patterns each day. A bivariate Pearson correlation was tested with the heart rate and classroom temperature data to determine whether there was a correlation between the two variables. No statistically significant correlation was found between heart rate and classroom temperature, $r(23) = .314, p = .145$. Across the entire study classroom temperatures were, on average, at suitable levels ($M = 18.07$, $SD = 1.15$). The highest classroom temperature that was recorded was 20.58 ($^\circ$C) degrees Celsius and the lowest was 15.16 ($^\circ$C) degrees Celsius. This lowest recorded temperature shows the classroom temperature was not always within the recommended level for a school classroom (Ministry of Education & Building Research Association of New Zealand, 2007).
A visual analysis of the effects of noise on Sarah’s heart rate was completed, and it was found that noise did not have any effect on Sarah’s heart rate. No direct effect was found because the data did not show that when noise levels were high, so were the levels of heart rate (Figure 62). A bivariate Pearson correlation was tested with the noise levels and heart rate data to determine whether there was a correlation between the two variables. No statistically significant correlation was found between heart rate and noise levels, $r(23) = -.035, p = .873$. Classroom noise was recorded when the students were doing mathematics ($M = 74.58, SD = 7.40$) and the loudest noise level recorded was 109.20 decibels, while the quietest was 45.20 decibels.

*Figure 62*. Sarah’s average heart rate (bpm) and the average classroom noise levels (dB) across the three phases during mathematics. Heart rate is in black and noise is in grey. The X-axis includes the date and day number for each of the data points. Missing data was due to the children being absent.
Average Heart Rate Data

Line graphs were created to visually analyse the average heart rate data for each of the three phases. Sarah’s average heart rate during workstation time only showed a downward trend during baseline, an upward trend during intervention, and an upward trend during baseline 2 (Figure 63). Nikki’s average heart rate during her 30 minutes of mathematics showed a downward trend during baseline, a downward trend during intervention, and an upward trend during baseline 2 (Figure 64).

Figure 63. Sarah’s average heart rate (bpm) for 25 days across the three phases of the study during the workstation component only. The X axis includes the date and day number for each of the data points. Missing data was due to the child being absent.
Figure 64. Nikki’s average heart rate (bpm) for 25 days across the three phases of the study during 30 minutes of mathematics. The X axis includes the date and day number for each of the data points. Missing data was due to the child being absent.

Social Validity

Self-reported enjoyment scores showed that the children did enjoy colouring-in the mandalas that were given to them during the intervention phase. The results showed that the two participants enjoyed colouring-in the mandalas. They scored either “I enjoyed it” or “I really enjoyed it” during the intervention phase using the SAM.

Results Summary

Differences between the planned methodology and the conducted study could have affected the results, so daily graphs with annotations were made to provide the most amount of detail from the heart rate data. Sarah’s heart rate was
observed to generally be lower during group learning and higher during workstation time. Her heart rate was found to increase after she finished group learning and began the workstation component of the class. This upward trend during workstation time was seen in 70% of the days in the baseline phase, 37.5% of the intervention phase, and 40% of the baseline 2 phase. Nikki was not observed during mathematics, so it is unclear as to what she was specifically doing when her heart rate was increasing or decreasing in her daily graphs.

No changes were found across the self-report arousal scores, as the children were shown to mark the same score for the majority of the study. Total positive and problem teacher-reported behaviour scores were visually analysed. For Sarah, baseline scores showed an upward trend, while Nikki’s baseline scores showed an almost flat downward trend. Sarah’s intervention scores showed a downward trend, while Nikki’s intervention scores showed an upward trend. For Sarah, baseline 2 scores showed a downward trend, while Nikki’s baseline 2 scores showed a downward trend. The total problem behaviour scores were quite variable for both children, so no trends or changes associated with the intervention were identified. Visual and statistical analysis of the heart rate data, room temperature, and noise levels showed no relationships, indicating that heart rate measures were independent of the environmental factors. Lastly, the children were found to enjoy the mandala colouring-in task on each day it was given.
Chapter 5

Discussion

The present study was conducted to determine if colouring-in mandalas could reduce the heart rate of children displaying symptoms of hyperarousal thought to be associated with being present during the Christchurch earthquakes (Heetkamp & de Terte, 2015). Visual analyses were conducted with all the recorded data to answer this research question. Sarah’s daily heart rate graphs during the baseline phase showed an upward trend in heart rate throughout the workstation segment of mathematics. This upward trend could be due to mild stress associated with the maths work she was asked to complete, as was seen by the increase in heart rate in some maths activities. The mandala colouring-in task was found to prevent this upward trend during workstation time after the colouring-in task was completed, which could indicate that the colouring-in task may have reduced heart rate. However, as stated in the results, the average heart rate data, teacher-reported positive and problem behaviours, and participant-reported arousal did not vary between the baseline, intervention, and baseline 2 phases, indicating that the colouring-in intervention did not have any effect on heart rate.

The present study was the first to have analysed whether colouring-in pre-drawn mandalas could reduce heart rate and participant-reported arousal in 6-year-old children. Previous mandala colouring studies, especially Curry and Kasser’s (2005) study, found positive results in using mandalas to reduce stress in adults, so there is a possibility that the children were too young for the same effects to be observed. If the theory behind colouring-in mandalas was that it could put a person,
who is colouring-in, into a meditative-like state to focus on the activity rather than any negative or stressful thoughts they could be having (Curry & Kasser, 2005), then maybe 6-year-old children are too young for this process to occur due to their level of cognition (Carsley et al., 2015). A child’s level of cognition is one of the reasons why the effectiveness of mindfulness stress programs and CBT have been debated on their suitability for young children (Grave & Blissett, 2004) and perhaps why the reduction in heart rate was not found when the mandala colouring-in task was introduced. If colouring-in mandalas were found to reduce the participant’s heart rate, then there would be a chance that the effects were due to the act of colouring-in rather than having been in a state of meditation. This could be possible as colouring-in a blank white page was also found to reduce anxiety in adults in previous mandala studies (Curry and Kasser, 2005; Small, 2006; van der Vennet & Serice, 2012).

Daily heart rate analyses were completed, and it was observed that Sarah’s heart rate was lower during group learning and higher during workstation time. Sarah’s heart rate was only reduced by the end of the colouring-in task on days 16 and 19 of the intervention phase. Her heart rate did reduce during these days, but it was found to either increase near the end or halfway through the mandala colouring-in task. Nikki’s daily heart rate was also observed, and her heart rate was reduced during the mandala colouring-in tasks only for days 17 and 18 of the study. On some of the intervention days, the heart rate did show a downtrend when Sarah and Nikki were colouring-in their mandalas. The observed downtrends might mean that the mandala colouring-in task could have provided short-term effects during or shortly after the task, but the effects could have been masked by the workstation
activities the children participated in after the mandala colouring-in task. The small number of days that were found to reduce the participant’s heart rate, during and immediately after the colouring-in tasks, did not provide strong support for the hypothesised arousal reducing effects of colouring-in mandalas.

From the results, Sarah did score that she was ‘calm’ for all but one day of the study. This consistent scoring does not seem to have been attributed to an inability to understand the question on the self-report form, as the scores reflected the normal ranges of heart rate recorded throughout the study. Nikki started scoring that she was ‘energetic’, but a few days later she was scoring on the middle of the scale. Her heart rate was mostly within the normal ranges of heart rate, but Nikki was not scoring that she was ‘calm.’ Nikki could have been scoring on the middle of the scale as she might not have known how aroused she had felt or had not fully understood the question on the self-report form (Mellor & Moore, 2013). These scores did not show any notable changes across the three phases for the participant-reported data to provide any support for determining whether colouring-in mandalas affected the reduction of heart rate in the two participants. After comparing the heart rate data with the participant-reported arousal scores, no notable changes were found as the participants, especially Sarah was correctly reporting her level of arousal across the whole study. This was why no notable changes were found and why the mandala colouring-in task did not greatly reduce Sarah’s and Nikki’s average heart rate levels.

The researcher was also observing the percentage of time Sarah was on-task during mathematics, as high levels of stress have been found to affect a child’s attention and on-task behaviour (Husain, Allwood, Bell, 2008). If the mandala
colouring-in task had been found to reduce heart rate, then the participants’ on-task behaviour should have improved. Since Sarah’s on-task behaviour was reasonably high throughout the study, especially during baseline, it is not possible to conclude that the mandala colouring-in task helped with her on-task behaviour. The teachers were also given report forms to record the participants’ positive and problem behaviours to identify whether the participants were working on tasks and following the teacher’s instructions. The problem behaviour total scores seemed to increase throughout the entire study, which shows that the colouring-in task did not affect their positive or problem behaviour during or after the colouring-in intervention phase.

Many variables, especially environmental factors can influence heart rate, so classroom temperature and noise levels were measured and analysed to control for any possible effects these two factors had on heart rate across the whole study. No relationships were found between these measures, which means that the classroom temperature and noise levels had no direct effects on the children’s heart rate. The classroom temperatures recorded during the study were mostly found to be within the recommended temperature range of 18-20 degrees Celsius (°C; Ministry of Education & Building Research Association of New Zealand, 2007) and the classroom temperature never reached 21 degrees Celsius (°C). Since room temperature was mostly within the recommended range for a school classroom, indicates that the room temperature throughout the study did not influence heart rate.

The average level of classroom noise was 74.58 decibels, which is above the level when noise could create problems with learning and a child’s reactivity to stressors (Evans et al., 2000). From the results, the children’s heart rate did not seem
related to noise levels as no correlation was found between the two measures across the three phases. This finding could indicate that the children are accustomed to working with a high noise level and that a high noise level did not affect heart rate on average, so, on average, a high noise level did not seem related to stress as indicated by heart rate. Thus, the heart rate seemed independent of noise levels, which indicates that additional confidence in the results can be considered (Wilson, Valentine, Halstead, McGunnigle, Dodd, Hellier, Wood, & Simpson, 2002).

This present study did not find any important reductions in heart rate after the mandala colouring-in tasks were completed compared to the children’s heart rate before the tasks were given, which does not support the results that were found in the previous mandala colouring studies. By having analysed Sarah’s daily heart rate graphs visually, an upward trend in heart rate during workstation time was found in 70% of the baseline days. When the intervention was introduced, the upward trend was only shown in 37.5% of the intervention days. This reduction seems to show some evidence that the pre-drawn mandala designs could have had some effect on Sarah’s heart rate, but its effect was not as evident as with the other mandala colouring studies (Curry & Kasser, 2005; Small, 2006; van der Vennet & Serice, 2012). Heart rate was not observed to immediately decrease after the mandala colouring-in tasks were completed, which does not support the results of the previous mandala colouring studies. However, colouring-in the mandalas did prevent an upward trend in Sarah’s heart rate during workstation time, so if the mandala colouring-in task was given when the participants were more aroused, then a more immediate effect might be observed in the reduction of heart rate.
Previous mandala colouring studies found that anxiety in healthy developing adults was reduced after they had coloured-in a mandala design (Curry & Kasser, 2005). This present study was conducted to determine whether this effect could also be found with children. Only mandala designs were chosen for this study due to how the study was planned, so no comparisons were made with other pre-drawn designs or conditions that were used in previous mandala colouring studies (Curry & Kasser, 2005; Small, 2006). Curry and Kasser’s (2005) study found that colouring-in mandalas significantly reduced anxiety levels in adults, aged 18 to 22 years, after they were given a stress-inducing task. Small’s (2006) study with adults aged 18 to 56 years did not find that mandala designs were the most effective in reducing anxiety as the plaid designs were found to be as effective in reducing anxiety. These results were also found in van der Vennet and Serice’s (2012) study with adults aged 21 to 59 years during which both the mandala designs and plaid designs were found to be effective in reducing anxiety. However, in Drake et al.’s (2014) study, plaid designs were slightly better at reducing anxiety compared to colouring in a mandala design, which was different compared to the results of the other mandala colouring studies (Curry & Kasser, 2005; Small, 2006; van der Vennet & Serice, 2012). One study by Carsley (2015) found that colouring in a pre-drawn mandala design or a blank white page was found to significantly reduce anxiety levels in children aged 9 to 13 years. After comparing the present study’s results with the other mandala studies, one limitation was identified. Plaid designs were not included in the present study which did not allow the researcher to compare the heart rate reducing effects of these designs and determine whether heart rate reduction was due to colouring-in a particular pre-drawn design or the act of colouring-in.
Social validity is an essential concept in assessing the usefulness of an intervention (Foster & Mash, 1999). Therefore, participants were asked to rate their enjoyment of colouring-in the mandalas (Luiselli & Reed, 2011). The participant-reported enjoyment scores showed that the participants liked colouring-in the mandala designs. Sarah told the researcher that she found colouring-in the mandala designs challenging, but it was still enjoyable to colour-in the mandalas. The participants’ positive feelings towards the mandala colouring-in task mean that children can be given pre-drawn mandala designs to colour-in as an art activity, but not as an activity for reducing heart rate.

In the next section, limitations are listed to provide information as to why the mandala colouring-in task was not as effective as previous mandala colouring studies.

Limitations

The activity of colouring-in mandalas did not reduce the heart rate of the participants when it was introduced, but several limitations were identified that could have attributed to the conclusion of this present study. These included; not having suitable participants, problems with the scheduling of the maths class, issues with controlling for other confounding factors, and the separation of the two participants. These limitations need to be addressed so other researchers interested in recreating this study are aware of all the situations that could weaken their findings. This information would provide the researchers with the ability to prevent or plan for these situations if they arise.
The first major limitation of the present study was that Sarah and Nikki did not exhibit hyperarousal, which means that they were not suitable for this study. The recorded heart rates were found to be within the normal heart rate range for a 6-year-old child, which is between 65 to 135 bpm (Fleming, Thompson, Stevens, Heneghan, Püddemann, Maconochie, Tarasenko, & Mant, 2011). Sarah’s heart rate stayed within this normal range for all the days of the study, while Nikki’s heart rate was below the normal range for 33.33% of the study days. These findings show that mathematics was not a highly arousing curriculum area for the participants. This could be why Sarah and Nikki’s heart rate did not greatly reduce after the mandala colouring-in task, as their heart rate levels were not outside of the normal range when the mandala colouring-in tasks were given. A more visible effect on heart rate could have been observed if the participants were highly aroused when they were given the mandala colouring-in task.

Further evidence that the participants were not suitable for the present study was shown in the baseline heart rates, participant-reported arousal scores, and teacher-reported positive and problem behaviour scores. The participants were mostly within the normal heart rate range for their age, Sarah was on-task and followed instructions for most of the study days, the arousal scores reflected the normal levels of heart rate data, and their total positive and problem behaviour scores were not reflective of children presenting with symptoms of hyperarousal. The main reason why the mandala colouring-in tasks were not shown to have any impact in the reduction of heart rate in the participants was that their levels of heart rate were not exceptionally high during mathematics. Future researchers need to ensure that suitable participants are recruited to analyse the effects of colouring-in
mandalas better, as seen in previous mandala studies. Difficulty in recruiting participants with hyperarousal may be due to parental concerns about their child’s behaviour.

Other mandala studies gave their participants a stress-inducing task to make them feel stressed before the colouring-in task was given to precisely determine whether the colouring-in task effectively reduced their self-reported anxiety levels (Curry & Kasser, 2005). The participants of this study were too young, so using a stress-inducing task was not an ethically viable option. This limitation was also acknowledged in Drake et al.’s (2013) study, as the participants were also not given a stress-inducing task before the colouring-in task. Other researchers should choose a time where the participants are observed to be the most aroused and see if their heart rates are found to decrease or drop after the mandala-colouring-in task is completed.

Specific workstations that Sarah worked at during workstation time either increased or decreased her heart rate. For example, Sarah was calmer when she was on-task and creating equations as her heart rate was observed to be lower or decreased while she was doing the task. Sarah was usually calmer when playing ‘snap’ with another student, as the maths activity was closer to a game. Since these activities during workstation time were not controlled for and were shown to vary on some days, meant that the type of activity Sarah was participating in appeared to have had a greater impact on heart rate than whether Sarah had coloured-in a mandala or not. This provided difficulties in determining the effects of colouring-in a mandala on the participant’s heart rate during workstation time.
Mathematics was scheduled at different times on Thursdays and Fridays compared to the other days of the week. These scheduling differences meant that on some days the participants would have eaten or had physical play before mathematics. Specific activities, such as eating or playing, have been found to affect heart rate, which could have affected the results. From the literature on the ANS (Porges, 1995), it would be predicted that there would be an increase in heart rate after returning from physical play and a decrease in heart rate after having eaten lunch or a snack before mathematics. These possible effects were analysed by comparing the initial heart rate at the start of mathematics on the day's mathematics began following lunch, the day's mathematics began following play, and on the day's mathematics began following another activity (e.g., another curriculum area). The visual comparisons did not show any support that the heart rate data or the results of the study were affected by these uncontrolled activities.

At the start of mathematics, heart rate was usually around 90 bpm regardless of when mathematics was scheduled, which is another reason why eating or physical play did not seem to affect Sarah and Nikki’s heart rate throughout the study. Regardless, this was still a limitation of the study as the activity that preceded mathematics was not controlled. These activities have been found to affect the ANS and heart rate, so these uncontrolled activities should have been considered before the present study was implemented (Porges, 1995). Future researchers need to ensure that the chosen curriculum area is always at the same time each day and that any other scheduling issues are controlled for to prevent confounding factors that could affect heart rate and mask the effects of the mandala colouring-in task (Skelly, Dettori, & Brodt, 2012).
One other limitation of the present study was the unplanned extension of the baseline phase. On one of the days during baseline, Sarah’s teacher created a workstation with a maths activity that was not used on the other baseline days. This newly introduced workstation would have produced different levels of heart rate as it was very different from the regular maths activities assigned at the workstations. Thus, an extra day was added. Another issue was that the first day of the intervention had to be postponed as a drawing activity using colouring-in techniques was completed before mathematics. This previous task would have added more issues with determining whether a reduction in heart rate was due to the drawing task completed before mathematics or the introduced mandala colouring-in task. Thus, another day was added to the baseline phase. The requirement was not to have the participants partake in any activity that was comparable to the mandala colouring-in task in case the reduction or other changes in heart rate was due to having completed the similar task. At least five days needed to be recorded that reflected how mathematics class was usually scheduled and how the participants’ heart rate usually changed during that time (Bailey & Burch, 2002). Future studies need to ensure that enough study days are planned for in case unforeseen changes limit the strength of the planned design and the collection of data.

Another limitation of the study was that the participants were in separate classrooms which prevented the researcher from observing both of their behaviours during mathematics. This separation meant that there was little evidence to explain why Nikki’s heart rate was rising or dropping at specific times throughout mathematics. Having observed Sarah during mathematics, the researcher was able to know when the various mathematics segments started and ended, and what she
was participating in or doing when a peak or drop in her heart rate was seen. These details are essential, (Berntson and Cacioppo, 2004), as there are many variables that can influence a child’s heart rate, (e.g., speaking to the entire class; Thomas, Lynch, Friedmann, Sugino, Hall, and Peterson, 1974), that must be known to understand how much of an effect an introduced intervention, like the mandala colouring-in task, had on a child’s heart rate. Also, the researcher could not record the classroom temperature and noise levels in both areas. It is unknown whether Nikki’s classroom had similar levels of temperature and noise, so it is difficult to know whether these environmental factors had any direct effect on her heart rate as Nikki’s classroom could have been hotter or louder than Sarah’s classroom. Future researchers need to ensure that the participants are recruited from the same classroom, so one researcher could observe both participants in the same classroom and measure the environmental factors that could affect their heart rate.

One other limitation of the present study was that the teacher reports were completed at the end of the day, which prevented the researcher from knowing how the teacher would have scored the participants’ behaviour during mathematics. The idea was to see whether the colouring-in task had any long term effects on their behaviour for the rest of the school day. In hindsight, it would have been more beneficial if the teacher reports were filled out after mathematics to provide a better understanding of how the teacher thought the children’s behaviour was during mathematics rather than for the rest of the day. The teachers from the three classrooms moved between the classrooms during mathematics, which would have made it difficult for Sarah’s and Nikki’s regular teachers to observe how they were behaving for the entirety of their mathematics class. Even if the participants’
behaviours were reported during mathematics only, the scores might not be representative of how the participants were behaving during mathematics due to the limited amount of time the teacher would have had to observe their chosen participant. Future studies need to ensure that teachers who are given the task to observe a participant can observe them during the study session, as classroom behaviours might be affected by the colouring-in tasks differently than the tasks effects on heart rate levels. Thus, both measures would improve the sensitivity of identifying the effects of the mandala colouring-in task on heart rate and classroom behaviour.

One other limitation of the study was the constructed 5-point Likert scale of arousal. In previous studies by Chamber and Johnston (2002) and Mellor and Moore (2013), young children were found to score at the extreme ends of Likert scales due to the inability to understand the question or not knowing the differences between each of the scores. In 2013, Mellor and Moore stated that this type of scoring had been found to occur when children are asked about abstract concepts (e.g., states of emotion). This inability to answer questions about their feelings could be due to not having yet learnt to identify and differentiate specific emotions (Mellor & Moore, 2013). The scale was reduced to 5 items to help the six-year-old study participants differentiate between the scores. However, the participants in the present study still showed the same patterns from the previous Likert scale studies (Chamber & Johnston, 2002; Mellor & Moore, 2013). The 5-point scale did not seem to help them discriminate between the points on the arousal scale, as not many changes were seen across the three phases of the study. Future researchers need to determine
whether self-reports should be used in a study with children, as inaccurate results could be reported, thus weakening the results of the study.

Another limitation of the present study was that the researcher did not measure interobserver agreement of observing on-task behaviour. It would have been beneficial to know whether other observers would have scored similarly on the observation sheet during the study and that the data collection was reliable (Ledford & Wolery, 2015). To measure the reliability of data collection, two observers would have needed to be in the classroom on some of the study days (Bailey & Burch, 2002). If other observers scored differently on the observation form, this would have provided unreliable results, especially with determining what percentage of the 30 minutes of mathematics was Sarah on-task (Bailey & Burch, 2002).

One last limitation of the present study was not having conducted a pilot study before the present study. This did not allow the observer to practice scoring on the on-task behaviour observer sheet, and for the researcher to repair any identified methodological issues before the main study was started. The researcher was also not able to conduct the pilot study due to time-limitations associated with a masters degree, as well as practical considerations.

Future researchers need to note all these critiqued major limitations, as these were found to weaken the results of the present study. If suitable participants were recruited, a heart rate reducing effect might have been seen when the mandala colouring-in tasks were given. If the curriculum area and the colouring-in task were scheduled to control for other confounding variables that could have affected heart rate (e.g., eating or physical play before class), then it would have improved the identification of the effects of the mandala colouring-in task on heart rate. Also, if
both participants were in the same classroom, this would have allowed the researcher to label the minute by minute impacts on heart rate for both of the participants on the daily heart rate data. Thus, improving the analysis of the intervention, behaviours, and activities during the chosen curriculum area for all the participants.

Strengths

In addition to the many limitations, this study had strengths that other researchers would benefit from knowing if they plan to design a similar study about colouring-in mandalas. The first strength of this present study was having measured two environmental controls, room temperature and noise level. Previous mandala studies did not determine whether any external variables could have affected their results (Curry & Kasser, 2005; Small, 2006; van der Vennet & Serice, 2012). Since room temperature and noise levels were recorded, this allowed the researcher to determine if the heart rate data was affected by these external variables. No correlations were found between the heart rate data and the two environmental measures, which improved the researcher’s confidence in the heart rate data. This meant that if heart rate was affected by an external variable, it was not due to the temperature or noise levels of the classroom. Future researchers should try and control for as many variables that could affect heart rate to strengthen the confidence of the heart rate data. Also, this would help determine the variables, which were not controlled for that affected the heart rate data.

Another strength of the present study was observing and noting minute by minute impacts of heart rate. Since many variables can affect heart rate (Berntson &
Cacioppo, 2004), this allowed the researcher to understand why Sarah’s heart rate peaked or dropped at specific points across the 30 minutes of observation. This provided details to understand whether a change in heart rate was due to the mandala colouring-in task or a maths activity Sarah was working on. It also allowed the researcher to identify what segments during mathematics increased Sarah’s heart rate the most, so the researcher was able to add the colouring-in task at the most suitable time. Since heart rate is sensitive to many variables and factors, future researchers need to observe and note down every possible detail that could increase or decrease a participants’ heart rate. This would also help with understanding the heart rate data during data analysis.

One other strength of the present study was conducting the study within a natural setting. All previously mentioned mandala studies, except Flett et al.’s (2017) study, were conducted within an experimental setting, which would not have been representative of a setting where the adult participants would have coloured-in a mandala (Reis & Gosling, 2010). In a natural setting many external variables cannot be controlled for (e.g., high noise levels), compared to an experimental setting. These variables would be present in a natural setting, so the mandala colouring-in task might show different results in reducing anxiety if the mandalas were coloured-in within a more natural context. The researcher of this present study gave the children the mandala colouring-in tasks during one of their school classes, which is a more typical setting for a possible stress-reducing task to be given by a teacher to a stressed child. Future studies should conduct the study within a similar environment to reflect a more natural setting where children would most likely be given a colouring-in task.
Another strength of this present study was not inducing stress in the children. Firstly, giving stress-inducing tasks to children is ethically inappropriate and harmful, as it would make them stressed and create difficulties for the children to calm down, as, at their age, the children are still learning skills for effective emotion regulation (Suveg & Zeman, 2010). Secondly, without a stress induction task, the researcher was allowed to examine how the mandala colouring-in task affected heart rate in a natural context. This would provide support as to whether the effects of colouring-in a mandala would reduce heart rate if it is given outside of a controlled and stress-induced experimental environment (Reis & Gosling, 2010). Future studies should not have a stress-inducing task to help with applying for ethical approval and to provide more details about how heart rate is affected in a natural context without artificially induced stressors.

One other strength of the present study was repeatedly measuring heart rate over many days in a single-subject research design. This allowed for a more sensitive consideration of the impact of the mandala colouring-in task (Bailey & Burch, 2002). Previous mandala studies only had one session of colouring-in, so they were unable to determine if there were any long-term effects of colouring-in the mandala designs (Curry & Kasser, 2005; Small, 2006; van der Vennet & Serice, 2012). Since heart rate is variable and easily affected (Berntson & Cacioppo, 2004), having many days provided the researcher with enough daily heart rate data to determine whether the mandala colouring-in task was effective in reducing heart rate and if the mandala colouring-in task had any long-term effects on heart rate.

Another strength of the study was having chosen a single-subject research design to determine whether the mandala colouring-in tasks was effective in
reducing heart rate. Since children have different patterns of heart rate (Fleming et al., 2011) and different responses to factors that are calming or stressful, it was best that each participants’ baseline was serving as a control. This also meant that the researcher did not need to recruit more participants for the study to make a separate control group. By having individual controls, this allowed the researcher to analyse how the mandala colouring-in task affected the heart rate of each participant. Future studies should consider choosing a single-subject research design, as heart rate is variable and would show different patterns with different children. Also, researchers would not need to create a control group, which would speed up the recruitment process as not many participants would be needed.

All the previous mandala studies, except DeLue’s (1999) study, used participant-reported anxiety tests to measure the anxiety-reducing effects of colouring-in mandala designs. As was stated by the previous researchers, self-reports can have response biases that would provide incorrect results and conclusions about an intervention (Curry & Kasser, 2005; Mortel, 2008). The strength of this present study was using a self-report measure of arousal and an instrument to measure physiological arousal. If changes in heart rate were reflective of the scores on the self-reports of arousal, then the participant was reporting truthfully. Also, heart rate is more sensitive and accurate in analysing the specific effects of certain variables and the mandala colouring-in task on a participants’ heart rate. Future studies should measure heart rate including a participant-report of arousal to provide as much detail about the effects of the mandala colouring-in task, as self-reports have been inaccurate when given to children (Mellor & Moore, 2013)
One last strength of the present study was having measured social validity to assess the usefulness of the intervention, in this case, the effectiveness of colouring-in mandalas to reduce heart rate. The enjoyment scores helped the researcher understand whether the children enjoyed colouring-in the mandala designs. This was especially important as no other study has examined the stress-reducing effects of colouring-in mandalas with children as young as six-years-old.

Implications

**Implications for practice.** The present study did not find the mandala colouring-in task to be effective at reducing heart rate in children. For any practical conclusions to be made, another mandala colouring study with children needs to be conducted. The limitations and strengths of the present study need to be considered to help determine whether the mandalas can reduce heart rate in children who are presenting with symptoms of hyperarousal. Also, if colouring-in mandalas are found to be effective in reducing heart rate in future research, children would have a cost-effective and suitable activity to complete at school or home whenever they feel stressed or anxious. Interventions, such as CBT (Grave & Blissett, 2004) and EMDR (Fernandez, 2007), can be costly treatments and they might not be found effective in reducing hyperarousal symptoms for all children due to the cognitive level of the child (Grave & Blissett, 2004).

**Implications for future research.** Even though colouring-in a mandala was not found to be effective in reducing the heart rates of the participants, other researchers should conduct more mandala colouring-in studies with young children, as this art activity might be found to be effective if all the limitations identified in this
study were addressed. Firstly, researchers need to determine how the study would determine the effects of colouring-in pre-drawn mandala designs on arousal. Since heart rate would be measured, a single-subject research design could be chosen as children have different patterns of heart rate, and this would not require for a control group as the baseline data would be the control for each participant in the study (Bailey & Burch, 2002). The length of the present study was reduced due to time constraints, so if possible, future studies should be longer. Each phase should have at least ten days per phase (Bailey & Burch, 2002) if a single-subject research design is chosen. This will provide the researcher with enough data for analysis, even if the participants are absent for a study day.

The next important elements of designing a study are the recruitment of participants and the setting of the study. The participants should have high arousal levels, as the mandala colouring-in task did not reduce heart rate in children who were calm. By comparing the findings of previous mandala studies, heart rate should have shown a decrease had the participants been highly aroused when the mandala colouring-in tasks were given to them. The participants should also be from the same classroom, so a researcher can note down specific behaviours or activities that might show a peak or drop in the heart rate data for all the participants. This was a limitation of the present study as both participants were from different classrooms. The setting of the study is also important, as the curriculum area where the mandalas would be introduced needs to be suitable for the study. The curriculum area that was chosen needs to be the most anxiety-provoking for the participants, and where the participants are found to have the highest problem and off-task behaviours. This is important as some curriculum areas might not be arousing for the
participants, which would prevent the possible heart rate reducing effects of the mandala colouring-in tasks, as seen in the present study.

As an ethical consideration, applying for ethical approval might prove difficult if it was proposed that young children would be given stress-inducing tasks in the study. Instead, researchers should choose natural environments (e.g., schools) when the participants are naturally aroused to see the effects of the mandala colouring-in task more clearly, as the effects might only be observed with highly aroused children. The curriculum area should also be scheduled at the same time each day of the week, and not be after an activity that could affect the children’s heart rate (Porges, 1995). The present study could not control for these variables, and it was difficult to know how much of an effect did eating or play have on heart rate.

Another important element of designing a study is choosing the instruments and reports that would measure the dependent and independent variables. The present study recorded abnormally high noise levels using a mobile sound meter application (SkyPaw Co. Ltd., 2011), which seems to have been due to recording errors. It would be useful for future studies if a proper sound meter were used to record noise, as the data would be more precise and more evident whether heart rate was affected by the noise levels throughout the study. If the teachers of a future study are given report forms to complete about how the participants behaved during the chosen curriculum, these teacher-report forms should be completed directly after the session. The present study had the teachers complete the teacher-report forms at the end of the day, which did not represent how the participants behaved during mathematics and whether there were any effects on their positive and problem behaviours when the mandala colouring-in task was introduced.
Researchers who decide to observe the participants within the classroom (e.g., the participant's on-task behaviours) should measure the procedural reliability and interobserver agreement of the constructed observation sheets. These measures would determine how accurate the observation sheet is, and whether another observer would score similarly on the sheet if they had observed the participants behaviour. Researchers could have more than one observer to measure interobserver agreement, or a pilot study could be conducted, before the actual study, to test the methodology of the study (Bailey & Burch, 2002).

Previous mandala colouring studies compared several designs to see whether a reduction in stress or arousal was observed due to the design or the act of colouring-in. Researchers might be interested in adding another design, like a typical outline design developed for young children, and see whether this design would show different or similar results compared to the mandala designs. This addition would determine whether a reduction in stress or arousal was due to a particular design or the act of colouring-in. One of the colouring-in designs could be a typical outline design developed for young children to see whether this design would show the same results as with colouring-in a mandala. If researchers follow these suggestions, there would be a better chance at finding out whether colouring-in mandala designs can reduce arousal in children diagnosed with PTSD.

Conclusions

There is a high risk for children, following a natural disaster, to present with PTSS which could lead to PTSD. If the natural disaster created fear and anxiety or that was life-threatening, PTSS and behaviours that are indicators of PTSD are most
likely to appear (e.g., physiological hyperarousal, terrifying dreams, and avoidance from stimuli linked to the event; Dygerov & Yule, 2006). Since children in New Zealand have a high chance of experiencing an earthquake, finding effective activities and interventions suitable for young children is essential, as not all interventions created in reducing PTSD symptoms, (e.g., CBT), are age-appropriate or effective with children who are 8-years and under who are still learning skills required for regulating their emotions (Grave & Blissett, 2004). If an intervention or activity is not found to be effective for a child, PTSS or behaviours indicating PTSD could be present for months or years after the traumatic event. For children, these symptoms and behaviours are likely to affect their learning at school, such as focusing on tasks or avoiding the school if the setting is linked to the traumatic event. These are the reasons why researchers need to develop alternatives to CBT, such as bibliotherapy (Schneider et al., 2013), that could help young children regulate their emotions or reduce their PTSD symptoms after experiencing a traumatic event. Researchers should consider developing more studies about bibliotherapy as Schneider et al., (2013) it to be effective in reducing arousal and intrapersonal functioning immediately and one month after the tailored book was read to the child participant. Also, this intervention would be an inexpensive, easy to implement, and effective alternative to CBT that could be given to children in various environments, such as schools and homes, to reduce their PTSD symptoms after experiencing a traumatic event.
References


doi:10.1080/17518420902858975


drawings of affectively characterised topics. Journal of Child Psychology and

Cacioppo, J. T., Berntson, G. G., Malarkey, W. B., Kiecolt-Glaser, J. K., Sheridan, J. F.,
immune responses to psychological stress: The reactivity hypothesis. Annals
of the New York Academy of Sciences, 840(1), 664-673. doi:10.1111/j.1749-
6632.1998.tb09605.x

family-law-journal.page


mindfulness coloring activity for test anxiety in children. Journal of Applied
School Psychology, 31(3), 239-255. doi:10.1080/15377903.2015.1056925


Transactions on Industrial Electronics, 58(10), 4857-4865.

doi:10.1109/TIE.2010.2103538


doi:10.1017/S0021963001007272


doi:10.1007/s11205-009-9493-y


THE EFFECT OF COLOURING-IN TASKS ON HEART RATE


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doi:10.1080/0969594042000304591

Retrieved from http://pediatrics.aappublications.org/content/90/3/491.short


doi:10.1111/j.1365-2729.2005.00118.x


Julian, L. J. (2011). Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). *Arthritis Care & Research, 63*(11), 467-472. doi:10.1002/acr.20561


THE EFFECT OF COLOURING-IN TASKS ON HEART RATE


Appendices

Appendix A: Letter of approval from the Human Ethics Committee

HUMAN ETHICS COMMITTEE
Secretary, Rebecca Robinson
Telephone: +64 3 304 2867, Ext 45568
Email human.ethics@canterbury.ac.nz

Ref: 2016/32/ERHEC

10 August 2016

Filip Pui
College of Education, Health & Human Development
UNIVERSITY OF CANTERBURY

Dear Filip

Thank you for providing the revised documents in support of your application to the Educational Research Human Ethics Committee. I am very pleased to inform you that your research proposal “The Effect of Colouring-in Task on Arousal Levels: An In-Depth Single-Subject Study,” has been granted ethical approval.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 23rd July 2016.

Should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please let me know.

We wish you well for your research.

Yours sincerely,

PP

[Signature]

Patrick Shepherd
Chair
Educational Research Human Ethics Committee

Please note that ethical approval relates only to the ethical elements of the relationship between the researcher, research participants, and other stakeholders. The granting of approval by the Educational Research Human Ethics Committee should not be interpreted as comment on the methodology, legality, value or any other matter relating to this research.
Appendix B: Parent/Guardian Information Sheet

Telephone: 

Email: 

Date: 

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

Information and consent sheet for parents/guardians

My name is Filip Piri and I am a postgraduate student currently doing a masters in child and family psychology. I am looking to see how well a certain colouring-in task can reduce levels of arousal in young children. This idea emerged after adult colouring books were found to be effective in reducing stress in adults.

I would like to invite your child to participate in this study to help lower their levels of arousal. The child’s classroom teacher nominated your child as they thought they would be suitable for this study. This choice was based on the Teacher Selection Criteria (TSC) that was given to them by the researcher. Your child will be given a colouring-in task to do which would last approximately 10 minutes before school. During the task your child’s heart rate would be measured with a heart rate monitor for the wrist called a Fitbit Charge 2. At the end of the hour the child would be given two pictorial self-report checklists to fill out to see how they are feeling and whether they enjoyed the task. Your child will wear the Fitbit Charge 2 for the first hour of the
school day (e.g., 8:30am – 9:30am). At the end of the day the teacher would rate your child’s behaviour using a 5-question checklist. I would also be observing your child’s behaviour only for the first half hour of class each day. I’ll have a noise monitoring device (iPhone App), lux meter to measure ambient light levels (iPhone App), room temperature, humidity and volatile organic compound measuring instrument (Elagto Eve) in the child’s classroom for the second half hour (in class) of school also. The child will do:

First ten days

Student will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the student’s heart rate. Following this ‘before school time’ the child will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

Second ten days

Student will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with two other students of their choice. Only the participant will be measured. These two other students are only present to prevent disrupting the student’s routine by having them be with other children before school. Filip will be observing the student to see whether certain
activities could cause a spike or drop in the student’s heart rate. Following this ‘before school time’ the child will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

Third ten days

Student will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the student’s heart rate. Following this ‘before school time’ the child will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

Fourth ten days

Student will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with two other students of their choice. Only the participant will be measured. These two other students are only present to prevent disrupting the student’s routine by having them be with other children before school. Filip will be observing the student to see whether certain
activities could cause a spike or drop in the student’s heart rate. Following this ‘before school time’ the child will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

They will do these tasks once a day for 40 days. The study will not disrupt the child’s teaching as the tasks would be done up to 30 minutes before the start of school. I would also like the parents/guardians to fill out a checklist to let me know the number of times the parents/guardians were aware the child woke up during the night as night waking can be an indicator of stressors over the forty days. A weekly checklist tracking the days the child has engaged in colouring-in at home for the previous week would also be filled out by the parents/guardians. If you notice your child experience an unusual event that could increase arousal you will report it on the night waking checklist. The study would be started on (date to be determined).

Your and your child’s participation in this study is voluntary so you and your child have the right to withdraw at any stage without penalty. If the child or the parents/guardians want to withdraw from the study, I will do my best to remove any information relating to your child, provided this is practically achievable.

Only I and my supervisors will have access to the data. My supervisor Lawrence Walker can be contacted for further information, Phone or email Confidentiality and anonymity will be assured by writing in a way that will not identify the child, teacher,
class, school, or location and also any information given to me will not be shared to anyone other than my two supervisors. The data will be securely stored on a password protected computer in a password protected folder and it will be destroyed after 5 years.

The results gathered will be reported in an outcome of the study. I will provide you a summary by email once the study is finished. The results of the study would be explained to the student with the parents/guardians present.

This study has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee. If there are any complaints they should be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

For participating at the end of the study, the child will get to keep the colouring-in pencils and pencil case used in the study and also a koha to the family of a Hoyts movie card.

If you would like your child to participate in this study, then please fill out this form to let me know how I can contact you and when would it suit to meet. Please return it to the school as soon as you can.

I ______________________________________consent to my child ____________________ being involved in this study.
Parents/Guardians Name: _______________________ Participant’s Name: _______________________

Contact Information: _________________________

Suitable Time and Date for Meeting: ________________________________

Thank you,

Filip Piri
THE EFFECT OF COLOURING-IN TASKS ON HEART RATE

Appendix B: Child Information Sheet

Telephone:

Email:

Date:

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

(for the child – Does colouring-in help you with getting on with your school work in class?)

Information sheet for child

(to be read to child by parent/guardian)

Filip Piri is doing a project at the University of Canterbury. He would like for you to help him with his project about colouring-in.

He will ask you to wear a Fitbit Charge 2 for the first hour of arriving at school. He would like you to arrive about 8:40am each day and work with him doing fun stuff. When school starts, you will keep wearing the Fitbit until he collects it about 9:30am.

The fun stuff will be listening to some stories and doing some things about the stories. Later you will colour in special designs. He will ask you to fill out a feelings
and enjoyment checklist to see how you are feeling after doing the fun stuff and how you enjoyed doing the fun stuff. You will do the fun stuff one hour each school day for eight weeks. You will also see Filip in the classroom where he will be watching how you work in the classroom.

If you choose to be a part of this colouring-in project, your personal information will be protected by giving you a different name so no one will know who you are, who your parents/guardians are, who your teacher is, and what school you go to. All the information collected will be safely stored on a computer. The information will be destroyed after 5 years. A small summary of the project will be given to your parents/guardians, teacher, principal, and the Board of Trustees Chairperson.

The results of the project would be explained to you by Filip with your parents/guardians present.

If you have any questions, you can talk to your parents/guardians, teacher or Filip. Also you are allowed to change your mind about being in the project at any time you want. All you have to do is tell your parent/guardian or Filip.

If you choose to help Filip with his project he will give you the colouring-pencils to keep and a movie voucher at the end of the eight weeks.

Thank you,

Filip Piri
Appendix B: Teacher Information Sheet

Telephone:

Email:

Date:

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

Information sheet for Teacher

My name is Filip Piri and I am a postgraduate student currently doing a masters in child and family psychology. I am looking to see how well certain colouring-in tasks can reduce levels of arousal in young children. This idea emerged after adult colouring books were found to be effective in reducing stress in adults.

You will nominate a child who is 6-7 years old that you think would be suitable for this study. This choice would be based on the Teacher Selection Criteria (TSC) that would be given to you. Following informed consent the student will be given a colouring-in task to do which would last approximately 10 minutes before school.

During the task the student’s heart rate will be measured with a heart rate monitor for the wrist called a Fitbit Charge 2. At the end of the hour the child would be given two pictorial self-report checklists to fill out to see how aroused they are feeling and whether they enjoyed the task. The children will wear the Fitbit Charge 2 for the first hour of the school day (e.g., 8:30am – 9:30am).
I’d like you to rate the child’s behaviour with a 5-question checklist at the end of each day. I will also be observing the student’s behaviour in class and scoring them against a behavioural checklist for the first half hour of class each day. I’ll have a noise monitoring device (iPhone App), lux meter to measure ambient light levels (iPhone App), room temperature, humidity and volatile organic compound measuring instrument (Elagto Eve) in the room for the second half hour (in class) of school also. The student will do:

**First ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

**Second ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with 4 other students of their choice. Each student can pick 2 other students. Only the participant’s will be measured. These 4 other students are only present to prevent disrupting the students’ routine by having them be with other children before school. Filip will be observing the
students to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

Third ten days

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

Fourth ten days

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with 4 other students of their choice. Each student can pick 2 other students. Only the participant’s will be measured. These 4 other students are only present to prevent disrupting the students’ routine by having them be with other children before school. Filip will be observing the
students to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

They will do these tasks once a day for 40 days. The study will not disrupt the child’s teaching as the tasks would be done up to 30 minutes before the start of school. Filip would like to conduct the study at the school, but the tasks would not need to be done in the classroom to avoid distractions. I would also like the parents/guardians to fill out a checklist to let me know the number of times the parents/guardians were aware the child woke up during the night as night waking can be an indicator of stressors over the forty days. A weekly checklist tracking the days the child has engaged in colouring-in at home for the previous week would also be filled out by the parents/guardians. If the parents/guardians notice their child experience an unusual event that could increase arousal they will report it on the night waking checklist. The study would be started on (date to be determined).

The participation of the student and their parents/guardians in this study is voluntary and they have the right to withdraw at any stage with no penalty. If the student or parents/guardians want to withdraw from the study, I will do my best to remove any information relating to the student, provided this is practically achievable.
Only I and my supervisors will have access to the data. My supervisor Lawrence Walker can be contacted for further information, Phone or email. Confidentiality and anonymity will be assured by writing in a way that will not identify the child, teacher, class, school or location and also any information given to me will be confidential to myself, and my two supervisors. The data will be securely stored on a password protected computer in a password protected folder and it will be destroyed after 5 years.

The results gathered will be reported in as an outcome of the study. I will provide you a summary by email once the study is finished. The results of the study would be explained to the student and parents/guardians by Filip.

This study has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee. If there are any complaints they should be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

The child and their parents/guardians will receive a koha at the end for participating in my study: the child will keep the colouring-in pencils and pencil case and the family will be given a Hoyts movie card.

If you would like to participate in this study, please fill out the attached consent form and return it to me in the envelope provided as soon as you can.
Thank you,

Filip Piri
Appendix B: Principal Information Sheet

Telephone: 

Email: 

Date: 

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

Information sheet for Principal

My name is Filip Piri and I am a postgraduate student currently doing a masters in child and family psychology. I am looking to see whether certain colouring-in tasks can reduce levels of arousal in young children. This idea emerged after adult colouring books were found to be effective in reducing stress in adults.

I would like to invite a student from your school to be a part of this study. The student would be chosen with the help from your teachers. They will nominate a child who is 6-7 years old that they think would be suitable for this study. This choice would be based on the Teacher Selection Criteria (TSC) that would be given to them by the researcher. Following informed consent the student will be given a colouring-in task to do which would last approximately 10 minutes. During the task the student’s heart rate will be measured with a heart rate monitor for the wrist called a Fitbit Charge 2. At the end of the hour the child would be given two pictorial self-
report checklists to fill out to see how aroused they are feeling and whether they enjoyed the task. The children will wear the Fitbit Charge 2 for the first hour of the school day (e.g., 8:30am – 9:30am). The teacher would rate the child’s behaviour with a 5-question checklist at the end of each day. I would also be observing the student’s behaviour scoring them against a behavioural checklist for the first half hour of class each day and I’ll have a noise monitoring device (iPhone App), lux meter to measure ambient light levels (iPhone App), room temperature, humidity and volatile organic compound measuring instrument (Elagto Eve) in the room for the second half hour (in class) of school. The student will do:

First ten days

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

Second ten days

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with 4 other students of their choice. Each student can pick 2 other students. Only the participant’s will be measured.
These 4 other students are only present to prevent disrupting the students’ routine by having them be with other children before school. Filip will be observing the students to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

**Third ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

**Fourth ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with 4 other students of their choice. Each student can pick 2 other students. Only the participant’s will be measured.
These 4 other students are only present to prevent disrupting the students’ routine by having them be with other children before school. Filip will be observing the students to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

They will do these tasks once a day for 40 days. The study will not disrupt the child’s teaching as the tasks would be done up to 30 minutes before the start of school. Filip would like to conduct the study at the school, but the tasks would not need to be done in the classroom to avoid distractions. I would also like the parents/guardians to fill out a checklist to let me know the number of times the parents/guardians were aware the child woke up during the night as night waking can be an indicator of stressors over the forty days. A weekly checklist tracking the days the child has engaged in colouring-in at home for the previous week would also be filled out by the parents/guardians. If the parents/guardians notice their child experience an unusual event that could increase arousal they will report it on the night waking checklist. The study would be started on (date to be determined).

The participation of the student and their parents/guardians in this study is voluntary and they have the right to withdraw at any stage with no penalty. If the student or parents/guardians want to withdraw from the study, I will do my best to
remove any information relating to the student, provided this is practically achievable.

Only I and my supervisors will have access to the data. My supervisor can be contacted for further information, Phone or email. Confidentiality and anonymity will be assured by writing in a way that will not identify the child, teacher, class, school or location and also any information given to me will be confidential to myself, and my two supervisors. The data will be securely stored on a password protected computer in a password protected folder and it will be destroyed after 5 years.

The results gathered will be reported in an outcome of the study. I will provide you a summary by email once the study is finished. The results of the study would be explained to the student with his/her parents/guardians present.

This study has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee. If there are any complaints they should be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

The child and their parents/guardians will receive a koha at the end for participating in my study: the child will keep the colouring-in pencils and pencil case and the family will be given a Hoyts movie card.
If you would like for your school to participate in this study, please fill out the attached consent form and return it to me in the envelope provided as soon as you can.

Thank you,

Filip Piri
Appendix B: Letter to the Board of Trustees

Name:

Address:

Telephone:

Email:

Date:

Board of Trustees Chairperson

XXXXX School

Dear Board of Trustees Chairperson,

My name is Filip Piri and I am a postgraduate student currently doing a masters in child and family psychology. I am looking to see whether certain colouring-in tasks can reduce levels of arousal in young children. This idea emerged after adult colouring books were found to be effective in reducing stress in adults. The title of my project is “The effects of colouring-in tasks on arousal: An in-depth single-subject study”.

I am approaching you to ask for your approval to work within your school. I would like to invite two students from your school to be a part of this study. The students
would be chosen with the help from a teacher. They will nominate two children who are 6-7 years old that they think would be suitable for this study. This choice would be based on the Teacher Selection Criteria (TSC) that would be given to them by the researcher. The students will be given a colouring-in task to do which would last approximately 10 minutes. During the task the students' heart rate will be measured with a heart rate monitor for the wrist called a Fitbit Charge 2. At the end of the hour the children will be given two pictorial self-report checklists to fill out to see how aroused they are feeling and whether they enjoyed the task. The children will wear the Fitbit Charge 2 for the first hour of the school day (e.g., 8:30am – 9:30am). The teacher will rate the students' behaviour with a 5-question checklist at the end of each day. I would also be observing and completing a checklist of the students' behaviour for only the first half hour of class each day. I’ll have a noise monitoring device (iPhone App), lux meter to measure ambient light levels (iPhone App), room temperature, humidity and volatile organic compound measuring instrument (Elagto Eve) in the child’s classroom for the second half hour (in class) of school also. The student will do:

**First ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half
hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

**Second ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with 4 other students of their choice. Each student can pick 2 other students. Only the participant’s will be measured. These 4 other students are only present to prevent disrupting the students’ routine by having them be with other children before school. Filip will be observing the student’s to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

**Third ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine. Filip will be observing their behaviour to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half
hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

**Fourth ten days**

Student’s will wear the Fitbit Charge 2 and engage in their regular ‘before school’ routine as well as doing a colouring-in exercise with 4 other students of their choice. Each student can pick 2 other students. Only the participant’s will be measured. These 4 other students are only present to prevent disrupting the students’ routine by having them be with other children before school. Filip will be observing the student’s to see whether certain activities could cause a spike or drop in the students’ heart rate. Following this ‘before school time’ the student’s will begin with their class and undertake usual classroom activities wearing the Fitbit Charge 2. The classroom noise levels, air temperature, humidity, ambient light levels and volatile organic compounds will be logged for the first half hour. Filip will be observing and filling out the behaviour checklist for the first half hour of school. At the end of this time Filip will collect the instruments and leave.

They will do these tasks once a day for 40 days. The study will not disrupt the child’s teaching as the tasks would be done up to 30 minutes before the start of school. I would like to conduct the study at the school, but the tasks would not be done in the classroom to avoid distractions. I would also like the parents/guardians to fill out a checklist to let me know the number of times the parents/guardians were aware the child woke up during the night as night waking can be an indicator of stressors over the forty days. A weekly checklist tracking the days the child has engaged in colouring-in at home for the previous week would also be filled out by the
parents/guardians. If the parents/guardians notice their child experience an unusual event that could increase arousal they will report it on the night waking checklist. The study would be started on (date to be determined).

The participation of the student and their parents/guardians in this study is voluntary and they have the right to withdraw at any stage with no penalty. If the student or parents/guardians want to withdraw from the study, I will do my best to remove any information relating to the student, provided this is practically achievable.

Only I, and my supervisors will have access to the data. My supervisor can be contacted for further information, Phone or email. Confidentiality and anonymity will be assured by writing in a way that will not identify the child, teacher, class, school or location and also any information given to me will be confidential to myself, and my two supervisors. The data will be securely stored on a password protected computer in a password protected folder and the data will be destroyed after 5 years.

The results gathered will be reported as an outcome of the study. I will provide you an overall summary by email once the study is finished. The results of the study would be explained to the student and their parents/guardians by Filip.

This study has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee. If there are any complaints they should be addressed to The Chair, Educational Research Human Ethics Committee,
University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

The child and their parents/guardians will receive a koha at the end for participating in my study: the child will keep the colouring-in pencils and pencil case and the family will be given a Hoyts movie card.

If you would like for your school to participate in this study, please fill out the attached consent form and return it to the school as soon as you can.

Thank you for taking the time to read this letter.

Yours sincerely,

Filip Piri
Appendix B: Parent/Guardian Consent Form

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

Consent form for parents/guardians

A full explanation of this study has been provided and I/we have been given the opportunity to ask questions.

I/We understand what will be required of my child and I if they take part in the study.

My/Our child and I/we understand that participation is voluntary and that I/we can withdraw at any time without penalty.

I/We understand that any information or opinions provided will be kept confidential to Filip and his supervisors and that any published or reported results will not identify the child, teacher, class or school.

I/We understand that all data collected for the study will be kept in locked and secure facilities and password protected electronic forms which will be destroyed after 5 years.
I/We understand that I/we will receive a summary of the study’s findings which would be sent to my/our email address. I/We understand that I/we will be with the teacher and Filip when the results are explained to my child.

I/We understand that I/we can contact the researcher, or my supervisors for further information.

I/We understand that if I/we have any complaints, these are to be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

By signing below, I/We am/are giving my/our consent to my child’s participation in this study.

Parents/guardians Name: ________________________________________________________________

Participant’s Name: _________________________________________________________________

Date: __/__/____ Signature: ____________________________________________________________

Email address (to send the summary): _________________________

Please post this consent form to me in the envelope provided as soon as you can.

Thank you,

Filip Piri
Appendix B: Child Assent Form

Telephone:

Email:

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

(for the child – Does colouring-in help you with getting on with your school work in class?)

Assent form for children

My parents/guardians have told me about your project.

I am happy to help you with your colouring-in project.

I know that any information about me will not be told to anyone else and will be safely stored on a computer. Filip and his supervisors will not use my name in the project, my teacher’s name or my school name. All the information will be destroyed after 5 years. My parents/guardians, teacher, principal, and the Board of Trustees Chairperson will receive a small summary of the project when it is finished.
I understand that I can change my mind about being in this project and no-one will mind if I do so.

I understand that I will learn about the results of the project with my parents/guardians and teacher present.

I understand that if I have any questions I can ask my parents/guardians or Filip.

Child’s Name: _____________________________________

Date: ____/____/_______

Signed by child (or on behalf of child) parent/guardian signature: __________________________

Please post this consent form to me in the envelope provided as soon as you can.

Thank you,

Filip Piri
Appendix B: Teacher Consent Form

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

Consent form for Teachers

A full explanation of this study has been provided and I have been given the opportunity to ask questions.

I understand what will be required of me and I agree to have a student from my class participate in this study.

I understand that any information or opinions I provide will be kept confidential to Filip Piri and his supervisors and that any published or reported results will not identify the child, teacher, class or school.

I understand that all data collected for the study will be kept in locked and secure facilities and password protected electronic forms which will be destroyed after 5 years.
THE EFFECT OF COLOURING-IN TASKS ON HEART RATE

I understand that I will receive a summary of the study’s findings which would be sent to my email address.

I understand that I can contact the researcher Filip Piri, or his supervisors for further information.

I understand that if I have any complaints, these are to be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

By signing below, I agree to participate in this study.

Teacher’s name: ____________________________________________________________

Date: ___/___/_______ Signature: _____________________________________________

Email address (to send the summary):
_______________________________

Please post this consent form to me in the envelope provided as soon as you can.

Thank you,

Filip Piri
Appendix B: Principal Consent Form

Telephone:

Email:

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

Consent form for the Principal

A full explanation of this study has been provided and I have been given the opportunity to ask questions.

I understand what will be required for my teacher/s and the chosen students and I agree for this study to take place in my school.

I understand that any information or opinions provided will be kept confidential to Filip, his supervisors and that any published or reported results will not identify the children, teacher, class or school.

I understand that all data collected for the study will be kept in locked and secure facilities and password protected electronic forms which will be destroyed after 5 years.
I understand that I will receive a summary of the study’s findings which would be sent to my email address.

I understand the parents/guardians and the child will have Filip explain the study’s results to the child.

I understand that I can contact the researcher Filip Piri, or his supervisors for further information.

I understand that if I have any complaints, these are to be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

By signing below, I agree for this study to take place at my school.

Principal’s name: __________________________________________________________

Date: ____/___/_______ Signature: __________________________________________

Email address (to send the summary): ________________________________

Please post this consent form to me in the envelope provided as soon as you can.

Thank you,

Filip Piri
Appendix B: Board of Trustees Consent Form

The Effects of Colouring-in Tasks on Arousal Levels: An in-depth Single-Subject Study.

Consent form for the Chair of the Board of Trustees

A full explanation of this study has been provided and I have been given the opportunity to ask questions.

I understand what will be required for the teachers and the chosen students and I agree for this study to take place at the school subject to the consent and assent of the parents/guardians and children.

I understand that any information or opinions they provide will be kept confidential to Filip Piri and his supervisors and that any published or reported results will not identify the children, teacher, class, or school.

I understand that all data collected for the study will be kept in locked and secure facilities and password protected electronic forms which will be destroyed after 5 years.
I understand that I will receive a summary of the study’s findings which would be sent to my email address.

I understand that I can contact the researcher Filip Piri, or his supervisors for further information.

I understand that if I have any complaints, these are to be addressed to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

By signing below, I agree for the school to participate in this study.

Chairpersons Name: ___________________________ Signature: __________________________

Date: ____/____/_______

Email address (to send the summary): _________________________

Please post this consent form to me in the envelope provided as soon as you can.

Thank you,

Filip Piri
Teacher Selection Criteria (TSC).

(for the teacher to use)

**Directions:** For these five set of statements answer by ticking ‘yes’ or ‘no’

Can you think of a child who...

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Lived during the Christchurch Earthquakes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Mostly has troubles with focusing on tasks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Frequently has angry outbursts</td>
<td></td>
<td></td>
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<tr>
<td>4 Mostly has troubles doing what the teacher asks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Mostly has trouble staying in their seat.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D: Mandala Designs
Appendix E: On-Task Behaviour Checklist


**Directions:** For every minute ‘tick’ the box if statement true and ‘cross’ the box if false.

<table>
<thead>
<tr>
<th>Date:</th>
<th>9am</th>
<th>30 mins</th>
<th>9:30am</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>On task behaviour</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(doing what most children are doing)</td>
<td></td>
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<tr>
<td>Gets started on required tasks as soon as this is signalled or requested</td>
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<td></td>
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<tr>
<td>Persists with</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Behaviour</td>
<td>Comments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>only set tasks when left unsupervised</td>
<td></td>
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<tr>
<td>Responds appropriately when other students try to interact socially with him/her</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Shows interest in what others are saying during conversations, e.g. by nodding, smiling, commenting etc.</td>
<td></td>
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</tr>
<tr>
<td>Takes his/her turn when others are waiting</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Compromises with others</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>When conflicts or disagreements arrive</td>
<td></td>
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<tr>
<td>----------------------------------------</td>
<td>---</td>
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<tr>
<td>Expresses anger appropriately (without becoming destructive or violent)</td>
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<tr>
<td>Ignores initial requests and directions even though he/she has heard them</td>
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<tr>
<td>Tries to get own way by throwing tantrums e.g. by sulking or shouting, or swearing and refusing</td>
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<tr>
<td></td>
<td>Column 1</td>
<td>Column 2</td>
<td>Column 3</td>
<td>Column 4</td>
</tr>
</tbody>
</table>
Appendix G: Arousal and Enjoyment Self-Report

Participant questionnaire on the colouring-in tasks.

(for the participant to fill out)

Arousal and Enjoyment Checklist

Participant’s name: ___________________________

Using the pictures below rate how you found the task? (Circle one)

1. I really did not enjoy it
2. I did not mind it
3. I did not enjoy it
4. I enjoyed it
5. I really enjoyed it

Using the pictures below rate how calm or energetic you are feeling? (Circle one)

1. Calm
2. 
3. 
4. 
5. Energetic
Appendix H: Daily Teacher Checklist (DTC)

Teacher daily questionnaire on the child’s behaviour.
(for the teacher to fill out)

Daily Teacher Checklist (DTC)

**Directions:** For these statements answer by rating 1 to 5.

Please complete at the end of the day. Date:

When filling this out compare the child to other children in the class on the day.

1 = never, 2 = sometimes, 3 = about the same as others, 4 = more frequently than others, 5 = often

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td></td>
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<tr>
<td>2</td>
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<td>5</td>
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</tbody>
</table>

Has difficulty concentrating, cannot pay attention for long.

Can get over being upset quickly (relative to the situation).

Is cheerful, happy.

Does what the teacher asks.

Is rather high strung, tense, and nervous.

Any comments, unusual behaviour/s please note here: