# THE EFFECT OF BRIEF FOCUSED ATTENTION MEDITATION ON MEASURES OF ATTENTION

A thesis submitted by

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## DECLARATION

The research presented in this thesis was conducted at the School of Psychology, University of Kent whilst enrolled as a full-time postgraduate student, and was supported by a University of Kent 50th Anniversary Graduate Teaching Assistantship Award. The theoretical and empirical work was supported by the supervision of Dr Dinkar Sharma, and the data collection with limited assistance from others. The present work has not contributed to any other degree or qualification. The findings have been presented at several academic meetings, namely: 2nd International Conference on Mindfulness 2016 (Rome. May 2016); The First Conference of the Timing Research Forum (Strasbourg. October 2017); 3rd International Conference on Mindfulness 2018 (Amsterdam. July 2018).

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## ABSTRACT

Finding interventions that lead to improvements in attentional abilities could be beneficial to a large range of populations. It has been suggested that mindful meditation practices might have such an effect. However, experimental practices in the mindfulness meditation literature mean that it is unclear if, and how, this might occur. Looking specifically at the effects of interventions on novice practitioners and using one consistent style of meditative intervention, this thesis looks at how much meditation may be needed to induce attentional changes in novice practitioners and what element of meditative practice might be involved.

Two experimental interventions were used, the first intervention was focused-attention meditation, the second was an externally focused mindful colouring. Studies 1 – 3 examined attentional ability using a time bisection task that has previous shown change over brief mindfulness interventions. Studies 4-7 used the Attention Network Test to examine whether different aspects of attentional ability change in different ways with varying dosages.

Key findings from across the seven studies suggested several conclusions. Firstly, that object of focused used in meditation may affect the cognitive processes that are utilised. Secondly that self-reported attentional awareness is not an accurate reflection of attentional ability and that measures of state-mindfulness need further investigation in their use as manipulation checks. Thirdly, that single brief dosages achieved attentional change in the time bisection task but not the attention network test, suggesting some differentiation between them as measures of attention. Finally, attentional change on the attention network test was seen when using repeated dosage over time but this change was a negative impact on alerting ability, possibly suggesting that the meditation and attention network task use similar styles of attentional processing which leads to vigilance decrement over prolonged periods.

# CHAPTER 1: GENERATING ALTERED STATES OF CONSCIOUSNESS

## 1.1 Overview

This chapter provides a broad overview of the mindfulness and meditation literature in relation to cognitive understandings of attention. Firstly, it considers the historical uses and contexts of mindfulness and meditation practices from Confucian ideas through to modern Buddhist conceptualisations. It then briefly covers the migration of mindfulness into Western culture. Next, it identifies key theoretical approaches to the study of cognitive attention. Followed by a summary of how research on the effects of mindfulness and meditation are mapping on to current understandings of neural and behavioural networks of attention.

## 1.2 Mindfulness and Meditation

Mindfulness and meditative practices have only become popular in the Western world in the last 30 years. Jon Kabat-Zinn introduced the idea that the practices used may induce state changes that improve health and wellbeing in many areas and brought Zen meditation practices to the West, creating an intervention called Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1982; Kabat-Zinn, Lipworth, Burney, & Sellers, 1986; Miller, Fletcher, & Kabat-Zinn, 1995). Such mindfulness-based interventions have gained popularity in clinical spheres and have resulted in an array of interventions such as Mindfulness-Based Cognitive Therapy (MBCT), Acceptance and Commitment Therapy (ACT) and Dialectical Behavioural Therapy (DBT). Programmes have shown to have effects on a range of clinical conditions, most notably on anxiety, depression, and chronic pain (Hempel et al., 2014). These interventions have brought with them an increased public awareness of mindfulness, turning it into a buzzword.

The terms 'mindfulness' and 'meditation' are both used frequently in the literature, and it is important to distinguish their separate meanings. Mindfulness can be defined as the process of being non-judgementally aware in the present moment (Kabat-Zinn et al., 1986), a state of mind as opposed to behaviour. Meditation is a form of practice that can be used to explore ideas, themes, and issues; it is found in many traditions and diverse cultures, both religious and secular. While the evidence for the clinical benefits of mindfulness meditation is beginning to build an informative picture, little is known about how it brings about such changes (Tang, Hölzel, & Posner, 2015). It is generally thought that mindfulness and meditation practices must elicit both short and long-term cognitive changes, which then generalise to other behaviours, including those supportive of health and wellbeing. However, such understanding is limited by inconsistency and a lack of rigour in the literature (Van Dam et al., 2018).

### 1.3 Altering States of Consciousness

The earliest records of consciously curated behaviours aimed at changing mental states appear in early Taoist texts of ca. 300 BCE (Johnson, 1982; Zhuangzi, 1996); Zhuangzi uses stories of Confucius to illustrate ideas for bringing about positive effects and includes the idea that "Fortune and blessing gather where there is stillness. However, if you do not keep still – this is what is called sitting but racing around" (Zhuangzi, 1996, p. 54). Zhuangzi (1996) later discusses the benefits of detachment from the material world and possessions and how such a detachment can lead to a richer and more satisfying existence, concepts that can still be found in modern religious thought (Langness, 2013; "Let Go of Attachment," 2013)

Trying to bring about change in an individual's mental state is a practice that is seen across cultures. Müller and Schummann (2011) argue that, when individuals are not addicted, psychoactive substances are used as tools to change mental states. The use of psychoactive substances such as the Central American use of peyote (Labate & Cavnar, 2016) has been found in many cultures and is often associated with transitional or spiritual experiences, both currently and historically (Durrant & Thakker, 2003; Johnson, 1982), and have been argued to share many elements with the meditative practices seen in Buddhism today (Johnson, 1982). It is thought that the preparations for many of these rituals closely resemble some practices that also surround meditative practices such as fasting (food or sensory), purging or ritual cleansing, repetitive or rhythmic sounds or movements thought to encourage altered states of consciousness (ASC) (Metzner, 1994; Shepard, 2005). Such practices are thought to make experiences more powerful or more likely (Johnson, 1982; Shepard, 2005).

Meditation practices are thought to have developed in the areas that previously used large amounts of a psychoactive drink known as 'soma' (Johnson, 1982; Staal, 2001).

Johnson (1982), in his book *Riding the Ox Home: A History of Meditation from Shamanism to Science,* theorises that religious circles found that soma rituals led to the desired change of mental state but that they may have reached an impasse as the psychoactive substance left little room for controlled change to mental states. Instead, there was a move towards using behavioural techniques which attempted to induce ASCs (Johnson, 1982).

Early Buddhist texts show divergent approaches to achieving desired ASCs. In the Theravada Buddhist texts known as the Pali Canon, the earliest versions of which were conveyed orally and first written down ca. 29 BCE (don Lehman Jr., 2015), Gautama Buddha describes methods for eliciting mental change. He is reported to have taught the idea of focusing one's attention to the breath (*Ānāpānasati* in Pali) as a transformative tool in ca. 500 BCE, with contemporaries experimenting with other possible ways of eliciting ASCs (Johnson, 1982). The Ascetics, with whom Gautama Buddha is thought to have experimented and interacted, are reported to have tried other methods for achieving positive and lasting state change (Wiltshire, 2013). These included different forms of sensory deprivation such as fasting. Although Buddhism subscribes to Gautama Buddha's teachings as the most parsimonious path to enlightenment, they do not believe that his teachings are the only way to achieve enlightenment. In fact, Buddhist texts contain two different terms that describe individuals that have achieved enlightenment without knowing or following Gautama Buddha's teachings in different ways (Wiltshire, 2013).

## 1.4 Mindfulness in Buddhism

Buddhism poses that *sati* (translated as ‘correct mindfulness’), practiced in concert with seven other positive practices collectively known as the eightfold path, moves the individual towards the ultimate ASC that is ‘enlightenment’. The Buddhist concept of ‘correct mindfulness’ is complemented by: correct view, correct intention, correct speech, correct action, correct livelihood, correct effort and correct concentration. The belief is that developing these elements together support a positive change in the individual that will help them to break free of suffering. Although the idea of *sati* was introduced in the earliest Buddhist literature, understanding of its nuances and the practices best used to encourage it were not clearly defined. The lack of definition has led to a wealth of interpretations and practices developing in the different Buddhist traditions. Buddhism is not about improving mental wellbeing, though this may be a side effect of enlightenment, it is about divorcing one from a state-of-self. Divorcing from a sense of self combined with the other elements of the eightfold path, leads to the cessation of suffering (Farias & Wikholm, 2015). One tool used to train the mind and move towards achieving this complete ASC is meditation, which is thought to be particularly adept at promoting the mindful element of the eightfold path.

## 1.5 Meditation for Promoting Mindfulness

In 'mindfulness meditation' practitioners use meditation exercises as a tool to focus on developing their mindfulness. There are many strategies to develop mindfulness, such as ‘mindful eating’, yoga and ‘mindful walking’. Some strategies developed from the same roots as meditation practices and may achieve similar results; however, in order to approach the literature in a rigorous manner this thesis will concentrate on aspects of meditation practice only. The particular processes now associated with mindfulness cultivation are generally thought to draw their roots from Burmese interpretations of the Pali Canon, specifically the *Satipaṭṭhāna-sutta* in only the 19th and 20th centuries (Sharf, 2015).

Meditation practices, though broadly similar, have devolved into several traditions such as Transcendental, Tantra, Yoga, Tibetan and Zen (Goleman, 1988). Each tradition has specific practices; these promote and focus on different components and concepts both practically and in their understanding of mindfulness. Goleman (1988) splits mindfulness into four main focuses; mindfulness of the body, mindfulness of feelings and mindfulness of mind-objects, mindfulness of external objects. Further to the four focuses, Mikulas (2010) emphasises the differences between traditions that begin by training concentration versus those who train awareness first. In all the traditions, however, meditation is only part of the path to producing positive ASC. Mindfulness in Buddhism, and by extension meditation, is only one element of the path to enlightenment or ‘the middle way’ (Mikulas, 2010).

### 1.6 Mindfulness and Related Practices in the West

Mindfulness has been mostly secularized in Western culture; doing so makes the practice more palatable to a broader spectrum of people (Wilson, 2014). Some have objected to the idea of mindfulness and meditation as health and wellbeing interventions when extracted from the Buddhist framework (Fronsdal, 2002), arguing that there is more good to be taken from the Buddhist traditions than can be taken from mindfulness practices alone ("What Secular Mindfulness Can learn From Buddhism (1) | Wise Attention," n.d.). Others, in developing Western traditions of mindfulness, see increased ethical conduct as the product of mindfulness meditation, and not as a synergistic tool for the creation of meditation experiences (Fronsdal, 2002). It is currently unclear whether the moral lessons, inherent in structures such as the eightfold path, aid in making the meditative practices more efficacious. Indeed, the idea that mindfulness meditation is a tool for achieving more abstracted ASCs is rarely covered in the Westernised discussions of mindfulness and meditation.

In the commercial market, mindfulness is being promoted as a tool to improve everything from wellbeing to productivity, and this image is being used to sell a range of products including, but not limited to: yoga, apps, online courses, socks and colouring books. Mindfulness in the West has some influential supporters and has been promoted widely by everyone from CEOs such as Arianna Huffington (Huffington, 2013) to Parliaments (Mindfulness All-Party Parliamentary Group (MAPPG), 2015) and has gained much recognition, but little understanding, in popular culture. It seems to be promoted as a panacea for mental health and wellbeing and as a tool to mitigate the adverse side effects of overwork.

Although not a panacea for mental health, mindfulness has been proven to have significant positive effects in some regions of clinical psychology (Kabat-Zinn, 2015). The results of practices extracted from Buddhism and combined with psychiatric practices such as relaxation techniques and cognitive behavioural therapy have shown conclusively that mindfulness-based interventions can help to reduce reoccurrence of depressive episodes, can alleviate the symptoms of chronic anxiety and help people who are living with chronic pain (Hempel et al., 2014). There are also suggestions, though contested that it may also have significant positive effects on stress, Multiple Sclerosis, PTSD, addiction, sleep and mood disorders (Hempel et al., 2014).

Within this westernised arena, the idea that it is a tool for inducing an ASC seems to be lost; it is seen more for its immediate benefits than as something to change how an individual perceives and relates to the world, though these concepts are linked. However, the rise in popularity in both the clinical literature and in the general populous has also led to a rising academic interest in the psychological and neurological sciences (Williams & Kabat-Zinn, 2011). Initial cognitive and neurological investigations have supported the idea that mindfulness meditation can lead to significant cognitive change and ASCs (Ben-Soussan, Glicksohn, & Berkovich-Ohana, 2017; Davidson & Goleman, 1977; Schuman, 1980).

## 1.7 Mindfulness Meditation in the Cognitive Neuropsychology of Attention

### Attention

The ability to selectively process, or avoid processing, stimuli while ignoring others is a crucial cognitive process ( Posner, 1995). It is a crucial process in our abilities to learn, assess and access information from any source (Carlson & Brown, 2005; Lavie, 2005; Posner & Petersen, 1990). Attention is needed at all stages of information processing. Good attentional abilities are described as a state that allows for the most efficient processing of relevant stimuli, while simultaneously inhibiting irrelevant and distracting stimuli, in order to complete a set task quickly and accurately. Attention is a multifaceted cognitive skill and is utilised in our conscious processing of all sensory input, current research treats sensory modalities differently and the most comprehensive theories are found surrounding visual attention – though research is expanding in studies of auditory processing and attention (Alho, Woods, Algazi, & Näätänen, 1992; Shinn-Cunningham, 2008).

Visual attention is limited by several key factors. Firstly attention is thought to act somewhat like a spotlight; attentional focus allows for the processing of detailed sensory information but the amount of sensory input that can be consciously processed at one time is finite, meaning that other sensory-inputs are not brought into consciousness (Heitz & Engle, 2007; VanRullen, Carlson, & Cavanagh, 2007). Secondly, studies have suggested that attention is a limited resource. Depletion of attention, such as when completing simultaneous tasks, can lead to attention failure (Lavie, 2005; Lavie, Hirst, de Fockert, & Viding, 2004). Attentional depletion is strongly influenced by both the perceptual and cognitive loads of specific tasks (Norman & Bobrow, 1975; Warm, Parasuraman, & Matthews, 2008). High cognitive loads reduce our ability to ignore both internal and external extraneous stimuli (Fockert, Rees, Frith, & Lavie, 2001), while high perceptual loads lead to a reduction of distraction (Lavie, 2005). These limiting factors make it imperative to use such resources as effectively as possible.

The method used for moving visual attention to specific stimuli can be split into two broad categories: active and passive. Active, or top-down, attention requires internal motivation to select objects that are relevant to the set task (Baluch & Itti, 2011). Passive, or bottom-up, visual attention is where stimuli attract attentional processing (Baluch & Itti, 2011). Active attention can also be described as 'effortful'. Concerted effort needs to be applied to direct attention, though the level of effort needed will be moderated by other factors such as saliency, skill and task absorption (Ben-Soussan et al., 2017; Harris, Vine, & Wilson, 2017; Koch & Ullman, 1987; Tang & Posner, 2009; Töllner, Zehetleitner, Gramann, & Müller, 2011). Passive attention is generally effortless, or involuntary; as it is characterised by the stimulus attracting attention, often because of intrinsic characteristics such as colour, shape or saliency (Bruya, 2010).

Functional neuroimaging has identified increased activation in ventral and dorsal areas that correlate strongly with identified attentional behaviours (Corbetta & Shulman, 2002). The ventral attention network (VAN) shows activity when it perceives salient stimuli, unexpected stimuli and abrupt changes in the environment (Downar, Crawley, Mikulis, & Davis, 2000; Dugué, Merriam, Heeger, & Carrasco, 2018; Fox, Corbetta, Snyder, Vincent, & Raichle, 2006). Though the ventral system consists of a wide arrange of attentional processes, the overarching theme of the system is to move attention to novel and salient stimuli (M. D. Fox et al., 2006). The dorsal attention network (DAN), sometimes referred to as the Task Positive Network, shows activation that is associated with task-focused attention (Fox et al., 2006, 2005), specifically with the selective orientation to task-relevant stimuli and the inhibition of task-irrelevant stimuli (Corbetta & Shulman, 2002). Initials research suggests that the DAN and a self-referential network called the default mode network (DMN) are flexibly co-ordinated by the frontoparietal control network (FPCN). The FPCN is believed to integrate the two networks and, within its functions, includes systems for exerting executive control over ongoing attentional processes (Fox et al., 2005; Gao & Lin, 2012; Vincent, Kahn, Snyder, Raichle, & Buckner, 2008).

The overarching networks observed in the functional literature coincide with networks of visual attention proposed in the behavioural literature (Posner & Petersen, 1990). Poser and Petersen (1990) hypothesised the three distinct networks of attention: Alerting, Orienting and Executive Networks. The Alerting Network governs the attraction of attention to a particular stimulus; it alerts the individual to changes in their environment. The Orienting Network controls the movement of attentional focus between stimuli, and the Executive Network is the network that allows the individual to deal with conflicting stimuli in the environment and to decide which stimuli are the most relevant (Petersen & Posner, 2012; Posner & Petersen, 1990). Over time, these have become broader categories for types of attention, with the original networks being hypothesised to include a range of differentiated neural processes (Petersen & Posner, 2012).

Links between these proposed networks and brain activation and physiology show a range of interactions that support the proposed separation of the broadly defined cognitive networks. Negative shifts in electroencephalogram (EEG) data during alerting tasks correlate with activation in the area surrounding the anterior cingulate (Nagai et al., 2004; Petersen & Posner, 2012). The Orienting Network has been linked to both the VAN and the DAN, though in different contexts (Corbetta & Shulman, 2002; Petersen & Posner, 2012); the DAN is thought to relate to conscious orienting to expected stimuli, i.e. a cued location; the VAN is thought to utilise bottom-up attentional processing to reorient attention to miss-cued stimuli (Petersen & Posner, 2012). The Executive Network has been studied extensively, and Petersen and Posner (2012) highlight evidence for the subdivision of executive attention into two control networks; the FPCN which directs moment-to-moment task regulation and the cingulo-opercular system which maintains overall goal-directed task selection (Dosenbach, Fair, Cohen, Schlaggar, & Petersen, 2008; Dosenbach et al., 2007, 2006). The evidence for the FPCN as a moment to moment regulator of attention has been further supported by evidence that it flexibly couples with both the DAN and the DMN in task efficient ways (Spreng, Sepulcre, Turner, Stevens, & Schacter, 2012; Vincent et al., 2008).

Attentional failure can occur with changing activation levels of any of these attentional systems, but those relating to the DMN, DAN and the FPCN have currently received the most attention (Brewer et al., 2011; Esterman, Noonan, Rosenberg, & DeGutis, 2013; Spreng et al., 2012). Strong activation in DMN, thought to indicate activity relating to the physical and mental self and self-related experience (Uddin, Clare Kelly, Biswal, Castellanos, & Milham, 2009), occurs directly before attention failures categorised as ‘mind wandering’ (Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012). Indeed, activation of the DMN is usually highest when participants are not engaged in externally-focused tasks (Berkovich-Ohana, Harel, Hahamy, Arieli, & Malach, 2016; Esterman et al., 2013). The FPCN, working between the DMN and the DAN, and has been strongly associated with abilities to deal with conflicting stimuli in the environment (Spreng et al., 2012) and failure in the FPCN is associated with failures in response inhibition and attentional shifting (Dodds, Morein-Zamir, & Robbins, 2011). Low activation of the DAN, thought to concern external goal-directed behaviour and attention maintenance, can lead to increased attention failures of mind wandering if the DMN is activated enough to subsume external-task attention-maintenance (Esterman et al., 2013). However, there is some evidence that high-levels of task-skill and task-absorption can lead to excellent levels of attention while both DAN and DMN activations are low (Esterman et al., 2013).

**Mindfulness Meditation as a Method for Attentional Change**

On the assumption that ASCs are a reflection of self-induced changes in neural and cognitive processes in the brain (Ben-Soussan et al., 2017; Davidson & Goleman, 1977; Pardo, Pardo, & Raichle, 1993), mindfulness meditation should be expected to induce a change in neural processes. Indeed, research has shown structural, functional and behavioural evidence of the effect of meditation and mindfulness on the brain, in both long and short-term interventions (for reviews see: Chiesa, Calati, & Serretti, 2011; Hölzel et al., 2011; Tang et al., 2015; Zenner, Herrnleben-Kurz, & Walach, 2014).

Although the explicit aims of mindfulness meditation do not cover improvements in cognitive processes of attention (Tang & Posner, 2009), the role of attention as a gateway to conscious perception and awareness makes it implicit in large-scale changes to states of consciousness (Hölzel et al., 2011). In order to train the more nuanced elements of mindfulness, the individual must be able to attend to them effectively. Hölzel and colleagues (2011) point out that many of the traditional Hindu and Buddhist meditative approaches have an early focus on training attention regulation with practices tending to be of the ‘focused attention’ (FA) style of meditation. Contrasted with ‘open monitoring’ (OM) meditation styles, which require more disparate maintenance of attention, FA meditations are tasks that require the practitioner to maintain focus on a single object or sensation for extended periods of time. One way in which it is hypothesised that meditational practices are producing ASC is by re-training attentional networks to operate in more efficient ways which allow for better use of attentional resources (Hölzel et al., 2011). By increasing attentional ability as soon as possible, mindfulness training regimes would increase the likelihood of effective long-term state change at later points of the process (Hölzel et al., 2011).

FA practices are assumed to encourage core aspects of mindfulness by promoting the importance of ‘awareness in the present moment’. In order to do this attention must be consciously processing current stimuli and orienting attention towards the present moment, actively regulating attentional conflict with intrusions from past and future (Berkovich-Ohana et al., 2016; Williams & Kabat-Zinn, 2011). The primary task of an FA meditation is to sustain attention to the set stimulus for a set amount of time; a process rarely achieved. However, the process of doing so has been linked to the DAN and attentional networks (see Figure 1). The FA object in meditation is often an internal or bodily-related sensation such as the sensation of the breath moving in and out. Such bodily-oriented focuses mean that FA meditations often contain both an internal focus and a motivated task. Theoretically, this would utilise both the DAN and the DMN in concert in order to maintain focus on the set task. Figure 1 illustrates the process of attention and mind wandering with is thought to be involved in a FA meditation, and its general relation to attentional networks and the DMN (Hasenkamp et al., 2012).

The first step in returning to the desired object of sustained attention is to become aware that that attention is no longer on the allocated focus point (i.e. breath) (Hasenkamp et al., 2012). Attention then needs to be shifted from the un-intentionally selected stimulus to the intentionally selected stimulus. Such shifting of attention takes two processes; the first is to disengage from the old stimuli and then engage or focus on the new stimuli and, in the behavioural literature, is generally referred to as ‘orienting’ (Hasenkamp et al., 2012; Petersen & Posner, 2012). Maintenance of this focus is then supported by vigilance, or alertness, for distracting stimuli that enter the internal or external environment. Once identified, exerting executive control over distractors eliminates attentional conflicts and sustains attentional focus on the target stimulus (Hasenkamp et al., 2012; Petersen & Posner, 2012; Sørensen et al., 2018).

One way in which meditation is hypothesised to increase attentional ability is by aligning attentional processes in such a way as to reduce cognitive load by improving efficiency in visual processing (MacLean et al., 2010). The diminished cognitive load should lead to a decline in the number of failures by the attention systems when perceptual-load is low, meaning fewer attention failures during times of concerted top-down control.

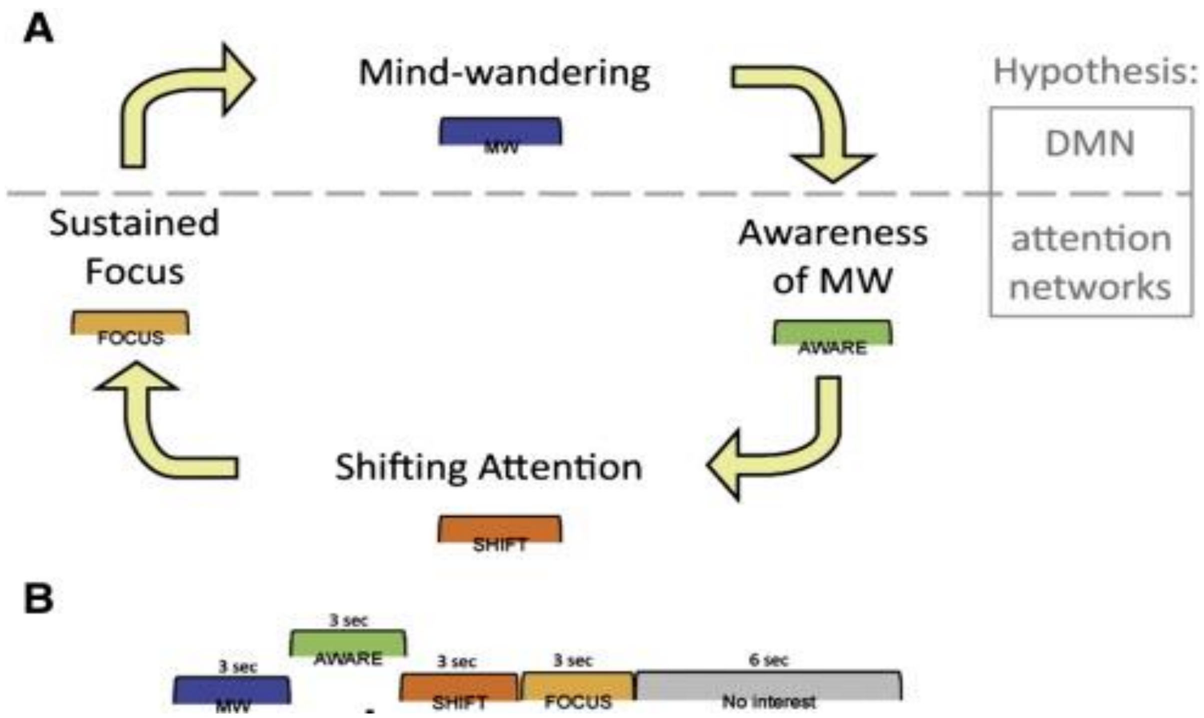


Figure 1. Hypothesis of relationship between task-positive attention networks and the Default Mode Network during FA meditation practices. This image is taken from Hasenkamp, W., Wilson-Mendenhall, C. D., Duncan, E., & Barsalou, L. W. (2012). Mind wandering and attention during focused meditation: a fine-grained temporal analysis of fluctuating cognitive states. *Neuroimage*, *59*(1), 750-760., pp. 751

**Evidence for Mindfulness Meditation as a Method for Attentional Change**

Neurologically, mindfulness and meditation practices are increasingly linked to changes in the DMN activation patterns, with activation during times with no external stimuli decreasing in meditators as opposed to non-meditators (Brewer et al., 2011). A link between the integrative networks of the DMN and DAN, the attention networks hypothesised by Peterson and Posner (2012) and FA meditation practices has been summarised by Hasenkamp and colleagues (2012), in which they illustrate the behavioural pattern of hypothesised attentional networks within the DAN and meditational practice. Comparison of high and low meditation experience participants showed connectivity within and between attention and medial frontal regions for high experience meditators (Hasenkamp & Barsalou, 2012). This increased connectivity was observed during non-meditative durations, suggesting that any benefits associated with increased connectivity were accessible to the participant outside of the meditational practice (Hasenkamp & Barsalou, 2012).

A recent study has also shown a reduction in variation of activation in the DMN for long-term meditators (Berkovich-Ohana et al., 2016); the standard pattern of peak DMN activity in non-task-oriented periods of time, and troughs of activity during external task engagement is replaced by a more consistent, intermediary, DMN activation. Such changes in a critical distractor of attention may put less pressure on effortful, top-down processes of attention. As the DMN has been linked to self-awareness, it is also possible that the increase in DMN during external-tasks is representative of increased self-awareness and regulation. Esterman and colleagues (2013) suggest that this could continue until a harmonious balance is struck between the DAN and the DMN.

Behaviourally, meditation and mindfulness techniques have been shown to improve all of Posner and Peterson's (1990) hypothesised networks (Ainsworth, Eddershaw, Meron, Baldwin, & Garner, 2013; Hurk, Giommi, Gielen, Speckens, & Barendregt, 2010; Jha, Krompinger, & Baime, 2007; Tang et al., 2007). Much of this support comes from behavioural studies using a moderated flanker task designed to look at the three attention networks, the Attention Network Test (ANT) (Fan, McCandliss, Sommer, Raz, & Posner, 2002). Evidence from the ANT is also supported by data from other attentional paradigms such as the Stroop (Basso, McHale, Ende, Oberlin, & Suzuki, 2019; Chan & Woollacott, 2007), attentional blink (Slagter et al., 2007; Slagter, Lutz, Greischar, Nieuwenhuis, & Davidson, 2009) and temporal bisection tasks (Droit-Volet, Fanget, & Dambrun, 2015; Droit-Volet & Heros, 2017; Kramer, Weger, & Sharma, 2013), among others.

Time bisection tasks, where individuals' are asked to judge whether a range of pre-determined stimuli were presented for 'long' or 'short' durations, are thought to give indications of attentional processing. This is because the longer a participants' attention is undistracted from the stimulus, the longer the stimulus seems to last (Kramer et al., 2013). Comparisons of the duration at which half of the participants' judgements are 'long' and half 'short' gives an indication of shifting patterns of focused attention. Studies using meditation-based interventions have found that it leads to increased overestimations of time, indicating an increase in focused attention post-meditation (Droit-Volet et al., 2015; Droit-Volet & Heros, 2017; Kramer et al., 2013). This overall increase in focused attention has been found in other attentional tasks, as have more specialised improvements.

A study by Jha and colleagues (Jha et al., 2007) showed improvements in all three networks in both MBSR trained and meditation-retreat experimental groups compared to a passive control group. In other research, alerting has been shown to maintain or improve, in comparison to worsening, over time using 'sustained attention' tasks that look at vigilance levels (MacLean et al., 2010). Alerting has also been correlated with specific neural activations observed by Brefczynski- Lewis and colleagues (2007). These activations increase from ‘novices’ (< 19,000h practice) to ‘experienced’ meditators (19,000h – 44,000h practice), and then decrease again for ‘expert’ meditators (>44,000h). This ‘U’ shaped function suggests that Alerting may not change in a purely linear fashion, possibly with the conscious change of Alerting and attentional practice comes higher cognitive effort. This effort may then reduce as eliciting the ASC becomes more automated.

Reduced Orienting scores on the ANT found by Hurk et al. (2010) indicate improvement in speed of shifting focus in experienced meditators compared to matched control participants. Hurk et al.’s findings further confirmed those shown in Jha and colleagues 2007 study. In further ANT research, improvements in the Executive Networks were reported after five 20-minute sessions of Integrated Mind-Body Training (IMBT) (Tang et al., 2007), a mindfulness-based intervention programme.

Improvements in the Executive Network scores were also reported after two different types of meditation intervention, but not the corresponding control group, by Ainsworth and colleagues (2013). Investigations using the Stroop task, a task that compares trials with cognitive interference to trials without cognitive interference (Stroop, 1935), correlate reducing interference in the Stroop task with the amount of meditation reported for long-term meditators (Chan & Woollacott, 2007). Other research using the Stroop task has shown improvements in novice meditator’s accuracy for congruent Stroop trials, though no corresponding improvement in incongruent trials, after eight weeks of 13 minutes meditation per day (Basso et al., 2019). This targeted improvement in accuracy suggests improved facilitation of attentional resources, suggesting possible improvement in areas of executive function.

Although there are a considerable number of behavioural and neuroscientific studies that provide evidence for cognitive changes associated with mindfulness meditation, there is also a wide variation in these findings. With the use of tasks such as the ANT and the Stroop task, there is little consistency in the results obtained. This must be in part due to the lack of rigour apparent in the literature (Lutz, Slagter, Dunne, & Davidson, 2008; Norris, Creem, Hendler, & Kober, 2018; Van Dam et al., 2018). Issues of definition, participant selection, and control design have all added noise to the literature and mean that our understanding of the cognitive implications of mindfulness meditation are still in their infancy. In order to understand whether mindfulness meditations facilitate attention modification, many of the methodological issues in the meditation literature must be addressed.

## 1.8 Summary

Mindfulness and meditation techniques, both separately and in combination, have been used to elicit cognitive change for thousands of years. In their move into Western culture they have been separated from many of the surrounding traditions and beliefs in which they were embedded. Although it is currently unknown to whether those traditions would make mindfulness and meditation interventions more effective, clinical research has clearly demonstrated some positive benefits from secularised, mindfulness-based interventions. However, the positive effects of mindfulness have been overstated in the media, with much of the hype being overstated in comparison to the academic evidence.

Research into the cognitive underpinnings for the clinical improvements has suggested that mindfulness and meditation practices may produce changes in attentional networks and attentional efficiency. However, the disparate nature of the research and a lack of rigour in the literature as a whole means that strong conclusions are difficult to make.

# CHAPTER 2: ISSUES IN COGNITIVE INVESTIGATIONS OF MINDFULNESS AND MEDITATION

## 2.1 Overview

This chapter will cover the issues of the varying definitions of mindfulness and meditation, variation in applications of meditation practice, type and style of intervention delivery, the lack of time-series investigations and objective measures of mindfulness, participant understandings of mindfulness and mediations and participant selection and dropout.

Though the growing literature suggests that mindfulness and meditation practices can and do have influence over cognition, the literature also suffers from a number of theoretical and methodological issues that reduce the reliability of these results. Criticisms of the mindfulness and meditative literature have been highlighted for years, but a recent review concluded that improvements in methods in the literature have been modest (Bishop, 2002; Goldberg et al., 2017). These issues vary in their implications depending on the researchers' aims and objectives; this chapter highlights those most applicable to cognitive understandings of mindfulness and meditation (for broader reviews see: Davidson & Kaszniak, 2015; Van Dam et al., 2018).

## 2.2 The Effects of Definition on Operationalisation and Interpretation

A central issue that arises across domains is the difficulty found in defining mindfulness; definitions affect empirical sides of the research by influencing choices of control conditions, selection of interventions and interpretation of results (Davidson & Kaszniak, 2015; Van Dam et al., 2018). They will also affect the theoretical background of the meditation literature; broadly, differing understandings of the concept of mindfulness has led to heterogeneous literature that makes cross-study comparisons difficult and misleading. However, even if a core definition of mindfulness is agreed, the variation of practices defined as ‘meditative’ leads to further variation in the literature.

As mindfulness and meditation practices have developed over centuries, a myriad of diverging methods and styles for approaching and encouraging mindfulness have appeared in both the Buddhist and Western literature. In general terms, mindfulness is described as ‘non-judgemental awareness of the present moment’, a definition supported by proponents such as Kabat-Zinn (Kabat-Zinn, 2009). This is supported by a consensus that mindfulness is a desired mental state that can be induced through practice. Whilst this definition is widely accepted, arguments on what this means in concrete terms and on how an individual goes about achieving such a state are diverse.

Two core threads to the discussion of definition have a significant impact on the style of delivery and research. The first thread is how to define mindfulness theoretically; to what extent should it be linked to Buddhist religious theory and other moral or spiritual practices, including ideas such as self-compassion, and how different spiritual approaches affect the understanding of the meaning of mindfulness (Lindahl, 2015; Miller, 2005; Monteiro, Musten, & Compson, 2015). The second thread is how it can go about encouraging the mental state of mindfulness in an individual, what practices and tasks are the most efficacious at inducing mindful states. These two threads lead to two core, and in some ways opposing, criticisms of the literature in relation to its definitions of mindfulness.

The broadest criticism of the definitions of mindfulness claim that the overuse of the term has limited the scope of scientific understanding and enquiry into the effects of the broader range of contemplative practices found around the world (Davidson & Dahl, 2018). The argument is that the literature should include a great range of ‘contemplative practices’ in its investigations, as ‘mindfulness’ is far from unique in its attempt to develop a practice for mental change. Relatedly, many practitioners have started to query the secularisation of mindfulness from its Eastern religious and moral accompaniments (for a summary see: Brown, 2016; Monteiro et al., 2015). This has sparked a discussion on the place of mindfulness in Western culture and how clinical and wellbeing interventions, religion and state legislation can or should interact (Baer, 2015; Fronsdal, 2002; Leary & Tate, 2007). In terms of research, such moral and ethical teachings may well provide a host of confounding or extraneous variables that affect the results without necessarily being recorded or included in the research and must, therefore, be controlled for and thoroughly investigated.

More specific criticisms of mindfulness literature take the opposite stance, citing that the term encompasses too wide a variety of understandings and applications to be helpful in producing replicable and rigorous streams of research (Green et al., 2019; Van Dam et al., 2018). ‘Mindfulness’ is applied to such a large range of disparate activities that comparison between interventions may well be inappropriate and possibly misleading. For example, the term meditation is often found in the literature, and some cases are used interchangeably with the term ‘mindfulness’; however, the two terms have clear distinctions. Meditation is a type of mental practice that often involves stillness of mind and body. Meditation is used cross-culturally in many religious and spiritual contexts, usually with the intent of deepening a mental state or understanding of the object meditated upon (Plante, 2010; Winkelman, 1986).

As such, ‘mindfulness meditation’ is the mental practice of encouraging and promoting the mindful state. However, even this understanding can be operationalised in a wide range of ways that may lead to very different types of cognitive engagement.

A raft of mindfulness-based interventions have been developed over the last decades. Two of the most prominent are the Mindfulness Based Stress Reduction (MBSR) (Miller et al., 1995) and Mindfulness Based Cognitive Therapy (MBCT) (Teasdale et al., 2000), but there are a range of other interventions and practices. Each intervention varies in length, intensity, content and purpose. These are used with a variety of populations, cultures and delivery systems. This variation means it can be difficult to define the success of ‘mindfulness’ as a whole; instead, conclusions should be drawn on the success of each intervention separately.

In terms of applying clinical findings to the development of hypotheses on the effect of mindfulness meditation practice on attentional ability, the heterogeneity in the literature means that little can be gleaned about the affective aspects of meditation practice. The literature has started to address the core issues leading to methodological variation and incomparability, but specific language to identify or separate out these different activities is only just beginning to emerge (Lutz et al., 2008; Van Dam et al., 2018). In order to make more headway in understanding the cognitive processes affected by such interventions, we need to move away from studying mindfulness as a whole. Streams of research need to focus on more particular ideas of mindfulness and meditation, whilst developing a more comprehensive language for discussing definitions and operationalisation of mindfulness and meditation.

## 2.3 Meditation Practice

There are many variants of meditation practice, and these may have different roles to play in modifying cognitive networks. Examples of these are; whether the focus of attention is located externally or internally, if awareness is focused or diffuse and whether there is a further emotional or moral aspect to the meditation instructions.

Cognitive and clinical literature has already identified two main categories of attentional style: focused and disparate, which are represented in meditation practices as FA and OM tasks (Ainsworth et al., 2013; Lutz et al., 2008; Travis & Shear, 2010). FA practices are characterised by paying attention to a single point or concept for prolonged periods of time, OM encourages an acknowledgement of all stimuli in the practitioners' environment (Lutz et al., 2008; Travis & Shear, 2010), though others have also been suggested and these attentional-focuses can still vary by internal or external focus and meditation intention. Many of the clinically used mindfulness-based interventions such as MBSR and MBCT, use a variety of practices that combine styles (Kabat-Zinn, 1990; Teasdale et al., 2000). The result of such combinations is that it is unclear whether different styles of mindfulness-based practices produce diverse effects on participants.

Lutz and colleagues argue that such practices should invoke different results (Lutz et al., 2008), and there is some research to support this view. A review of studies researching the effect of meditation or mindfulness on electroencephalographic (EEG) band activity observed that differential changes were seen if studies were split by their predominant intervention style: FA, OM or Automatic Self-Transcending (Travis & Shear, 2010). To avoid confusion, it is necessary to separate and test such styles separately, and to clearly state how they are approached in research and interventions so that studies can be accurately categorised (Van Dam et al., 2018).

## 2.4 Type of delivery

Further variation in the literature comes from delivery style. Key variables include numbers of participants in a session, delivery location, training or background of the person delivering the content, whether delivery is personalised or generic, and method of delivery (i.e. online or face-to-face). Many courses and experiments contain a wide combination of delivery styles within the intervention (for an example see: Jha et al., 2007). These elements have not been overly investigated, though there is some evidence that style of delivery does not have strong effects in other long term educational settings (Cavanaugh & Jacquemin, 2015; Larson & Sung, 2009; Summers, Waigandt, & Whittaker, 2005).

Examination of the literature shows that meditation and mindfulness practices are delivered to a range of audience groupings, from delivery to a single individual through to large groups. This may well relate to other aspects of population and delivery selection for each study but will bring in another layer of noise. There is evidence in other cognitive areas that third party observers effects test performance (Eastvold, Belanger, & Vanderploeg, 2012; Yantz & McCaffrey, 2007; Yantz & McCaffrey, 2005), and that learning of complex ideas and concepts is moderated by whether the learners approach the content as an individual or a group (Kirschner, Paas, & Kirschner, 2009). Similarly, whether the study is conducted in a classroom, laboratory, hospital, meditation space or an individual's home is likely to influence their engagement and results in a variety of ways that are untested in the mindfulness literature. Correspondingly, and especially if the training is personalised, the training and background of the person delivering the mindfulness practice will lead to variation. Mindfulness practitioners are not regulated or registered and do not have to undergo any particular training course to begin practice, though many choose to do so (Lustyk, Chawla, Nolan, & Marlatt, 2009). They may also come from different spiritual and religious backgrounds and therefore highlight different aspects in apparently similar practices.

Participant engagement may be further modified dependant on whether the practice used is personalised for them and involves some form of interaction and response or reading of non-verbal cues by the practitioner, or whether it is scripted and un-personalised. Presence and levels of personalisation may be moderated by other experimental choices. Whilst the idea of online presentations of both set (i.e. the meditations found on apps like headspace) and personalised (i.e. video conferencing with a practitioner) content appears to be increasing, there is no concept of how this may affect the outcomes of mindfulness meditation and cognitive change. Face-to-face or blended online learning may lead to a wide variety of personalised or depersonalised experiences.

All of these variants have implications for empirical testing of the underpinning cognitive mechanisms of cognitive change. For example it may be hypothesised that tailored delivery by an experienced practitioner should produce the strongest effects of mindfulness meditation in participants as they can ensure that content is delivered in a fashion appropriate to the individual. However, such delivery does raise issues about replicability, as the course would vary for each participant or group of participants. Conversely, pre-recorded learning and scripted delivery might improve replicability but impair the participants understanding of the complexities of mindfulness meditation.

## 2.5 Intervention Quantity and Length

Further issues arise when comparing studies that occur across different time scales. From short 5-minute interventions (Mahmood, Hopthrow, & Randsley de Moura, 2016) through to month-long intensive retreats (Jha et al., 2007), time scales for both practising and novice meditators varies widely within the research. This makes it very difficult to gauge the onset of effects and to understand where such different commitments to practice have an impact on the outcomes of individual studies.

Intervention length can vary in several ways. There is the length of each session (i.e. five minutes to five hours), frequency of repetition (i.e. twice a day or twice a week), and the overall length of experimental training (i.e. a day, a month or a year). These vary experimentally and are contextually effected. For example, the effects of one month of retreat could be expected to be greater than one month of practise at home, as on retreat, the focus is consistently on mindfulness practices. Overall practice, can also be affected by any extra-curricular practice carried out by the participants. If, for example, participants are on an eight-week mindfulness course and are asked to practice outside of the course as 'homework', it is likely that some participants will go above the suggested practice times and others will not meet the self-practice targets. It is also increasingly common that meditation and mindfulness related courses are available to participants in their general community. Yoga of different styles is available at gyms, and mindfulness and meditation sessions are found to help with stress in academic and work environments. A knock-on effect of the popularisation of mindfulness and meditation techniques is that an increasing amount of 'novice' participants, who are often university students, may well have previously taken part in other mindfulness and meditation research or programmes. However, despite this rise in popularly available mindfulness-based activities and the amount of self-practice reportedly required for many mindfulness-based interventions, there is insufficient evidence that researchers are considering levels of extra-experimental practice in their analyses (Huppert & Johnson, 2010).

## 2.6 Lack of Time-Series Research

The majority of published longitudinal work looks only at results pre- and post-interventions and not at change over time. In terms of investigating the active cognitive elements of mindfulness and meditation, the literature is beginning to see the emergence of time-series data in the meditation and mindfulness literature (Snippe, Bos, et al., 2015; Snippe, Nyklíček, Schroevers, & Bos, 2015). Time-course analysis can help to illuminate the most efficient dosages and highlight possible relationships between networks. For example, improvement in specific networks or functions may facilitate or relate to later changes in other networks or functions.

## 2.7 Mindfulness Measurement

Issues arise in the literature due to the lack of a clear definition of mindfulness; it is difficult to measure something for which there is not an agreed definition. However, to investigate what it is or how it works, there needs to be a form of measurement. This can lead to issues of circular thinking. In general, mindfulness is thought to occur in individuals in two key ways: dispositional mindfulness and state mindfulness (Sørensen et al., 2018; Tanay & Bernstein, 2013). Dispositional, or trait, mindfulness is the level at which the individuals' personality reflects mindful tendencies, and state mindfulness is how the individuals' current mental state reflects mindful tendencies. Self-report measures are used for both of these types of mindfulness; however, repeated use of self-report introduces issues such as demand characteristics.

Though there is evidence of self-report having reasonably reliable psychometric properties (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Baer et al., 2008), there is an over-reliance on self-report in the mindfulness literature (Van Dam et al., 2018). The self-report measures all aim to measure different aspects or facets of dispositional or state mindfulness. In the bracket of dispositional mindfulness measures there is the Five-Facet Mindfulness Questionnaire (FFMQ) (Baer et al., 2008), the Mindful Attention Awareness Scale - Trait (MAAS-T) (Brown & Ryan, 2003; Carlson & Brown, 2005), the Cognitive and Affective Mindfulness Scale (CAMS) and the revised CAMS questionnaire (CAMS-R) (Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007). There are less measures of self-report state mindfulness, which are limited to the Mindful Attention Awareness Scale - State (MAAS-S; Brown & Ryan, 2003), , the Toronto Mindfulness Scale (TMS), and the State Mindfulness Scale (SMS) (Lau et al., 2006; Tanay & Bernstein, 2013). Each of these self-report measures focuses on different traits or facets associated with mindfulness, which is agued to be a multifaceted and variable construct (Baer et al., 2006). One of the concerns to arise from this line of thought is the lack of evidence to suggest that practising mindfulness increases state mindfulness, indeed to date, there is only one published paper that supports the idea (Mahmood et al., 2016). This also means that there is currently no self-report or empirical task that can be used as a manipulation check.

There have been some attempts at finding more empirical methods for estimating mindfulness, of which the most prominent is breath counting (Wong, Massar, Chee, & Lim, 2018; Levinson, Stoll, Kindy, Merry, & Davidson, 2014). Initial investigation suggests that there is a relationship between breath counting accuracy and cognitive skills that are hypothesised to be related to mindfulness. However, the practice has only been related to dispositional or trait mindfulness, not state mindfulness (Wong et al., 2018; Levinson et al., 2014). In addition, the practice of breath counting bears a striking resemblance to many of the FA meditations that request a focus on the breath; this could have implications for the type of control tasks utilised to control for both the ‘meditative’ practices and the focus on the breath specifically. A further idea is examining ratios of participant counted versus experimenter recorded heartbeats (Otten et al., 2015), which may offer a task unrelated to the core meditation or mindfulness practice. However, there are issues of standardisation and bias associated with the most easily collected and monitored of heartrate detection tasks which means that this type of mindfulness measurement may be easiest to run in a laboratory setting (Brener & Ring, 2016). It therefore appears that self-report may still be the best option for measuring mindfulness in more ecologically valid settings, though these should receive further validation as manipulation checks for mindfulness practice (Mahmood et al., 2016).

## 2.8 Participant Selection and Dropout

There are several aspects of participant selection and matching that complicate comparisons between mindfulness and meditation studies, core among these are issues of participant self-selection and engagement. Due to the nature of research, it is often difficult to obtain information on why people drop out of longitudinal studies – though some early studies suggest personality differences between individuals who chose to start meditating and those who do not as well as discovering predictive characteristics for continued practice (Nystul & Garde, 1979; Rivers & Spanos, 1981). There are both ethical and practical issues in collecting such data, so it is currently unclear what proportion drop out of studies due to the interventions themselves, and what proportion drop out for other reasons.

Self-selection effects many participant pools in mindfulness meditation research. In novices, especially clinical populations, those who do not think that meditation could or should be effective are probably less likely to engage with interventions and research. When looking at experienced and long-term meditators, those who believe that mindfulness and meditation have not provided positive emotional or health benefits will probably not maintain practice and will therefore not be included in the analysis of the positive benefits of long-term meditation. In non-clinical longitudinal studies, it may be that emotional investment in mindfulness may affect dropout rates.

Research looking at long-term improvements in meditation faces many obstacles. The first is incomparability between long-term meditators; different individuals will have probably been trained in different methods and practices. This is because many practitioners will have used a variety of practices over time, experimenting with their own practice to find what works best for them. Individuals may also use more than one type of practice on a regular basis. Many traditions also change their approaches over time, suggesting different activities and styles as you become more at ease with the last (Hölzel et al., 2011). The second issue arises in finding an appropriate control group. An issue that arises in matching control participants is that there is not enough research, currently, to match people based on the personality characteristics that may have lead individuals to meditation (Bishop, 2002; Nystul & Garde, 1979) and no clear picture of whether such personality differences are mediated by cultural practices and norms.

Research on why some people engage or disengage with mindfulness has started to look at the elements such as the effect of self-compassion on how individuals relate to and engage with mindfulness. Recent research also studied the effect of self-compassion on mindfulness and willingness to engage further with mindfulness practices (Rowe, Shepstone, Carnelley, Cavanagh, & Millings, 2016). However, it appears that the issues surrounding mindfulness are not just related to getting people to engage with the practice. Although Western popular culture and medicine have embraced mindfulness as a strong therapeutic tool there is anecdotal and a small amount of evidence that suggests that in some individuals mindfulness and/or meditation practices can lead to significant negative effects (Farias & Wikholm, 2015; Shapiro, 1992; Yorston, 2001). There are reports of some individuals finding mindfulness not as effective as others (Farias & Wikholm, 2015), and one study found that 55% of long term meditators reported having had negative experiences whilst meditating (Shapiro, 1992). There have also been incidents where even those who have been meditating for many years suffer serious psychological consequences from mindfulness or meditation practice (Yorston, 2001).

## 2.9 Summary

The reliance of the clinical literature on courses such as the MBSR and MBCT illuminates little about the underlying cognitive changes due to the variety of practices and the lack of rigorous control conditions. In studies that look at more restricted practices and timelines, there needs to be an increased focus on using targeted control conditions and greater reporting of engagement and self-practice from the participants. For further comparability, it would be ideal to find consistent measures of manipulation success, even if these start as self-report measures. This will make it easier to see if interventions are encouraging the same types of self-perceived change in individuals.

There also needs to be a greater focus on producing incremental, multi-study research that can show replications of findings whilst using comparable or identical interventions, participant groups and control tasks. This would allow stronger results to build up around certain practices and cognitive structures that would lead to more nuanced and reliable understandings of both practice and cognitive change. Working with novices and slowly expanding the period of research may be one way of addressing these issues. In terms of the attentional research, it might be ideal to start by using short interventions with novices where changes in attention or attention-related tasks have already been found.

# CHAPTER 3: TIME PERCEPTION, ATTENTION AND MEDITATION

## 3.1 Overview

Chapter 3 is the first of two empirical chapters; it focuses on the effects of brief FA meditative tasks on judgement of short time durations. It builds on previous research by Kramer, Weger and Sharma (2013), who found that a brief, 8-minute FA meditation task from the book '*Mindfulness: A Practical Guide to Finding Peace in a Frantic World*' (Williams & Penman, 2011) led to participants overestimating the passing of time. They linked the changes in time-duration judgement to increases in attention and reductions in arousal.

Following these findings, Study 1 aimed to replicate this increase in attention and to explore whether these changes were induced by the construal of attention to either more concrete objects or more abstracted objects, as suggested by previous research on time perception (Hansen & Trope, 2013). Study 2 looked at the effect of increasing and decreasing the amount of self-practice contained in the original FA meditation. Studies 3a and 3b replicated the method of Study 2, but with an externally focused variant of the FA meditation task.

The internally focused FA meditation task showed the expected changes in both attention and arousal related scores, the externally focused task showed changes in attention-related scores, but not arousal related scores. The results suggested that there was no effect of priming construal, that changing dosage in quantities used in Studies 2, 3a, and 3b does not lead to differing or increasing effects on attention as measured by time perception.

## 3.2 Time Perception, as a Measure for Attention, and Meditation

Previous research using brief meditations has found significant changes in duration judgements over short time-spans (Droit-Volet et al., 2015; Kramer et al., 2013). These findings are used as a starting point for two reasons; theoretically, perception of time passing is linked to attentional processes also highlighted in the mindfulness and meditation literature (Burle & Casini, 2001; Droit-Volet et al., 2015; Glicksohn, 2001; Matthews & Meck, 2016). Methodologically, the effective use of brief meditations on novice practitioners provided a clear springboard for research into the effects of FA meditations on attentional processes (Kramer et al., 2013).

Prominent models of time perception, such as Scalar Expectancy Theory (SET), posit that attention has a key role to play in our perception of the passing of time (Gibbon, 1977; Glicksohn, 2001; Matthews & Meck, 2016). According to SET, judgements on the duration of passing time are made possible through the simultaneous functioning of several internal elements. Firstly, an internal pacemaker releases ‘pulses’ at consistent time intervals. When attention is paid to the pacemaker, these pulses are collected by a memory store referred to as the ‘accumulator’. Once the time to be judged is over, the number of pulses in the accumulator is compared to other previous durations and a judgement on the time passed can be made (Gibbon, 1977; Glicksohn, 2001).

The judgement of time durations is affected by changes in both attention and arousal (Burle & Casini, 2001; Gil & Droit-Volet, 2012). Increases in arousal are thought to increase the number of pulses produced by the pacemaker, which results in more pulses entering the accumulator in the same amount of time, which results in longer temporal judgements (Burle & Casini, 2001; Glicksohn, 2001). Attention is thought to act like a ‘gate’ to the accumulator (Zakay & Block, 1995). When attention is being paid to the temporal presentation of the stimulus, the pulses move into the accumulator; however, if attention is not paid to the temporal nature of the stimulus, then pulses are lost or prevented from entering the accumulator. Therefore, the less attention paid to the stimulus, the shorter the judgement of the stimulus duration (Zakay & Block, 1995). Key to this theory of a 'gate' is that this allows the effects of arousal and attention to occur simultaneously but separately (Burle & Casini, 2001). For example, high arousal may increase the number of pulses emitted by the pacemaker but does not guarantee that the individual is paying attention to temporal processing.

Fortin, Rousseau, Bourque, & Kirouac (1993) hypothesise that this could mean that if the individual is engaged in sufficient non-temporal processing that there is not enough mental space to continue attending to temporal processing. The gate will be automatically closed and prevent the continued accumulation of pulses by the accumulator whilst attention is directed to non-temporal stimuli. This idea feeds into a key theory in the attentional literature that attention is a limited resource that needs to be allocated selectively for maximised function (Norman & Bobrow, 1975). This theory has evidence from outside (Posner, Snyder, & Davidson, 1980) and within the temporal processing literature. Within the temporal literature, studies have shown that an increase in the cognitive load of non-temporal tasks results in biased estimations of time in dual-task conditions (Brown, 1997; Fortin et al., 1993; Gautier & Droit-Volet, 2002; Macar, Grondin, & Casini, 1994; Matthews & Meck, 2016).

The judgment of duration in the time perception literature can be measured using temporal bisection tasks. These tasks present participants with stimuli that appear for a range of durations (i.e. 400ms, 600ms, 800ms), participants are asked to judge whether each stimulus was presented for a 'long' duration or a 'short' duration (Kramer et al., 2013; Wearden, 1991). The idea of long and short duration is calibrated through training on the shortest and longest duration before the test trials. The results can then be used to calculate the stimulus duration at which each participant is equally likely to judge the duration as long or short; this is known as the Bisection Point (BP). The change in the proportion of ‘long’ judgements over the progressively longer stimuli durations can also be informative as changes in slope steepness, also known as Weber’s Ratio (WR), indicate consistency of judgement across time durations (Gibbon, 1977; Gil & Droit-Volet, 2012; Kramer et al., 2013). Theoretically, shifts in BP are linked to changes in attention with greater attention leading to all durations seeming longer. Increased attention should be associated with the BP shifting towards longer stimuli durations, but no change in WR (Kramer et al., 2013). Changes in WR are linked to arousal; increased arousal would lead to increased pulse emissions from the pacemaker, which would display itself as longer judgements of time at longer durations and minimal effect on the shortest durations (Gil & Droit-Volet, 2012).

According to SET, FA meditation should affect time perception on both arousal and attentional axes separately (Burle & Casini, 2001; Gibbon, 1977). Meditation has been shown to reduce arousal (Fennell, Benau, & Atchley, 2016; Hafenbrack & Vohs, 2018), which should lead to subsequent underestimations of time as the pacemaker slows the production of pulses. In contrast, FA meditations are hypothesised to have dual effects on the attentional process, both of which would lead to overestimations of time. FA meditations are thought to train the ability to disengage from distracting stimuli, therefore increasing the amount of attention paid to the set task (MacLean et al., 2010; van Leeuwen, Singer, & Melloni, 2012). They are also thought to increase the level of attentional processing space that is available for use by increasing attentional efficiency, further increasing the level of attention that a practitioner should be able to pay to a set task (Jha et al., 2007; MacLean et al., 2010; Warm et al., 2008). Both of these changes should increase the number of pulses that are collected in the accumulator and therefore be associated with greater overestimations of stimuli duration.

Any increase in the reported judgement of time should demonstrate increased attention to the passing of time (Kramer et al., 2013). To date, published reports using short-duration time-bisection tasks agree that modification of attentional processes are key to producing the shift in duration judgement but have not attempted to investigate the exact nature of that attentional change (Droit-Volet et al., 2015; Gil & Droit-Volet, 2012; Kramer et al., 2013).

### 3.3 Study 1: Time Perception and Abstract and Concrete Construal

In FA meditations, the processes of dissociation of attention from a distractor and returning of attention to the set task are thought to be from a general focus to a specific focus (van Leeuwen et al., 2012), with OM meditations encouraging a more global perspective. The encouragement of a particular thinking and processing style could affect the way that attention is paid to the small-scale passing of temporal stimuli such as those presented in time bisection tasks. If the moving from a general to more specific focus in FA meditations leads to the changes seen in previous research, then further priming of this skill should lead to further or maintained overestimations of stimuli duration. Priming a more general or abstracted thinking style would then lead to a reversal of the effects of meditation.

In keeping with the idea that a detail-oriented thinking style is facilitating the change seen after FA mindfulness interventions, a focus on concrete concepts and small-scale changes in the environment has previously been associated with an increased feeling of time passing more quickly. High-level or abstracted processing has been conversely associated with the feeling of time passing more slowly (Hansen & Trope, 2013). Processing levels (high or low) can be primed using construal tasks that encourage the participant to focus on specific or general extensions of an observed stimulus. For example, presented with the word ‘plant’ low-level processing may suggest the more specific extension of ‘parsley’ and high-level processing the more general extension of ‘garden’ (Fujita, Trope, Liberman, & Levin-Sagi, 2006; Hansen & Trope, 2013). It is possible that the changes seen in these construal priming conditions and the changes seen after FA meditations are both caused by the same, or similar, cognitive shifts.

In order to examine whether these processes work in a synonymous fashion, the first step would be to confirm the presence of an increased time estimation after completion of the meditation intervention used by Kramer and colleagues (2013). Following the meditation, a construal intervention could prime construal patterns in different experimental conditions. If the construal approach is a driving factor in the attentional change, there should be maintenance or an increase in time estimation in a concrete construal condition and a reversal of the effects of mindfulness in an abstract condition.

Investigation of the change in time duration estimations before and after an FA meditation can be assessed with a repeated temporal bisection task, and a further investigation of changes from post-FA meditation to post-construal-priming conditions could be assessed by a further repetition of the temporal bisection task following the construal intervention.

## Method

**Participants.** Participants were psychology students at the University of Kent and were reimbursed with course credit. 92 participants took part in the experiment of whom 65 were female. The average age was 20.83 years (Range: 18-37, SD=3.73). Of the 92, 70 participants had no previous meditation experience, 14 had used it in previous experiments, and 8 had experiences using mindfulness or meditation outside of university.

**Measures.** ***Temporal Bisection Task.*** The same task as used in Kramer, Weger and Sharma (2013), this task is comprised of two sections. Presented via MATLAB software, the first is a training session and the second is a testing session. In the training session, the participants were presented with a series of grey ovals for either 1600ms or 400ms. They were then asked whether it had been presented for a short or long duration and were given feedback on whether they were correct or incorrect on their judgement. The training session continued until the participant had completed eight consecutive trials accurately. After the training session, participants moved on to the testing phase. The testing phase stimuli consist of squares and circles in red, blue or green. Each of these combinations was presented in each of the seven time durations (400ms, 600ms, 800ms, 1000ms, 1200ms, 1400ms and 1600ms). On each trial, participants were once again asked to make a judgement on whether the time was ‘long’ or ‘short’, though in this section there was no feedback on their responses.

Judgements that the time was ‘short’ are coded as ‘0’ and judgements of ‘long’ duration are coded as ‘1’. The coding system allows for proportions of long judgements to be calculated for each of the time durations; probit analysis was then used to calculate the duration at which every individuals’ records 0.25, 0.50 and 0.75 of durations as ‘long’. The point at which the ‘long’ judgement is made 0.5 of the time is known as the Bisection Point (BP) and can be used to identify overall shifts in time perception, with smaller values representing ‘long’ judgements being made at shorter durations. Further to this, the participants' ability to discriminate between periods was investigated using Weber’s Ratio (WR). WR judges the steepness of increase in ‘long’ judgement as the time durations lengthen using the values from the probit analysis

$$WR = \frac{0.75(long)\ \text{x}\ 0.25(long)}{2\ x\ 0.5(long)}.$$

***Five Factor Mindfulness Questionnaire (FFMQ).*** The FFMQ is a 39-item, 5-factor questionnaire that measures aspects of dispositional mindfulness (Baer et al., 2008). Each item is rated on a 5-point Likert scale from 1 (never or very rarely true) to 5 (very often or always true), some items then require reverse coding. Once recoded, items were averaged into five facets of mindfulness identified by the FFMQ: *observing*, *describing*, *acting with awareness*, *non-judging of inner experience* and *non-reactivity to inner experience(see Appendix A for all items)*. Higher averages are representative of higher levels of mindfulness.

***Meditation and Mindfulness questions.*** One question was asked to check previous meditation experience: ‘*Do you have any previous experience with mindfulness and/or meditation? YES/NO*’. If the participant answered ‘yes’ they were asked to describe their experience. Answers to the open-ended question were coded into either '*Previous experimental experience'* or '*Experience outside of university'.*

***Meditation.*** The 'Mindfulness of the Body and Breath' meditation is Track One from the meditations by Williams and Penman (2011). It is an 8 minute 5 second meditation that includes a body scan and breathing exercise with periods of silence to practice the instructions, a transcript of the meditation is presented in Appendix B. All participants took part in the meditation before completing the interventions. The meditation was selected as it has previously been shown to produce significant shifts in the bisection points of the Temporal Bisection Task (Kramer et al., 2013).

**Interventions.** ***Control conditions.*** The control groups listened to clips from the audiobook of 'The Hobbit' (Shaw, 2005). This is the same clip that was used in Kramer, Weger & Sharma (2013). There were two audio clip conditions, in condition 'Hobbit 1' participants were asked to pay attention to the audio clip and told that they would be tested on the content. No test was included in the experiment, but the idea was to make the participants engage more actively with the audio content as they would in the experimental conditions. The 'Hobbit 2' condition only asked the participants to follow along with the audio clip as well as they could; this was the same instruction used by Kramer et al. (2013) in their control condition.

***Abstract or Concrete construal tasks*****.** The construal tasks, presented in Appendix C, are word generation tasks that are designed to encourage the participant to think in either a more concrete or more abstract fashion. Each task is made up of 39 items, and each item had a base word from which the participant is asked to generate a new word (Fujita et al., 2006; Hansen, Kutzner, & Wänke, 2013). In the abstract condition, the participant is asked to think globally about the base word, the example of the base word '*car*' can be abstracted to ‘*transportation*’. In the concrete condition, participants are asked to generate more specific examples of the base word, an example of a more concrete concept than ‘*car*’ would be ‘*chevy*’.

**Procedure.** On arrival, all participants were led to an individual laboratory room. After giving informed consent, participants completed demographic information, the FFMQ and questions on their previous meditation/ mindfulness experience. Participants then completed an initial time bisection task (Time 1), the meditation and a second-time bisection task (Time 2). Following this, they either completed the abstract construal task, the concrete construal task or listened to one of the two Hobbit clips (Hobbit 1 /Hobbit 2). Participants were randomly assigned to a condition on their arrival for testing. They then completed a final time bisection task (Time 3).

**Results**

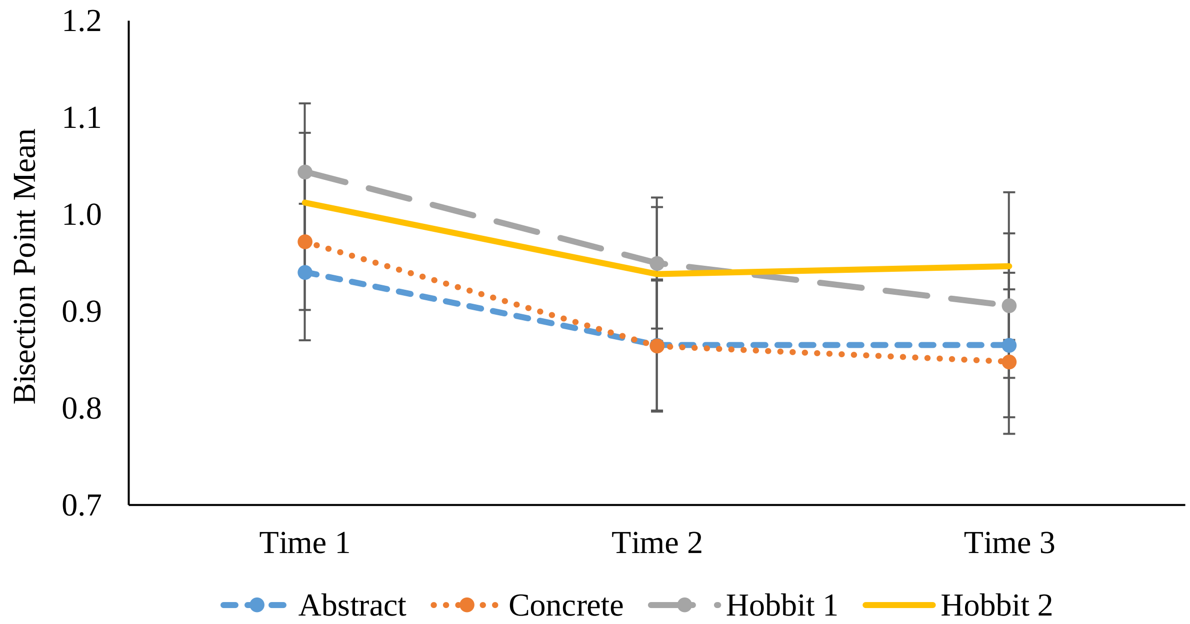


Figure 2. Study 1: Bisection Point means for each intervention group (Abstract Construal, Concrete Construal, Hobbit 1 and Hobbit 1) for each time point. Error bars represent 95% Confidence Intervals.

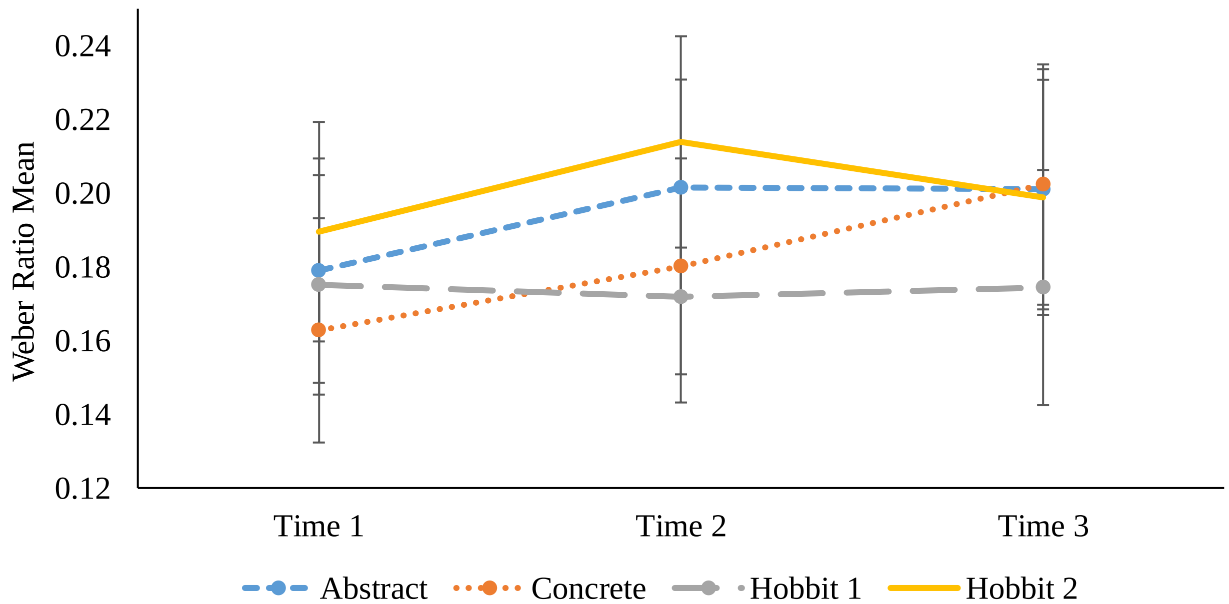


Figure 3. Study 1: Weber's Ratio means for each intervention group (Abstract Construal, Concrete Construal, Hobbit 1 and Hobbit 1) for each time point. Error bars represent 95% Confidence Intervals.

**Time Perception Change after Meditation.** The procedure is premised on the idea that an initial meditation will lead to change in the participants time perception congruent with that found in the study by Kramer and colleagues (2013). All groups complete the meditation before the experimental intervention and, therefore, should not show differences in time perception from Time 1 to Time 2. As expected, a two-way ANOVA of Time (Time 1, Time 2) and Intervention Group (Abstract, Concrete, Hobbit 1, Hobbit 2) on the BP showed no main effect of Intervention Group [$F$ (3, 88) = 1.98, $p$ = .122, $\eta p^2$ = .06] and no interaction [$F$ (3, 88) = 0.38, $p$ = .770, $\eta p^2$ = .01]. As in the Meditation Group reported by Kramer and colleagues (2013), BP reduced after meditation indicating that participants perception of time has lengthened [see Figure 1; $F$ (1, 88) = 44.25, $p$ < .001, $\eta p^2$ = .34].

The same ANOVA run on WR showed no main effect of Intervention Group and no interaction between Time and Intervention Group [$F$ (3, 88) = 1.19, $p$ = .317, $\eta p^2$ = .04 and $F$ (3, 88) = 0.75, $p$ = .524, $\eta p^2$ = .03 respectively]. However, there was a main effect of Time [$F$ (1, 88) = 4.25, $p$ = .042, $\eta p^2$ = .05; see Figure 2], with WR increasing from Time 1 [$M$ = 0.18] to Time 2 [$M$ = 0.19] suggesting a clearer delineation between 'short' and 'long' durations for the participants. The increase in WR indicates participants a reduction in levels of arousal across participants. Overall, these results show that FA meditation has produced the anticipated effect.

**Time perception Change after Interventions.** A mixed-design ANOVA of Time (Time 2, Time 3) and Intervention Group (Abstract, Concrete, Hobbit 1, Hobbit 2) shows no main effects of Time or Intervention Group and no interactions for either the BP or WR scores [$M_{BP}$ = 0.90, $M_{WR}$ = .19 ; $p$-values > .306]. These results show that there is no change in time perception post-intervention, regardless of intervention task. Overall, this indicates that there are no extending or negating effects of construal priming on this time perception task (see Figures 1 and 2).

**FFMQ**

One-way ANOVAs of the FFMQ facets show no evidence of pre-existing differences between Intervention Groups [*p*-values > .086, see Table 1]. Correlations run between FFMQ scores and the change in BP and WR scores from Time 1 to Time 2 (see Table 2) and from Time 2 to Time 3 (see Table 3) explored the idea that dispositional mindfulness may affect the way that participants interact with the interventions. The correlations showed no relationships between BP change and FFMQ scores. However, higher increases in WR from Time 1 to Time 2 were associated with higher reported overall FFMQ scores, suggesting a relationship between dispositional mindfulness and arousal.

For correlations from Time 2 to Time 3 participants were split by Intervention Group. Neither of the groups who completed the construal tasks showed changes on the bisection task that correlated with FFMQ scores. The group who completed the Hobbit 1 intervention showed a correlation between change in BP and reported Non-Reactivity scores, with higher Non-Reactivity associated with larger increases in BP scores. Conversely, the same group showed a negative relationship between change in BP and Acting with Awareness scores, with greater change in BP being related to lower reports of Acting with Awareness. The WR from the Hobbit 1 group showed no correlations, and the Hobbit 2 group showed a significant negative correlation between changes in WR and both Non-judging and overall FFMQ scores (see Table 3).

Table 1

*Mean and standard error scores for the Five Facet Mindfulness Questionnaire.*

| FFMQ Facet | Construal Condition Mean (SE) | | Control Condition Mean (SE) | | Overall Average Mean (SE) |
|---|---|---|---|---|---|
| | Abstract | Concrete | Hobbit 1 | Hobbit 2 | |
| Observing | 2.83 (0.65) | 3.33 (0.66) | 3.23 (0.84) | 3.16 (0.55) | 3.14 (0.70) |
| Describing | 3.11 (0.28) | 3.14 (0.51) | 3.20 (0.37) | 3.08 (0.58) | 3.13 (0.44) |
| Nonreactivity | 2.83 (0.62) | 3.04 (0.63) | 2.83 (0.45) | 2.94 (0.56) | 2.91 (0.57) |
| Nonjudging | 2.71 (0.67) | 2.92 (0.61) | 2.89 (0.60) | 2.91 (0.68) | 2.86 (0.63) |
| Acting with awareness | 2.83 (0.55) | 2.79 (0.74) | 2.79 (0.78) | 3.03 (0.55) | 2.86 (0.66) |
| FFMQ Average | 2.86 (0.32) | 3.04 (0.33) | 2.99 (0.31) | 3.03 (0.30) | 2.98 (0.32) |

Table 2

*Correlations between Five Facet Mindfulness Questionnaire scores the change in Bisection Point and Weber's Ratio scores from Time 1 – Time 2, N=92.*

| FFMQ Facet | BP | WR |
|---|---|---|
| Observing | -0.11 | 0.16 |
| Describing | -0.01 | 0.15 |
| Non-reactivity | 0.14 | 0.04 |
| Non-judging | -0.09 | 0.20 |
| Acting with awareness | 0.04 | 0.16 |
| **FFMQ Average** | **-0.03** | **.28**** |

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Table 3

*Correlations between Five Facet Mindfulness Questionnaire scores and the change in Bisection Point or Weber's Ratio scores from Time 2 – Time 3.*

| | Construal Condition | | Control Condition | |
|---|---|---|---|---|
| FFMQ Facet | Abstract (*N = 23)* | Concrete (*N = 23)* | Hobbit 1 *(N = 24)* | Hobbit 2 *(N = 22)* |
| *BP* | | | | |
| Observing | 0.18 | 0.09 | 0.26 | 0.02 |
| Describing | 0.14 | 0.15 | 0.07 | -0.06 |
| Non-reactivity | 0.26 | 0.18 | .46* | -0.02 |
| Non-judging | 0.12 | 0.08 | -0.08 | 0.03 |
| Acting with awareness | -0.24 | 0.22 | -.55** | 0.20 |
| **FFMQ Average** | **0.16** | **0.28** | **-0.03** | **0.07** |
| *WR* | | | | |
| Observing | -0.13 | 0.20 | -0.10 | 0.06 |
| Describing | 0.08 | 0.10 | 0.26 | -0.37 |
| Non-reactivity | 0.15 | 0.04 | -0.05 | -0.24 |
| Non-judging | -0.23 | -0.07 | -0.12 | -.42* |
| Acting with awareness | -0.04 | -0.07 | 0.19 | -0.10 |
| **FFMQ Average** | **0.11** | **0.07** | **0.04** | **-.44*** |

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

**Discussion**

The effect of meditation seen in previous studies was replicated, with participants showing the reduction in BP and increase in WR associated with increased attention to time and decreased physiological arousal respectively (Droit-Volet et al., 2015; Kramer et al., 2013). However, no further effects were observed in the construal or control conditions.

The FFMQ correlations with changes in WR and BP seem to indicate a complex relationship between dispositional mindfulness and time perception. Although there is an explicit self-report facet for Acting with Awareness that relates theoretically to attentional awareness and qualities of attention, there is no evidenced relationship between this facet and the observed changes in cognitive attention. This could mean either that the self-report measure is not a valid measure of attentional awareness or that the conscious experience of attentional processing is a related but distinct concept to the cognitive process of attention. Alternatively, responses to the FFMQ do not relate to the fine-grained changes in cognition elicited by brief meditations. Further research should include measures of state mindfulness, as there may still be a relationship between state-mindfulness and cognitive processes. Conversely, there does appear to be a relationship between self-reported dispositional mindfulness and changes in arousal, with those who reported the highest dispositional mindfulness showing the greatest reduction in arousal after FA meditation. This corresponds with the theory that emotion regulation is an important aspect of the cognitive underpinnings of state mindfulness (Hölzel et al., 2011).

The dual nature of the construal interventions shows that construal neither enhanced or mitigated the effects of the meditation, suggesting that abstract versus concrete construal priming does not interact with the effects of mindfulness on the time bisection task. This lack of interaction may be due to several explanations; the first is that construal manipulations were not effective though this particular task has been successfully used in previous studies including those looking at time perception (Fujita et al., 2006; Hansen & Trope, 2013). The second is that FA meditation does manipulate construal, but that manipulating effect of the FA meditation is stronger than the construal-priming task, meaning that the priming task is ineffective in reversing the construal effects. The third possibility is that the change of attention seen in this study is not related to the participants' construal levels.

**Implications.** The lack of change between Time 2 and Time 3 for all tasks does suggest that the effects of meditation on time perception are not mitigated by engaging in other tasks, which could have implications for the application of brief FA meditations. If the effects can last over successive tasks, then it increases the chances that brief, one-off, FA meditations can have real impact on individuals in the short term.

**Conclusion.** If the assumption is made that construal is not the driving force behind the observed attentional changes, then it may be that focussing on the active elements of FA meditative practices that have been shown to induce attentional change will present a clearer hypothesis of the underlying mechanisms of change.

## 3.4 Study 2: Time Perception and Focused Attention Meditation Dosage

Guided meditations are made up of two distinct portions of activity: periods that are being narrated and guided by an orator or session leader, and periods in which the participant is instructed to practice the tasks on their own. This time of ‘self-practice’ is usually a time of silence in the meditation. As one element is usually explaining the task and the other element is asking the participant to practice the skill, if it is the practising of meditation tasks that is inducing the temporal bisection changes then increasing the self-practice element of the meditation would lead to greater cognitive effects. Duration interventions has previously been shown to change the effect of meditation on time perception, though with different durations to the brief FA meditations used in Study 1 (Droit-Volet et al., 2015). If longer durations of meditation have increasing impacts on underlying cognitive processes even in brief durations, it can be assumed that increased self-practice would lead to a greater increase in the overestimation of time for longer practice durations. If, however, duration does not have an effect then overestimation should remain stable across a range of self-practice durations.

One of the issues with changing dosage is that it can introduce more elements into the meditation. Usually, a longer meditation also means different exercises or amounts of instruction. However, if only the self-practice element is altered, then issues of confounding results due to changing tasks are avoided. For this reason, it was decided to use the same meditation as used in the previous experiment but to only change the amount of self-practice given to the participants, contracting or lengthening the pauses already included in the meditation. In anticipation of creating further variations in intervention, the meditation was re-recorded by the experimenter (ZC) so that there would be parity in gender and pitch for all narrated interventions.

**Method**

**Participants.** This study used 77 participants (55 females), all of whom were students at the University of Kent. Some were rewarded for participation in course credit, and others were paid. Those who received course credit were recruited using the School of Psychology research participant system and the rest were recruited using advertisements placed on the University of Kent Jobshop page. Participants had a mean age of 19.44 years (Range: 18-29, SD = 1.55). 2 participants were excluded from analysis as they reported not engaging with the task at all, and a further 3 were excluded in line with previous research (Gonidis & Sharma, 2017), as their bisections points for the Time Bisection Task were below 400ms or above 1600ms, leaving 72 participants (51 females), with a mean age of 19.42 (Range: 18-29, SD = 1.60).

**Design.** This study looked at the difference between pre- and post-intervention temporal-bisection task scores (BP, WR) for three durations of self-practice (Short, Medium and Long).

**Measures.** All tasks and questionnaires apart from the demographic and mindfulness questionnaires were presented using the software package PsychoPy v1.84.2 on 19-inch monitors (1,024 x 768, 60Hz). Demographic and mindfulness questions were completed online using Qualtrics. Participants completed the study in individual laboratories.

***Temporal Bisection Task.*** Based on the original task by Kramer, Weger and Sharma (2013), this was an updated version of the Time Bisection Task found in Study 1. It has previously been used in a modified version by Gonidis and Sharma (2017). This task is comprised of two sections; the first is a training session, and the second testing session presented on PsychoPy. In the training session participants were presented with the picture of a hat on a grey background, for either 1600ms or 400ms. They were then asked whether it had been presented for a short or long duration. Participants were given feedback on whether they were correct or incorrect on their judgement, and the training session continued until the participant had completed eight consecutive trails accurately. After the training session, participants moved on to the testing phase. The testing phase consists of two shapes (square, circle) in red, blue or green. Each of these combinations was presented in each of the time durations (400ms, 600ms, 800ms, 1000ms, 1200ms, 1400ms and 1600ms) on a grey background. Participants were once again asked to make a judgement on whether the time was ‘long’ or ‘short’, though in this section there was no feedback on their responses.

***Mindful Attention Awareness Scale, State (MAAS-S).*** A 5-item measure of quality attentional awareness, the MAAS-S is thought to indicate levels of state-mindfulness relating specifically to attention (Brown & Ryan, 2003). This measure was included to explore the relationship between reported attentional state mindfulness and changes in time perception. Each item is ranked from 0-6, with 6 being the least mindful (see Appendix D for all items). Results were reverse coded so that high scores equal high state mindfulness.

***International Positive and Negative Affect Schedule, Short Form (I-PANAS-SF).*** An internationally validated short-form of the Positive and Negative Affect Schedule, the I-PANAS-SF is a ten-item, two-factor measure of participant effect (Thompson, 2007). The two factors are Positive and Negative Affect, and they are each calculated from the mean score of five items. The I-PANAS-SF was selected to assess changes in participant mood due to its brevity; the short questionnaire should reduce incidence of participant fatigue.

***Mindfulness Experience Questionnaire.*** The questionnaire consisted of two questions: firstly, "*Have you taken part in mindfulness activities or meditation previously?*" and secondly, "*If you answered 'Yes' or 'Unsure' to the last question, please elaborate*.” Examples of possible elaborations were provided as a guide for answering. The ‘please elaborate’ question was used to check that their definitions of mindfulness meditation fit ours and where it did not they were re-allocated into the appropriate group. Those who answered 'unsure' were reallocated to either 'yes' or 'no' groups (see Appendix E for full questionnaire).

**Procedure.** Participants all began by answering the I-PANAS-SF and then completing the time bisection task, followed by the MAAS-S and intervention. Participants had been randomly assigned to their condition and were unaware of their assignment. After the intervention, they then completed the MAAS-S once more, followed by the Time Bisection task and the I-PANAS-SF. They were then asked some basic demographic questions and some questions about previous meditative experience and their experience of the intervention. The whole study took between 30 and 45 minutes per participant, depending on their intervention assignment.

**Interventions.** The interventions were all based on the same meditation by Williams and Penman (2011), re-recorded by the researcher (ZC). Originally the meditation lasted 8 minutes 5 seconds; however, for this experiment, all of the time allocated to self-practice without instruction was removed, leaving 5.40 minutes of instructions. There are two main points for self-practice built into the scripted meditation, for the short intervention, 10 seconds of self-practice was allocated to each of these points. For the medium-length meditation, 3 minutes was allocated for each point; for the long meditation, 6 minutes was allocated to each point. As such, the short meditation was 6 minutes; the medium meditation was 11 minutes 40 seconds and the long meditation 17 minutes 40 seconds.

**Results**

**MAAS-S.** A mixed-design ANOVA of MAAS-S scores by Time and Intervention Length showed no main effects of Time or Intervention Length [$p$ = .993 and $p$ = .925 respectively], but there is an interaction between the two [$F$ (2, 69) = 3.24, $p$ = .045, $\eta p^2$ =

.09]. This interaction appears to be because the short meditation shows a tendency towards decrease in state mindfulness [*p* =.086] , the medium length shows no change [*p* = .950] and the long intervention shows a tendency towards an increase in state mindfulness [*p* = .067, see Figure 4].

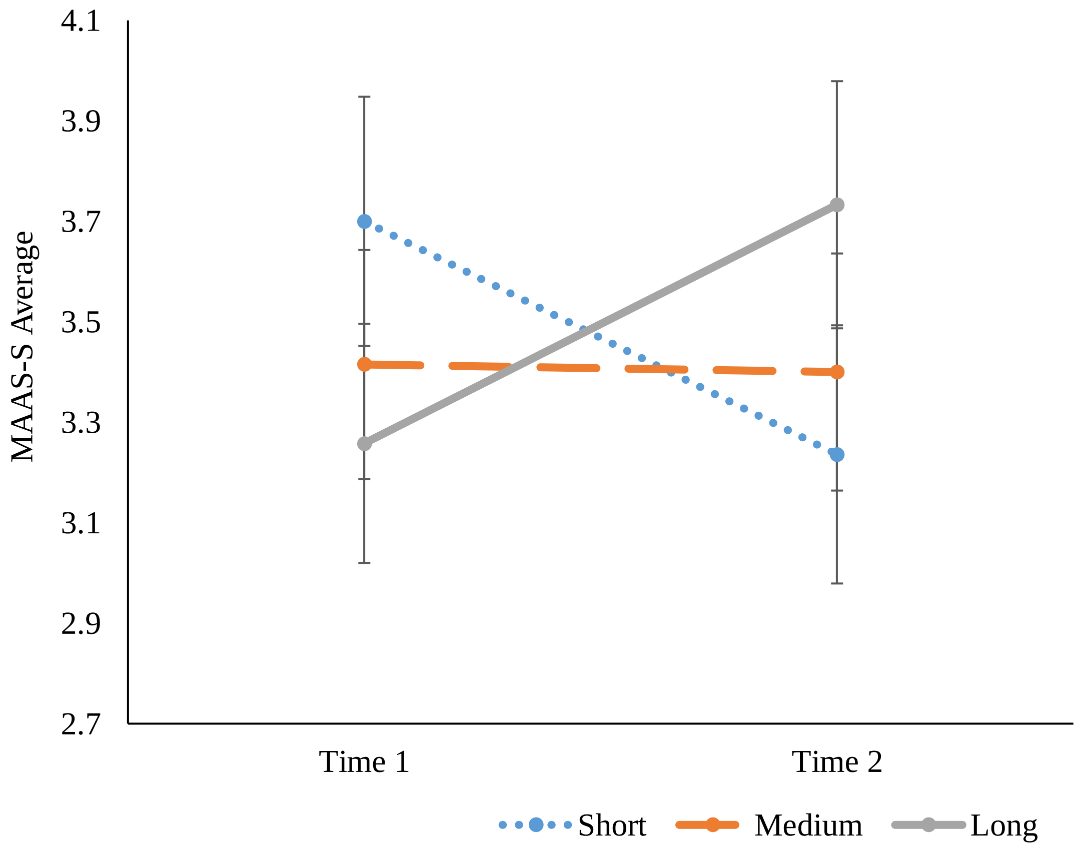


Figure 4. Study 2: Mean scores for the Mindful Attentional Awareness Scale – Short (MAAS-S) for each intervention (Short, Medium and Long). Error bars represent 95% Confidence Intervals.

**I-PANAS-SF.** ***PA.*** PA scores showed a main effect of Time in a two-way ANOVA (Time by Intervention Group), with positive effect decreasing after the intervention [$F$ (1, 68) = 17.02, $p$ < .001, $\eta p^2$ = .20]. However, there was no main effect of, or interaction with, Intervention Length [$p$'s > .979, see Table 4 for means].

***NA.*** The same analysis run on NA scores also showed a main effect of Time [$F$ (1, 68) = 82.56, $p$ < .001, $\eta p^2$ = .55], with scores NA decreasing over time. There was a marginally significant effect of Intervention Length [$F$ (2, 68) = 2.42, $p$ = .097, $\eta p^2$ = .066], though this could indicate pre-existing group differences as there is no interaction between the two [$p$ = .660].

Table 4
*Positive and Negative affect scores from the I-PANAS-SF for each intervention and time point.*

| | Short | Medium | Long |
|---|---|---|---|
| | Mean (SE) | Mean (SE) | Mean (SE) |
| *PA* | | | |
| Time 1 | 3.50 (.15) | 3.52 (.13) | 3.53 (.14) |
| Time 2 | 3.14 (.18) | 3.18 (.16) | 3.18 (.17) |
| *NA* | | | |
| Time 1 | 2.22 (.13) | 2.29 (.12) | 2.03 (.13) |
| Time 2 | 1.64 (.13) | 1.79 (.11) | 1.40 (.12) |

**The Bisection Task.** ***Bisection Point Analysis.*** Analysis of BP data using a mixed-design ANOVA of Time (Time 1, Time 2) and Intervention Length (20 seconds, 6 minutes or 12 minutes) showed a decrease in BP over Time [$M_{\text{Time1}}$ = .98, $M_{\text{Time2}}$ = .91; $F$ (1, 69) = 21.62, $p$ < .001, $\eta p^2$ = .24] but no main effect of Intervention Length and no interactions [$p$-values > .272]. As the hypothesis was that all changes from Time 1 to Time 2 would be in the same direction, but to different degrees, the means and simple effects were looked at. The mean changes showed the expected decreases in BP in all three Intervention Lengths (see

Figure 5), and simple effects showed that these were marginal in the Short intervention [mean difference = .06, $p$ = .054], and significant in the Medium [mean difference = .05, $p$ = .041] and the Long intervention [mean difference = .112, $p < .001$]. While the differences between the different Intervention Lengths were not significant, the means are moving in the predicted direction and that these results become more significant with longer meditations. Trend analysis using Kendall's tau-b shows no relationship between change in BP over time and length of self-practice [$\tau_b = .14$, $p = .118$].

***Weber's Ratio.*** Analysis of Weber's Ratio data using a two-way mixed-design ANOVA of Time (Time 1, Time 2) and Intervention Length (20 seconds, 6 minutes or 12 minutes) showed a decrease in WR over time [$M_{Time1} = .47$, $M_{Time2} = 0.42$; $F$ (1, 69) = 21.82, $p < .001$, $\eta p^2 = .24$] and no other main effects or interactions [$p$-values > .552]. As the hypothesis predicted that all conditions should reduce WR, the means and simple effects were investigated. All conditions showed decreased WR, this decrease was significant in the Short and Long conditions [$p = .006$ and $p < .001$, respectively]. The Medium condition showed a tendency toward change [$p = .058$]. Trend analysis using Kendall's tau-b shows no relationship between change in BP over time and length of self-practice [$\tau_b = .06$, $p = .521$]

Filtering the results to exclude those with previous mindfulness experience produces no change to the patterns presented above.

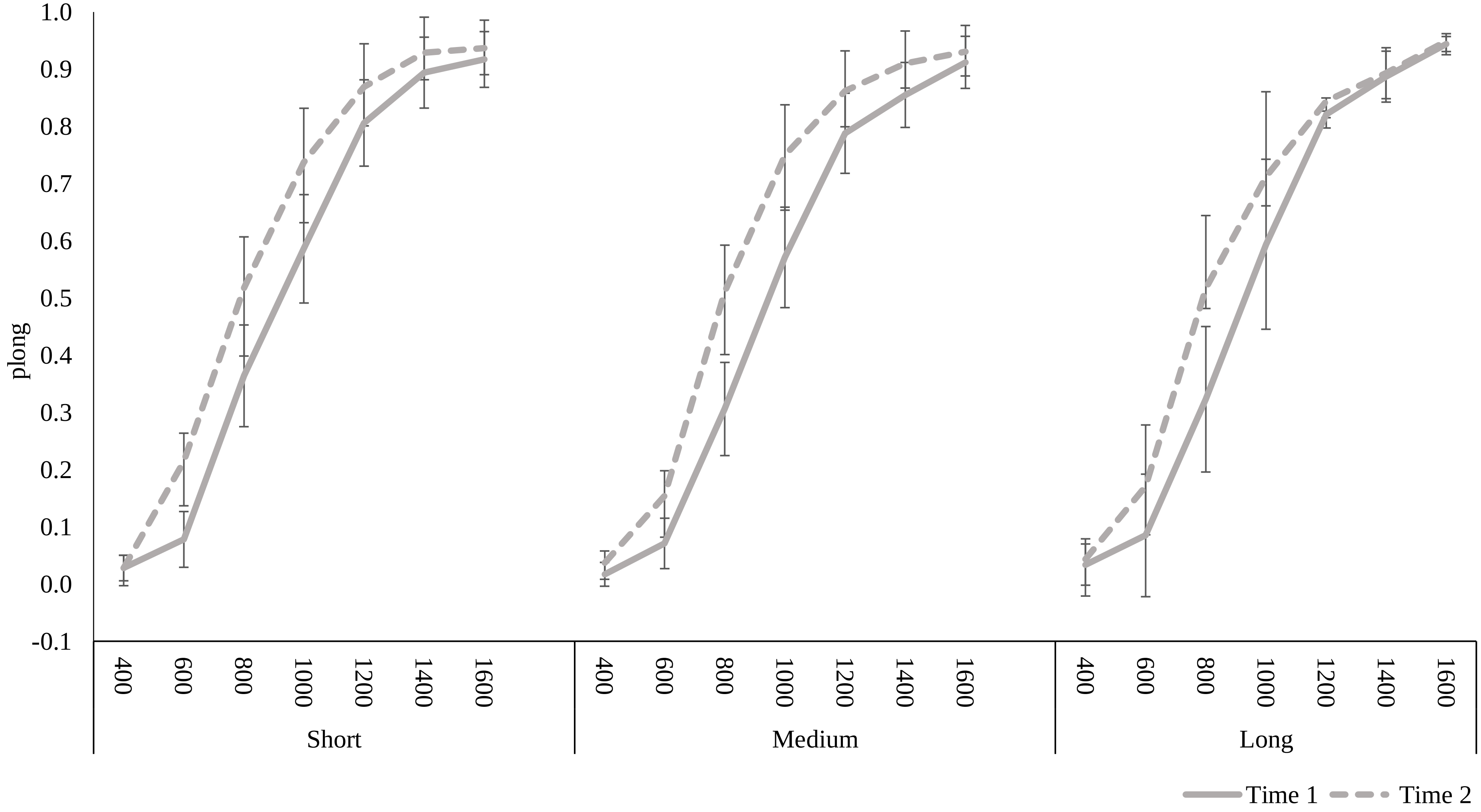


Figure 5. Study 5: Mean scores for the proportion of long judgements for each intervention (Short, Medium and Long) and each duration of stimuli. Error bars represent 95% Confidence Intervals.

***Correlations.*** There is no correlation between changes in WR and changes in BP [$r$ (72) = -.19, $p$ = .111], suggesting that the affects of FA meditation on BP and WR may be produced by different elements of the meditation practice. This relationship stays true when the sample is split by Intervention Length [$p$-values > .237]. There are no correlations between changes in BP and WR with changes in MAAS-S, PA or NA [$p$-values > .195]. This does not change when the sample is split by Intervention Length [$p$-values > .088].

**Discussion**

The results of the I-PANAS-SF indicate a general decrease in affect over time, with no interaction between Time and Intervention Length, this is consistent with the overall decrease in arousal and increased emotional regulation that would be expected with meditational practices (Feldman et al., 2007; Gil & Droit-Volet, 2012). A similar pattern that is reflected in the WR results, which show decreased arousal across all intervention lengths, though the two do not correlate, suggesting a further factor in the relationship between arousal and affect.

The results from the MAAS-S show a negative impact of the interventions on the MAAS-S scores for the shortest intervention and a positive impact from the longest intervention. This result suggests that self-practice can affect an individual's self-perception of mindful and attentional awareness as measured by the MAAS-S. As the first study to use MAAS-S as a form of manipulation check, it is interesting to note that levels of state mindfulness incurred during a mindfulness exercise may be contingent on the amount of self-practice offered in the task.

Though the effects of the different lengths of self-practice on BP scores are not different from each other, the results suggest that longer meditations are leading to more significant changes over brief periods. It is possible that greater practice durations would lead to consistent time perception differences between different intervention lengths. The lack of correlation between the MAAS-S scores as a measure of self-reported attentional awareness and BP as a behavioural indicator of attention suggests that the individuals' perception of attention and the attentional abilities captured by BP shifts are not the same, which supports the same suggestion from the dispositional FFMQ results of Study 1.

**Conclusion.** Overall, these results seem to imply that small changes in the amount of self-practice in FA meditations do not lead to significant improvements in attention, but that longer meditations may affect participant's self-perception of attentional awareness. The relationship between self-report measures of state and trait mindfulness and attention measured by temporal bisection tasks highlighted in Kramer et al. (2013) remains unclear. To further test the hypothesis that task engagement leads to attentional change, it may be worth varying the task to a more observable task.

## 3.5 Study 3a: Time Perception and Focused Attention Colouring Dosage

To continue exploring the idea of whether self-practice is important for training attention processes, we decided to change the meditation task to an externally focused, physical task. It is very difficult to observe or collect information on what participants are doing when instructed to meditate, so a physical task with observable behaviours provides a means of checking that participants are engaging with the task, therefore acting as both a motivator for the participants and checking mechanism for the experimenter. The Mindful Colouring task retained many of the same elements as the original meditation but with an external focus.

### Method

**Participants.** As with Study 2, participants for Study 3a were recruited through both the University of Kent, School of Psychology Research Participant Scheme (RPS) and adverts at the university JobShop. Those recruited through RPS were awarded course credit for taking part, and those recruited through JobShop were paid. 77 participants (58 female) were recruited, of these one was removed for reporting having not engaged with the assignment at all and three were removed during data cleaning for BP scores above 1600ms or below 400ms, in line with previous research protocols (Kramer et al., 2013). The final number of participants was 73 (58 females) with an average age of 21.97 years (Range: 18 – 52, SD = 6.70).

**Design and Procedure.** Study 3a followed the same design and procedure as Study 2, with a different set of interventions. A mindful colouring intervention was designed to establish whether the effect of meditation is from the internal focus of attention, as opposed to focusing attention externally. As such, there were three intervention lengths (Short, Medium and Long) and measures of time perception before and after the colouring interventions (Time 1, Time 2).

**Colouring Interventions.** The FA colouring intervention was designed to control for the internal focus of the FA meditation. The instructions were like the meditation instructions with an external focus on a pattern instead of on the internal body focus and were recorded by the researcher (ZC) (see Appendix F for a transcript). The timing of the instructions was identical to those of the FA meditation, as were the periods of silence. As with Study 2, the intervention was delivered in three different time lengths. The times were based on the amount of silent ‘self-practice’ in the conditions, with this being 20 seconds, 6 minutes or 12 minutes. The colouring patterns were found online (http://www.coloring-pages-adults.com/coloring-zen/) and consisted of mandalas and repetitive patterns; there were seven separate patterns all printed on A5 white paper. Participants could choose which of the seven patterns they wished to colour-in. The patterns were too large to complete in the allotted time.

**Results**

**MAAS-S.** A Time by Intervention Length ANOVA showed no main effects or interactions for MAAS-S scores [$M$ = 3.48; $p$-values > .136].

**I-PANAS-SF. *PA.*** A Time by Intervention Length ANOVA showed a significant decrease in PA over Time [$M_{Time1 =}$ 3.50 $M_{Time2}$ = 3.24; $F$ (1, 70) = 12.70, $p$ = .001, $\eta p^2$ = .15]. There is no main effect of Intervention Length, and no interaction [$p$-values > .414].

***NA.*** A Time by Intervention Length ANOVA shows a significant decrease in NA over Time, [$M_{Time1}$ = 3.40 $M_{Time2}$ = 3.14 ; $F$(1, 70) = 77.04, $p$ < .001, $\eta p^2$ = .52], but no main effect of Intervention Length, and no interaction [$p$-values > .414] between Intervention Length and Time.

**The Bisection Task.** ***BP.*** As expected, BP scores decreased over Time [$M_{Time1}$ = .98, $M_{Time2}$ = .88; $F$ (1, 70) = 38.01, $p$ < .001, $\eta p^2$ = .35]. However, there was no main effect of Intervention Length or interaction between the two [$p$-values > .138]. Simple effects were looked at as the directionality for all Intervention Lengths should be the same; this showed that all three Intervention Lengths show a significant decrease in BP over Time [$p$-values < .046], but the score of the individual Intervention Lengths are never different from each other [$p$-values > .762; see Figure 6]. Trend analysis using Kendall's tau-b shows no relationship between change in BP over time and length of self-practice [$\tau_b$ (73) = .11, $p$ = .224].

***WR.*** WR scored show a significant increase over Time [$M_{Time1}$ = .22, $M_{Time2}$ = .25; $F$ (1, 70) = 6.68, $p$ = .012, $\eta p^2$ = .09], however, there is no main effect of Intervention Length or interaction between the two [$p$-values > .215]. Simple effects were looked at as the directionality for all Intervention Lengths should be the same; this showed no significant effects within each Intervention Length across Time [$p$-values > .108; see Figure 6]. Trend analysis using Kendall's tau-b shows no relationship between change in WR over time and length of self-practice [$\tau_b$ (73) = -.07, $p$ = .447].

**Discussion**

The changes seen in BP and WR demonstrated that an FA task that was not internally-focused could produce changes in BP, consistent with the use of FA meditations. However, it suggests that something about the original meditation leads to a reduction in arousal that is not evidenced after the FA colouring intervention.

The lack of change in the MAAS-S scores lends further evidence to the idea from Study 2 that there may be a dissociation between attentional awareness and cognitive attentional processes. The comparative changes in MAAS-S and BP scores, suggests that aspects of the

FA colouring task have produced attentional change without effecting self-perceived attention.

**Limitations.** This study design does not allow for the direct comparison with those completing the FA meditation and the FA colouring tasks. It was also noted that although it was checked that the individual had done some colouring during the task, failure to collect the colouring samples means that any further data on task engagement was lost.

**Conclusion.** This study indicates that the FA aspect of FA meditations may be involved in rendering the attentional changes in time perception that have been shown using FA meditations previously (Kramer et al., 2013). However, the previously observed reduction in arousal may be related to FA being directed internally, as in the original meditation, or mitigated by the motor elements found in the current colouring FA task. Study 3a also supports the findings of Study 2, in that cognitively measured attentional change does not appear to relate to self-reported attentional awareness as measured by the MAAS-S.

**Study 3b: Time Perception and Focused Attention Colouring Dosage Replication**

In order to verify the results that we found in Study 3a and to look at the data from the completed colouring task, Study 3a was replicated. The replication had the dual purpose of providing more information about the engagement of the participants in the FA task and checking that the results could be reproduced.

**Method**

**Participants.** Study 3b recruited 81 participants (61 female), one participant was removed for reporting having not engaged with the assignment at all and two were removed for incomplete data. Data were filtered for BP scores above 1600ms and below 400ms, but no participants needed to be removed. The remaining 78 participants (58 female) had a mean age of 19.40 (Range: 18-27, SD = 1.57).

**Design and procedure.** The design and procedure of Study 3b was the same as 3a with one small change in Study 3b the colouring patterns were collected and analysed for: the number of colours used, pattern selected, whether the participant had stayed within the lines and how much of the pattern had been coloured. The amount of pattern coloured was calculated by laying a grid, with 1cm by 1cm squares, aligned with the top and left edges of the paper, and then a of $1cm^2$ squares that contained colour was counted.

**Results**

**MAAS-S.** A Time (Time 1 and Time 2) by Intervention Length (Short, Medium, Long) ANOVA showed a main effect for Time [$F$ (1, 75) = 4.16, $p$ = .045, $\eta p^2$ = .05], with reported state mindfulness scores increasing from a mean of 3.29 to 3.59. There was no main effect for Intervention Length [$p$ = .969] or interaction between Time and Intervention Length [$p$ = .165].

**I-PANAS-SF. *PA.*** A Time by Intervention Length ANOVA showed a decrease in PA over Time, and a significant interaction between Time and Intervention Length [$F$ (1, 75) = 12.34, $p$ = .001, ηp2 = .14 and $F$ (2, 75) = 3.82, $p$ = .026, $\eta p^2$ = .09 respectively, see Table 5 for means]. There is no main effect of Intervention Length [$F$ (2, 75) = 1.12, $p$ = .331, $\eta p^2$ = .03]. Further investigation of the simple effects shows that, both the short and long meditation groups decreased in PA over time [$p$ < .001 and $p$ = .014 respectively]. The medium length meditation group shows no change in PA over time [$p$ = .955], though there are no differences in the mean scores of the Intervention Lengths at either Time 1 or Time 2 [$p$-values > .238].

***NA.*** A Time by Intervention Length ANOVA showed a decrease in NA over Time [$F$ (1, 75) = 72.52, $p$ < .001, $\eta p^2$ = .50] and a tendency towards a main effect of Intervention Length [$F$ (2, 75) = 2.60, $p$ = .081, $\eta p^2$ = .07] but no interaction between the two [$F$ (2, 75) = 0.59, $p$ = .555, $\eta p^2$ = .02]. The means suggest that the Intervention Length differences came from the Medium Interventions overall higher scores for NA than the other groups, though they are not significantly different from the Short and Long Groups' NA scores (see Table 5).

Table 5
*Positive and Negative Affect scores from the I-PANAS-SF for each intervention and time point.*

| | | Short<br>Mean (SE) | Medium<br>Mean (SE) | Long<br>Mean (SE) |
|---|---|---|---|---|
| *PA* | | | | |
| | Time 1 | 3.41 (.12) | 3.26 (.12) | 3.53 (.13) |
| | Time 2 | 2.90 (.14) | 3.25 (.14) | 3.26 (.14) |
| *NA* | | | | |
| | Time 1 | 2.02 (.15) | 2.34 (.15) | 2.02 (.16) |
| | Time 2 | 1.42 (.13) | 1.88 (.12) | 1.55 (.14) |

**The Bisection Task.** ***BP.*** As expected, BP scores showed a decrease over Time [$F$ (1, 75) = 27.41, $p < .001$, $\eta p^2 = .27$, means are presented in Table 6]. Results also showed a tendency towards a main effect of Intervention Length but no interaction between the two [$F$ (2, 75) = 2.77, $p = .069$, $\eta p^2 = .07$ and $F$ (2, 75) = 0.02, $p = .979$, $\eta p^2 < .01$ respectively]. Trend analysis using Kendall's tau-b shows no relationship between change in BP over time and length of self-practice [$\tau_b$ (78) < .01, $p = .996$].

***WR.*** WR scores showed an increase over Time [$F$ (1, 75) = 13.75, $p < .001$, $\eta p^2 = .16$, means presented in Table 6]. However, there is no main effect of Intervention Length or interaction between the two [$p$-values > .657]. Trend analysis using Kendall's tau-b shows no relationship between change in WR over time and length of self-practice [$\tau_b$ (78) = -.09, $p$ = .311].

Table 6
*Mean Bisection Point and Weber's Ratio scores.*

| | Intervention | | |
|---|---|---|---|
| | Short<br>Mean (SE) | Medium<br>Mean (SE) | Long<br>Mean (SE) |
| *BP* | | | |
| Time 1 | 0.97 (.03) | 1.04 (.03) | 0.97 (.03) |
| Time 2 | 0.87 (.03) | 0.95(.03) | 0.86 (.04) |
| *WR* | | | |
| Time 1 | 0.20 (.01) | 0.21 (.01) | 0.22 (.01) |
| Time 2 | 0.25 (.02) | 0.24 (.02) | 0.25 (.02) |

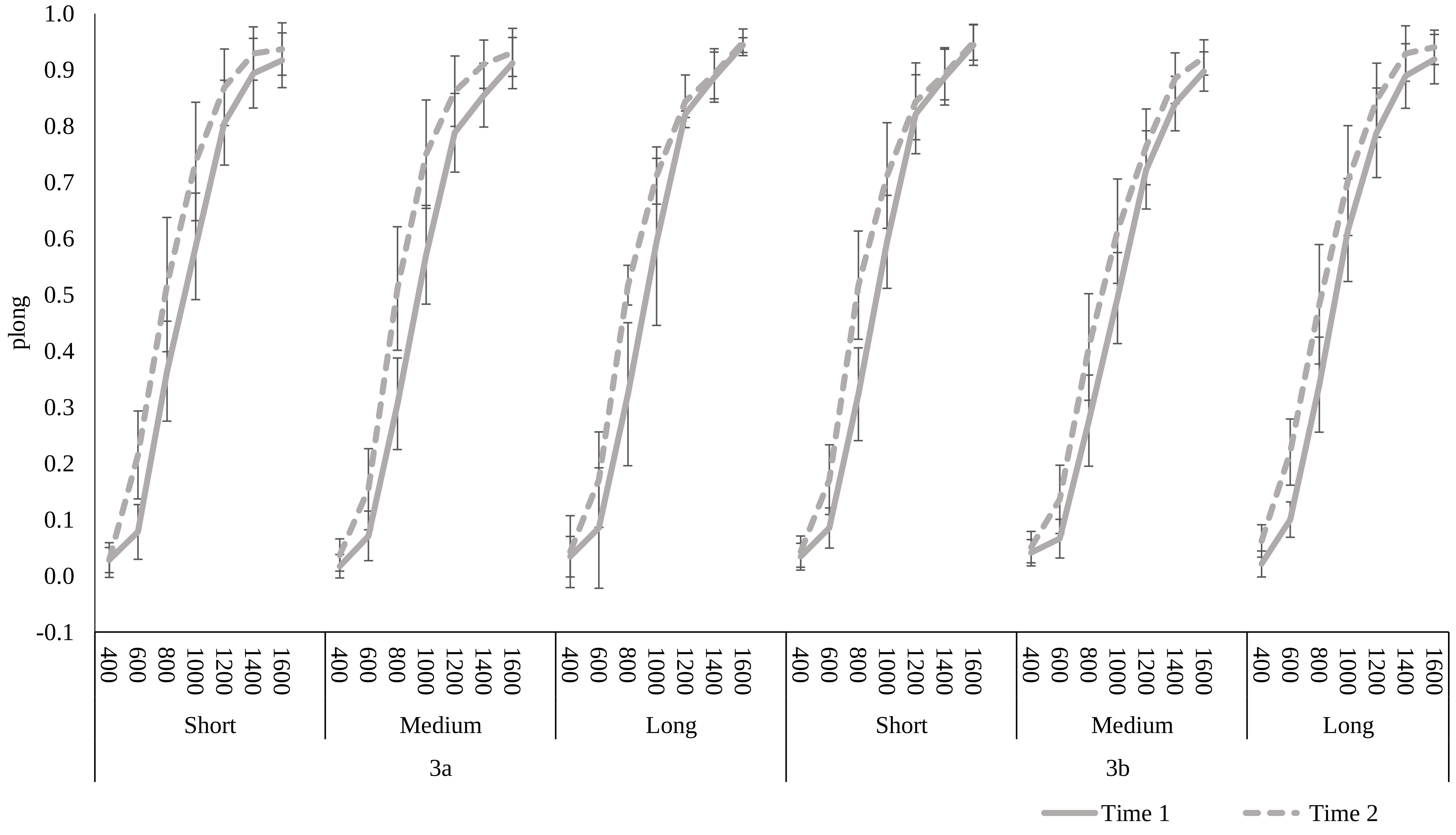


Figure 6. Mean scores for the proportion of long judgements for each intervention (Short, Medium and Long) and each duration of stimuli for Studies 3a and 3b. Error bars represent 95% Confidence Intervals.

***Colouring measures.*** No correlation between either BP or WR and the colouring measures was present [$p > .315$]. However, there is a correlation between the number of colours used in the colouring task and reported engagement in the task [$r$ (76) = -.303, $p$ = .008] with lower numbers of colours being associated with higher reported engagement. A breakdown of the scores by Intervention Length shows that this relationship is present in the Medium and Long duration interventions but not in the Short intervention [Short: $r$ (25) = -.13, $p$ = .531; Medium: $r$ (27) = -.35, $p$ = .074; Long: $r$ (24) = -.48, $p$ =.019]; this could be because there is less time in the Short intervention for the use of multiple colours.

**Discussion**

The results of Study 3b replicate Study 3a, with decreased BP and increasing WR across the intervention lengths, lending credence to the conclusions of 3a. As the changes were found in BP, and not WR scores, it could be that it is the internal-focus of the FA meditation that precipitates changes in arousal. Conversely, it could be the motor-aspect of the colouring that prevents arousal-reduction in participants. Comparisons between externally-focus but stationary tasks and the FA colouring and FA meditation tasks would be needed to distinguish between these possibilities.

The further information collected from the colouring patterns shows an inverse correlation between self-reported engagement and the number of colours used. Although this may seem counter-intuitive, it could be that this is because engaged individuals were taking their time and not colouring whilst the instructions asked for other activities such as looking at the patterns, or that when colouring they were being more mindful of the activity and taking their time.

## 3.6 Conclusion

### Summary of Findings

Studies 1 and 2 confirm that FA meditation affects time perception as measured by the BP and WR scores. Study 1 suggests that this is not due to changing styles of construal elicited through the FA meditation task and Study 2 implies that longer amounts of self-practice consolidates these changes. The first two studies also suggested that there is no direct relationship between self-reported attentional awareness (dispositional or state) and changes in the BP that are thought to indicate changes in cognitive processes of attention. This lack of relationship was further supported by the results of Studies 3a and 3b, both of which found no changes in MAAS-S and improvements in BP.

Studies 3a and 3b found that the external-focused FA mindful colouring task led to changes in BP but not WR, suggesting that the different aspects of the task meant that there was no associated reduction in levels of arousal, but that there was still an improvement in cognitive attentional processes. The information on colouring patterns collected in Study 3b showed that in the longer durations there was an inverse relationship between the number of colours used and reported engagement.

### Strengths and Limitations

Though it is generally agreed that BPs of temporal bisection tasks are representative of attention ability (Droit-Volet et al., 2015; Gautier & Droit-Volet, 2002; Kramer et al., 2013), such scores do not allow for the breakdown of the different theoretical elements of attention. In order to gain a more detailed understanding of the changes precipitated by the FA meditation, future research will need to use attentional tasks that can give more information on these different aspects of attention. However, the repeated use of a set FA meditation has consistently shown the effect previously reported by Kramer and colleagues (2013) which demonstrates good replication and means that the ability of the FA meditation to produce attentional change can be relied upon.

The combined studies also indicate that it might be useful to investigate the active elements of meditation by using selective control conditions that look at the internal or external task focus and an active versus passive tasks. Continued direct comparison between the FA meditation and the FA mindful colouring task might be able to elucidate some of the active components of FA meditation. This should continue to be supported by more passive tasks such as the Video task, though in the future other variations may be needed to address specific hypotheses.

**Implications**

It is clear that the brief FA meditation consistently effects both arousal and attentional ability; though this does not appear to be due to changes in construal primed by the meditation process, or of the length of self-practice within brief sessions. It, therefore, remains unclear which practice elements are producing the changes associated with both of the FA tasks used in these studies. The lack of distinction possible between the effects of the FA tasks on the theorised networks of attention (see Petersen & Posner, 2012) makes further inferences on the possible active elements more difficult. If the effects are specific to an attentional network, it may help to identify more constrained lines for future enquiry on the elements producing attentional and arousal level changes.

The lack of relationship between the measures of attentional awareness (both dispositional and state) with the changes in BP scores, suggests that they may tap into different processes. This may be due to other interfering mental systems, such as the individual’s capacity for accurate metacognition. Mindfulness has been hypothesised to decrease the dissociation between awareness and meta-awareness (Fox et al., 2012; Jankowski & Holas, 2014), but is unlikely to occur in such brief sessions. Metacognitive and introspective accuracy may have significant effects on self-report tasks such as the MAAS-S and the FFMQ, therefore leading to a lack of relationship between attentional performance and self-reported attentional performance (Glenberg & Epstein, 1985; Song et al., 2011; Washburn, Smith, & Taglialatela, 2005). In order to assess whether this is the case, measures of metacognitive accuracy would need to be introduced as a moderating variable to the relationship between self-reported attentional awareness and measures of attentional performance. It is also possible that attentional awareness and the aspects of attention measured by the time perception BP are separate processes that are affected differently by the FA tasks or that the variability within the self-report tasks mean that changes do not appear at low levels of FA task practice, but that greater doses may incur attention-related changes.

The lack of change over increasing durations also needs further investigation with more nuanced measures of cognitive attention. Whilst it appears that there is little change over increased time durations, it is also possible that the different networks are reacting in different ways and therefore cancelling out any changes that each network would render on the BP scores. By introducing a task that distinguished between networks it may be that a more nuanced picture of change emerges.

# CHAPTER 4: REPEATED BRIEF MEDITATIONS REDUCE ALERTNESS

## 4.1 Overview

Finding interventions that lead to improvements in attentional abilities could be beneficial to a large range of populations. It has been suggested that mindfulness meditation practices might have such an effect. However, experimental practices in the mindfulness meditation literature mean that it is unclear if, and how, this might occur. Looking specifically at the effects of interventions on novice practitioners and using one consistent style of meditative intervention, this chapter looks at how much meditation is needed to induce attentional improvements and what element of meditation might be involved in such change.

Three interventions were used in the current chapter, the first intervention was focused-attention meditation, the second was an externally focused mindful colouring, and the third was a control condition of nature video clips. Study 4 measured attentional ability using the Attention Network Test (ANT) immediately before and after a brief intervention. Study 5 used three different time-lengths for each of the three interventions, with ANT measurement prior to and post-intervention. Study 6 included four repetitions of each intervention, with the ANT before the first intervention and after each repetition. Studies 4-6 found no differential effects of brief interventions on attentional networks.

Study 7 consisted of nine sessions to examine the effect of repeated intervention sessions over time. This number of sessions was chosen as it was thought that drop-out would be too high if more sessions were added. The full study took 4.5 weeks and included eight interventions per participant. Session 1, a pre-test session, ascertained a baseline measure of attentional ability using the attention ANT. Sessions 2-9 included an intervention and a state-mindfulness manipulation check pre- and post-intervention and an ANT at the end of each session. Both the meditation and colouring interventions led to increased state-mindfulness post-intervention, the video intervention led to no change. Both the experimental interventions showed more maintained Alerting scores than the control intervention, confirming that brief focused-attention activity can improve a participant's ability to stay alert. This pattern appears to generalise to a second attention test (ANT displaying different stimuli).

## 4.2 The Attention Network Task and Focused Attention Meditation

Mindfulness meditation is currently used in both clinical and non-clinical populations to address a range of behavioural and psychological disorders and maintain positive mental states (Hempel et al., 2014); however, there is limited understanding as to how it produces these effects. Hözel et al. (2011) suggest that practices affect four key cognitive areas which combine to produce overall behaviour change: body awareness, emotion regulation, change in perspective on the self and attention regulation.

Attention is an umbrella term for a set of cognitive processes that are integral to much of our daily interactions and behaviour, and deficits can have serious consequences for health and wellbeing. It is thought to comprise of three networks: the Alerting Network, the Orienting Network and the Executive Network (Posner & Petersen, 1990). The Alerting Network is responsible for alerting the individual to the presence of new or changing stimuli in their environment (Corbetta & Shulman, 2002). The Orienting Network is responsible for releasing attention from a previous stimulus and moving the focus of attention to a new stimulus, and the Executive Network is responsible for dealing with issues of distracting stimuli in the environment to maintain attention on the target stimulus (Corbetta & Shulman, 2002; Michael I. Posner & Petersen, 1990). Fan and colleagues (2002) developed the Attention Network Test (ANT), a modified flanker task, to test the efficiency of the Attentional Networks. This task and other attentional measures have provided some evidence that mindfulness and meditation practices could improve attentional abilities in a range of ways (Posner & Rothbart, 2000; Tang et al., 2007); however there are several issues with the current literature that prevent strong conclusions about the efficacy of these interventions.

Activation of the Alerting Network has been observed to change in an analysis of correlations between meditation practice and neural activations (Brefczynski-Lewis et al., 2007). Higher activation of the Alerting Network was recorded in experienced meditators with 19,000h – 44,000h experience than in novices. However, those with +44,000h of experience have demonstrated less alerting activation than the novice meditators. Similarly, MacLean and colleagues (2010) have found that 3 months of *Shamatha* meditation retreat improves vigilance within experienced meditators using a ‘sustained attention’ task. Jha et al. (Jha et al., 2007) have shown that a 30-day retreat can lead to more maintained Alerting scores in experienced meditators as compared to both an inactive control group of novices and novices who completed an 8-week Mindfulness-Based Stress Reduction (MBSR) course.

Jha and colleagues (Jha et al., 2007) have also found improvements in novice meditator's Orienting scores following an MBSR programme, as compared to both the control and retreat groups and an increased ability to deal with attentional conflict in both meditation-based groups as compared to the control group. Orienting scores have also been observed to be smaller for experienced mindfulness meditators than in matched controls using the ANT (Hurk et al., 2010).

Improvements in the Executive Network have been recorded by Tang and colleagues (2007) after only five 20-minute sessions of the mindfulness-based intervention ‘Integrated Mind-Body Training’ (IBMT). The same study, however, has reported no changes in either Alerting or Orienting scores. Similarly, Ainsworth and colleagues (2013) have seen improvements in Executive scores after two different meditation interventions, but no corresponding changes in their control group.

The inconsistency of findings in the literature may be due to the methodological issues inherent in the mindfulness and meditation literature. Key issues include: definitions of mindfulness and meditation, the range of activities that fall under the terms mindfulness and meditation and their inclusion into umbrella mindfulness courses, a lack of research into change over time using single meditation type, the difficulty in identifying effective control conditions and the differential effects of interventions on novice and expert meditators (Chiesa, 2012; Van Dam et al., 2018).

*Mindfulness* and *meditation* are terms often found in the literature covering a range of meanings, intentions and behaviours. As such, it is often difficult to compare the results of different studies. For the context of this study, *mindfulness* is defined as 'the process of being non-judgementally aware in the present moment', indicating a state of mind as opposed to behaviour. *Meditation* can be understood as a behavioural practice that aims to help the individual to approach and explore ideas and themes and is utilised in both secular and religious ways (Goleman, 1988; Kabat-Zinn, 1982; Wilson, 2014). *Mindful meditation* is, therefore, the use of meditation to explore and practice the mindful state. This definition still leaves room for the inclusion of a variety of meditative practices, highlighting issues with the specificity of experimental interventions.

Brief mindfulness meditation interventions allow for the removal of some of the experimental issues encountered by the common 8-week courses such as the Mindfulness-Based Stress Reduction (MBSR), in which a wide range of activities and practices are utilised. Growing evidence suggests that meditation style affects the outcome of mindfulness-based interventions (Ainsworth et al., 2013; Lutz et al., 2008). Lutz et al. (2008) suggest that differences stem from the primary tasks involved in the different styles; FA meditations centre around maintaining focused attention on a particular subject, OM meditations involve no explicit instructions to maintain attentional focus. As the focus of this study is attentional change, an FA breathing and body scan meditation was selected, this intervention has been used previously by Kramer, Weger and Sharma (2013) and has been taken from meditation 1 in '*Mindfulness: A practical guide to finding peace in a frantic world*' (Williams & Penman, 2011). In order to control for the internal focus of the meditation intervention, an externally-focused FA Mindful Colouring task has been included in the study. The ‘Colouring' task uses the same timings and instruction base as the FA meditation but asks participants to focus on the external visual pattern as opposed to the internal body environment. A more passive visual video-watching task has also been used as a further control task.

Previous research suggests that repetition of the ANT leads to a reduction in the participant’s ability to remain alert, no change in orienting ability and an increased ability to deal with the attentional conflict (Ishigami & Klein, 2010, 2011; Jha et al., 2007). Any benefits of FA tasks should lead to a maintenance or reduction of Alerting scores, a reduction in Orienting scores (Becerra, Dandrade, & Harms, 2016; Hurk et al., 2010; Jha et al., 2007), and a greater reduction in Executive scores than would be seen in the control condition (Ainsworth et al., 2013; Becerra et al., 2016; Tang et al., 2007). However, there is no evidence of this being consistent in novice meditators (Becerra et al., 2016; Jha et al., 2007; Tang et al., 2007).

The aim of this work was to investigate the ability of brief, FA meditations to induce a change in attentional abilities and to identify whether this was related to internal or external loci of attention. As such, only novice meditators were included to ensure that meditation techniques were not being consciously applied to the other conditions. In all the ANT scores, the closeness of the Colouring intervention’s scores to either the Video or Meditation interventions would indicate the amount of similarity between the active elements of FA Meditation interventions and the active elements of the FA Colouring interventions.

## 4.3 General Method

Measures and study details that generalise across studies are presented below.

### Participants

Undergraduate students from the University of Kent participated for course credit. All reported normal (or corrected-to-normal) vision. All studies were conducted in accordance with the guidelines stipulated by the British Psychological Society. Ethical approval was given by the School of Psychology Ethics Committee. Participant recruitment numbers were set to be comparable or higher than other studies that have found effects of meditation on attentional processes (Becerra et al., 2016; Jha et al., 2007; Watier & Dubois, 2016). For participant summaries, see Table 7.

Table 7

*Summary of participant details for Studies 1-4*

| Study | Mean Age (SD)* | Age Range | Final N** | Female | Excluded N*** | Length of Intervention | Intervention N: Meditation | Intervention N: Colouring | Intervention N: Video |
|---|---|---|---|---|---|---|---|---|---|
| **4** | 19.47 (3.13) | 18-38 | 79 | 69 | 19 | 8m5s | 24 | 30 | 25 |
| **5** | 19.17 (1.92) | 18-35 | 181 | 150 | 34 | 6m0s | 19 | 18 | 25 |
| | | | | | | 11m40s | 21 | 19 | 18 |
| | | | | | | 17m40s | 19 | 20 | 22 |
| | | | | | | *Total* | 59 | 57 | 65 |
| **6** | 20.02 (2.89) | 18-35 | 83 | 65 | 19 | 8m5s | 29 | 24 | 30 |
| **7** | 20.49 (5.28) | 18-47 | 57 | 51 | 39 | 8m5s | 18 | 20 | 19 |

* One-way ANOVAs show no differences in participant numbers between Intervention Types for all studies (*p*'s > .203)

** This represents N for the Attention Network Test analyses; in Study 7, missing data has lowered these numbers for other measures, and these Ns are noted in-text.

*** Participants were excluded if they reported undertaking extensive previous mindfulness or meditation, such as MBSR courses or similar long periods of self-practice, or for not completing the full study.

## Measures

**Mindful Attention Awareness Scale, Trait (MAAS-T).** The MAAS-T, presenting in full in Appendix G, is a 15-item measure of trait mindfulness (Brown & Ryan, 2003) which assesses the individuals dispositional level of mindfulness. The MAAS-T focuses specifically on attention-related statements such as ‘I find myself doing things without paying attention’ and asks the participant to rate how frequently they have each experience on a 6-point Likert scale. Each item is scored from 1 (Almost Always) to 6 (Almost Never), with 1 being the least mindful and 6 being the most mindful. The MAAS-T has been shown to have good internal reliability with reported Chronbach’s α of .89 (MacKillop & Anderson, 2007) and .88 (Van Dam et al., 2018).

**Mindful Attention Awareness Scale, State (MAAS-S).** In Studies 5 - 7, the MAAS-S was used to assess self-reported mindful awareness. There is currently little use of manipulation checks in the meditation and mindfulness literature, with depositional and state mindfulness usually being measured at the beginning or end of a meditation course, not before and after each meditation session (Johnson, Gur, David, & Currier, 2015; Mahmood et al., 2016).

The MAAS-S is a 5-item measure of the participants’ current state of mindfulness with reported internal reliability (alpha) of .92 (Brown & Ryan, 2003). As with the MAAS-T, the MAAS-S has a specific focus on self-reported attention awareness. Each of the 5 items is a statement such as: ‘*I was preoccupied with the future or the past*’, participants are asked to report how much they were experiencing each of the 5 statements during the last task they completed. Each item was scored from 0-6, with 0 (Not At All) being the most mindful and 6 (Very Much) being the least mindful. Results were recoded for analysis so that high scores indicated higher levels of state mindfulness.

International Positive and Negative Affect Schedule, Short Form (I-PANAS-SF). The I-PANAS-SF is an internationally validated 10 item version of the widely used PANAS (Thompson, 2007). Each item identifies an affected state which is then categorised as either a positive affect (PA) or negative affect (NA). Participants were asked to rate how much they were currently feeling each of the affected states on a 5-point Likert scale from 1 (Very slightly or not at all) to 5 (Extremely). This short form was chosen due to its brevity, so as not to contribute to participant fatigue. There are five items in each of the generalised affect scores, a mean of the five items creates an overall score of PA and NA. Validation of the measure records internal reliability of the PA factor as having a Cronbach's $\alpha = .80$ and NA with $\alpha = .74$ (Thompson, 2007).

**The Attention Network Test (ANT).** The ANT measures the three networks of attention proposed by Posner and Petersen (1990); alerting, orienting and executive control. Developed by Fan and colleagues (2002), the ANT is comprised of a modified flanker task containing four cueing conditions (see Figure 7): No-Cue, no cuing stimulus is provided prior to the onset of the flanker stimuli, Double-Cue – cues are present both above and below the fixation point prior to the onset of the flanker stimuli, Spatial-Cue – a cue is presented either above or below the fixation point prior to the onset of the flanker stimuli, the placement matches where the flanker arrows appear, Centre-Cue – one cue is presented centrally at the fixation point prior to the onset of the flanker stimuli. The flanker stimuli are made up of arrows facing either left or right and they can appear either above or below the central fixation point. There are three flanker congruency conditions: Neutral – a single arrow is presented, Congruent – five arrows are presented facing the same direction (left or right), and Incongruent – five arrows are presented with the centre arrow facing the opposite direction to the other four arrows. The instructions introduce the task as an attentional measure but do not provide any further detail as to the process of measurement.

On completion of the task, mean RTs for correctly answered trials are calculated for each of the cueing and flanker conditions. Differences between the mean RTs of the cueing and flanker conditions are then calculated to look for changes in the Alerting, Orienting and Executive Networks. The Alerting score is generated by subtracting the mean RT of double-cued trials from the mean RT of no-cue trials, the no-cue condition acting as a baseline measure. The Orienting score is calculated by subtracting mean RTs on spatial-cue trials from mean RTs on centre-cue trials. The Executive score subtracts mean RTs on congruent trials from mean RTs on incongruent trials, which compares the speed of participants between trials with and without the visual conflict induced by incongruent flanker arrows. Alerting and Orienting scores are calculated so that a higher score indicates higher levels of attentional efficiency; in Executive scores, lower scores indicate higher efficiency.

All ANT data were trimmed prior to analysis, with any responses below 200ms and above 1200ms being removed as these values are thought to represent overall in-attention to the task rather than valid responses (Ishigami & Klein, 2011). All final scores were calculated after trimming.

***The Attention Network Test ($ANT_1$).*** The $ANT_1$ was downloaded from the Inquisit Test Library (http://www.millisecond.com/) and used with Inquisit 4. The $ANT_1$ consists of one practice block of 24 trials in which trial-by-trial feedback is administered. This is followed by three experimental blocks of 96 trials each, in which no feedback is provided. Each block contains two iterations of each possible combination of cue-condition, flanker condition, flanker position and target direction. In addition, each trial is preceded by a fixation cross lasting 400-1600ms followed by one of the four cue conditions lasting 100ms. The fixation point is then displayed again for 400ms followed by the flanker task which is displayed until a response is made to the direction of the central target arrow or for 1700ms, whichever occurs first.

Fan and colleagues (2002) report test-rest correlations of .52 for Alerting, .61 for Orienting and .77 for Executive scores, all significant at the < .01 level. Other assessments of reliability have found lower reliabilities, for example, MacLeod and colleagues (2010) report reliabilities of .38 for Alerting, .55 for Orienting, and .81 for Executive scores. As the ANT scores are difference scores, in that one item must be subtracted from another to create a meaningful value, reliabilities are not a clear indication of the statistical power of this test (MacLeod et al., 2010; Trafimow, 2015). As such, it has been concluded that the ANT was the most efficient task to measure the three networks simultaneously, regardless of the low reliability estimates (MacLeod et al., 2010).

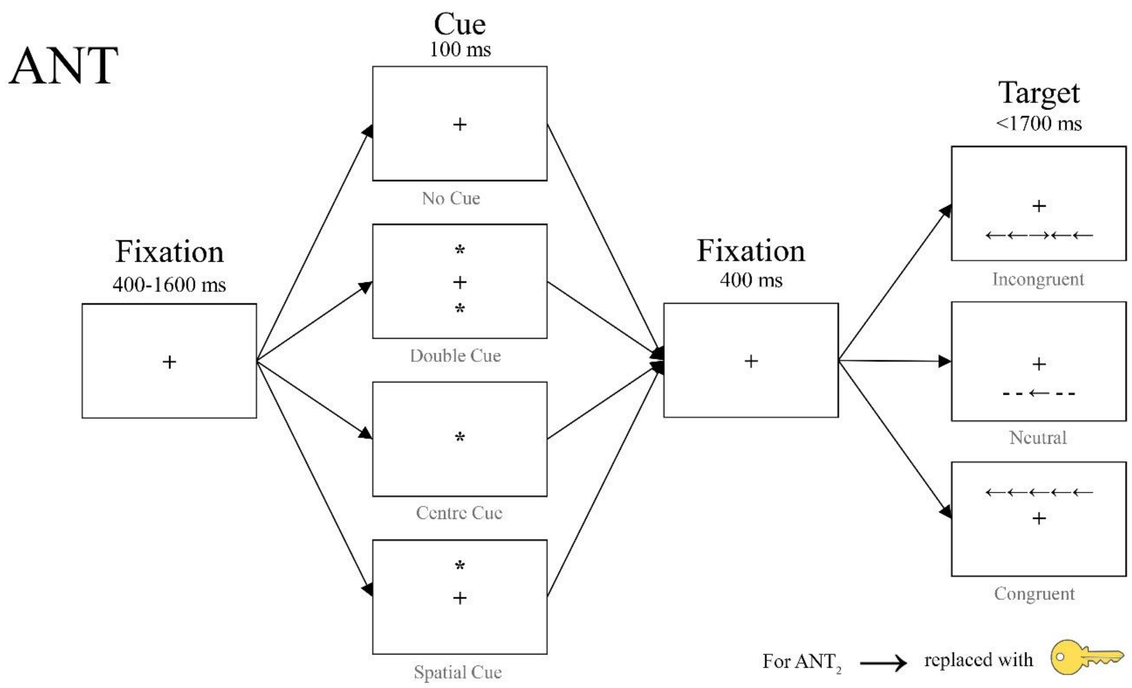


Figure 7. Details of the Attention Network Test showing the cue conditions, flanker examples and trial procedure.

***Key Stimulus Attention Network Test (ANT$_2$).*** The ANT$_2$ is a variant on the ANT$_1$, the researchers used yellow keys instead of arrows (see Figure 7) but is the same in every other respect. The key was taken from an open clip art page ("Free Clipart: Key Yellow | gerhard-tinned," n.d.). This task was used to address issues of stimulus learning that may have occurred after considerable repetitions of the $ANT_1$. If the results of $ANT_1$ and $ANT_2$ show the same patterns, it can be assumed that the results are not due to over-familiarisation with specific stimuli.

***The Shortened Attention Network Test (ANT-S).*** The ANT-S was downloaded from the Inquisit Test Library (see CRSD-ANT, http://www.millisecond.com/). Taking just ten minutes, the ANT-S is the same as the $ANT_1$ in stimuli timings and cue-conditions; however, it does not have a neutral flanker condition and the time before automatically moving to the next trial was shortened from 1700ms to 1500ms. The ANT-S starts with 32 practice trials with feedback and then has two blocks of 64 trials. Each experimental block contains two repetitions of each possible combination of trial conditions. RTs of the ANT-S have previously been shown to correlate highly with scores produced on the $ANT_1$ (Weaver, Bédard, & McAuliffe, 2013), as such the ANT-S has been used to reduce participant fatigue in Studies 1-3 where multiple tasks and iterations of the ANT are used in a single session. Weaver, Bédard and McAuliffe (2013) report low correlations between network scores the $ANT_1$ and the ANT-S, however, comparisons of the median scores of the underlying conditions show correlations all .88 or above.

**Interventions**

There were three intervention types used throughout the studies: Meditation, Colouring and Video. The Meditation interventions were based on the 'Mindfulness Meditation of the Body and Breath' Meditation Track 1 by Williams and Penman (2011) which consists of a short breathing exercise, grounding exercise and a body scan. The Colouring interventions were designed to control for the internal focus of the Meditation interventions; the instructions simulate the meditation instructions but with an external focus on a pattern. Both sets of interventions contained periods of instruction and periods of silent practice. The timings of the instructions for the Meditation and Colouring interventions were identical, as were the periods of silence (see the Appendix F for a transcript of the Colouring Intervention).

The colouring patterns given to participants were found online (http://www.coloring-pages-adults.com/coloring-zen/) and consisted of abstract and repetitive patterns. There were eight separate patterns all printed on A5 white paper, all too large to complete in the allotted times. At each intervention, participants could choose which of the 8 patterns they wished to colour in.

The Video interventions asked participants to watch clips of underwater nature scenes from 'The Blue Planet' documentary series (Fothergill, 2001). Clips were different for each session, and the chosen footage included underwater shots only for consistency, the audio was removed leaving just the image. Images of snakes and sharks were also excluded from the clips, in case they incurred particular reactions.

In Studies 4, 5 and 6, each intervention lasted for 8 minutes and 5 seconds. For Study 7, each of the interventions was delivered in three different time lengths. The times were based on the amount of silent 'self-practice' in the Colouring and Meditation Intervention, with this being 20 seconds, 6 minutes or 12 minutes. This led to interventions of 6 minutes, 11 minutes 40 seconds and 17 minutes 40 seconds for each intervention type.

Participants were randomly assigned to conditions at arrival for the studies but were not informed of the assignment. In all studies, between each task, and each block of the ANT's, there was the option to take short, self-paced, breaks. All studies were run on 17" LG Flatron L1753HR screens, with Compusys PCs in laboratory cubicles. All the tasks were delivered online via the experimental software Inquisit Web 4. The interventions were delivered in PowerPoint (Microsoft Office Professional Plus 2013), video image dimensions were 14.30cm by 25.60cm. All participants were asked to provide demographic information which included a question on their previous meditation and mindfulness experience. This consisted of two questions: firstly, *"Have you taken part in mindfulness activities or meditation previously?"* and secondly, *"If you answered 'Yes' or 'Unsure' to the last question, please elaborate."* Examples of possible elaborations were also provided as a guide for answering.

All analyses were conducted using the IBM SPSS 24 software. Due to unequal participant numbers, analyses used type IV sums of squares. In Studies 6 and 7, where multiple sessions are reported, the Greenhouse-Geisser correction has been used if sphericity has been violated. For each study, univariate ANOVAs of the network scores were planned in line with previous research and under the assumption that the networks would change independently (Huberty & Morris, 1992). All pairwise comparisons were adjusted for multiple comparisons using the Bonferroni correction.

## 4.4 Study 4: The Attention Network Test and a Brief FA Meditation

In order to see whether a single brief meditation would show beneficial effects on attentional networks, attention was measured prior to and immediately after one iteration of the interventions.

### Design and Procedure

A two-way design, looking at Intervention Type (Video, Colouring and Meditation) as a between-subjects factor and Time (Time 1: pre-intervention, Time 2: post-intervention) as a within-subjects factor, Study 4's dependent variable was the ANT-S scores. Following the demographics questionnaire participants completed the I-PANAS-SF, MAAS-T, the ANT-S, one of the interventions, the ANT-S and finally questions on previous mindfulness experience and self-reports of their experience of the study.

### Results

**MAAS-T and I-PANAS-SF.** A series of one-way ANOVAs showed no pre-existing differences between Intervention Type for MAAS-T [$F$ (2, 78) = 0.64, $p$ = .529], or affect [PA: $F$ (2, 78) = 0.68, $p$ = .511; NA: $F$ (2, 78) = 2.36, $p$ = .102] (see Table 8 for means). This suggests that both trait mindfulness and mood were consistent across groups prior to completing the interventions.

Table 8

*Mean MAAS-T and I-PANAS-SF scores for Study 4.*

| | Means (SE) | | |
|---|---|---|---|
| | Meditation | Colouring | Video |
| *MAAS-T* | 2.16 (.62) | 2.20 (.80) | 2.36 (.56) |
| *I-PANAS-SF* | | | |
| PA | 3.57 (.43) | 3.69 (.68) | 3.49 (.68) |
| NA | 2.17 (.63) | 2.45 (.63) | 2.53 (.65) |

**ANT-S.** Analyses of the network scores showed that the Executive scores decreased from Time 1 to Time 2 [*F* (1, 76) = 5.27, *p* = .024, $\eta p^2$ = .07], a lack of interaction between Time and Intervention Group [*F* (2, 76) = 1.90, *p* = .156, $\eta p^2$ = .05] suggest that this is a practice effect. No other main effects or interactions were significant of any of the network scores [*F's* < 1.60, *p's* > .514]. Means are presented in Table 9.

Table 9

*Mean ANT network scores, Study 4.*

| | Means (SE) | | |
|---|---|---|---|
| | Alerting | Orienting | Executive |
| *Time* | | | |
| 1 | 43.05 (3.93) | 28.76 (3.59) | 82.55 (4.48) |
| 2 | 46.20 (4.19) | 28.26 (2.94) | 73.86 (3.82) |

**Discussion**

Although previous research has shown that the meditation from Williams and Penman (2011) can have effects on cognitive processes (Kramer et al., 2013), Study 4 suggests that the FA interventions have not affected change in the attentional networks as only practice effects that fit with previous research are shown in the results (Ishigami & Klein, 2011). As other studies have previously shown changes in attentional abilities after similar meditative practices, it may be the brevity of the interventions that are restricting observable changes in the attentional scores. Longer interventions may encourage observable levels of change in the ANT scores. Although previous research has shown that the meditation from Williams and Penman (2011) can have effects on cognitive processes (Kramer et al., 2013), Study 4 suggests that the FA interventions have not affected change in the attentional networks as only practice effects that fit with previous research are shown in the results (Ishigami & Klein, 2011). As other studies have previously shown changes in attentional abilities after similar meditative practices, it may be the brevity of the interventions that are restricting observable changes in the attentional scores. Longer interventions may encourage observable levels of change in the ANT scores.

## 4.5 Study 5: Effect of FA Meditation Length on ANT scores

To observe the effects of changes in the length of interventions without changing the interventions themselves, the FA meditations were modified by reducing or increasing the amount of self-practice time that was included in the intervention.

### Design and Procedure

A three-way design with between-subject factors of Intervention Type (Video, Colouring, Meditation) and Intervention Length (Short: 6 minutes, Medium:11 minutes 40 seconds, and Long:17 minutes 40 seconds) and the within-subject factor of Time (Time 1: pre-intervention, Time 2: Post -Intervention) was used to assess the effect of longer FA interventions on ANT scores. The dependent variables were ANT-S scores and MAAS-S scores. Participants completed the basic demographics, I-PANAS-SF, ANT-S, MAAS-S, and then one of the 9 interventions (3 Interventions Types x 3 Intervention Lengths). They then repeated the MAAS-S, ANT-S and then answered questions on previous mindfulness experience.

### Results

**MAAS-S.** A mixed-factorial ANOVA of Intervention Type, Intervention Length and Time showed no main effects or interactions [*F*'s < 1.42, *p*'s > .244; see Table 10], suggesting both no pre-existing group differences and no effect of Intervention Type or Length on state mindfulness.

**I-PANAS-SF.** Analysis of the I-PANAS-SF PA scores (Intervention Type x Intervention Length) show no interactions between Intervention Type and Length for PA [$F$ (8, 172) = 0.45, $p$ = .770]. There are also no main effects for either Intervention Type [$p$ =

.357] or Intervention Length [*p* = .758]. Overall, this suggests that all Intervention Types are comparable for PA prior to undertaking the intervention.

Factorial analyses of the NA scores also showed no interaction between Intervention Type and Length [$F$ (8, 172) = 0.45, $p$ = .770] and no main effect of Intervention Length [$p$ = .219], means are displayed in Table 10. However, there was a main effect of Intervention Type [$F$ (2, 172) = 3.47, $p$ = .033]. Independent-samples *t*-tests showed that those in the Video interventions had higher pre-existing levels of NA than those in the Colouring interventions [$t$ (118) = 2.71, $p$ = .008]. The Meditation interventions were also marginally different to the Video interventions [$t$ (118) = 1.93, $p$ = .057], but not to the Colouring interventions [$t$ (118) = -0.90 $p$ = .37].

Due to the presence of pre-existing differences between Intervention Type in NA, correlational analyses between NA scores and the ANT scores were conducted to explore the relationship. Results showed that there was a negative correlation between NA scores and post-intervention Executive scores [$r$ (181) = .20, $p$ = .006], but that the NA scores did not correlate with the amount of change seen in the Executive scores over Time [$r$ (181) = -.12, $p$ = .105]. This suggests that whilst there may be an overall effect of NA on executive scores, this has no effect on the amount of change between Time 1 and Time 2.

Table 10
*Mean MAAS-S and I-PANAS-SF scores for Study 5.*

| | Means (SE) | | |
|---|---|---|---|
| | Meditation | Colouring | Video |
| *MAAS-S* | 2.87(.20) | 3.12 (.22) | 2.48 (.20) |
| *I-PANAS-SF* | | | |
| PA | 3.45 (.07) | 3.31 (.07) | 3.39 (.07) |
| NA | 2.17 (.08) | 2.07 (.09) | 2.38 (.08) |

*Note.* MAAS-S scores have been reverse coded so that high-scores represent high state mindfulness.

**ANT-S.** Mixed-methods ANOVAs showed interactions between Time and Intervention Length for both Alerting scores [$F$ (2, 172) = 3.14, $p$ = .046, $\eta p^2$ = .04] and Executive scores [$F$ (2, 172) = 4.45, $p$ = .013, $\eta p^2$ = .05]. Both scores show increased efficiency in the Long interventions, with Alerting scores increasing and Executive scores decreasing as compared to the Medium or Short interventions. Both of these interactions are congruent with practice effects. However, it is unclear how the Longer interventions would activate this when the shorter versions did not (scores are shown in Figure 8).

Executive scores also showed a main effect of Intervention [$F$ (2, 172) = 3.27, $p$ = .041, $\eta p^2$ = .04], with larger overall Executive scores for the Colouring interventions than for the Video and Meditation conditions. No other main effects or interactions were reported in the analyses [*F'*s < .1.81, *p*'s > .132].

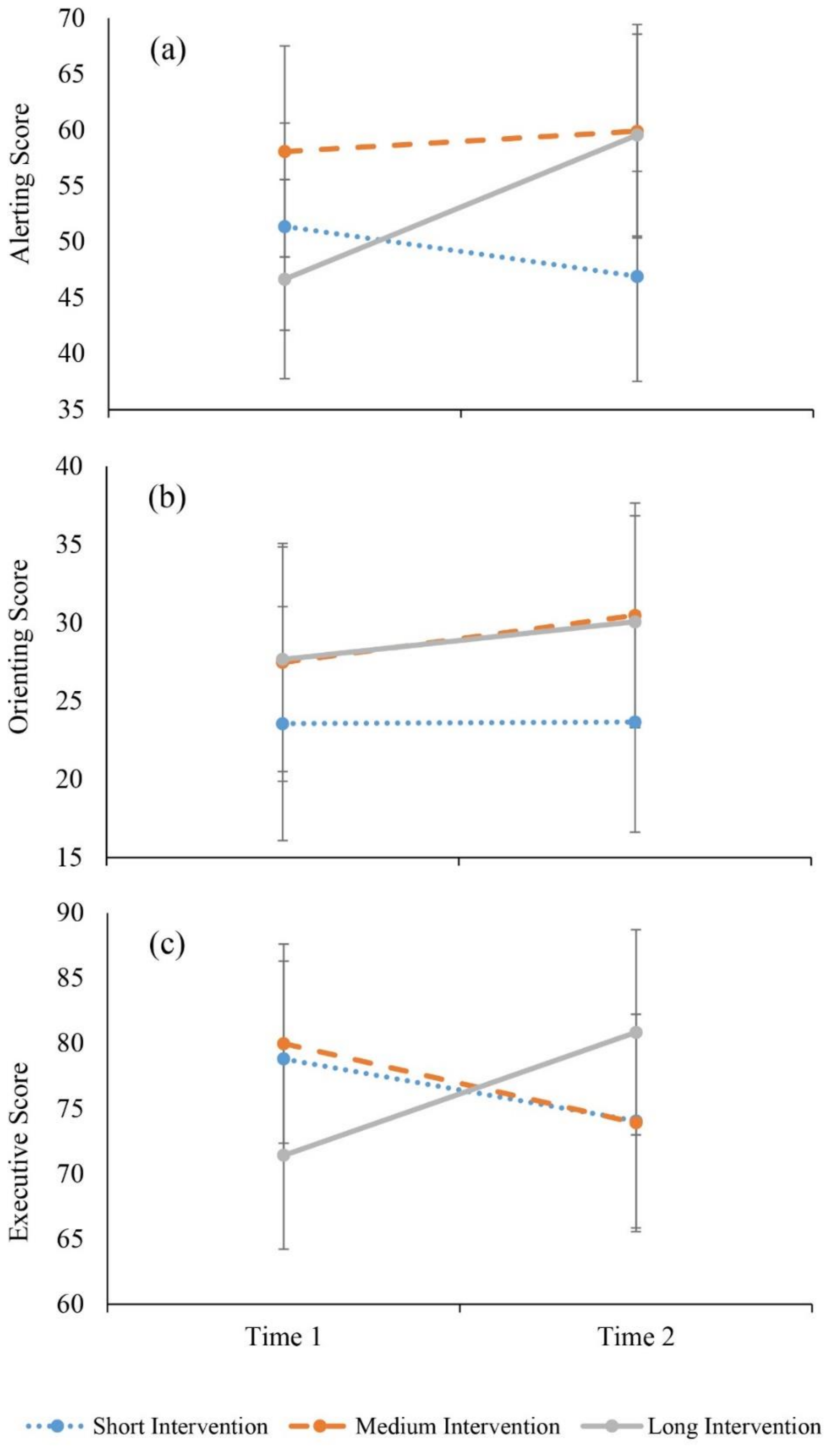


Figure 8. This figure shows the results of the Attention Network Test - Short (ANT-S) from Study 5. It shows the difference in change over Time (Time 1: pre-intervention, Time 2: post-intervention) for each Intervention Length (Short: 6 minutes, Medium: 11 minutes 40 seconds, Long: 17 minutes 40 seconds) for the Alerting (a), Orienting (b) and Executive (c) network scores. Error bars indicate 95% confidence intervals.

**Discussion**

The results of both the Alerting and Executive scores indicate that the longer interventions show an increased network efficiency regardless of Intervention Type. This increase in attentional efficiency fits with previous findings and is thought to represent a practice effect.

The lack of interaction with Intervention Type suggests that increasing the duration of the intervention has not led to an effect of either of the FA interventions on attentional ability. However, many studies in the literature use multiple doses of meditation and mindfulness training as opposed to just a single dose.

## 4.6 Study 6: Effect of Repeated Sessions of ANT and Meditation on ANT scores

It is possible that using multiple iterations of the FA interventions may be more effective in encouraging attentional change. As such, the original 8m5s interventions were used multiple times in one laboratory visit to establish whether repetition would lead to attention change.

### Design and Procedure

A two-way Intervention Type x Session design for the ANT-S, Study 6 increased the repetition of both intervention and ANT-S measurement. In one laboratory visit, the participants completed several repetitions of their allocated intervention. On arrival, participants completed the tasks in the following order: ANT-S, I-PANAS-SF, MAAS-S, their allocated intervention and the MAAS-S (Session 1). This 'session' was repeated a further 3 times (Sessions 2 – 4) with an additional half session (Session 5) of just the ANT-S occurring prior to demographic and meditation information gathering. Four iterations of the intervention were deemed the most that participants would comfortably be able to complete in one sitting. The total study time was approximately 2 hours 30 minutes per participant, though this varied depending on the breaks taken by each participant.

### Results

**MAAS-S.** A three-way ANOVA of Intervention Type x Session (1 through 4) x Time showed main effects of Session [$F$ (2.15, 172) = 32.03, $p < .001$, $\eta p^2 = .29$] and Time [$F$ (1, 213.05) = 4.63, $p = .034$, $\eta p^2 = .06$], means are shown in Table 11. Means show that this is due to an overall increase in mindful awareness after the interventions, and a contrasting general reduction in reported mindful awareness over the course of the study. There were no other main effects or interactions [$F$'s < 2.32, $p$'s > .105]. The lack of interactions, especially with Intervention Type, suggests that the FA meditations were not influencing self-reported mindful attention compared the Video Intervention.

**I-PANAS-SF.** A Session (1 through 4) x Intervention Type ANOVA showed no differences between Intervention Type or interactions between Session and Intervention Type for either PA or NA [*p*'s > .137], however they both showed a significant reduction of affect over Time [$F$ (3, 231) = 41.75, $p > .001$, $\eta p^2 = .35$ and $F$ (3, 231) = 34.63, $p < .001$, $\eta p^2 = .31$ respectively], as seen in Table 11. This reduction is seen across all Intervention Types and is therefore unlikely to be linked directly to elements of the FA interventions.

**ANT-S.** Analysis of the network scores showed a main effect of Session for Alerting scores only [$F$ (1, 80) = 17.61, $p < .001$, $\eta p^2 = .18$], with scores increasing from Session 1 to Session 5. The analysis highlighted no other main effects or interactions [*F's* < 1.56, *p*'s > .216; see Table 12 for means].

Table 11
*Mean MAAS-S and I-PANAS-SF scores for Study 6.*

| | Session Means (SE) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Mean (SE) |
| *MAAS- S* | | | | | |
| Time 1 | 3.33 (.12) | 2.70 (.15) | 2.53 (.15) | 2.35 (.16) | 2.73 (.12) |
| Time 2 | 3.51 (.13) | 2.83 (.15) | 2.85 (.18) | 2.47 (.17) | 2.92 (.13) |
| *Mean* | 3.42 (.11) | 2.80 (.13) | 2.69 (.15) | 2.41 (.16) | |
| *I-PANAS-SF* | | | | | |
| PA | | | | | |
| Video | 3.51 (.10) | 3.17 (.13) | 2.97 (.17) | 2.85 (.18) | 3.13 (.13) |
| Colouring | 3.57 (.11) | 3.18 (.15) | 2.59 (.20) | 2.66 (.21) | 3.00 (.14) |
| Meditation | 3.44 (.10) | 3.33 (.13) | 2.78 (.17) | 2.67 (.18) | 3.06 (.13) |
| *Mean* | 3.51 (.06) | 3.23 (.08) | 2.78 (.11) | 2.73 (.11) | |
| NA | | | | | |
| Video | 2.39 (.13) | 2.06 (.14) | 1.92 (.14) | 1.76 (.12) | 2.03 (.11) |
| Colouring | 2.23 (.15) | 1.87 (.16) | 1.63 (.16) | 1.57 (.14) | 1.83 (.13) |
| Meditation | 2.20 (.13) | 1.57 (.14) | 1.59 (.14) | 1.52 (.12) | 1.72 (.11) |
| *Mean* | 2.27 (.08) | 1.83 (.08) | 1.71 (.08) | 1.62 (.08) | |

*Note.* MAAS-S scores have been reverse coded so that high-scores represent high state mindfulness.

Table 12
*Means of the Study 6 ANT scores for Sessions 1 & 5.*

| | Mean (SE) | | | |
|---|---|---|---|---|
| | Session 1 | Session 5 | Mean Difference | *p* |
| Alerting | 43.22 (3.05) | 63.30 (4.13) | 20.08 | < .001 |
| Orienting | 25.30 (3.35) | 20.70 (4.36) | -4.60 | .346 |
| Executive | 77.29 (3.25) | 77.70 (3.41) | -0.42 | .913 |

## Discussion

The change in the Alerting scores over time fits with previous research that looked at the effects of repeating the ANT over time (Ishigami & Klein, 2011), which showed that Alerting scores increase with repetition. However, the FA interventions do not appear to have had any differing effects on the attention networks than the Video intervention. It appears that four consecutive iterations of FA interventions do not lead to changes in attentional processing. However, most mindfulness and meditative interventions have longer spacing of time between sessions and include more repetitions.

## 4.7 Study 7: Spaced and Repeated FA Meditations and the ANT

In order to see if increasing the session spacing and the number of iterations would lead to changes in mindfulness and attentional processes, it was decided to move to a longitudinal design. Study 7 comprised of 8 meditations over 4 weeks, spacing out both the interventions and the ANTs. As most sessions would contain one intervention and ANT, participant fatigue was reduced, so it was decided to use the original, longer $ANT_1$ instead of the ANT-S for Study 7. In line with previous research, analysis of attentional measures focused on scores recorded at the beginning and end of the study, however, to have a more nuanced picture of change over time, ANT and MAAS-S measurements were taken at each session.

### Design and Procedure

The key measures were the $ANT_{1\&2}$ scores, for which there was a two-way design of Intervention Type x Session. For the I-PANAS-SF and MAAS-S scores, there was an added dimension of Time (Time 1: pre-intervention, Time 2: post-intervention). Nine sessions were administered over four and a half weeks; sessions were delivered on the same days at approximately the same times each week and were spaced 3-4 days apart.

**Session 1.** Participants were randomly assigned to one of the three interventions (Mindfulness, Colouring or Video) at Session 1, but not told which intervention they were assigned to until Session 2. Each participant completed a short demographic questionnaire. Participants then completed the MAAS- T, MAAS-S, I-PANAS-SF, $ANT_1$ and $ANT_2$.

**Sessions 2-8.** Each of the following seven sessions followed the same format as Session 1. An additional question was added prior to completing the session: *"Please indicate any time (in minutes) spent on mindfulness exercises since the last session:"* The response options where: *"0", "5", "10", "15", "30", "45", "60", "+60"*. The results of this question were averaged across the sessions and then subjected to a median split to create two categories of participant, those who completed 'low' [$Range_{Low}$: 0.00 – 1.88 minutes, $M_{Low}$ = 0.29 minutes] amounts of extra-experimental mindfulness practice and those who completed 'high'[$Range_{High}$: 2.14 – 60.00 minutes, $M_{High}$ = 20.10 minutes] amounts of extra-experimental practice. They then completed the MAAS-S and I-PANAS-SF, an intervention (Meditation, Colouring or Video), then repeated the I-PANAS-SF followed by the MAAS-S followed by the $ANT_1$, sessions took 30-35 minutes.

**Session 9.** Session 9 was identical to Sessions 2-8, except that the $ANT_2$ was also completed at the end of the session.

**Results**

**Dispositional and State Mindfulness.** ANOVA analysis of the MAAS-T results collected at Session 1 confirmed that the intervention groups were not different in dispositional mindfulness prior to the study [$F$ (2, 54) = .50, $p$ = .609; Means: Video = 3.40, Colouring = 3.45, Meditation = 3.60].

A three-way mixed-design ANOVA was conducted on the MAAS-S results, with Intervention Type (Video, Colouring, Meditation) as a between-subjects factor and Time (pre- or post-intervention) and Session (2 through 9) as within-subject factors, see Figure 9a-c. This showed only a main effect of Time, which indicated an increase in self-reported attentional awareness following the intervention regardless of Intervention Type [$F$ (1, 39) = 4.15, $p$ = .048, $\eta p^2$ = .10].

Closer examiner of Figure 8a-c, however, indicated a change in pattern between early and later sessions. Exploratory analysis of this pattern was conducted by averaging Sessions 2-5 and 6-9 and then conducting a mixed-design ANOVA with the averaged sessions, Time and Intervention Type (see Figure 9d). This resulted in a three-way interaction [$F$ (2, 54) =

3.22, $p = .048$, $\eta p^2 = .11$]. The early sessions (2-5) showed increases in reported attentional awareness post-intervention for the Mediation and Colouring Interventions, but no change for the Video Intervention. In the latter sessions (6-9), none of the Intervention Groups showed changes in reported attentional awareness from pre- to post-intervention though overall the post-intervention scores of the Meditation and Colouring groups were higher than the post-intervention scores from the early sessions. This could suggest that effects of the mindfulness were attenuating across sessions and that there is a limit to the amount of state change that can be accrued using these interventions.

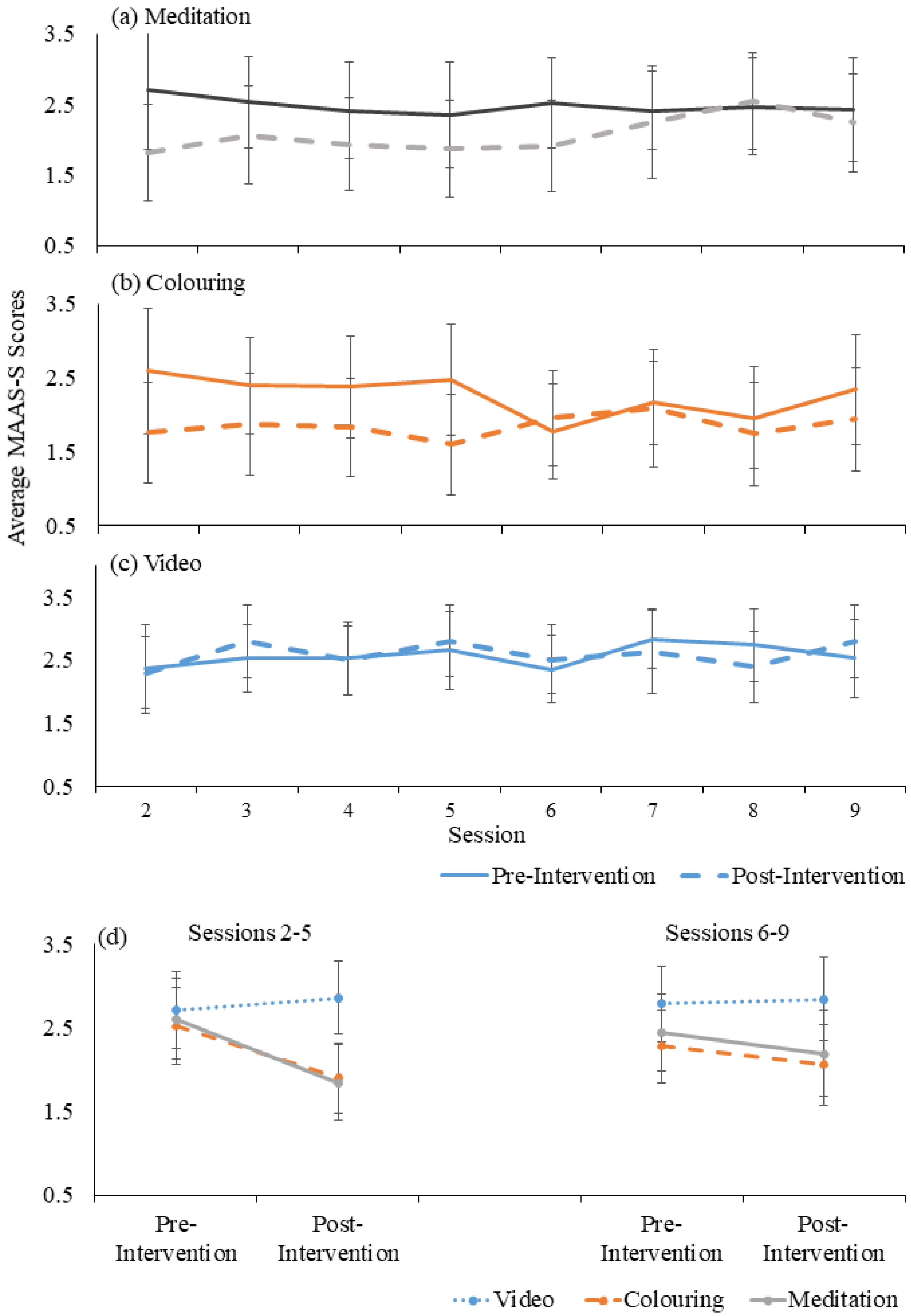


Figure 9. Mean responses to the Mindful Attention Awareness Scale - State (MAAS-S) pre- and post-intervention for all Sessions. (a) shows results for the Video Group, (b) Colouring Group (c) Meditation Group and (d) Combined results averaging sessions 2-5 and sessions 6-9. Error bars indicate 95% Confidence Intervals.

**I-PANAS-SF.** ***Positive Affect.*** A three-way mixed design ANOVA, with Session (2-9) and Time (Time 1: Pre-intervention, Time 2: Post-intervention) as within participant variables and Intervention Type (Video, Colouring or Meditation) as the between participant variable, shows a main effect of Session [$F$ (7, 273) = 4.53, $p$ < .001, $\eta p^2$ = .10], but not of Time [$F$ (1, 39) = .44, $p$ = .510, $\eta p^2$ = .01], or Intervention Type [$F$ (2, 39) = .19, $p$ = .826, $\eta p^2$ = .01]. There was also an interaction between Session, Intervention Type and Time [$F$ (14, 273) = 1.75, $p$ = .047, $\eta p^2$ = .08, see Figure 6].

Further analysis focused on each of the three groups. For the Video Intervention there was a significant main effect of Time [$F$ (1, 15) = 11.48, $p$ = .004, $\eta p^2$ = .43] indicating that positive affect decreased immediately after watching the video ($M_{Time\ 1}$ = 3.13, $M_{Time\ 2}$ = 2.98). For the Colouring Intervention there was a significant Session x Time interaction [$F$ (7, 70) = 3.32, $p$ = .004, $\eta p^2$ = .25] which was due to a significant increase in positive affect from Time 1 to Time 2 in Session 2 [$p$ = .009] which reversed in Session 8 [$p$ = .024]. There was also a main effect of Session [$F$ (7,70) = 3.79, $p$ = .002, $\eta p^2$ = .28] indicating a general decrease in positive affect across sessions. For the Meditation Intervention there were no significant main or interaction effects [all $F$'s < .90, $p$'s > .400].

***Negative Affect.*** The same three-way mixed design ANOVA run on the negative affect scores shows a main effect of Time [$F$ (7, 273) = 47.61, $p$ < .001, $\eta p^2$ = .55], with scores being lower at Time 2 [$M$ = 1.52] than Time 1[$M$ = 1.71]. There was no effect for Session [$F$ (7, 273) = 1.15, $p$ = .335, $\eta p^2$ = .03], or Intervention Type [$F$ (2, 39) = .53, $p$ = .593, $\eta p^2$ = .03]. There was an interaction between Time and Session [$F$ (7, 273) = 3.79, $p$ = .001, $\eta p^2$ = .09]. Simple effects analysis shows that in all Sessions, Time 2 negative affect was significantly lower than Time 1 [all $p$'s < .05] (see Figure 6). In Time 1 averages there is a significant decrease [$p$ = .008] in negative affect between Session 2 and Session 5, no other Sessions were different from one another [$p$ > .123]. This indicates that Time 1 negative affect decreases up to Session 4 after which negative affect remains constant, suggesting that there is some initial effect of all interventions on overall negative affect, but that this effect is achieved early and then plateaus.

In the Time 2 results no sessions were different from one another [*p's* > .900]. This indicates that although all the interventions lead to immediately decreased negative affect, this does not vary over the course of the study.

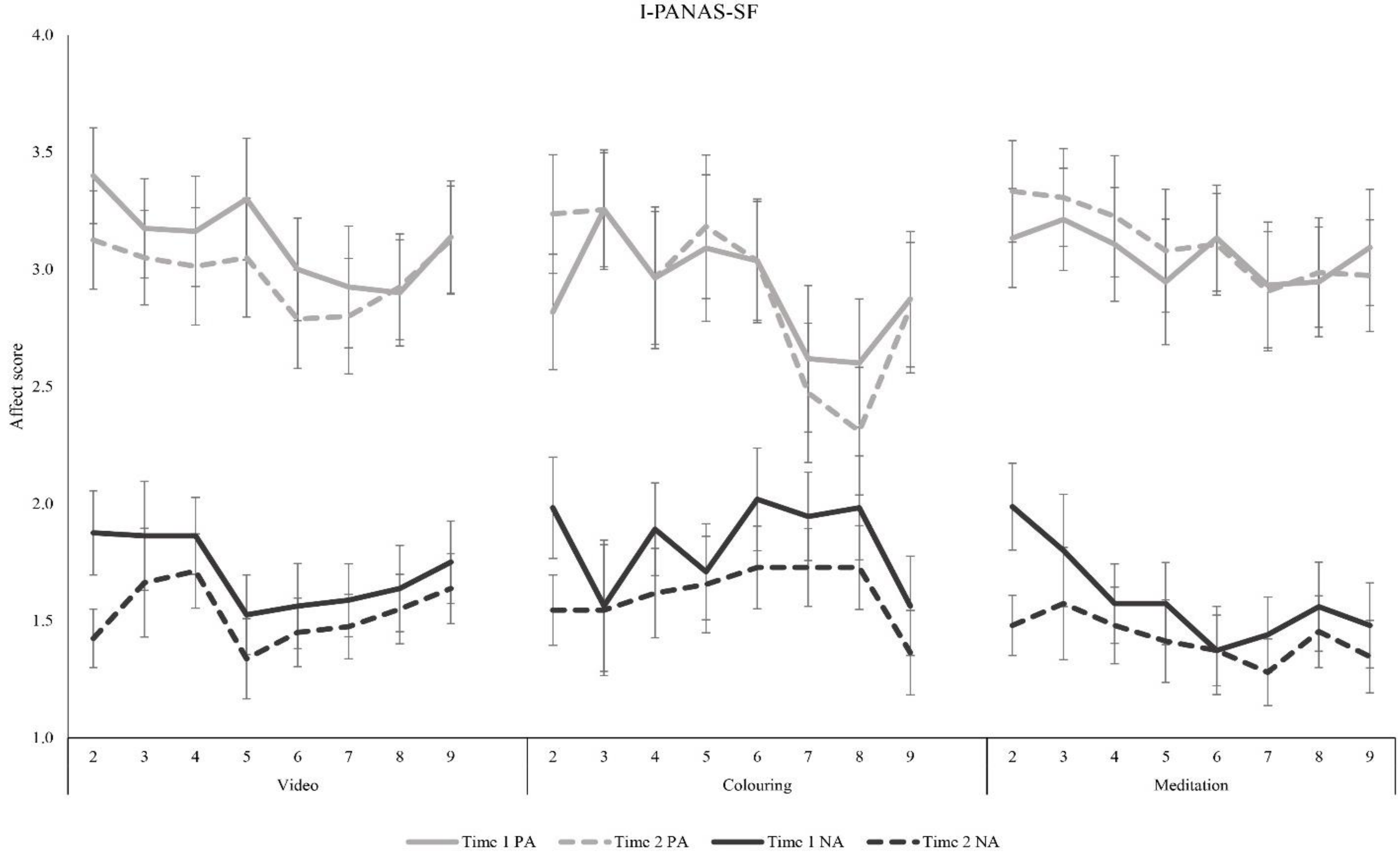


Figure 10. Mean scores for the International Positive and Negative Affect Schedule, Short Form (I-PANAS-SF) in Study 7. Error bars indicate 95% Confidence Intervals.

**ANT.** Mean results for the $ANT_1$ scores are presented in Figure 9. For each of the $ANT_1$ scores, an initial ANOVA was run to look at the effect of one iteration of the interventions, with a between-subjects factor of Intervention Type and a within-subject factor of Session (1 & 2). To look at the cumulative effect of training a second ANOVA was then conducted using Intervention Type and Sessions 1 & 9.

***One Session.*** After one iteration of the interventions, there were no interactions between Session and Intervention Type for any of the network scores [$F$'s $< 1.16$, $p$'s $> .321$]. However, there were indications of practice effect congruent with previous findings by Ishigami and Klein (2011); main effects show an increase in Alerting scores, a decrease in Executive scores and no difference in Orienting scores [Alerting: $F$ (1, 75) = 17.31, $p < .001$, $\eta p^2 = .19$; Orienting: $F$ (1, 75) = 0.21, $p = .651$, $\eta p^2 < .01$; Executive: $F$ (1, 75) = 13.55, $p < .001$, $\eta p^2 = .15$].

***Eight Sessions.*** The main effects of Session are replicated over after eight interventions. Alerting scores increased, there was no change in Orienting Scores and a decrease occurred in the Executive scores, suggesting an overall practice effect on the $ANT_1$ [Alerting: $F$ (1, 54) = 18.18, $p < .001$, $\eta p^2 = .25$; Orienting: $F$ (1, 54) = 2.20, $p = .144$, $\eta p^2 = .04$; Executive: $F$ (1, 54) = 57.02, $p < .001$, $\eta p^2 = .51$].

Orienting and Executive scores showed no interaction between Intervention Type and Session [$F$'s $< 1.30$, $p$'s $> .282$], but there was a moderate interaction for the Alerting scores [$F$ (2, 54) = 3.13, $p = .052$, $\eta p^2 = .10$]. Simple effects indicate that this interaction stems from a difference in change between the Meditation and Video Groups, with the Colouring Group sitting between the two. The Video Group shows an increase in the Alerting scores from Session 1 to Session 9 [$p < .001$], a change that is seen less strongly in the Colouring Group [$p = .069$] and is not seen at all in the Meditation Group [$p = .29$]. Table 13 shows the mean

RTs for the individual cue conditions ‘No Cue’ and ‘Double Cue’.

Table 13
*Mean RTs for No Cue and Double Cue Conditions (N=57) for $ANT_1$*

| | | Video Group | Colouring Group | Meditation Group |
|---|---|---|---|---|
| No Cue | | | | |
| | Session 1 | 501.79 | 511.6 | 495.76 |
| | Session 9 | 510.21 | 494.56 | 475.38 |
| | Difference | 8.42 | -17.04 | -20.38 |
| Double Cue | | | | |
| | Session 1 | 453.03 | 462.27 | 448.83 |
| | Session 9 | 431.40 | 432.88 | 421.20 |
| | Difference | -21.63 | -29.39 | -27.63 |

| | | | | |
|---|---|---|---|---|
| Alerting scores | Session 1 | 48.76 | 49.33 | 46.93 |
| | Session 9 | 78.81 | 61.68 | 54.18 |

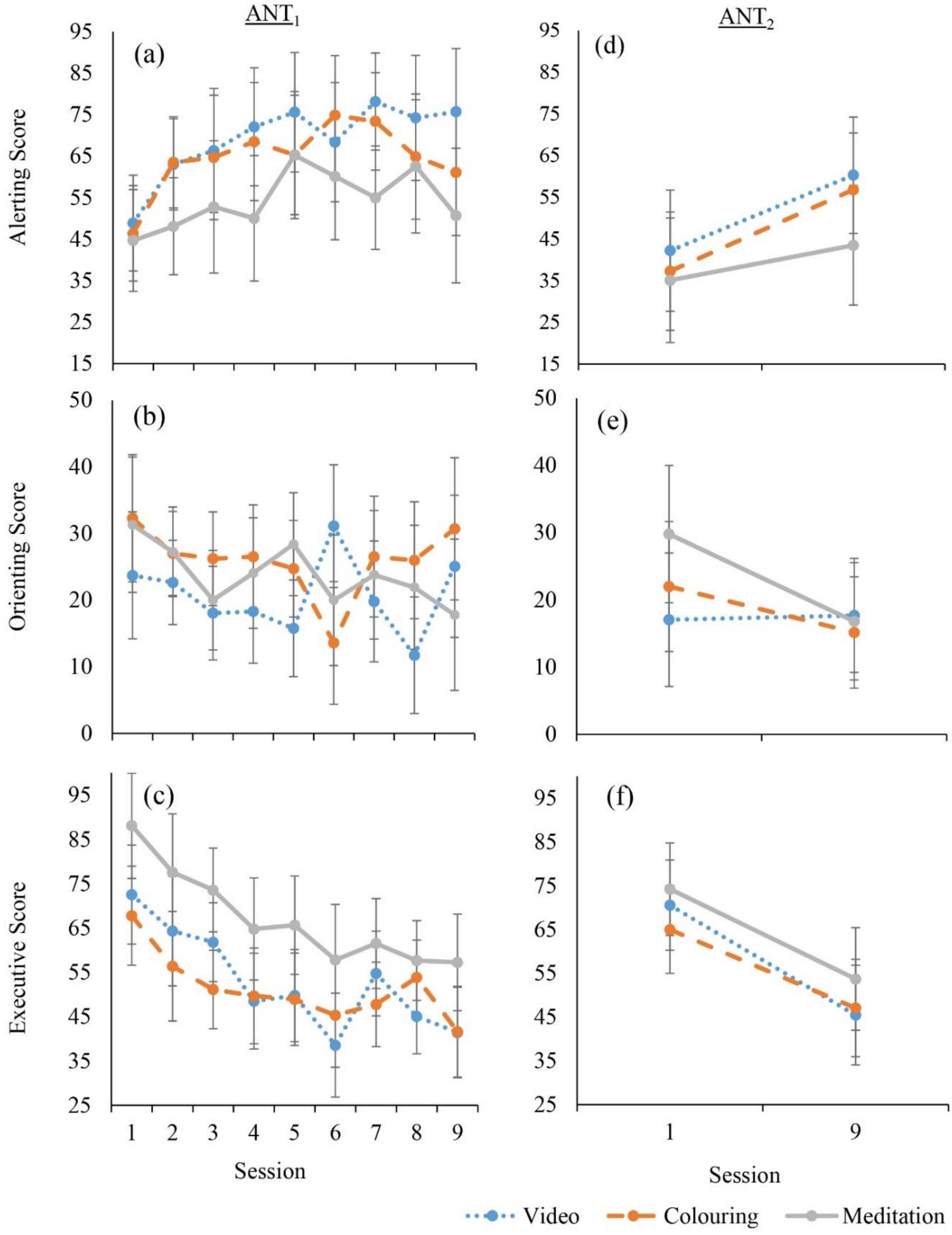


Figure 11. This figure shows the results of the Attention Network Tests ($ANT_1$ and $ANT_2$) from all sessions of Study 7. (a) shows the change in alerting scores from Session 1 through to Session 9 for the $ANT_1$ using arrow stimuli. (b) and (c) show the same information for the orienting and executive scores, respectively. (d) shows the alerting scores for the $ANT_2$, which uses the key stimulus in replacement of the arrow, for Sessions 1 and 9. (e) and (f) show the same information for the orienting and executive scores respectively. Error bars indicate 95% confidence intervals.

To check whether these results could have been affected by meditation and mindfulness conducted outside of the experiment this analysis was re-conducted after filtering out those who conducted ‘high’ amounts of extra-experimental practice. The pattern of results for the Alerting scores remained the same [$F$ (2, 29) = 3.90, $p$ = .032, $\eta p^2$ = .21].

There is some indication in Figure 11 that the Alerting scores changed at different rates for the three Intervention Types over the 9 sessions. For each group the trend was consistent with a linear pattern [all $F$’s > 4.5, $p$’s < .05], in addition there was a significant quadratic trend for the Meditation and Colouring Groups [$F$ (1, 14) = 8.19, $p$ = .013, $\eta p^2$ = .37 and $F$ (1, 16) = 11.86, $p$ = .003, $\eta p^2$ = .43 respectively]. This indicates that the increase in Alerting scores seen in the Video Group also occurs to some extent for the Meditation and Colouring Groups, but these later two reach a peak earlier and start to decrease during later sessions. This suggests that the meditation and colouring counteract practice effect on the $ANT_1$.

The Session (1 & 9) by Intervention Type ANOVA was also run with the added within-subject factor of ANT Style ($ANT_1$ & $ANT_2$) to see whether the results were seen in $ANT_1$ generalised to different target stimuli. ANT Style did not interact with either Intervention Type or Session for either Alerting or Orienting scores [$F$’s < 1.32 , $p$’s > .277], however, there was a moderate interaction between ANT Style and Session for the Executive scores [$F$ (1, 54) = 3.89, $p$ = .054, $\eta p^2$ = .07]. This appears to stem from a higher Executive score for the $ANT_1$ at Session 1 than found in the $ANT_2$ [$p$ = .041], which may be due to task learning in $ANT_1$ being carried over to $ANT_2$ immediately.

**Discussion**

**State Mindfulness.** The increase of state mindfulness seen in Sessions 2-5 of the Mindfulness and Colouring Interventions supports findings by Mahmood and colleagues (2016) showing that state mindfulness, measured by the Toronto Mindfulness Scale, increases shortly after meditation interventions. The lack of difference between the Mindfulness and Colouring interventions suggests that the internal focus of the FA meditation is not producing the observed change. Two possibilities for this lack of differentiation are that either it is the focused attention element of the tasks that is producing change, or that there is a placebo effect due to the 'mindfulness' label attached to both the meditation and the colouring task. Further research could explore whether 'mindful colouring' or simply 'colouring' produce a different pattern of results.

Although the MAAS was unable to distinguish between the Meditation and Colouring Groups, it is possible that other measures of state mindfulness might be able to do so. The Toronto Mindfulness Scale includes subscales for decentring and curiosity, which may elucidate more detail than the single factor MAAS scales. The reduction of the immediate effect of the Colouring and Meditation Groups in Sessions 6-9 indicates reduced efficacy of the interventions to create change in self-reported mindfulness. It would be interesting to explore in future research, whether further increases in attentional awareness are possible. For example, it is possible that attentional awareness might increase with either the duration of the meditation and/or continuing to practice for more sessions.

**I-PANAS-SF.** ***Positive Affect.*** The pattern of change (Time 1 to Time 2) in PA was different across the three Intervention Types. The Video Intervention showed an immediate decrease in PA after viewing the video at each session. The magnitude of this change did not vary across sessions. The Meditation Intervention showed no change either immediately after the intervention or over the course of the study. The Colouring Intervention showed a general decrease in PA over the course of the study as well as an initial increase in PA which reversed during Session 8. The changing pattern may reflect the level of engagement with the interventions. The colouring task required physically colouring in the patterns to produce something tangible which, over time, they may have become more reluctant to complete though there is no way of measuring this as record of the amount of colouring of each pattern was not collected. In comparison, the Meditation and Video Interventions were free not to engage with the task as there would be no objective measure of disengagement.

***Negative Affect.*** Neither of the focused attention tasks invoked a discernibly different reaction to the Video intervention, though all three interventions reduced negative affect.

***Overall***. It seems like the changes in positive or negative affect cannot explain the changes seen on the ANT.

**ANT.** ***Alerting Scores.*** Our findings demonstrate that a relatively brief meditation intervention can effect change with a few repeated sessions. In comparison with those completing the other interventions, those in the meditation intervention did not display the increased alerting efficiency associated with repetition of the ANT. It is unclear from these results why meditation would prevent the onset of the practice effect. However, one possible theory is that the participants found that the FA meditation practice required similar cognitive demands to those of the ANT and, as such, were affected by vigilance decrement.

Vigilance decrement is thought to be caused by the sizeable cognitive demands of vigilance tasks, the stress that they cause, and the limited nature of cognitive resources (Norman & Bobrow, 1975; Posner et al., 1980). Previous work has shown that the more similar a ‘break’ task is to the vigilance task, the less likely participants are to benefit from the change of task in terms of renewing their vigilance level (Helton & Russell, 2015). Therefore, if the FA meditation task shares cognitive requirements with the ANT you might expect to see reduced alertness and vigilance on the ANT after completing an FA meditation.

This runs contrary to previous theories on the expected effects of mindful meditation interventions on attentional processes. MacLean and colleagues (2010) hypothesised that mindful meditation interventions lead to a reduction in the cognitive cost of visual perception tasks which is directly related to improved vigilance in such tasks, their findings were further supported by those of Brown, Forte and Dysart (1984). However, this could be moderated by the amount and style of mindful meditation used in their interventions as it has also been shown that the level of activation in alerting tasks is higher in novices than those who have completed 19,000h – 44,000 hours of meditation (Brefczynski-Lewis et al., 2007). Participants may well alter the way in which they engage with both the cognitive and mindful meditation tasks as their meditation practises progress. Certainly, this would be an interesting avenue for future research.

The Colouring intervention results appear to sit between those of the Video and Meditation conditions. This suggests that the nature of the FA, whether it is directed internally or externally, might be important to the effect of the task on alerting efficiency. This possibly suggests that the meditation condition is either more cognitively demanding than the Colouring intervention or has more in common with the ANT.

Our results indicate that the maintenance of Alerting scores seen for the FA Meditation Intervention as well as the increase in Alerting scores for the Video Intervention may have generalised from $ANT_1$ to $ANT_2$. This suggests that the interventions used altered attentional processes that are independent of the particular stimuli (arrow or key) used in the two tasks;

however, this generalisation may be affected by the fact that we changed the flanker stimuli but not the cue stimuli.

***Orienting and Executive scores.*** There is no clear evidence of either FA tasks having a significant impact on either the Orienting or Executive scores. It is interesting that others have found effects of meditation and mindfulness on both Orienting and Executive scores whilst this approach has not. This may be because FA styles of meditation do not include the elements of mindfulness practice that induce these changes. There is some evidence to suggest that both Orienting and Executive Networks are linked to processes of self-regulation and emotional regulation (Harman, Rothbart, & Posner, 1997; Posner & Rothbart, 1998, 2000). Tang and colleagues have found changes in Executive scores using IBMT techniques (Tang et al., 2007; Tang, Tang, Jiang, & Posner, 2014), though Alerting scores were not consistently found to improve suggesting that self-regulation can improve separately from vigilance. Conversely, it is possible that short FA interventions have had a significant effect on participant's vigilance they have not increased self-regulation of attention, and have therefore not induced significant changes in either the Orienting or Executive Networks.

***Control task.*** The Video Intervention's results replicate previous research on longitudinal testing of the ANT (Ishigami & Klein, 2011); Alerting scores increased, Orienting scores did not change on average, and Executive scores decreased. This indicates that it worked as a passive control task.

**Limitations.** It has been suggested that the difficulty in estimating statistical power, due to issues of accurately calculating reliability, should lead to all network-specific effects being treated with caution (MacLeod et al., 2010). This idea is further supported by recent work that highlights issues of RT reliability in cognitive literature and difference scores particularly (Draheim, Mashburn, Martin, & Engle, 2019). Further work should look to replicate these findings using other attentional tasks and with greater sample sizes to compensate for the high rates of attrition present due to the longitudinal design.

## 4.8 Conclusion

### Summary of Findings

Study 4 showed no effect of intervention on ANT scores. Scores did change over time, possibly as a function of practice.

Study 5 indicated that length of task might affect the presence of practice effect, with the longer interventions displaying changes congruent with practice effect on the shortest intervention showing no changes over time. However, these changes did not interact with interventions and therefore show no evidence of FA or meditation related change. MAAS-S scores also showed no change and there was no relationship been changes seen in the I-PANAS-SF and changes in the ANT scores. Increased Executive scores in the colouring condition suggest that there was higher levels of conflict for participants in the colouring conditions than the other conditions. There were no three-way interactions between Time, Intervention Length and Intervention Type that would indicate increased effects of a particular intervention on attentional scores.

In Study 6, MAAS-S scores increased after all interventions, but decreased over repetitions of the experimental session. I-PANAS-SF affect scores decreased over repeated session but showed no effect of Intervention Type. In the ANT, Alerting scores increased over the repeated sessions demonstrating increased alerting efficiency, however this did not interact with Intervention Type. Neither Orienting or Executive scores showed any main effects or interactions.

In Study 7, MAAS-S scores showed a general increase in MAAS-S scores after participants had completed and intervention, when this was divided across early sessions and later sessions there was an interaction with Intervention Type. With the FA tasks having a positive impact on MAAS-S in early sessions and a plateau of these changes in later sessions.

The I-PANAS-SF scores showed a reduction in NA over the course of the study, but no other effects. The ANT tasks showed Increased Alerting scores in the Video and FA colouring tasks, but no associated increase in FA meditation tasks. Orienting and Executive scores showed differences between Intervention Types.

### Implications

This research gives an insight into the time-course effects of FA mindful meditation practice, something not previously examined in the literature. Applying our method of investigation over a range of dosages and meditation approaches may lead to a clearer understanding of their effect on different cognitive functions and therefore help develop more targeted applications of mindfulness-based interventions.

### General Conclusion

These results suggest three novel findings; the first is that 8-minute FA interventions significantly change state mindfulness as measured by the MAAS-S and do so repeatedly in the same population. The second is that single sessions of up to 18 minutes of FA meditation do not induce attentional change in novice meditators as measured by the ANT. Thirdly, mindfulness-based FA tasks delivered in short sessions can lead to significant changes in individual's ability to maintain alertness and that an internal focus may make this change more pronounced than an external focus. Future research should continue to break down the effects of mindfulness meditations and related interventions. For example, more research using variants of the Meditation and Colouring Interventions could lead to more accurate hypotheses on the efficacy of individual elements at invoking cognitive change.

# CHAPTER 5: GENERAL DISCUSSION

## 5.1 Overview

This chapter summarises the four main chapters of the thesis, and reviews the key findings from the empirical work presented in Chapters 3 and 4. The findings are discussed in relation to the literature, and lines of further enquiry are highlighted. It then covers the strengths and weaknesses of the present research and discusses implications for these in relation to the reliability and generalisation of these findings to the wider field. Overall observation and conclusions are contextualised and discussed and final conclusions are then drawn.

## 5.2 Summary of Chapters

### Chapter 1

Chapter 1 introduced the origins of mindfulness and meditation. Associated practices developed mainly in societies that had used psychoactive substances to purposely induce changes in mental state, otherwise known as Altered States of Consciousness (ASCs). These practices then developed in eastern religious and spiritual traditions (Johnson, 1982). In Buddhist traditions 'sati' or 'Correct Mindfulness' is a desired mental state that is one of the eight elements of the eightfold path, which leads to enlightenment and the cessation of human suffering. It has been translated into English as meaning 'non-judgemental awareness of the present moment' (Kabat-Zinn, 1990). Meditation is one of several methods that are commonly used to encourage, practice and consolidate mindful mental states. It is can be identified in several ways. The first is the object of focus (Goleman, 1988) and the second is the specificity of attentional focus (Lutz et al., 2008). Specificity of focus is usually split into two clear categories, focused attention (FA) where the attention is aimed a narrow stimulus or set of stimuli, and open monitoring (OM) where the focus is diffuse across arising stimuli.

The movement of these ideas into the West has led to increased secularisation and a growing use of mindfulness and meditation in clinical settings. With this rise of clinical usage has come a rising interest in the cognitive mechanisms involved in producing behavioural change. Hölzel and colleagues (2011) have hypothesised four key areas of cognitive change: emotion regulation, self-perception change, body-awareness and attention regulation. Research into the effect of mindfulness-based interventions on the processes associated with attention have shown a range of conflicting results. In general, it is believed that mindfulness-based interventions do have a positive effect on the three core networks of attention: alerting, orienting and executive control (Tang & Posner, 2009). However, there are issues in the mindfulness and meditation literature that mean that firm conclusions on the affects of interventions on cognitive processes are hard to make.

**Chapter 2**

Chapter 2 covered the core issues in the meditation and mindfulness literature that influence cognitive research. These issues have affected the literature by rendering studies incomparable and by lacking elements that would improve academic rigour.

The first issue discussed in Chapter 2 is the variation in definition and operationalisation of both mindfulness and meditation. The breadth of meaning that these terms encompass means that there is a proliferation of practices that are hard to differentiate (Van Dam et al., 2018). This has particularly effected style of practice. Practice style shows variation is affected by the tradition from which it has developed, as well as the individual session length, time between sessions and overall number of sessions in the intervention (Hölzel et al., 2011). The comparison of results is further affected by the varied delivery systems and approaches. Content can be personalised for the recipients in varying degrees and is sometimes targeted individually and sometimes to groups. Some content is delivered face-to-face, some online and some in combinations. However, even if the effects of task delivery, quantity and personalisation did not affect the cohesiveness of the literature, experimental design has limited our understanding of underlying cognitive processes.

Experimental practices have not included the use of time-series data collection and analysis. The effect of this is that it remains unclear whether meditation and mindfulness induced cognitive change is linear or follows different trajectories. Training and learning is an effortful process that involves many cognitive networks, and it may be assumed that not all processes will change in concert. Added to this lack of time series data, there is a distinct issue with measuring mindfulness. There is no empirical method for checking that mindfulness meditation interventions are invoking a more mindful state. The lack of suitable empirical methods leads to a reliance on self-report measures (Van Dam et al., 2018).

Lack of ability to measure the difference pre-to-post intervention is compounded by the lack of understanding about how people engage with mindfulness and why they dropout from longer-term studies. It has been suggested that some people have negative experiences with mindfulness and meditation practice, though the evidence for or against this argument is limited (Farias & Wikholm, 2015). Similarly, there could well be selection biases for studies advertised as mindfulness or meditation-based research. Certainly, participant selection and matching for longer term meditators is lacking in rigour on several fronts. Controlling for types of practice in longer-term meditators is extremely difficult, as most will have utilised a range of practices over time (Nystul & Garde, 1979; Rivers & Spanos, 1981). Controlling for possible personality characteristics that encourage prolonged use of meditation and mindfulness is also difficult.

**Chapter 3**

Chapter 3 focused on the effects of a brief FA meditation on measures of time perception from a time bisection task (BP and WR). This was because the brief FA meditation had previously been shown to produce change in time perception in comparison to control tasks on these measures; as such, it was a known effect that could be manipulated.

Study 1 suggested that the changes induced in BP and WR after brief FA meditations are not produced by changing patterns of construal to more concrete or more abstract patterns. Study 2 showed that increasing the amount of self-practice in FA meditations does not change the amount of change in BP or WR, but may consolidate these changes. Studies 1 and 2 also suggested that self-reported attentional awareness and changes in BP are not related.

Studies 3a and 3b focused on the effects of the FA colouring task. They also demonstrated the lack of relationship between self-reported attentional awareness and BP. The FA colouring task elicited the change in BP seen in the FA meditation conditions but did not replicate the changes in WR. Study 3b found an inverse relationship between the number of colours used by participants and their reported engagement.

**Chapter 4**

Study 4 showed that the brief meditation and colouring FA tasks have no impact on attention measured by the ANT. Study 5 indicated that longer tasks between ANT repetitions elicited changes in score that replicate practice effects from the literature across all intervention and control tasks, though there was a group-difference in Executive scores for the FA colouring condition. In both Studies 4 and 5 there was no change in MAAS-S scores.

Study 6 showed increasing Alerting scores over the 5 repeated testings' of the ANT, showing increasing alerting efficiency. The other ANT scores showed no change and the changes in Alerting were uniform across intervention and control tasks. Study 6 showed increased MAAS-S post intervention, but MAAS-S decreased overall over the 4 repetitions of the interventions and control tasks. Changes in MAAS-S and Alerting scores did not correlate.

Study 7 elicited a quadratic change in the Alerting scores over the 9 testing sessions for the FA meditation participants, with scores for the FA meditation task being no different at Session 9 to Session 1. Conversely, the FA Colouring and the Video conditions showed increased alerting efficiency. MAAS-S score again increased directly post-intervention. Division of early sessions and later sessions in the programme suggested maintained overall increases in MAAS-S for the FA tasks not found in the Video tasks. Once again, changes in

MAAS-S were not related to changes in ANT scores. I-PANAS-SF scores showed that NA declined over the course of the study, but there were no other effects on mood.

## 5.3 Review of Key Findings

The empirical studies have produced five key findings that have implications for both the methodical and the theoretical literature. This section will explore the findings and contextualise them within the literature, as well as making some suggestions for lines of further enquiry for each of the key findings.

### Bodily Focus and Arousal Modification

The FA tasks used in this programme of research show changes in time perception associated with attentional processes and in line with the results of Kramer, Weger and Sharma (2013), whether the task is internally or externally focused. However, this finding is not replicated in the temporal measures associated with arousal. Reductions in arousal are present in the FA meditation conditions of Kramer, Weger and Sharma (2013) as well as Studies 1 and 2, but not the FA colouring tasks used in Studies 3a and 3b. There are two elements that differentiate the colouring and meditation conditions that may have led to the different manipulations of time perception. The first is the bodily-focus of the FA meditation versus external object-focus of the FA colouring task, the second is the motor element of colouring that is not in the FA meditation.

Hölzel and colleagues (2011) hypothesised that there were four areas of cognition that were changed by mindfulness practices: attention regulation, body awareness, emotion regulation and change in self-perception. An extension of these hypotheses is that focusing attention on bodily sensation and awareness in a mindful manner may lead to cognitive changes not seen if the focus is located on external objects. Further research suggests that focusing on the self, mental or physical, should be associated with increases in DMN activity that is not replicated if the focus is on an external locus (Andrews-Hanna, Smallwood, & Spreng, 2014; Berkovich-Ohana et al., 2016). The DMN and DAN have, in turn, been linked to physiological measures of autonomic arousal. This link to autonomic arousal processes has led some to postulate that large portions of the activity of both networks are associated with monitoring internal and bodily states (Fan et al., 2012). If, then, the FA meditations bodily focus leads to a more active engagement of the DMN it should have an impact on levels of arousal. In contrast, the FA colouring requires less conscious processing of bodily sensations and may not activate the same self-referential processes. This would explain the observed differences between the results of the FA tasks on the measures of arousal.

Overall, the reduction of arousal seen between Studies 1 & 2 and the lack of such reductions in Studies 3a & 3b suggest that the processes in FA meditation that lead to the observed changes in attention and arousal are separable, and may be related to the presence or absence of bodily focus. However, further research directly comparing the interventions, and further variants of the tasks would be needed to rule out the confounding motor movement differences between the FA interventions.

**MAAS-S Scores and Dosage**

MAAS-S does not seem to be effected by the shorter FA meditations, but is changed by longer and repeated interventions. Study 7 shows this change attenuating over time. As mindfulness is conceptualised as a combination of different facets (Baer et al., 2006; Leary & Tate, 2007), it could be that short FA interventions invoke some state changes immediately and others only as the individual learns the practice. This means that MAAS-S may be a helpful manipulation check for longer meditations, but the evidence presented here is that these short FA interventions do not induce perceived changes in attentional awareness.

It may be that a few measures of state-mindfulness need to be actively compared to look at the efficacy of brief mindfulness interventions to invoke change in different measures and facets of state-mindfulness. A breathing exercise of 5 minutes has been found to elicit change in the Toronto Mindfulness Scale (TMS) by Mahmood and colleagues (2016), so comparisons between this, the MAAS-S and other state mindfulness scale would be a productive line of enquiry for informing future use of self-report mindfulness as manipulation checks.

As the MAAS-S is a self-report measure, it is also possible that there are demand characteristics associated with repeated or elongated interventions. If individuals feel that, having completed a mindfulness intervention for a certain duration, they should feel more mindful or more aware of themselves they may report accordingly. It might therefore be interesting to know if other state mindfulness measures show similar changes, and to investigate the relationships between attitudes towards mindfulness and meditation and the mental experience of mindfulness and meditative practice in novice practitioners.

**Metacognitive Judgements and Measures of Attention**

Although larger FA meditative dosages have elicited increases in self-reported mindfulness through this programme of research, analysis of changes in TP and ANT scores show no relationship between cognitive and self-report measures of attention. The lack of relationship between changes in self-reported attentional awareness and cognitive measures of attentional change suggest that the two tap into separate concepts. Self-reported attentional awareness requires personal judgement of attentional awareness not attentional awareness itself; therefore, it might reflect meta-cognitive ability as well as attentional ability.

Metacognition is our awareness of our own qualities and awareness-states. It is commonly measured on several axes, one of which is accuracy (Song et al., 2011; Washburn et al., 2005). Metacognitive accuracy is our ability to accurately report on our own abilities and qualities. As such, if meta-cognition is inaccurate then self-reported attentional awareness will be inaccurate. As there is some evidence to support the idea that mindfulness practices lead to more accurate judgements of self-awareness (Baird, Mrazek, Phillips, & Schooler, 2014; Jankowski & Holas, 2014; Song et al., 2011), it is possible that a relationship between self-reported attentional awareness and cognitive measures of attention would be seen at higher levels of meditation experience.

Overall, this supports previous research that suggests a dissociation between ability and metacognitive judgments on ability. More specifically for the mindfulness and meditation literature, it suggests that self-reported attentional awareness should not be used in place of behavioural and empirical measures of attention and attentional efficiency. Though self-report mindfulness measures may have been shown to be fairly robust (Baer et al., 2006), it does not mean that they are measuring the desired concept.

**Single Brief Dosages and the ANT**

A single session of the brief FA tasks did not produce change in the ANT in comparison to the control task in through Studies 4-7, neither did the ANT scores show change in Study 6 when there were repeated interventions. The lack of effect of single or un-spaced dosages of up to 18 minutes in inducing immediate attentional change, as measured by the ANT, contradicts the observed changes in the BP scores of the time bisection task. The reasons for the disparity between the findings of the two tasks is unclear. It is possible that the amalgamated attentional measure represented by the BP score is more sensitive to attentional change than the ANT, or that it represents a greater range of attentional processes that is exemplified by the three scores from the ANT.

Observing the changes in BP over longitudinal interventions such as those found in Study 7 may also provide more information, as it is currently unclear how the positive change in attention seen in the BP data might mesh with the negative impact of the FA meditation task on the Study 7 Alerting scores. A direct comparison between changes in the ANT and time bisection task BP scores might provide a clearer picture of whether the attentional measures are indicative of the same processes. Further investigation of the statistical issues surrounding difference scores are also of particular relevance for the comparisons between tasks, but this is discussed in the limitations below.

**Spacing and Repeated Dosing Leads to Changes in Alerting**

The spaced, repeated dosing of FA meditation in Study 7 invoked a reduction in alerting efficiency in comparison to the FA colouring and the Video conditions. Although the changes in Alerting are not supported by similar changes in the other networks, the fact that attention is theoretically assumed to be a set of competing, but related, processes should lead to the assumption that these systems will interact, but that changes in attention may not occur in a purely linear fashion. Although the changes represent ‘negative’ changes, this may not be the whole picture. A change in processing style may lead to improvements down the line (see the study that shows changing effects of meditation over larger scales). For example, if it is assumed that the reduction in Alerting is a reflection of vigilance decrement due to the continued cognitive demand of the FA meditation task, then this would suggest that the participants are engaging in learning a new skill or task. As that skill/ task becomes more automated it may be that there are benefits from that learning that would be present themselves until later testing, when the skills have been improved and consolidated.

It is possible that the increased cognitive effort involved in the meditation task, as compared to the Video task, has led to greater participant fatigue in those using the meditation. In this case the reduction in alerting could be interpreted as vigilance decrement (Norman & Bobrow, 1975; Posner et al., 1980). Vigilance decrement, the degradation of vigilance efficacy over time when a participant is completing a continuous vigilance task, is thought to continue to increase across consecutive tasks, if the tasks involve similar cognitive demands. Therefore, if the ANT shows evidence of vigilance decrement then it might be assumed that the FA meditation task is utilising the vigilance networks in a way that is similar to their measurement in the ANT. The FA colouring task includes a greater range of activity that may make it different enough from the meditation task to avoid the vigilance decrement in this paradigm.

The quadratic trend seen in the longitudinal Study 7 suggests that there are attention changes over time with the repeated use of FA meditations. This fits with data presented by Brefczynski-Lewis and colleagues (2007) that attention can change for the worse whilst training mindfulness and meditation techniques. In their study they show measures of neural activation during attention-based tasks are higher in ‘experienced’ than ‘novice’ meditators (note that in this study novices were defined as having completed less than 19,000h of mindfulness or meditative practice), but that these indices improved in ‘expert’ meditators. This changing activation pattern suggests cognitive effort for attentional processing changes over the course of meditation or mindfulness-based practice. Considering that other researchers have found improvements in attention over much shorter time and practice intervals, the increased activity may be an indication of changing cognitive processes, but does not necessarily imply reduced attentional ability (Jha et al., 2007; MacLean et al., 2010; Posner & Rothbart, 1998). If FA meditations do lead to improved attentional abilities, longer longitudinal versions of Study 7 might indicate the point at which attentional improvements begin to be seen or at which the other attentional networks start to be affected by the intervention.

## 5.4 Strengths and limitations of the research

The key findings should be considered within the context of this research. As such, this section covers the key strengths and limitations of the research, covering first the methodological and statistical approaches and then generalisability of the research. The methodological and statistical section covers: data collection on possible confounds, manipulation checks, consistent use of interventions, thorough investigation of small-scale changes to interventions, issues of statistical power and reliability, and sampling technique. Generalisability looks at the use of control conditions, lack of knowledge on placebo effects and theoretical and practical implications of dividing 'meditation and mindfulness' into more specific subsections of practice style. In-depth discussion of the strengths and limitations of the research is considered important for the on-going improvement of the mindfulness and meditation literature.

### Methodological and Statistical Approach

**Strengths.** ***Comparisons between self-report and behavioural measures*****.** Examination of the relationship between changing state-mindfulness measures such as the MAAS-S and cognitive tasks has not previously been looked at over a brief intervention. The continued use of the MAAS-S both pre- and post-intervention has highlighted several important ideas for further explorations. Firstly, that there is, consistently, no relationship between the changes in MAAS-S and either the BP or ANT scores, suggesting that changes in awareness of attention are not related to changes in cognitive measures of attention. Secondly, that brief FA meditations do not always invoke change in measures of MAAS-S though the ~20-minute interventions and the longitudinal interventions did lead to increased mindful attentional awareness as measured by the MAAS-S. These findings suggest that the use of a combination of self-report and cognitive measures might lead to a richer understanding of the relationship between perceived and actual behavioural change.

***Dosages.*** Another strength of this research is its thorough investigation of dosage effects, taking in to account that dosage can be changed and administered in a wide range of different ways. Taking a methodological and incremental approach to examining the effect of dosage has led to a replicated set of findings that have slowly built a reliable base-picture of the effect of these FA meditation and FA colouring tasks on both time perception and attention networks. By trialling many combinations using the same interventions, this research programme has avoided of the incomparability between dosage amounts found in other streams of mindfulness and meditation literature. Continuing on this incremental approach would further enhance our understanding of the mechanisms of such FA tasks as it may show larger changes over time and might highlight relationships between networks that have not previously been identified. However, identifying whether such relationships exist across time we might learn more both about the effects of FA meditations and the nature and interactions of attentional networks.

***Extra experimental practice***. Collection of extra-experimental practice information in longitudinal studies and thorough record of previous practice in one-session studies has provided us with a more accurate picture of how FA meditation changes over time. The fact that results in the longitudinal study 7, are watered-down by the inclusions of those who conducted extra-experimental practice suggested further evidence that using a range of practices may induce different cognitive changes over time. It also demonstrates that when working with novice meditators is important to account for the fact that mindfulness and meditation techniques are being offered by many sources in their day-to-day lives, so longitudinal studies are unlikely to remain the sole source of mindfulness and meditation over extended periods. These experiences can then lead to participants experiencing styles other than the intended ones, and for those in control conditions to bring meditative techniques where they are not supposed to occur. Even at the University of Kent sources of mindfulness practice are being offered at the gym, by Health and Wellbeing, by student led groups, as pre-exam sessions to alleviate stress, others by experimenters working on a range of paradigms across academic schools

Indeed, the ability of this approach to duration and modelling of networks over time is important for the understanding of the onset of cognitive change, especially in novices. The ability of meditation to produce meaningful change in both cognition and wellbeing is valuable information. With the rise in popularity of meditation interventions across society, understanding the levels that are meaningful for invoking the intended positive effect will be invaluable information, especially for institutions such as the NHS for whom cost/ benefit calculations are vital. Especially for investigations in novice practitioners and for cognition-based research, dosage should be carefully considered and extending to time-series would further highlight longitudinal change.

**Limitations.** ***Reliability of the ANT scores.*** A key limitation of this research resides in the unclear reliability of difference-score based measures, such as the ANT. Though there is some evidence to suggest that repeated use of the ANT improves reliability of results (Ishigami & Klein, 2011), the statistical community remains divided on how reliability of difference-score measures should be accurately calculated (Draheim et al., 2019). This has led to suggestions that all network specific effects from the ANT should be treated with caution (MacLeod et al., 2010). Draheim and colleagues (2019) have argued that the conventional methods of calculating task reliability underestimate difference scores, but there is currently no better framework for assessing reliability. In order to be more certain of the results, replication of the effects on the ANT would need to be found and it may be necessary to show similar findings on tasks that are not reliant on difference scores but still have some ability to distinguish between attentional networks.

***Sample sizes.*** A second limitation of the research is the sample sizes of the intervention groups. Whilst all of the experiments would benefit from higher participant numbers to increase statistical power, this is particularly true for Study 7. The sample sizes collected in Study 7 were lower than expected as they suffered from high dropout rates. For longitudinal research, there are several methods that may reduce fatigue or investment-based drop-out or increase the number of participants that can be included in the analysis even with partial data sets. Firstly, the use of linear mixed models could increase power by allowing for the modelling of missing data therefore leading to lower exclusion rates (Ibrahim, Chen, & Lipsitz, 2001).

Planned missing data designs in time-series data would make the testing process less onerous on the participant (Jorgensen et al., 2014). Planned missing data designs are when different participants provide, for example, data at Time 1 and Time 5 but only at two of the four intervening times points. Participants are randomly assigned to their missing data points. As missing data designs require less input from the individual over a longer course of data collection, this may encourage more participants to maintain participation across longitudinal testing and therefore reduce dropout rates. Combining this approach with longitudinal mixed-models analysis approach, which allows for the modelling of missing data, would further increase power.

***Statistical tests.*** As stated above, Study 7 suffered from high participant drop out, but was also affected by missing data in the intervening sessions. Designing for analysis using linear mixed-models approaches would allow for the modelling of missing data.

**Generalisability**

**Strengths.** ***Control Tasks*****.** The majority of control tasks in the literature are either wait-list style control tasks or relaxation tasks that involve breathing and muscle relaxation, without a focus on the intentions that might invoke a mindful state (for examples see: Roeser et al., 2013; Droit-Volet et al., 2015). These control tasks are not designed to elucidate the working mechanisms of mindfulness interventions they are associated with, as they are not designed to control for active elements within the practices they are used to control for. The FA colouring task, however, was specifically designed to control for internal focus and providing an objective measure of engagement. This allowed for the observations of lack of changes in arousal for the FA colouring task compared to the FA meditation task. Further exploration of incrementally changed FA tasks could therefore provide further insight into which elements are the most efficacious in provoking cognitive change.

The results of the ANT did generalise from $ANT_1$ to $ANT_2$, though the cue stimuli were the same. However, the fact that the results seen in the time perception task were not clearly observed in the ANT suggests that generalising across attentional tasks with these intervention lengths is not appropriate. The use of the FA colouring task, and its related results, suggests that elements of the 'FA' part are efficacious, but also that internal-focus, whether because it is self-directed or because of increased body-awareness, leads to some of the change.

**Limitations.** ***Lack of placebo investigation.*** An issue rarely covered in the literature is the possibility of placebo effects of the terms 'mindfulness' and 'meditation', with the growing popularity of the term and the positive hype around the terms it is possible that they will induce certain states of mind or behaviours in participants (Baer, 2003; Goldberg et al., 2017). Further research should investigate these effects, particularly in their relationship to active control tasks and the effects of brief meditation or mindfulness practices. Whilst the placebo effect is not negative in and of itself, it is certainly worth knowing whether the practices or merely the beliefs in the efficacy of the practices are inducing a change in short term interventions.

The use of the 'mindful' colouring FA task as an active intervention was used in comparison with a more passive nature-watching Video task and a FA meditation for Studies 4-7. Whilst the use of the colouring task provided an observable, externally focused comparison to the FA mindfulness meditation, there was no control for the idea that both the meditation and the colouring task were 'mindful' as the term was not associated with the nature-watching Video task. Though there is little published research looking at whether the term mindfulness induces specific cognitive reactions or states (Goyal et al., 2014; Malec & Sipprelle, 1977; Segal et al., 2010), it does mean that there is an added and unnecessary confound in the comparison of the meditation and active control task to the passive control task.

***Dual nature of the FA tasks.*** In general, these results should not be generalised to other types of mindfulness and meditation practice, but some more research needs to be done to generalise across FA styles of meditative practice. Particularly in comparing the effects of explicitly FA meditation practices. Even within this short FA meditation there are multiple tasks and elements. The FA meditation task includes both a breathing and a body scan task and, particularly in the body scan task, there is a shift in the specificity of attention, with the instructions '*expand your attention to include…*' culminating in the inclusion of the whole body in attention. It is possible that it might be better to further breakdown tasks to include one set task, this would give a clearer, more definitive answer to the affective parts. Further research may wish to use a variety of interventions that include the original FA meditation task and the component tasks of breathing exercise and body scan individually as further experimental tasks. This continued breakdown of practices may face resistance from factions of the research arena, as it moves away from the compliment of practices that are usually found in Buddhist and religious practices, but may also highlight particular importance of individual types of task or practice.

The majority of work on the cognitive effects of mindfulness in novices must first work towards an excepted set of manipulation checks, active control tasks and brief meditations that are confined to a single task or element allowing for more highly controlled experiments. Without this, the conclusions relating to mindfulness and meditation patterns are open to wide range of interpretations, unpublished null-results and disparity that may lead to erroneous comparisons and conclusions.

## 5.5 General Implications

### Methodological Implications

***Theoretically designed control tasks.*** The majority of work on the cognitive effects of mindfulness in novices must first work towards an excepted set of manipulation checks, active control tasks and brief meditations that are confined to a single task or element allowing for more highly controlled experiments. Without this, the conclusions relating to mindfulness and meditation patterns are open to wide range of interpretations, unpublished null-results and disparity that may lead to erroneous comparisons and conclusions.

***Sensitivity and reliability of attention measures***. In terms of methods for future research, there needs to be some discussion about the efficacy and sensitivity of attentional measures. Is the hypothesis that shifts in BP are reflective of shifting attentional performance, and then the time perception task is indicating attentional shifts after only 5 minutes of FA meditation. Conversely, the ANT – specifically designed as an attentional measure - is not. There are several possible explanations for this. The first is that the time perception task is more sensitive to attention change. If this is the case, this may be a reflection of the reliability of the ANT. Further exploration of attention measures not dependant on difference scores would be needed to evaluate comparative reliability of the ANT in measuring small-scale attentional change. Alternatively, it is possible that the hypothesis that the shifting BP is indicative of attentional shift could be erroneous; again, this may be further elucidated by comparing changes in BP to other attentional tasks.

**Theoretical Implications**

The differences seen throughout this programme of research between the two FA tasks may be the result of the bodily versus the external focus of the two tasks. Theoretically, this fits with the changes in observed activations of the DMN and DAN in novice and experienced meditators (Berkovich-Ohana et al., 2016). If learning to co-regulate the DMN and DAN is possible utilising tasks that are both task positive and self-aware, then this should be dissociable using internally and externally oriented tasks. If co-regulation leads to the ability to more effectively maintain awareness of the self, whilst simultaneously increasing the individual’s ability to control mental intrusions from the self, this should then be associated with improved attentional ability (Brewer et al., 2011). However, learning new skills is mentally expensive and incurs cognitive load (van Merriënboer & Ayres, 2005). This suggests that for skills such as vigilance that are negatively affected by ongoing use and by increased cognitive load, it should be expected that abilities decrease post-intervention at the start of any training programme.

If FA tasks do lead to attentional improvement over time and are associated with initial decreases in attentional ability measures then this would support the findings of Study 7. Changes in Alerting scores may represent the beginnings of attentional change, however, they also appear to contradict previous findings from the ANT that show changes in attentional control after brief meditations. Tang and colleagues (2014) have found changes in executive function after short interventions. It is possible that this difference is due to the style of intervention used, or the fact that they had semi-personalised and group-based interventions that led to different changes. To pinpoint which of these elements, or what combination of elements, led to the difference in cognitive change it would be necessary to examine all of these aspects. These contradictions may also stem from a non-linear attentional change; the study in question used five one-hour interventions and reported ANT pre and post the training programme. The quadratic trend seen in the Alerting scores of Study 7 represents a much briefer training paradigm. If the unfamiliar integration of the DAN and DMN is initially difficult then it should be assumed that higher levels of activation and cognitive load would be associated with FA meditational practices that utilise both networks than FA activities that use only the DAN.

## 5.6 Conclusion

In conclusion, the cognitive-focused meditation and mindfulness literature needs to continue to concentrate on developing a more stringent language for approaching the meditation and mindfulness literature and to think strategically about the control and experimental tasks that it is utilising. A stronger focus should be placed on developing our knowledge from observing complete novices in longitudinal designs, allowing for time-series analysis.

This research has demonstrated that attentional tasks find different results when comparing the same task and as such, a clearer understanding of these differences and their strengths and limitations should be explored in regards to the FA mindfulness and meditative literature. The evidence from Study 7 is that FA mindfulness and meditation may not be a purely positive influence on attentional ability, and this should be taken into account when using it for gains in attentional ability. Further explorations of different types and styles of intervention may find that certain activities do encourage positive changes at an earlier time point. However, it is possible that further dosage of the FA meditation would have encouraged positive attentional change over a longer period; future research should aim to understand the time-course of attentional change in this way.

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# APPENDIX A

Five Facet Mindfulness Questionnaire

The Five Facet Mindfulness Questionnaire (FFMQ) was taken from the link below. The instructions were kept the same.

https://goamra.org/wp-content/uploads/2014/06/FFMQ_full.pdf

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Five Facet Mindfulness Questionnaire Description: This instrument is based on a factor analytic study of five independently developed mindfulness questionnaires. The analysis yielded five factors that appear to represent elements of mindfulness as it is currently conceptualized. The five facets are observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. More information is available in:

Please rate each of the following statements using the scale provided. Write the number in the blank that best describes your own opinion of what is generally true for you.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Never or very rarely true | Rarely true | Sometimes true | Often true | Very often or always true |

_____ 1. When I'm walking, I deliberately notice the sensations of my body moving.
_____ 2. I'm good at finding words to describe my feelings.
_____ 3. I criticize myself for having irrational or inappropriate emotions.
_____ 4. I perceive my feelings and emotions without having to react to them.
_____ 5. When I do things, my mind wanders off and I'm easily distracted.
_____ 6. When I take a shower or bath, I stay alert to the sensations of water on my body.
_____ 7. I can easily put my beliefs, opinions, and expectations into words.
_____ 8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
_____ 9. I watch my feelings without getting lost in them.
_____ 10. I tell myself I shouldn't be feeling the way I'm feeling.
_____ 11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
_____ 12. It's hard for me to find the words to describe what I'm thinking.
_____ 13. I am easily distracted.
_____ 14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
_____ 15. I pay attention to sensations, such as the wind in my hair or sun on my face.
_____ 16. I have trouble thinking of the right words to express how I feel about things
_____ 17. I make judgments about whether my thoughts are good or bad.

_____ 18. I find it difficult to stay focused on what's happening in the present.
_____ 19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.
_____ 20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
_____ 21. In difficult situations, I can pause without immediately reacting.
_____ 22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.
_____ 23. It seems I am "running on automatic" without much awareness of what I'm doing.
_____24. When I have distressing thoughts or images, I feel calm soon after.
_____ 25. I tell myself that I shouldn't be thinking the way I'm thinking.
_____ 26. I notice the smells and aromas of things.
_____ 27. Even when I'm feeling terribly upset, I can find a way to put it into words.
_____ 28. I rush through activities without being really attentive to them.
_____ 29. When I have distressing thoughts or images I am able just to notice them without reacting.
_____ 30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
_____ 31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
_____ 32. My natural tendency is to put my experiences into words.
_____ 33. When I have distressing thoughts or images, I just notice them and let them go.
_____ 34. I do jobs or tasks automatically without being aware of what I'm doing.
_____ 35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.
_____ 36. I pay attention to how my emotions affect my thoughts and behavior.
_____ 37. I can usually describe how I feel at the moment in considerable detail.
_____ 38. I find myself doing things without paying attention.
_____ 39. I disapprove of myself when I have irrational ideas.

Scoring Information:

Observe items: 1, 6, 11, 15, 20, 26, 31, 36

Describe items: 2, 7, 12R, 16R, 22R, 27, 32, 37

Act with Awareness items: 5R, 8R, 13R, 18R, 23R, 28R, 34R, 38R

Nonjudge items: 3R, 10R, 14R, 17R, 25R, 30R, 35R, 39R

Nonreact items: 4, 9, 19, 21, 24, 29, 33

Reference: Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using selfreport assessment methods to explore facets of mindfulness. Assessment, 13, 27- 45.

# APPENDIX B

Breathing and Body Scan Meditation Transcript

00:00 Mindfulness of Body and Breath. *Gong.*

00:06 this is a short mindful exercise designed to settle and ground yourself in the present moment. So, finding a comfortable position, allowing your feet to be flat on the floor with your legs uncrossed and allowing your spine to be straight so that you posture support your intention to be awake and aware. So the posture can be dignified but comfortable not stiff or tense. Allowing your eyes to close if that feels comfortable or lowering your gaze

00:53 bring your awareness to the sensations to where the body is in contact with whatever is supporting you. Spend a few minutes exploring these sensations

01:15 now gathering your attention and moving it to focus on your feet. So that the spotlight of attention takes in the physical sensations in both feet and ankles. Any and all sensations - moment by moment.

01:45 noticing how sensations arise and dissolve in awareness, and if there are no sensations just registering a blank - this is perfectly fine, we are not trying to make sensations happen we are simply paying attention to what is already here

02:05 now expanding your attention to take in the lower legs

02:10 then the knees

02:15 and the rest of the legs

02:20 so holding both legs now centre stage in awareness

02:45 now expanding attention again up the body to the pelvis and hips, the lower back and the lower abdomen and gradually expanding attention to move up the torso to the chest and right up to the shoulders. Noticing all the physical sensations in this region of the body

03:00 now expanding attention again to include the left arm, then the right arm, then the neck, the face, the head

03:20 until you are holding the whole body in awareness now and seeing it is possible to let the sensations in the body be just as they are - not trying to control anything or wanting things to be different from how you find them.

04:05 now bringing your awareness to the centre of the body. To the sensations in the abdomen as the breath moves in and out of the body. Noticing the changing patterns of physical sensations here. If you like place your hand here for a few breathes and feel the abdomen rising and falling.

04:35 being fully alive to the sensations of breathing, for the full duration of each in breath and the full duration of each out breath. Not trying to control the breath in any way at all, simply letting the breath breathe itself.

04:45 sooner or later you will probably find that the mind wanders away from the breath to thinking, planning, remembering or daydreaming when this happens there is no need to criticize yourself. Simply registering where the mind had wandered to then gently escorting your attention back to the breath. And this mind wandering may happen over and over again so each time remembering that the aim is simply to register where the mind has been, then gently escorting your mind back to the breath.

05:25 and using the stretches of silence now to practice this by yourself.

06:05 coming back to the breath whenever the mind wanders.

07:05 and remembering that the breath is always available to you, to help bring you back into the present moment when you find your mind scattered and dispersed by the rush and busyness of your life. Always here, as an anchor deep within you a place of stillness and peace.

07:45 *Gong.*

08:05 *End.*

# APPENDIX C

Abstract and Concrete Construal Tasks

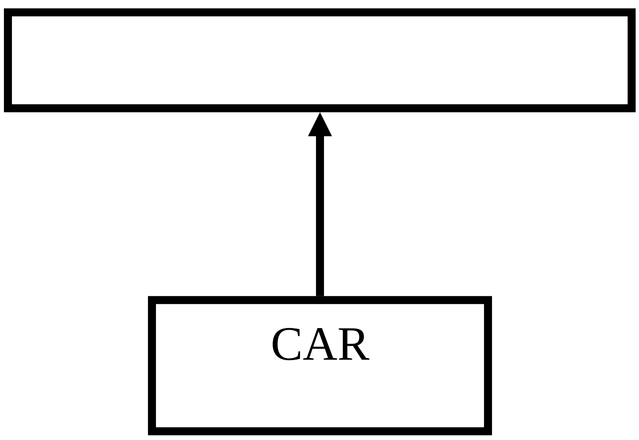
Construal task first used in Fujita, K., Trope, Y., Liberman, N., & Levin-Sagi, M. (2006). Construal levels and self-control. *Journal of personality and social psychology*, *90*(3), 351.

C.1 Exemplar Abstract Construal task.

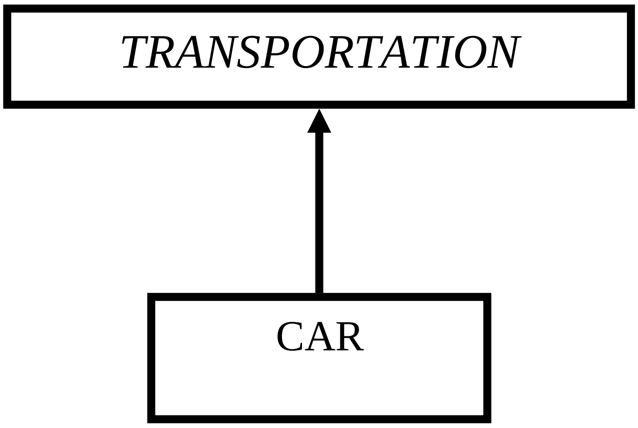
Thank you for participating in this experiment. We are interested in the psychological factors that influence people's opinions and evaluations.

The first task you will be completing is a short word generation task. In this task, you will be provided with a series of words. Your task will be to write a word that you think each provided word is an example of. That is, ask yourself the question, "[Provided word] is an example of what?" and then write down the answer you come up with. For instance, if we gave you the word "POODLE," you might write down "DOGS" or even "ANIMALS," as a poodle is an example of a dog or animal. Be creative and come up with the most general word for which the provided word is an example.

Each "example" word will be presented in one of two boxes, such as the one shown below:



Please write your answers in the box above the "example" word, like this:




If you have any questions, please ask the experimenter at the current time.  If not, turn the page to begin.

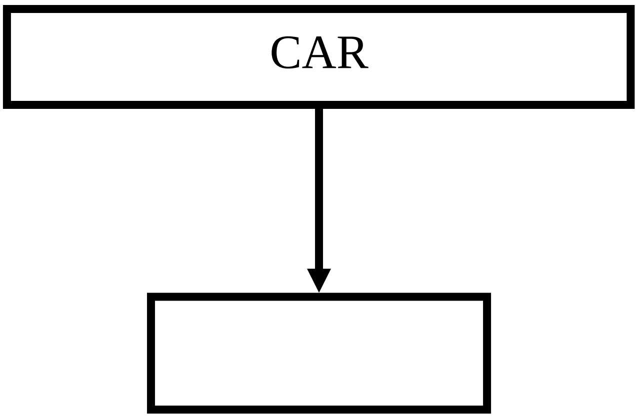
***NOTE: THIS PACKET IS DOUBLE-SIDED!!!***

C.2 Exemplar of Concrete Construal Task

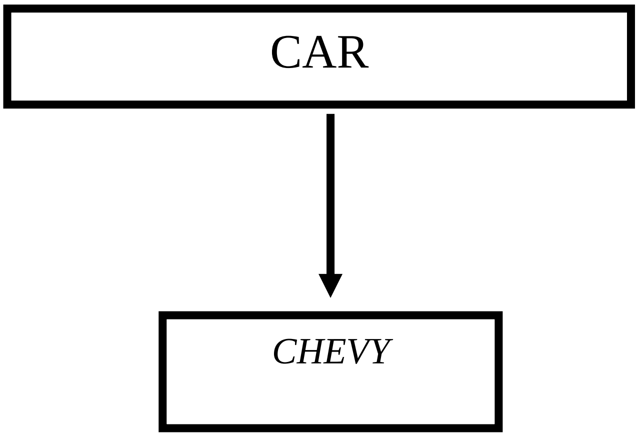
Thank you for participating in this experiment. We are interested in the psychological factors that influence people's opinions and evaluations.

The first task you will be completing is a short word generation task. In this task, you will be provided with a series of words. Your task will be to write down a word that is an example of this word. That is, ask yourself the question, "An example of [provided word] is what?" and write down the answer you come up with. For example, if we gave you the word "DOGS," you might write down the category "POODLE" or even "PLUTO" (the Disney character). Be creative, and try to think of as specific an example of the category as you can.

Each word to be exemplified will be presented in one of two boxes, such as the one shown below:



Please write the example you come up with in the box below the provided word, like this:




If you have any questions, please ask the experimenter at the current time.  If not, turn the page to begin.

***NOTE: THIS PACKET IS DOUBLE-SIDED!!!***

C. 3 List of 38 base words used for both construal tasks.

| | | | |
|---|---|---|---|
| *water* | *college* | *soda* | *computer* |
| *newspaper* | *professor* | *pasta* | *book* |
| *sport* | *table* | *shoe* | *movie* |
| *pen* | *senator* | *lunch* | *train* |
| *mail* | *actor* | *beer* | *phone* |
| *soap* | *fruit* | *coin* | *restaurant* |
| *tree* | *game* | *painting* | *bag* |
| *water* | *dance* | *candy* | *guitar* |
| *mountain* | *poster* | *Soap opera* | *river* |
| *math* | *king* | *whale* | *singer* |

**APPENDIX D**

Mindful Attention Awareness Scale - State

The state MAAS was taken from the page below. The instructions were kept the same as seen below with the exception that 'when you were paged' was replaced with 'in the last task you completed'.

https://ggsc.berkeley.edu/images/uploads/The_Mindful_Attention_Awareness_Scale_-_State.pdf

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The Mindful Attention Awareness Scale (MAAS) - State The state MAAS is a 5-item scale designed to assess the short-term or current expression of a core characteristic of mindfulness, namely, a receptive state of mind in which attention, informed by a sensitive awareness of what is occurring in the present, simply observes what is taking place.

Brown, K.W. & Ryan, R.M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, 84, 822-848.

Instructions: Using the 0-6 scale shown, please indicate to what degree were you having each experience described below when you were paged. Please answer according to what really reflected your experience rather than what you think your experience should have been.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| not at all | | | somewhat | | | very much |

1. I was finding it difficult to stay focused on what was happening.
2. I was doing something without paying attention.
3. I was preoccupied with the future or the past.
4. I was doing something automatically, without being aware of what I was doing.
5. I was rushing through something without being really attentive to it.

Scoring: To have high scores reflect higher state mindfulness, reverse score all items then average all 5 values.

# APPENDIX E

International Positive and Negative Affect Schedule, Short Form

The original task was taken from Thompson, Edmund R. "Development and validation of an internationally reliable short-form of the positive and negative affect schedule (PANAS)." *Journal of cross-cultural psychology* 38.2 (2007): 227-242.

---

I-PANAS-SF stem question:

During the most recent task you completed, indicate the extent to which you have felt:

I-PANAS-SF Items:

PA: Alert, Inspired, Determined, Attentive, Active

NA: Upset, Hostile, Ashamed, Afraid, Nervous,

Likert Scale

1. Very slightly or not at all
2. A little
3. Moderately
4. Quite a bit
5. Extremely

# APPENDIX F

Colouring Meditation Transcript

0:00 Mindful Colouring. *Gong.*

0:06 this is a short mindful exercise designed to settle yourself in the present moment. So, finding a comfortable position, scroll through the patterns in front of you and select one to use in the following exercise. Allowing your eyes to settle on the pattern in front of you

00:53 bring your awareness towards the pattern and spend a few moments observing it.

01:15 now gathering your attention and moving it to focus on the lowest part of the pattern. So that the spotlight of attention takes in the all the intricacies of that area of the pattern. Observing the pattern moment by moment

01:45 just observing the pattern, not trying to make sense of it or in any way control how we perceive the pattern

02:05 now expanding your attention to take in the next small piece of the pattern

02.10 then the next small piece

02.15 So holding the lowest quarter of the pattern centre stage in awareness

02.45 now expanding attention again up the halfway point, then on up the pattern. Noticing all the intricacies in each region of the pattern

03.00 now expanding attention again to include the entirety of the pattern.

03.20 until you are holding the whole pattern in awareness now - not trying to control anything or wanting things to be different from how you find them

04.05 now bringing your awareness to the centre of the pattern. Noticing the patterns here. Select a colour and begin to fill in the centre of the pattern. Take your time

04.35 being fully aware of the emerging and changing pattern as you colour

04.45 sooner or later you will probably find that the mind wanders away from the process to thinking, planning, remembering or daydreaming when this happens there is no need to criticize yourself. Simply registering where the mind had wandered to then gently escorting your attention back to the pattern. And this mind wandering may happen over and over again so each time remembering that the aim is simply to register where the mind has been, then gently escorting your mind back to the pattern.

05.25 and using the stretches of silence now to practice this by yourself.

06.05 coming back to the pattern whenever the mind wanders.

07.45 *Gong.*

08.05 *End.*

**APPENDIX G**

Mindful Attention Awareness Scales - Trait

The trait MAAS was taken from the page below. The instructions were kept the same.

https://ggsc.berkeley.edu/images/uploads/The_Mindful_Attention_Awareness_Scale_-_Trait_(1).pdf

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The Mindful Attention Awareness Scale (MAAS) The trait MAAS is a 15-item scale designed to assess a core characteristic of mindfulness, namely, a receptive state of mind in which attention, informed by a sensitive awareness of what is occurring in the present, simply observes what is taking place.

Brown, K.W. & Ryan, R.M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, 84, 822-848.

Carlson, L.E. & Brown, K.W. (2005). Validation of the Mindful Attention Awareness Scale in a cancer population. *Journal of Psychosomatic Research*, 58, 29-33.

Instructions: Below is a collection of statements about your everyday experience. Using the 1-6 scale below, please indicate how frequently or infrequently you currently have each experience. Please answer according to what really reflects your experience rather than what you think your experience should be. Please treat each item separately from every other item.

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Almost always | Very frequently | Somewhat frequently | Somewhat infrequently | Very infrequently | Almost never |

_____ 1. I could be experiencing some emotion and not be conscious of it until some time later.
_____ 2. I break or spill things because of carelessness, not paying attention, or thinking of something else.
_____ 3. I find it difficult to stay focused on what’s happening in the present.
_____ 4. I tend to walk quickly to get where I’m going without paying attention to what I experience along the way.

_____ 5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.
_____ 6. I forget a person's name almost as soon as I've been told it for the first time.
_____ 7. It seems I am "running on automatic," without much awareness of what I'm doing.
_____ 8. I rush through activities without being really attentive to them.
_____ 9. I get so focused on the goal I want to achieve that I lose touch with what I'm doing right now to get there.
_____ 10. I do jobs or tasks automatically, without being aware of what I'm doing.
_____ 11. I find myself listening to someone with one ear, doing something else at the same time.
_____ 12. I drive places on 'automatic pilot' and then wonder why I went there.
_____ 13. I find myself preoccupied with the future or the past.
_____ 14. I find myself doing things without paying attention.
_____ 15. I snack without being aware that I'm eating.

Scoring: To score the scale, simply compute a mean (average) of the 15 items.