Mindfulness and eating: An exploration of effects and mediators.

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Mindfulness and eating: an exploration of effects and mediators

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Summary (Abstract)

Mindfulness meditation is increasingly being incorporated into psychotherapeutic interventions. However, whilst much research has addressed the question of whether mindfulness-based interventions work, less has been directed at *how* they work. The current thesis describes four studies that explored potential mechanisms by which mindfulness interventions may bring about change. Study 1 employed a correlational design to examine whether mindfulness practice is associated with increased attentional control. Studies 2 to 4 used experimental methods to examine the ways in which individual mindfulness-based techniques might exert their effects on a health-related behaviour (chocolate consumption). Study 1 (N=125) showed no evidence that meditation practice was associated with reduced attentional bias (assessed using dot-probe and emotional Stroop tasks). Study 2 (N=135) showed that a cognitive defusion task (but not an acceptance task) helped individuals to resist chocolate over a five-day period. There was evidence to indicate that the defusion task worked by interrupting automatic links between chocolate-related thoughts and chocolate consumption. Study 3 (N=108), however, failed to find evidence that the defusion strategy worked either by reducing automaticity or increasing the accessibility of competing goals. Study 4 (N=60) further showed that the defusion strategy did not influence chocolate cravings. In conclusion, the current research demonstrated the need to go beyond merely describing the positive effects of mindfulness on changing self-control related behaviours. The findings also highlighted the potential problems of current mindfulness-based interventions due to their complexity, and that one mindfulness-based intervention does not 'fit' all health-related behaviours to bring about change. Ensuring the population maintains a healthy diet is important. Brief mindfulness training may be a useful means of helping people choose more healthy options. Further dismantling design studies were however advised before the evidence can be used to inform public health policy and services.

Declaration and Statements

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly marked in a footnote(s).

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Research Publications and Conference Presentations

- Jenkins, K. T. & Tapper, K. (2012). The effects of two brief mindfulness-based strategies on chocolate consumption. *Appetite, 59(2),* 628. *Oral presentation at the annual meeting of the British Feeding and Drinking Group,* Brighton, 2012.

- Jenkins, K. T. & Tapper, K. (2012). Relationship between meditation experience and attentional bias to chocolate. *Appetite, 59(2),* 629. *Poster presentation at the annual meeting of the British Feeding and Drinking Group,* Brighton, 2012.

- Jenkins, K. T. & Tapper, K. (2012). Relationship between meditation experience and attentional bias to chocolate. *Poster presentation at the Treatment of Obesity conference,* Birmingham, 2012.

- Jenkins, K. T. & Tapper, K. (2012). Resisting chocolate temptation using a brief mindfulness strategy. *Poster and oral presentation at the annual Health and Social Care conference; Conversazione,* Swansea, 2012

- Jenkins, K. T. & Tapper, K. (2013). Using a brief mindfulness strategy to reduce chocolate consumption. *Oral presentation at the annual meeting of the British Feeding and Drinking Group,* Loughborough, 2013.

- Jenkins, K. T. & Tapper, K. (2013). Effects of a brief cognitive defusion task on chocolate craving. *Poster presentation at the annual meeting of the British Feeding and Drinking Group,* Loughborough, 2013.

- Jenkins, K. T. & Tapper, K. (2013). Resisting chocolate temptation: Effects of two brief mindfulness-based strategies. *Oral presentation at the annual conference of the British Psychological Society Division of Health Psychology,* Brighton, 2013.

- Jenkins, K. T. & Tapper, K. (2013). Resisting chocolate temptation using a brief mindfulness strategy. *British Journal of Health Psychology.*

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Abbreviations

%	Percent/percentage
AB	Attentional Bias
AB100	Attentional Bias for the dot-probe presentation time, 100ms
AB2000	Attentional Bias for the dot-probe presentation time, 2000ms
AB500	Attentional Bias for the dot-probe presentation time, 500ms
ACQ	Attentional Control Questionnaire
ACT	Acceptance and Commitment Therapy
ADHD	Attention Deficit Hyperactivity Disorder
ANOVA	Analysis of Variance
BAS	Behavioural Approach Scale
BIS	Behavioural Inhibition Scale
BMI	Body Mass Index
CD	Cognitive Defusion
CEQ	Craving Experience Questionnaire
cm	Centimeter
CO_2	Carbon Dioxide
DASS	Depression Anxiety Stress Scale
DBT	Dialectical Behavioural Therapy
DEBQ	Dutch Eating Behaviour Questionnaire
EQ	Experiences Questionnaire
FAAQ	Food Acceptance and Action Questionnaire
FFMQ	Five Facet Mindfulness Questionnaire
fMRI	Functional Magnetic Resonance Imaging
g	Grams
G1	Group 1
G2	Group 2
G3	Group 3
htz	Hertz
K-S	Kolmogorov-Smirnov
LDT	Lexical Decision Task
LOC	Locus of Control

M	Mean
MAAS	Mindfulness Awareness Assessment Scale
MANOVA	Multivariate Analysis of Variance
MBCT	Mindfulness-Based Cognitive Therapy
MBRP	Mindfulness-Based Relapse Prevention
MBSR	Mindfulness-Based Stress Reduction
mm	Millimeter
ms	Milliseconds
NART	National Adult Reading Test
NFA	Need For Affect
NFC	Need For Cognition
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NS-SEC	National Statistics – Socio-Economic Classification
NW	Non-Word
OCEAN	Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism
OM	Open Monitoring
PHLMS	Philadelphia Mindfulness Scale
RCT	Randomised Control Trial
RT	Reaction Time
S1	Session 1 (baseline)
S2	Session 2 (follow-up)
SCS	Self-Control Scale
SD	Standard Deviation
SOA	Stimulus-Onset Asynchrony
S-R	Stimulus-Response
SRHI	Self-Report Habit Index
T1	Time 1 (handgrip)
T2	Time 2 (handgrip)
TAS	Tellegen's Absorption Scale
TSDI	Trait Self-Description Inventory
UK	United Kingdom

VSSP	Visuo-Spatial Sketchpad
W	Word

Chapter One

General Introduction

Mindfulness is 'awareness that emerges through paying attention on purpose, in the present moment, and non-judgementally to the unfolding of experience moment by moment' (Kabat-Zinn, 2003, p.145). Formally, mindfulness skills are taught as an eight-week, group-based course whereby participants can learn new ways of handling stress, pain and difficult feelings through guided instruction, group dialogue, and home assignments (Kabat-Zinn, 1990). Mindfulness is most frequently cultivated in practices such as sitting meditation, walking meditation or mindful movements and is considered separate from relaxation (Baer, 2003). According to Hölzel et al. (2011) mindfulness consists of an array of distinct but interacting mechanisms which constitute a process of enhanced self-control, leading to positive behavioural outcomes (Carver & Scheier, 2011; Vohs & Baumeister, 2004). Some of these mechanisms include attention to present internal and external experience, a non-judgmental stance which involves the component of decentering (Segal, Williams & Teasdale, 2002) or defusion (Hayes, Strosahl & Wilson, 1999) of cognitive content, and an attitude of acceptance toward oneself and one's experience (Segal et al., 2002). Others however have suggested that these mechanisms are not related to one another (Baer, 2003; Brown, Ryan & Creswell, 2007) or that differing components are more or less critical in leading to behavioural change (Shapiro, Carlson, Astin & Freedman, 2006). The continued disagreement within the literature about the precise mechanisms of action has caused the development of mindfulness research to become somewhat stunted. As a result of this, important questions such as; 'how does mindfulness work?' and 'which specific component(s) bring about its' effects?' remain largely unanswered. The current thesis attempted to address this issue with the wider aim of re-stimulating the growth of novel mindfulness research.

To date, attempts to explore mindfulness have predominately been achieved via clinical intervention studies. These interventions typically combine mindfulness strategies with existing health-related treatments, such as cognitive therapy (mindfulness-based cognitive therapy, MBCT; Segal, Williams & Teasdale, 2002), stress reduction (mindfulness-based stress reduction, MBSR; Kabat-Zinn, 1990), relapse prevention (mindfulness-based relapse prevention, MBRP; Bowen et al., 2009; Brewer et al., 2009) as well as Dialectical Behavioural Therapy (DBT; Linehan, 1993) and Acceptance and Commitment Therapy (ACT; Hayes, Strosahl & Wilson, 1999). The results have been promising, suggesting that mindfulness-based interventions are effective at bringing about health-behaviour change (Baer, 2003; Bishop, 2002; Grossman, Niemann, Schmidt & Walach, 2004). Whilst such research is fundamental to evaluating mindfulness as an efficacious psychological intervention, they fail to offer any interpretation as to how mindfulness achieves the change in behaviour. Thus, any one, if not all of the tested mindfulness mechanisms could have contributed to the clinical effects of these interventions. Furthermore, traditional mindfulness interventions mainly target symptom management for a few psychological disorders, such as anxiety and depression (Hofmann, Sawyer, Witt & Oh, 2010; Roemer, Orsillo & Salters-Pedneault, 2008; Teasdale et al., 2000). Thus, based on these studies, understanding how mindfulness works is limited given that these interventions are designed to treat a specific type of health behaviour. Mindfulness is a complex practice. Its plasticity to be applied to several diverse health-related issues and behaviours may therefore lead to the logical suggestion that the same intervention may work differently depending on the health behaviour being targeted. For example, current mindfulness-based interventions which focus on symptom reduction may work in a different way from those which focus on changing self-control related behaviours. The present thesis aimed to further explore the effects of mindfulness on self-control related behaviours.

Studies investigating the use of mindfulness to change self-control related behaviours were first published in the late 1990's with the majority focusing on improving health by targeting smoking cessation, drug and alcohol abuse, binge eating and weight-loss (Davis, Fleming, Bonus & Baker, 2007; Gifford et al., 2004; Kristeller & Hallett, 1999; Tapper et al., 2009; Zgierska et al., 2008). Tapper et al. (2009) found that compared to controls, participants who were still employing mindfulness techniques six months after a mindfulness-based weight loss programme showed reductions in body mass index (BMI) and increased levels of physical activity. Similarly, Gifford et al. (2004) found higher levels of smoking abstinence at one year follow-up amongst individuals who had completed a mindfulness-based programme compared to those that had received nicotine replacement therapy. Bowen et al. (2006) also reported that inmates who had completed a ten-day intense mindfulness course showed a significant decrease in substance use three months following their release compared to a control group. The value of using mindfulness to change self-control related behaviours is considered important for health research given that self-control is a fundamental and major determinant of health behaviour (Baumeister, Heatherton & Tice, 1994; Tangney, Baumeister & Boone, 2004; Baumeister & Heatherton, 1996). The main focus of these studies is however to identify whether mindfulness is effective at changing self-control related behaviours, as opposed to exploring how they bring about its' effect. Thus, understanding how mindfulness works in terms of changing self-control related health behaviours remains ambiguous within mindfulness research. The current thesis aimed to breech this 'literature gap' by exploring how mindfulness works to change such behaviours using unhealthy eating as an example.

Unhealthy eating behaviour is commonly defined as the consumption of excessive quantities of energy dense foods that are high in fat and sugar (Epstein, Paluch, Beecher & Roemmich, 2008). It can also however be defined as the reduced control of eating when not metabolically hungry (Berthoud, 2011). More formally referred to as 'non-homeostatic', this term implies that eating is not only regulated by metabolic feedback but also cognitive, reward and emotional factors. Much progress has been made to identify the metabolic feedback signals and neutral systems that represent a homeostatic regulator. These are typically located in the brainstem and hypothalamus. The same level of knowledge of the neural pathways and functions for non-homeostatic eating has however not yet been achieved. To obtain a greater knowledge of the different processes involved in unhealthy eating behaviour it is necessary to understand how these metabolic (bottom-up) and non-metabolic (top-down) pathways interact together. A brief description of each process is discussed. Figure 1.1 (see page 6) is also included as a visual overview of some of the main factors involved in top-down and bottom-up modulation processes.

Bottom-up: The metabolically regulated appetite is controlled by homeostatic mechanisms. Thus the over-consumption of unhealthy foods has been, by some, attributed to individuals having a faulty metabolic brain (Guyenet & Schwartz, 2012). This is also sometimes referred to as the homoeostatic regulator (Bouchard, 1995). In support of an ineffective homoeostatic regulator being a causal factor in unhealthy eating behaviour, research has shown evidence of impaired leptin and/or melanocortin-signalling in obese individuals (Farooqi & O'Rahilly, 2006). These impaired signals are responsible for the modulation of 'wanting' of food, thus causing the desire for, and ultimately consumption of, certain foods to be increased irrespective of there being no physiological 'need' for food. Related to this is the notion that, overconsumption of unhealthy foods it attributable to specific genes which are ineffective in curbing appetite during times when food is abundant. This is demonstrated in studies whereby better success is evident with leptin-treatment when given in addition to moderate food intake restriction (Bouchard, 1995). An alternate view is that an inability to control unhealthy eating behaviours is due to the homoeostatic regulator acting to defend against the under-intake of nutrients, but not the over-intake of nutrients. When functioning in this way, the regulator is believed to be a physiological adaptation to internal (e.g. pregnancy) and external (e.g. seasonal changes) contingencies (Hall et al., 2012; Speakman et al., 2011). Whilst this may have been an effective survival process in ancient years, in the modern 'obeseogenic' environment it may lead to severe consequences of peoples overall health and well-being.

Unhealthy eating by metabolic signals is however not only achieved via bottom-up modulation. Rather, bottom-up processes continually interact with top-down influences. For instance, in addition to the hypothalamus other brain areas involved in the circuitry of the homoeostatic regulator are also involved in reward-based decision making. Attempting to abstain from eating an unhealthy food product has shown to increase the reinforcement value of a food reward (Zheng, Lenard, Shin & Berthoud, 2009). Several neuro-imaging studies have supported this, showing greater neural activity in reward related areas in the brain when fasting individuals viewed pictures of high-calorie compared to low-calorie foods (Asmaro & Liotti, 2014). These findings suggest that some fasting-related signals which convey 'caloric need' modulate the hedonic value assigned to certain foods, making them more preferred if available for eating. The interaction between the cognitive and emotional brain can better help us understand how unhealthy eating develops in an ever changing environment. This evidence shows that the metabolic state can strongly modulate emotional effects of food and food-related stimuli. Together, these ascending modulatory influences determine the level of incentive salience directed to specific foods.

Top-down: Similarly to bottom-up processes, the top-down modulation of food intake encompasses a number of different cognitive and emotional factors. Some of these include external sensory input (e.g. taste and smell) to the hypothalamus and other related brain areas, food-related cues and social influences, along with thoughts, memory and mental imagery (Epstein et al., 2009). Emotional regulation has also been found to involve top-down regulation of pre-frontal brain regions such as the amygdala (Quirk & Beer, 2006). Importantly, appetite and food consumption in this context are influenced by the mental representations of the food rather than the actual sensory properties which would be involved in bottom-up processes. Furthermore, it has been recognised that an increasing consumption of foods high in fat and sugar is driven by 'hedonic hunger' (Lowe & Butryn, 2007) rather than the homeostatic principles of energy balance. In turn, increased attention has been focused on the influence of reward sensitivity (Davis et al., 2008) and the mechanisms underlying liking and wanting (Finlayson, King & Blundell, 2007). In an obesity-promoting environment, the hedonic response to food stimuli is believed to disrupt the homeostatic mechanisms that regulate satiety, thus leading to the over-consumption of unhealthy food products (Hofmann et al., 2010). Following on from this, another important process in the top-down modulation of eating is the executive functioning system. This involves regulating and inhibiting impulsive responses to food (Guerrieri, Nederkoorn & Jansen, 2008). Inhibitory control exerts the stop-signal necessary to override automatic responses, thereby enabling goal-oriented actions. The pre-frontal cortex guides this 'top-down' processing in order to align behaviour with internal states, goals or intention (Goghari & MacDonald, 2009). Many have shown that a less efficient response inhibition is related to increased food intake and overeating (Logan, Schachar & Tannick, 1997; Nederkoorn et al., 2006). Neuro-imaging studies have confirmed a role for the pre-frontal cortex in hedonic feeding inhibition by linking activation patterns with motivation to consume palatable foods (Fregni et al., 2008; Goldman et al., 2011; Uher et al., 2005). Conversely, the ability to adopt and maintain healthy eating habits has been linked to greater inhibitory control.

In conclusion, it is clear that unhealthy eating is driven by many factors. Over-eating can be triggered by metabolic need and hedonic drive, or an interaction between several different factors. Importantly, metabolic signals of energy status can modulate processing of cognitive and reward functions in various brain regions systems (bottom-up processing), which influence regulatory processes to restore energy status to the optimal level. Yet the cognitive and emotional brain can also override homeostatic regulation (top-down processing), to yield an energy imbalanced state. With the rate of health-related problems set to increase due to the unhealthy diets of the population, investigations into the mechanisms underlying top-down and bottom-up processes are needed to effectively target unhealthy eating behaviours and halt further overindulgence.

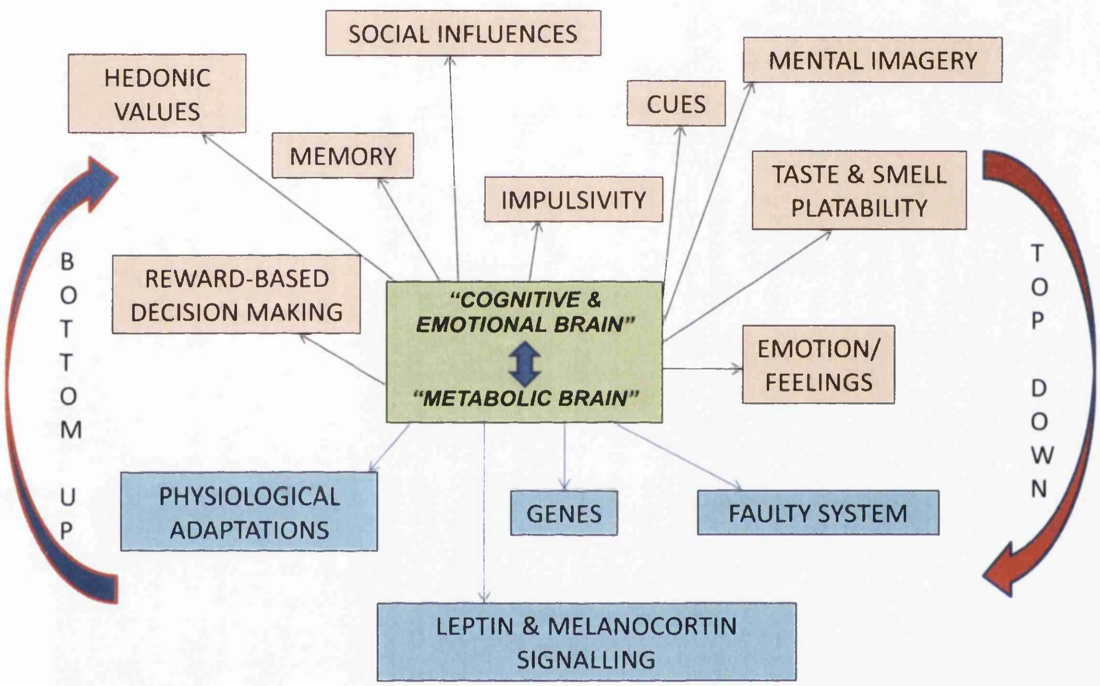

Figure 1.1 Diagram showing the major factors determining, and the interaction between top-down and bottom-up neural control of appetite and regulation of energy balance. Bottom-up modulation of cognitive and emotional processes by metabolic signals and its derivatives. Top-down modulation by cognitive and emotion/reward systems.

As previously discussed, the beneficial effects of mindfulness have received substantial support from empirical studies (Baumeister, Heatherton & Tice, 1994; Tangney, Baumeister & Boone, 2004; Baumeister & Heatherton, 1996). The functional neural mechanisms underlying these benefits have however not been investigated to the same extent. Some suggest that mindfulness is best described as a top-down regulatory strategy given that mindfulness is described as a central element facilitating positive appraisal (Garland et al., 2010). Supporting the top-down process underlying mindfulness training, Fresco, Segal, Buis, & Kennedy (2007) observed a modest but significant correlation between decentering, a psychological construct within cognitive psychology that shares strong resemblances with the concept of mindfulness, and positive reappraisal. Research has also shown that mindfulness can support the maintenance of healthy behavioural habits in a top-down manner by strengthening executive control such as, reducing behavioural automaticity (Brown & Ryan, 2003). Others however disagree instead arguing that mindfulness should be described as a bottom-up regulatory strategy (Grabovac et al., 2011). This is based on the definition of mindfulness being 'an increased attention to present moment experiences in a non-judgemental manner' (Brown et al., 2007). Accordingly, mindfulness training should be associated with reduced activation of limbic regions in response to emotionally salient stimuli (i.e. cues). Supporting the bottom-up process underlying mindfulness training, Slagter et al. (2007) amongst others (van Leeuwen, Muller, & Melloni, 2009) have provided evidence that mindfulness is associated with improvements in attentional blink tasks performance. These findings reflect a reduction in brain allocation that is independent from cognitive evaluation processes. Mindfulness therefore supports healthy habits in a bottom-up manner by wakening existing habitual patterns (Brown & Ryan, 2003). Others have found that mindfulness practitioners gradually shift from a larger use of top-down mechanisms of regulation during early stages of practice to a larger use of bottom-up mechanisms of regulation during later stages of practice. For instance, initially, the attentional training component of mindfulness strengthens attention regulation to create awareness of stimuli, internal and external to individuals, and enhances cognitive control and top-down regulations (Hölzel et al. 2011). In more advanced practitioners of mindfulness however, non-judgmental acceptance and non-reactivity has been found to weaken earlier neural connections freeing individuals from old habitual emotional reactions (Hölzel et al. 2011).

At present, it is impossible to draw definitive conclusions about these claims because the studies supporting each process have several methodological shortcomings. As a result, it is unclear whether the observed neural effects associated with the cultivation of mindfulness are specifically attributable to mindfulness training or to other non-specific factors. Current discrepancies about the neural mechanisms involved in mindfulness also derive, in part, from the many different descriptions and applications of mindfulness (Farb et al., 2007, 2010; Westbrook et al., 2011). Moreover, contradictions in opinions of the processes involved in mindfulness have been debated suggesting that certain mindfulness strategies are more or less important than other (Bishop et al., 2004; Hayes, Luoma, Bond, Masuda, & Lillis, 2006; Chiesa & Malinowski, 2011). Understanding whether mindfulness involves a top-down or a bottom-up regulation strategy has many important clinical implications (DeRubeis, Siegle, & Hollon, 2008; Roffman, Marci, Glick, Dougherty & Rauch, 2005). Further exploration of the relationship between mindfulness and eating behaviour is therefore advised. The current thesis investigates the hypothesis that mindfulness can be used to change unhealthy eating behaviours by top-down regulation strategies.

Only a relatively small number of studies which investigate the effectiveness of mindfulness in the domain of unhealthy eating behaviours currently exist. For instance, the practice of mindfulness has shown to reduce binge eating (Kristeller & Hallett, 1999), decrease food cravings (Alberts, Mulkens, Smeets & Thewissen, 2010) and also reduce BMI in an overweight sample (Tapper et al., 2009). More studies are however beginning to emerge. A recent publication by Alberts, Thewissen & Raes (2012) demonstrated that participants who had undergone an eight-week mindfulness-based cognitive behavioural intervention showed significantly greater decreases in food cravings, dichotomous thinking, body image concern, emotion eating and external eating compared to controls. Timmerman & Brown (2012) also found that, compared with a no treatment control group, women who had completed a mindful restaurant eating intervention reported lower totals of energy and fat intake. Whilst these are encouraging findings, understanding how mindfulness brings about a change in unhealthy eating behaviour is largely unexplored. It is therefore important that further research is conducted. Understanding how mindfulness can change unhealthy eating behaviour can also be considered important to help reduce the adverse effects on health caused by unhealthy eating. An unhealthy diet, often characterised by an excessive intake of high sugar and fat snack foods, has been associated with numerous health problems such as obesity, type 2 diabetes, stroke, cancer, heart disease and hypertension (Kopelman, 2007; Must et al., 1999). Each of these major health risks adds further strain to the already over-stretched National Health Service's financial budget.

Recognition of this has led to the launch of several government supported healthy eating campaigns aimed at encouraging individuals to take responsibility for their eating habits (e.g. Change for Life, 2013). Given that these health initiatives are not evidence based, a scientifically evaluated mindfulness-based intervention may offer a new, improved approach to help change society's unhealthy eating behaviours.

The lack of understanding about how mindfulness works is in part due to the current method used to acquire this knowledge; namely, the evaluation of mindfulness-based interventions. Mindfulness interventions incorporate several different mindfulness components, or combine mindfulness skills with a range of intervention techniques. Mindfulness is a multifaceted practice, thus in order to understand how mindfulness works, a simplified evaluation method is needed. One suggestion is to separate and analyse individually the central constructs and different mindfulness strategies using a dismantling design. Whilst dismantling studies are not new (Cahill, Carrigan & Frueh, 1999; Foley & Spates, 1995; Roehrig, Thompson, Brannick & van den Berg, 2006), their application to help understand how mindfulness works is only apparent in the literature within the last few years. The first study to use a dismantling design to explore potential mechanisms accountable for the effects of mindfulness was pioneered by Sears & Kraus (2009). The authors attempted to tease apart different core practices of mindfulness-based interventions, including bare attention and loving-kindness in order to measure their unique effects. Interestingly, the results showed that both interventions decreased cognitive distortions. No new attempts have recently been made to understand how mindfulness works through the use of a dismantling design. At best, most mindfulness studies simply acknowledge the benefits of dismantling methods, highlighting the need for its further use in mindfulness research. Baer (2003) for example concluded that both the integrative treatments such as ACT, and even interventions where mindfulness appears to be predominant, need to be dismantled to identify the true active ingredients. Shapiro, Carlson, Astin & Freedman (2006) also proposed that with the efficaciousness of mindfulness fairly well established, a next line of inquiry would be to determine mediators and moderators of these beneficial effects via the use of dismantling research designs. Dismantling designs have also been considered important in determining whether mindfulness-based interventions work by altering the relationship between thoughts and feelings (Roemer & Orsillo, 2003), though as of yet, no research has been conducted to support this assumption.

In view of the above, the current thesis aimed to investigate the mechanisms of action underlying mindfulness by carrying out two different, but complementary, lines of inquiry. The first line of inquiry examined the central construct of mindfulness; attention. The second line of inquiry used a dismantling design to separate and compare two mindfulness strategies (cognitive defusion and acceptance) which are widely used within mindfulness-based interventions. Research on how mindfulness works is still in its infancy. The current thesis therefore made three assumptions of how the individual mechanisms explored brought about behavioural change. The first suggested that attention is one of the main components of mindfulness. It was therefore predicted that practicing mindfulness positively effects behaviour change by increasing attentional control. Study One explored this hypothesis by comparing differences in attentional bias to chocolate-related stimuli between those who practice meditation and those who do not. The second predicted that mindfulness works by reducing automaticity and increasing tolerance of difficult thoughts and feelings. Study Two therefore looked at the effects of two different mindfulness-based strategies, cognitive defusion and acceptance, on resisting chocolate over a five-day period. Based on the findings from Study Two, a follow-on study (Study Three) was conducted in an attempt to further understand how the defusion strategy brings about its effects. The third assumption predicted that mindfulness changes the self-control related behaviour, unhealthy eating, by reducing the total number of cravings experienced. This was explored in Study Four by asking participants to practice either a mindfulness-based strategy or a control strategy during a ten-minute craving induction task whilst sitting in front of a range of chocolate products.

To conclude, the thesis used a two-pronged approach to identify the way in which mindfulness brings about its effects in relation to changing self-control behaviours, using unhealthy eating as an example. The present research was mainly exploratory given that existing literature in this area is limited. It is believed that the findings have many important implications. For instance, the current research may contribute to wider mindfulness research in that it aimed to identify the precise mechanisms at work. Moreover, the current study may help to identify how mindfulness changes self-control related health behaviours in addition to helping to improve health and health research. The latter is important given that health psychologists are frequently asked to offer their expertise in the development of new government health initiatives (Johnston, Weinman & Chater, 2011). This empirical work is also considered critical in order to optimally apply mindfulness to a diverse population and to advance techniques that specifically target the treatment of unhealthy eating behaviours.

Chapter Two

Relationship between mindfulness meditation experience and attentional bias to chocolate

2.1 Introduction

2.1.1 Chapter overview

This chapter aimed to explore whether the practice of mindfulness meditation is associated with changes in self-control related health behaviours by increasing attentional control. If so, mindfulness may prove useful for reducing attentional bias to emotionally motivating stimuli. The current study examined links between mindfulness and attention by examining differences in attentional control and attentional bias between those with different levels of meditation experience. Meditation experience was defined by self-assessment (i.e. practitioner's personal opinion of whether they were an experienced or novice meditator) and the length of time mindfulness was practiced (i.e. average number of minutes, weeks and months spent meditating). In addition to this, a novel method of defining meditation experience, based on the type of attentional skills (i.e. focused attention or open monitoring) currently used by the recruited meditators, was explored to identify any significant effect on attentional control and attentional bias. Attentional bias was measured using emotional Stroop and dot-probe tasks. The main purpose of this study was to identify how the practice of mindfulness meditation may work to change unhealthy eating behaviours, namely reducing chocolate consumption.

2.1.2 Mindfulness: A form of attention re-training

Mindfulness practices and meditation are not synonymous. Most mindfulness-based interventions however utilise some form of meditative practice which highlight attention as a core component (Bishop et al., 2004; Brown & Ryan, 2003; Walach, Buchheld, Buttenmuller, Kleinknecht & Schmidt, 2006). Consequently, mindfulness is readily described as a set of diverse practices that train attention and awareness, with the ultimate goal of fostering physical and psychological wellbeing due to improved attentional control (Moore, Gruber, Derose & Malinowski, 2012).With an emphasis placed on attention, mindfulness is believed to be neither contemplative nor ruminative. Instead, it is considered a process whereby the mind becomes functionally re-trained to increase mental focus (Davidson, Kabat-Zinn, Schumacher, Rosenkranz, Muller & Santorelli, 2003; Grossman, Niemann, Schmidt & Walach, 2004; Jha, Krompinger & Baime, 2007). In the context of mindfulness practice, paying attention involves observing the operations of one's moment to moment internal and external experience. Practitioners are invited to focus on present experiences, or in the event of their attention becoming distracted from the object of focus, to redirect their attention back to the current moment (Shapiro & Schwarz, 2000; Teasdale, 1999; Teasdale et al., 1995, 2003). Mindfulness practice therefore enhances many different aspects of attentional abilities. These include sustained attention and attentional switching, thus incorporating elements of both attention regulation and an open attentional orientation (Bishop, 2002; Bishop et al., 2004; Brown & Ryan, 2004; Hayes & Shenk, 2004). In view of this, it has been suggested that mindfulness practices may be effective at reducing automatic or inappropriate reactive behaviours by significantly decreasing attentional bias (Brewer, Elwafi & Davis, 2013).

2.1.3 What is attentional bias?

Attentional bias is defined as the ability to selectively attend to personally relevant or emotionally motivating information over neutral information (Mathews & MacLeod, 2005). Behaviourally, attentional bias is the tendency for a stimulus to attract and hold attention whilst also impairing disengagement from, and possibly elaborative processing of, relevant stimuli (Derryberry & Reed, 2002; Kavanagh, Andrade & May, 2004; Waters, Sayette & Wertz, 2003; though see Pothos & Tapper, 2010). Such effects may be the result of novel or past association of the stimulus with threat (Calvo & Avero, 2005) or reward (Krank, O'Neill, Squarey & Jacob, 2008). When attention is directed to such stimuli there is less available cognitive capacity to focus on other stimuli. Thus, cognitive models assume that attentional bias is not simply a by-product of emotional disorders but it plays a vital role in their causation and maintenance. It is believed to facilitate a vicious cycle of events whereby increases in either emotional disturbance or emotional excitement causes certain stimuli to become even more salient (Ohman, Flykt & Esteves, 2001). Research has shown that an individual's performance can become impaired as a result of selective attention to emotionally relevant stimuli on tasks where the processing of such information would be disruptive (Buckley, Blanchard & Neill, 2000). Any intervention that enhances voluntary control of these attentional components may help to bring about reductions in both attentional bias and the associated behaviour. Attentional re-training has been found to lower attentional bias in this context (Tang & Posner, 2009). One identified form of attentional re-training is mindfulness meditation (Valentine & Sweet, 1999).

2.1.4 Effects of mindfulness training on attention

There is increasing evidence to suggest that mindfulness training enhances attentional control (e.g. Baijal & Gupta, 2008; Brefczynski-Lewis, Lutz, Schaefer, Levinson & Davidson, 2007; Carter et al., 2005; Chambers, Lo & Allen, 2008; Jha, Krompinger & Baime, 2007; Lazar et al., 2000, 2005; Lutz, Greischar, Rawlings, Ricard & Davidson, 2004; Moore & Malinowski, 2009; Moore, Gruber, Derose & Malinowski, 2012; Rani & Rao, 1996, 2000; Redfering & Bowman, 1981; Semple, 2010; Tang et al., 2007; Wallace, 2007; Wenk-Sormaz, 2005). To describe just a few examples, in a study investigating motion-induced blindness and binocular rivalry, Carter et al. (2005) found that meditators who practiced mindfulness at least every other day were less prone to change blindness and were faster at identifying changes. Hodgins & Adair (2010) also reported that frequent mindfulness meditation caused more effective attentional orientation in that the meditators suffered less from invalid cues in a spatial cueing task. Moreover, this type of meditation has been found to reduce attentional blink after training in addition to causing less distractibility (Slagter et al., 2007). In further support of the relationship between mindfulness and attentional control, van Leeuwen, Muller & Melloni (2009) found that compared to matched meditation naive controls, meditators showed higher detection rate on an attentional blink task. The result therefore supported the hypothesis that meditation practice alters the efficiency with which attentional resources are distributed. Mindfulness training has also been associated with better response inhibition and conflict monitoring by more effective voluntary response levels as well as input level selection processes (Baijal, Jha, Kiyonaga, Singh & Srinivasan, 2011). In addition, Lutz et al. (2009) concluded that training attention via mindfulness was associated with higher levels of sustained attention, as demonstrated by better attentional stability and lower task effort.

More recently, Kerr, Krishnapriya & Littenberg (2011) found that after eight weeks of mindfulness training, meditators had greater ability to sustain attention. This was shown by an enhanced alpha power modulation in early sensory cortices in response to a cue. van den Hurk, Giommi, Gielen, Speckens & Barendregt (2010) also reported that compared to a control group, experienced mindfulness meditators were more efficient at several different attentional processes. Interestingly, mindfulness users responded more slowly to the attention tasks and therefore had better accuracy rates. Another supportive finding was published by MacLean et al. (2010). In a perceptual discrimination task, greater discriminative skills were associated with meditation training compared to controls. This association was also evident at five-month follow-up testing, though the improvements in visual discrimination (i.e. increased perceptual sensitivity and improved vigilance during sustained visual attention) were positively correlated with the amount of post-meditation training practice (MacLean et al., 2010). Additionally, practitioners have reported that regular meditation practice enables them to focus attention for an extended period of time without their attention being biased (Barinaga, 2003). While trained mindfulness meditators are able to keep their attention on the object of meditation, non-meditators switched between the task and a day-dreaming state, demonstrating increased attention shifting (Gusnard, Akbudak, Shulman & Raichle, 2001). Consequently, self-report data indicated that the meditators kept more continuous attention on the task, felt less bored, and encountered fewer difficulties with attentional bias tasks than the non-meditators.

So far, the evidence described offers consistent support for the notion that the practice of mindfulness meditation is significantly associated with improved attentional control. Other findings are however less conclusive (Lutz et al., 2008). Lutz et al. (2008), for example, reported no significant group difference between meditators and non-meditators for any of the attentional tasks used in their study. Polak (2009) also found no meditation-related differences in attention after completing two attentional control tasks. In addition, using a randomised controlled trial Semple, Lee, Rosa & Miller (2010) found that, although the meditation group demonstrated a greater ability to discriminate on a signal detection task and more effective sustained attention, differences in concentration and inhibition of distraction were not found.[1] As a result, this study only partially supported the hypothesis that mindfulness enhances attentional control by reducing attentional bias. Furthermore, Srinivasan & Baijal (2007) found that mindfulness meditators' increased awareness of their environment was only enhanced immediately after full meditation compared to when they performed their daily breathing exercises. This latter finding brings into question whether attentional benefits derived from meditating carry over into everyday life or are limited to following meditation practice. More generally, it also questions whether mindfulness training truly affects attention by increasing attentional control.

2.1.5 Summary

It is clear that the evidence for and against the theory that mindfulness increases attentional control is inconclusive. One explanation for this may be the different types of methodology used to explore the effects of meditation on attentional control. For instance, in an attempt to use the 'gold standard' of determining whether a cause and effect relation exists, some researchers have used randomised controlled trials (e.g. Semple et al., 2010). This particular type of methodology however does not allow the experimental groups sufficient training to become 'experienced' meditators. This would require too much commitment from the participants as adequate training to acquire the skills of an experienced meditator may span decades. Consequently, very high attrition rates would be likely. In support of this explanation, studies which use randomised control trials do not always reflect the positive effects of mindfulness on attentional control which non-randomised control trials often claim (Anderson, Lau, Segal & Bishop, 2007). Given that the current study included a sample of highly experienced meditators, in addition to a group of novice meditators and non-meditative controls, a RCT design was considered inappropriate.

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[1] Semple et al (2010) measured sustained attention using the Continuous Performance Task (Rosvold et al., 1956) whereas concentration was measured using the Digit Symbol Substitution Task (Wechsler, 1997). The difference between these two attentional components was therefore defined by target detection (i.e. vigilance of distractors) (sustained attention) verses freedom from distraction (concentration).

In addition to exploring the effects of meditation experience on attention, the current study aimed to bring further clarity to this area of mindfulness research by exploring whether mindfulness was useful for reducing attentional bias specifically to emotionally motivating stimuli.

2.1.6 Effects of mindfulness experience on attentional bias

It has been suggested that improvements in attentional control, as demonstrated by a decrease in attentional bias, will depend on an individual's level of mindfulness experience (Chan & Woollacott, 2007). In view of this, some have suggested that more experienced meditators will perform more effectively on attentional control tasks compared to novice meditators (Brefczynski-Lewis et al., 2007). A literature review on the relationship between attention and mindfulness experience is provided. Experienced and novice meditators are discussed individually.

2.1.6.1 Experienced meditators

A large number of studies have reported that attentional control related changes are associated with long term practice of mindfulness meditation (Carter et al., 2005; Slagter et al., 2007; Srinivasan & Baijal., 2007; Zeidan, Johnson, Diamond, David & Goolkasian, 2010). Carter et al. (2005) found that extensive mindfulness training by Tibetan monks improved practitioners' ability to sustain attention on a particular object for a prolonged period of time, compared to both short-term meditators and non-meditator controls. Additional support for the notion that experienced mindfulness meditators demonstrate reduced attentional bias compared to novice meditators was shown by Tang et al. (2007). In this study, Tang et al. found that experienced mindfulness meditators were able to detect targets more easily and efficiently than when cues about where and when the targets would appear were unavailable. This suggested that the meditators had more attentional readiness and alertness. Additionally, Valentine and Sweet (1999) reported that mindfulness meditators scored significantly higher than non-meditators on a Wilkins' Counting Test, again demonstrating greater sustained attention and decreased attentional bias. More specifically however, the results showed that when the meditators were analysed based on their level of meditation experience, the experienced meditators (more than 24 months of meditation experience) from a variety of traditions scored significantly higher than novice meditators (less than 24 months of meditation experience).

Experienced mindfulness meditators are also considered to perform better on attentional bias tasks because, unlike novice mindfulness meditators, they learn to monitor attention (also referred to as open monitoring; OM). This helps them to determine when their focus of attention has wandered; subsequently enabling the effective disengagement from distracters and re-orientation of attention to the intended object (Lutz, Slagter, Dunne & Davidson, 2008). Over time, less energy is required to maintain focus and their attention monitoring capacity increases allowing them to detect distraction more quickly. The practitioner is therefore able to achieve moment to moment awareness of internal and external experiences, as they occur, without prioritizing or rejecting particular elements of experience. In support of this, findings from an attentional blink task showed that experienced mindfulness meditators who practiced OM were more efficient than novice meditators at registering the first target by not 'over investing' in it and disengaging from it relatively quickly. This gave the experienced meditators sufficient resources to process the second target upon detection of the first more often than non-meditators (van Leeuwen, Muller & Melloni, 2009; Lutz et al., 2008; Slagter et al., 2007).

An investigation of the effects of novice and experienced meditation practice on attentional control was also conducted by Brefczynski-Lewis et al. (2007). In this study it was found that, compared to novice meditators, on the Hick's S-light Reaction Time task experienced mindfulness meditators reported they were able to perceive the whole field of eight lights simultaneously. They also responded more quickly and accurately when the target light came on, rather than serially scanning the lights and trying to anticipate the correct choice. Furthermore, in response to distracter sounds, expert meditators had more activation (as measured by fMRI) in regions related to response inhibition and attention than did novice meditators. However, as van Leeuwen et al. (2009) noted, in addition to having practiced OM meditation, experienced meditators also often engage in extensive focused attention meditation training. Thus, it may be this attentional component (i.e. focused attention as opposed to open monitoring) that caused a reduction in attentional bias. Given that novice mindfulness meditators also use focused attention, it is difficult to conclude from this data if experienced meditators benefit from superior attentional control compared to novice meditators. Furthermore, despite the abundance of evidence to suggest that intensive mindfulness meditation training can better attention, as previously discussed (see section 2.1.5), it is impossible to use randomised control trials to confirm these findings.

Experience based on the duration of meditation practice is not the only factor which has been found to effect attentional control by reducing attentional bias. The intensity of which meditation is practiced may also be relevant. Chambers, Lo & Allen (2008) found that an intense period of meditation training (over ten-days) showed higher levels of self-reported mindfulness, sustained attention, and attention switching relative to a comparison group who did not undergo any meditation training. Slagter et al. (2007) also found that after only three months of meditation training the experimental group performed significantly better on an attentional bias task compared to the control group. Similar findings have been reported by others (Doyon et al., 2002; Lutz et al., 2008). Defining meditation experience using more than one method is therefore advised when exploring its effects on attention.

2.1.6.2 Novice meditators

Whilst the literature supporting the benefits of long-term meditation in relation to reducing attentional bias is substantial (Brefczynski-Lewis et al., 2007; Chambers et al., 2008; van Leeuwen, Muller & Melloni, 2009; Lutz et al., 2008; Slagter et al., 2007) more recently, some have found that short-term mindfulness meditation training can also enhance attentional control. Although considered to be less effective than extensive meditation practice, the positive effects of short-term meditation training is important from an applied point of view. Dickenson, Berkman, Arch & Lieberman (2012) found that the neural mechanisms of a brief mindfulness induction were related to more effective attentional control in novice meditators. Zeidan et al. (2010) also reported that even with short-term meditation training there were significant differences (i.e. higher levels) in both sustained attention and executive functioning in the meditation group compared to the non-meditating group. This suggests that short-term meditation is associated with greater ability to focus on timed or speed tasks, which may be the result of the meditation practice reducing attentional bias to the stimuli presented throughout the tasks. Furthermore, novice meditators who completed a five-day mindfulness course showed higher scores in conflict resolution on the Attentional Network Task, as well as higher fluid intelligence scores, compared to a similarly chosen group given relaxation training (Tang et al., 2007). The importance of the latter finding is that fluid intelligence is closely related to processes of attention control (Carpenter, Just & Shell, 1990; Kane & Engle, 2002). Thus, these results suggest a main effect of short-term mindfulness meditation training on processes of cognitive control and subsequently, attentional bias. In further support of this, McHugh, Simpson & Reed (2010) found that a focused attention meditation group displayed lower levels of stimuli over-selectivity and greater levels of stimulus control when training was provided over only a ten-minute period. However, when mindfulness and concentrative meditation practices were compared using an auditory counting task susceptible to lapses in sustained attention, superior attentional performance was obtained for only long-term meditators. Thus the benefits of short-term meditation may only be immediate and fade away gradually over time.

In view of the discussed literature, it may be concluded that the study of long-term meditators offers the most realistic assessment of the effects of meditation practice on attentional functioning (Lykins et al., 2010). Furthermore, if more effective attention is only short lived, it would be logical to expect there to be higher levels of attentional control and lower levels of attentional bias for only those who are actively practicing meditation on a regular basis. Moreover, not all studies agree that short-term meditation practice is beneficial. McMillan, Robertson, Brock & Chorlton (2002) for instance found that brief exposure (five-weeks) to mindfulness meditation cannot be recommended as a treatment technique for patients suffering from attentional regulation difficulties. This was because significantly higher levels of attentional control were not evident in the mindfulness group relative to a non-treatment control group. The participants in their study had however suffered significant brain injuries and as a result, their attentional networks may have been too compromised to make remediation via mindfulness-based intervention viable. It is therefore possible that a brief mindfulness meditation practice may demonstrate greater reductions in attentional bias but only within a non-clinical population. Further research is needed to confirm this assumption. McMillan's study can also be criticised for using a training period (five-weeks) which was unrepresentative of the effects of *brief* mindfulness training compared to other studies which have used a much shorter training period (e.g. McHugh et al., 2010).

2.1.7 Summary and limitations of the current literature

The evidence for the effects of mindfulness meditation experience on attention is promising, yet contradictory. Whereas some studies support the notion that mindfulness requires intense practice of meditation to demonstrate better attentional control and thus, lower attentional bias (Brefczynski-Lewis et al., 2007; Chambers et al., 2008; Slagter et al., 2007) others argue that only a brief exposure to mindfulness practice is needed for the same effects to be seen (Dickerson et al., 2012; Tang et al., 2007; Zeidan et al., 2010). One possibility for these conflicting findings may be due to meditators varying widely in the length and consistency of their practice. As no standard method currently exists for denoting levels of meditation experience, it is unsurprising that there is considerable variation in how meditation experience is defined across studies. Some studies classify the level of experience as measured by minutes of meditation practiced per day, or by the total hours spent meditating across a practitioners' lifetime (e.g. between 2,000 and 45,000 lifetime hours) (Grant et al., 2010; Perlman et al., 2010). Others have classified the level of meditation experience depending on attendance rates of intense meditation retreats (e.g. either a 5-7 days retreat, or a silent retreat lasting a minimum of a week; Falkenstrom, 2010).

A weak method of operationalising practitioners' level of meditation experience was noted as a flaw in a study carried out by Sabel (1980). In Sabel's study, meditators ranged from a few days to 99 months, yet no statistical analyses were performed to compare possible differences between novice meditators and experienced meditators. Limited studies have incorporated assessments from meditation teachers to denote level of proficiency (Brown & Engler, 1980), but the majority simply report how long individuals have engaged in meditation practice. Shapiro and Walsh (2003) suggested that in order to ensure rigorous research is conducted the "frequency and duration of meditation practice must be recorded to determine if greater meditation induces greater effects (p. 94)." The current study aimed to address this issue by analysing the effects of mindfulness meditation experience on attention by; (1) the self-reported level of experience by the practitioner, (2) the number of times mindfulness meditation was practiced per week, (3) the number of minutes mindfulness meditation was practiced per meditation session, and (4) the number of months mindfulness was practiced in total. To my knowledge, this was the first study to explore the effects of mindfulness experience on attentional bias using these different defining methods.

Another possibility for the inconsistency in the literature is that, current research has failed to identify a reliable method of exploring the effects on meditation experience on attention between meditators across different practices. Often, to obtain a sufficient sample size the majority of mindfulness studies, including some of those outlined previously (e.g. Valentine & Sweet, 1999), do not contain *pure* mindfulness meditators (i.e. practitioners may identify themselves as mindfulness meditators but still practice strategies from other meditations). It is therefore difficult to determine with confidence whether better attentional control and lower levels of attentional bias is associated with meditation experience or meditational type. The current study proposed the novel idea that meditation experience can be defined by practitioners' ability to utilise the attentional components; focused attention and/or open monitoring. Mindfulness meditators are generally taught both of these skills (Chambers et al., 2009), whereas non-mindfulness meditators (e.g. concentrative and transcendental meditators) are typically taught only focused attention (Lutz, Slagter, Dunne & Davidson, 2008; Rapgay & Bystrisky, 2009).

Given the greater simplicity of learning focused attention, the current study predicted that meditations which place more of an emphasis on focused attention would be practiced by 'novice' meditators whereas meditations which encourage the learning of focused attention in addition to the more complex skill, open monitoring, would be practiced by 'experienced' meditators. In support of this, some have argued that the complexity of mindfulness meditation compared to concentrative meditation encourages a high drop-out rate of novice users (Delmonte, 1988). Despite some obvious limitations of this new categorisation method (e.g. assuming that all mindfulness meditators practice open monitoring in addition to focused attention, and non-mindfulness meditators the opposite of this), given the complexity of meditation, in addition to this study being the first to use this method, initial explorations were believed to benefit from a simplistic approach.

2.1.8 The current study

The idea that attention could be trained through mindfulness meditative practice is an intriguing possibility and one that formed the subject of this investigation. As previously discussed, there is increasing evidence to suggest that meditation training enhances attentional control by reducing attentional bias (e.g. Chambers et al., 2008; Jha et al., 2007; Wenk-Sormaz, 2005; Tang et al., 2007; Moore & Malinowski, 2009). The current study aimed to further investigate the impact of mindfulness training, taking into account meditation experience on attentional bias to the emotionally motivating stimuli; chocolate. No other studies have directly investigated the impact of experience of mindfulness training on attentional bias towards this emotionally motivating stimulus.

2.1.8.1 Evidence for attention bias to emotionally motivating food-related stimuli

Research has shown that when individuals are attempting to abstain from a substance with a high reward or threat value, attentional bias for information in the environment relating to that substance is increased (Cox, Fadardi & Pothos, 2006; Pothos et al., 2009). Using various versions of the Stroop paradigm (Channon & Hayward, 1990, but see Stewart & Samoluk, 1997 for a non-replication) and also the dot-probe task (Mogg, Bradley, Hyare & Lee, 1998) research has consistently shown attentional bias to high sugar, high fat food names, including chocolate (Mogg et al., 1998; Pothos et al., 2009). Specifically, attentional biases to such food products have been identified amongst dieters (Cooper & Fairburn, 1992), restrained eaters (Francis, Stewart & Hounsell, 1997) and those particularly sensitive to the appetitive qualities of food (i.e. external eaters; Daryna, 2005). Newman et al. (2008) also found a significant interaction between the effect of external eating and experimentally induced stress in the colour-naming interference of snack-related food words. These findings were very similar to attentional biases reported in drug dependence research, with enhanced attentional bias evident at the visual probe exposure durations, 500 and 2000ms. The findings are also consistent with previous research which has indicated a bias for appetitive cues operating in the maintenance of attention (Field et al., 2004). Thus, there may be a common mechanism that controls the holding of attention on emotionally motivating stimuli. Successfully identifying a way of lowering levels of attentional bias to such stimuli has many health-related benefits given that attentional biases may contribute to the maintenance and escalation of addictive behaviours (e.g. Cox, Pothos & Hosier, 2007; Field & Eastwood, 2005; Waters & Feyerabend, 2000; Waters et al., 2003). To name just one advantage, lower levels of attentional bias may help to reduce obesity given that Calitri, Pothos, Tapper, Brunstrom & Rogers (2010) found that an attentional bias to unhealthy foods (as measured by an emotional Stroop task) predicted an increase in BMI one year later.

2.1.8.2 Effects of mindfulness meditation on attention bias to food-related stimuli

The current study proposed that practicing mindfulness meditation may be one approach of lowering levels of attentional bias to emotionally motivating stimuli. In support of this, it has been suggested that applying the principle of meditation offers a powerful means of preventing impulsive reactions as demonstrated by less attentional bias (Papies et al., 2011). Papies et al. hypothesised that mindfulness attention training would lower or even possibly eliminate participants' attentional bias to attractive foods, compared to a control condition. Mindful participants should therefore respond to attractive food pictures in the same unbiased manner that they respond to neutral pictures. In Papies et al's study, participants were randomly allocated to either a mindful attention condition or to a control condition. First, a sample of forty student participants were shown a number of emotionally evoking pictures. The mindfulness group were instructed during this task to observe any thoughts they had about the pictures without suppressing or avoiding them. Each picture was viewed for a brief period of five seconds. The control group (i.e. reverse instruction group) were told to 'completely experience' and 'get immersed' in the emotions and thoughts they experienced in relation to each picture. After this task had finished, participants completed an approach-avoidance task which contained five pictures of attractive foods (e.g. pizza), five pictures of neutral foods (e.g. cucumber) and ten filler pictures.

The findings showed that spontaneous approach reactions elicited by attractive food were fully eliminated in the mindful attention condition compared to the control condition in which participants viewed the same items without mindful attention training. This effect occurred systematically across three experiments when, (1) compared to a non-mindful attention control group, (2) independent of participants' goal of dieting, and (3) evident to be persistent over a five minute distraction period. Papies et al. concluded that mindfulness meditation training helps people to recognise that the desire they have for a certain food can be attributed to transient thoughts, rather than to the stimulus itself. It is potentially this change in attribution that dissipates food impulses by lowering attentional bias. Whilst these findings are promising, further examination of the precise mechanisms underlying these effects was advised.

2.1.9 Measuring attentional bias

To obtain a measure of attentional bias numerous paradigms have been implemented, with the most common of these being various versions of the Stroop task (e.g. original and emotional) (Schatzberg, Posner, DeBattista, Kalehzan, Rothschild & Shear, 2000; Tapper, Pothos, Farardi & Ziori, 2008; Williams, Mathews & MacLeod, 1996) and the dot-probe (visual probe) task (Bradley, Mogg & Lee, 1997; Tapper, Pothos & Lawrence, 2010). In view of this, the current study also used these tasks to assess whether mindfulness experience had a significant effect on attention. The emotional Stroop, as opposed to the original Stroop task, was however used given that the current study aimed to explore the effects of meditation on attentional bias to emotionally motivating stimuli. The emotional Stroop assessed attentional bias in the form of elaborative processing. The dot probe was used to assess attentional bias in the form of impaired disengagement at 100, 500 and 2000ms durations. The shorter durations of 100 and 500ms were chosen to allow for the investigation of initial attentional orientation, whilst the longer 2000ms duration provided a measure of sustained attention. These time durations were also selected based on their used in similar research studies (Field, Mogg, Zetteler & Bradley, 2004; Tapper, Pothos & Lawrence, 2010).

2.1.9.1 The emotional Stroop task

In the original Stroop task (Stroop, 1935) participants are asked to identify the colour of a series of words as quickly as possible and to ignore their semantic content. Typically for this version of the task the words are matched on variables such as word length and number of syllables. Colour naming reaction times are significantly slower when the words are incongruent colour names compared to non-colour words, or strings of letters. The Stroop effect is taken as evidence that attention paid to the words themselves interferes with attention that would otherwise be focused on the colour-naming task. Over the years, the Stroop has been modified with newer versions of the task (i.e. the emotional Stroop) having the ability to examine whether words related to an individual's emotional problems interfere more greatly with colour naming than control words. For example, an individual with an eating disorder may demonstrate greater colour-naming interference when the target words refer to food. There exists a vast body of literature demonstrating that colour naming is significantly impaired when the target words are relevant to an individual's area of emotional concern, including anxiety disorders, phobias, and obsessive-compulsive disorder (see Williams, Mathews & MacLeod, 1996, Williams, Watts, MacLeod & Mathews, 1997 for a review). Findings from studies using the emotional Stroop demonstrate that this task can act both as a diagnostic of an emotional condition (Foa, Ilai, McCarthy, Shoyer & Murdock, 1993; McNally, English & Lipke, 1993) and successful treatment of a disorder, as shown by a reduction in the Stroop effect (Mathews, Mogg, Kentish & Eysenck, 1995). Some researchers have however argued that the emotional Stroop task does not provide a reliable measure of attentional allocation. This is because colour-naming can result from attention either being directed towards or away from emotionally relevant stimuli (de Ruiter & Brosschot, 1994). Despite this criticism, researchers have still chosen to utilise the emotional Stroop task to investigate the effects of mindfulness training on attentional control and attentional bias (Wenk-Sormaz, 2005).

2.1.9.1.1 Using the emotional Stroop task to explore the effects of mindfulness training on attention.

The demonstration of decreased Stroop interference in mindfulness meditators implies that cognitive processes that become automated can be brought back under cognitive control, and previously automatic responses can be interrupted or inhibited (Deikman, 2000). The literature investigating the effects of meditation practice on emotional Stroop task performance is less researched than that on the original Stroop task (Dillbeck & Orme-Johnson, 1987). Some positive findings have however been shown. Wenk-Sormaz (2005), for example, demonstrated that a mindfulness induction in the laboratory promoted less automatic and habitual responding on an emotional Stroop task; suggesting increased attentional control in the emotional domain. Lutz et al. (2008) later replicated this finding. These results support Bishop et al's (2004) argument for the utility of using the emotional Stroop task to assess mindfulness skills. This is because mindfulness training cultivates the ability to inhibit semantic/secondary elaborative processing of the thoughts, feelings, and sensations that arise following confrontation with a stimulus. Bishop predicted that this should lead to shorter latency and fewer mistakes in colour-naming emotional words in this paradigm. Not all studies which use the emotional Stroop to explore the effects of meditation training on attention however demonstrate these findings. A study by Anderson, Lau, Segal & Bishop (2007) failed to find greater attentional control after participation in an eight-week mindfulness-based programme as assessed by emotional Stroop interference[2]. Accordingly at present, no definitive conclusions can be made in terms of the efficacy of the emotional Stroop task to measure the effects of meditation training on attention. The current study aimed to further understand the effects of mindfulness on emotional Stroop task performance by using a food version of the task (Tapper & Pothos, 2009) to test for attentional biases to chocolate (Faunce, 2002).

2.1.9.2 The dot-probe task

This task was first devised by MacLeod, Mathews & Tata (1986) and involved the presentation of word or picture pairs side by side on a computer screen for a fixed duration. One half of the pair is concern or interest-related whereas the other stimulus is a matched, concern/interest-neutral picture or word. After the fixed duration has lapsed, the images are removed and a probe stimulus (e.g. a dot) appears in the location of one of the previously occupied pair members. Participants are asked to indicate the probe location by selecting the correct response key out of two options as quickly as possible. Attentional bias is indicated by either faster reaction times to probes that replace concern/interest-related images or words (orienting) and/or slower response times to probes replacing the neutral stimuli (disengagement). Many of the limitations posed by Stroop-based task are believed to be avoided by the dot-probe task (see Cisler, Bacon & Williams, 2009). The dot-probe for instance is less subjective to carryover effects (i.e. colour-naming interference produced by concern-related words slowing down responding to the next word in the list). This is because the location of the control and emotional

[2] The emotional words used in this study were positive (e.g. loyal) and negative (e.g. shallow) adjectives which the participants had previously rated as being 'most characteristic of them'.

stimuli are randomly varied across trials between the left and right sides of the computer screen.

The dot-probe task also provides a more ecologically valid assessment of attentional bias than the emotional Stroop task. Shifting visual attention between different stimuli reflects situations in the natural environment in which individuals are confronted with multiple events competing for his/her attention. Another advantage of the dot-probe task is that it measures the two components of attention used in mindfulness meditation; continued maintenance of attention (i.e. focused attention) and shifting attention away from stimuli of threat or reward (i.e. open monitoring). Thus, this task is able to individually measure the different components of attention. Furthermore, the inclusion of the dot-probe in addition to the emotional Stroop tasks allows for more clear interpretation of how different levels of mindfulness experience effects attention. Research has shown that there is no significant correlation between these two tasks (Egloff & Hock, 2003; Pothos, Calitri, Tapper, Brunstrom, & Rogers, 2009). A limitation of the dot-probe task however is that some studies report identifying attentional bias after only brief stimulus presentations (500ms or less) (Bradley et al., 1997; Mogg et al., 1995, 2004) whereas others report attentional bias using longer stimuli presentations (1000ms or more) (Gotlib, Krasnoperova, Yue & Joormann, 2004). As a result of this, further investigation is needed to explore the efficacy of measuring attentional bias using the dot-probe task.

2.1.9.2.1 Using the dot-probe task to explore the effects of mindfulness training on attention

In comparison to the emotional Stroop task, investigations into the effects of mindfulness experience on performance of the dot-probe task are to date, unexplored. Hodgins & Adair (2010), however, recently used a similar visual selection attention task to the dot-probe task to explore the effects of mindfulness training on attention. The findings were promising, showing that meditators demonstrated less interference from invalid cues compared to non-meditators. No direct use of the dot-probe task has though been published. This demonstrates a gap in the research literature which has the potential to uncover novel findings in the area of meditation and attention. The current study aimed to bridge this gap. It also attempted to explain how mindfulness works to achieve more effective attentional control (e.g. delaying orientation to, or enhancing disengagement from motivationally stimulating stimuli).

2.1.9.2.2 Using the dot-probe task to explain reductions in attentional bias; delayed orientation or enhanced disengagement

Attentional bias is often measured in two parts; orientation of bias and maintenance of bias (Calvo & Avero, 2005; Calvo & Lang, 2004; Field et al., 2006; Fox, Russo, Bowles & Dutton, 2001; Mogg et al., 2005). The first component is involved in early attentional processing (typically within 0-2 seconds) whereas the second component is involved in late attentional processing (Calvo & Avero, 2005; Calvo & Lang, 2004; Field et al., 2006). The distinction between the initial orienting of selective attention and the maintenance, or disengagement, of attention is recognised as an important one (Corbetta & Shulman, 2002). The orientation of bias and maintenance of bias have been found to differ depending on the type of stimuli and the experiences of the individuals. Many studies have shown that higher levels of attentional bias to concern/interest stimuli is the result of delayed disengagement as opposed to heightened orientation (Fox, Russo, Bowles & Dutton, 2001; Georgiou et al., 2005; Koster, Crombez, Verschuere & De Houwerm 2006; Salemink, van der Hout & Kindt, 2007; Yiend & Mathews, 2001; but see Mogg, Holmes, Garner & Bradley, 2008). Using a modified visual probe task to examine the influence of hunger and trait reward drive on food-related attentional bias, Tapper, Pothos & Lawrence (2010) found that these predicted delayed disengagement from food images at short (100ms), but not long (500, 2000ms) stimulus durations. A study by Kemps & Tiggemann (2009) also found difficulties in disengaging attention from chocolate images in chocolate cravers.

Similarly to Tapper et al. (2010) and Kemps & Tiggemann (2009) the current study aimed to investigate the effects of food stimuli on attentional bias. More specifically however, the study aimed to explore the effects of mindfulness experience on participants' ability to lower levels of attentional bias to these emotionally motivating stimuli. Ortner, Kilner & Zelazo (2007) explored the effects of mindfulness meditation on attentional control in emotional contexts. Using an emotional interference task (Buodo et al., 2002) participants were asked to judge whether a tone was high- or low-pitched while viewing neutral, pleasant, or unpleasant pictures. The results showed that participants with more mindfulness meditation experience showed less interference from affective pictures compared to those who had experience of relaxation meditation or no meditation at all. This study suggested that experienced meditators were better able to disengage their attention from emotional stimuli. Others studies have however found the opposite, with meditation training being associated with delayed orientation of attention (Jha et al., 2007; van den Hurk et al., 2010)[3]. Thus, it remains ambiguous whether mindfulness is associated with lower levels of attentional bias by delaying attentional orientation to emotionally motivating stimuli, or by enhancing a practitioner's ability to successfully disengage from the stimuli. Given the limited amount of literature published in this research area, the current study aimed to offer further clarity as to how mindfulness experience affects attention control and attentional bias.

2.1.10 Predicted mediators: mindfulness, attentional control and self-control

Several researchers have reported that meditation training is associated with greater self-reported mindfulness (Chambers et al., 2008; Jha et al., 2010; Moore & Malinowski, 2009; Zeidan et al., 2010), attentional control (Singh et al., 2007, 2003) and self-control (Tang et al., 2009, 2007). Reported lower levels of attentional bias to emotionally motivating stimuli, due to the practice of meditation, may therefore be caused by these variables mediating the effects. As a result, using questionnaire measures the current study aimed to examine the extent to which the effects of meditation training on attention were brought about by increases in mindfulness, attentional control and self-control ability. A brief literature review in support of the potential mediator effects of each variable is provided.

2.1.10.1 Mindfulness

Research using the Five Facet Mindfulness Questionnaire (FFMQ) has shown that after controlling for demographic variables such as age, education and mental health, meditation experience is significantly associated with levels of self-reported mindfulness (Baer et al., 2008; Carmody & Baer, 2008; Lykins & Baer, 2009). This may suggest that the practice of meditation leads to a greater ability to use

[3] Both studies measured orientation of attention using attentional network tests.

mindfulness skills in daily life. Furthermore, the subjective sense of attentional control has been found to correspond to individual differences in trait mindfulness (Baer, Smith, Hopkins, Krietmeyer & Toney, 2006; Herndon, 2008). Schmertz et al. (2009) for example reported that self-reported mindfulness was positively related to performance on a task of sustained attention. More specifically, the findings showed that mindfulness scores were negatively related to task target omission. Schmertz and colleagues therefore concluded that self-reported mindfulness is related to exaggerated lapses of attention. Baer (2009) also reported that higher levels of mindfulness appeared to mediate improvements in psychological functioning (e.g. observation of internal and external experiences), probably by cultivating an adaptive form of self-focused attention. The aforementioned evidence supports the notion have self-reported mindfulness may mediate the effect of mindfulness training on attention.

2.1.10.2 Attentional control

Attentional control refers to attention-related regulatory processes which are needed to ensure that information processing is in accord with long- and short-term goals. One possible way of achieving greater attentional control is through meditation training. Some have suggested that, although there is strong evidence to infer that meditation training is positively related to attention, the strength of the relationship is mediated by individual differences in attentional control abilities (longitudinal study; Singh et al., 2003). Walsh et al. (2009) for example found that self-reported attentional control correlated with mindfulness scores. Dorjee (2010) also found that increased sustained attention in a meditation group was marked by significantly lower levels of variability of individual reaction times. Furthermore, Derryberry & Reed (2002) reported that people high in attentional control were better at focusing attention, shifting attention, and controlling thoughts in a flexible manner than low control counterparts. Some have suggested that these characteristics overlap considerably with meditative practices (Brefczynski-Lewis et al., 2007; Dickenson, Berkman, Arch & Lieberman, 2012). As a result of this, many scientific studies have been carried out to investigate whether greater attentional control, and consequently, lower levels of attentional bias, is a true benefit of meditation (see Shapiro & Walsh, 2003 for a review).

Another measure of attentional control is absorption. Absorption is typically assessed using Tellegen's Absorption Scale (TAS; Tellegen & Atkinson, 1974), a questionnaire that measures an individual's openness to new emotional and cognitive experiences, as well as the ability to engage attention fully in an experience (Roche & McConkey, 1990). The TAS is believed to capture an aspect of attention that may act as a meditating variable in studies of meditation. Davidson, Goleman & Schwartz (1976) found a reliable linear increase in TAS scores from controls to long-term meditators. This study however used a cross-sectional design of meditators from different traditions, therefore it remains unclear whether absorption was developed by, or was a predisposing characteristic of, long-term meditation. Warrenburg, Pagano, Woods & Hiastala (1980) reported that long-term meditators who maintained regular meditation practice were significantly higher in absorption than non-meditators. Moreover, there was a significant correlation between absorption and tonal memory in the meditation group. This evidence, plus a failure to find an association between length of meditation practice and absorption, led the authors to conclude that the attention trait was not a result of practice, but possibly a predisposing variable. In view of this, future investigations of the relationship between meditation and attention ought to include a measure of absorption, in addition to other measures of self-reported attentional control. The purpose of this is to gain some statistical control over performance variability.

2.1.10.3 Self-control

Self-control is described as the capacity to maintain stability of functioning in the face of unpleasant internal states and to be less controlled by particular emotions and thoughts (Wright, Day & Howells, 2009). Self-reported scores on self-control measures have been found to be significantly positively correlated with mindfulness scores (Black et al., 2011). As a result, some studies have supported the use of mindfulness meditation in the self-control of health-related disorders including, anxiety and depression, pain management, cancer support, hypertension, coronary artery disease, substance abuse, binge eating and stress management (Alterman, Koppenhaver, Mulholland, Ladden & Baime, 2004; Bowen et al., 2006; Carlson, Ursuliak, Goodey, Angen & Speca, 2001; Chang et al., 2004; Davidson et al., 2003; Kabat-Zinn, 1982; Kabat-Zinn et al., 1992; Kristeller & Hallett, 1999; Majumdar, Grossman, Dietz-Waschkowski, Kersig & Walach, 2002; Miller, Fletcher & Kabat-

Zinn, 1995; Tacon, McComb, Caldera & Randolph, 2003; Williams, Kolar, Reger & Pearson, 2001). The concept of self-control through the practice of meditation has also been supported in the development, testing and use of the Mindfulness Awareness Assessment Scale (MAAS) (Brown & Ryan. 2003).

The intentional cultivation of mindfulness attention may promote self-control by allowing for greater attention to internal and environmental cues (Kabat-Zinn, 1982; Linehan, 1993). Trait mindfulness has been found to correlate significantly with self-reports of self-control, goal setting, goal clarity, and a stronger intention-behaviour relationship (Baer et al., 2006; Chatzisarantis & Hagger, 2007; Kee & Wang, 2008; Lykins & Baer, 2009), while a mindfulness induction and the intentional direction of attention, respectively, have been shown to lead to less automatised and habitual responding and the ability to override unwanted responses (Baumeister, Heatherton & Tice, 1994; Wenk-Sormaz, 2005). This is all suggestive of more effective self-control. Thus, if the deliberate direction of attention involves self-control, and if meditation practice cultivates the ability to direct attention mindfully while using fewer executive resources, then meditators should show higher performance on the attentional control tasks compared to non-meditators. It is also possible that individuals with naturally high levels of mindfulness in the absence of meditation experience will also show lower levels of attentional bias on these tasks. Testing for the effects of self-reported self-control is therefore advised when exploring the effects of meditation training on attention.

2.1.11 Methodological problems in research exploring the effects of meditation on attention and how to overcome them

There are many studies that have investigated the benefits of meditation training on attention (Shapiro et al., 2006; Slagter et al., 2007; Zeidan et al., 2010). These studies are however not free from limitations. A discussion of some of these limitations is provided, followed by a discussion of how to overcome the noted methodological problems.

2.1.11.1 Subject selection factors

One recognised methodological problem is the inconsistent subject selection factors when comparing meditators with non-meditator controls. This makes the interpretation of findings difficult. Failing to identify predisposing factors that may influence the effect of meditation on attention also has its limitations. Some have reported that certain personality characteristics such as openness, neuroticism, impulsivity and anxiety predispose an individual to start, or maintain, meditation practices (West, 1980; Takahashi et al., 2005) which, in turn, may impact their attentional control ability. More specifically, neuroticism, impulsivity and anxiety have been found to be negatively correlated with mindfulness (Brown & Ryan, 2003). Thus, people high in these traits are thought to possess attentional biases which may be contrasted with mindfulness. On the contrary, openness has been found to be positively associated with mindfulness; people high in this trait are thought to possess less attentional biases due to acceptance of what is present. Positive associations have also been observed between trait mindfulness and the personality characteristics, agreeableness and conscientiousness (Brown & Ryan, 2003; Thompson & Waltz, 2007). The relationship between other personality characteristics, such as extraversion and meditation practice, however remains unclear due to the fact that research has found both positive (Baer et al., 2004) and negative (Thompson & Waltz, 2007; Waters, 2007) correlations.

2.1.11.2 Practitioners' psychological well-being

Another confounding factor may be practitioners' psychological well-being. Empirical findings suggest that meditation training can be applied to help reduce symptoms in a considerable number of psychological disorders including, stress, anxiety and depression (Atin, 1997; Baer, 2003; Carmody & Baer, 2008; Giommi, 2006; Grossman, Niemann, Schmidt & Walach, 2004; Kabat-Zinn, 1982, 1990, 2003; Kabat-Zinn, Lipworth & Burney, 1985; Kristeller & Hallett, 1999; Nyklicek & Kuijpers, 2008; Speca, Carlson, Goodey & Angen, 2000; Teasdale, Segal & Williams, 1995; Teasdale et al., 2000). Many studies have found that self-report mindfulness scores are negatively associated with measures of anxiety, depression and negative affect (Baer et al., 2004; Brown & Ryan, 2003; Feldman et al., 2007) with significant group differences between meditators and non-meditators evident in the expected direction (Lykins & Baer, 2009). Chambers et al. (2008) also found that participation in an intensive meditation retreat led to significant decreases in depressive symptoms and rumination relative to a control group, while Tang et al. (2007) found that a brief mindfulness training session led to lower anxiety, depression, and stress-related cortisol levels.

Furthermore, Schreiner & Malcolm (2008) investigated the effect of meditation on these three emotional states, in addition to exploring whether people with varying severity of stress, anxiety and depression responded differently after meditation training. The results showed that the severity levels of all affective measures decreased by the end of the meditation courses. More specifically, participants with severe emotional difficulties at the time of starting the meditation course demonstrated the most notable improvements over time. Schreiner & Malcolm (2008) concluded that meditation training is beneficial in reducing the symptoms of sub-clinical depression and anxiety and can substantially reduce stress. Meditation practice may improve psychological wellbeing by teaching unbiased observation of all stimuli, therefore potentially reducing maladaptive forms of selective attention. Campbell-Sills, Barlow, Brown & Hofmann (2006) supported this, finding that when individuals diagnosed with mood and anxiety disorders were asked to watch a distressing film clip in an accepting, mindful way, they experienced faster recovery from the induced negative affect than those instructed to suppress their reactions to the film. Arch & Craske (2006) also showed that individuals completing a focused breathing induction experienced the least emotional volatility while viewing emotion-relevant slides and the greatest willingness to view highly negative slides, compared with individuals engaging in unfocused attention or worrying.

2.1.11.3 Individual differences

Individual differences in eating behaviours are also thought to influence the effect of meditation on attention. Restrained eaters (i.e. people who restrict food intake to achieve weight loss or to prevent weight gain, Herman & Mack, 1975) can be driven by appearance-related evaluative processes (e.g. self-judgement of the self, such as body weight and shape) (Papies & Nicolaije, 2012). Mindfulness meditation cultivates acceptance of the self and reduced self-judgement. Consequently, it is believed that the practice of mindfulness is beneficial in that it is likely to reduce restrained eating (Alberts, Thewissen & Raes, 2012). As a result of this, mindfulness meditators are considered to have lower attentional bias than unrestrained eaters (Francis, Stewart & Hounsell, 1997; Stewart & Samoluk, 1997).

2.1.11.4 Overcoming these methodological limitations: identifying group differences

Whilst controlling for the identified methodological flaws in meditation and attention research is very difficult, one suggested way of doing so involves identifying significant group differences prior to conducting the main data analyses. Lykins & Baer (2009) highlighted the importance of this, arguing that many studies showing significant and non-significant effects of meditation training on attentional bias may be due to a failure to control for demographically dissimilar meditator and non-meditator groups. Whereas it seems that making no attempt to explore the similarity of meditators and non-meditator controls is a thing of the past (Jha et al., 2007), the majority of studies in this research area limit investigations to only a few demographic and characteristic variables, with the most common being age (Hölzel et al., 2008; Lazar et al., 2005; Luders et al., 2009; Moore & Malinowski, 2009; Travis & Shear, 2010) or gender (Valentine & Sweet, 1999; van den Hurk et al., 2010). Others have also however included the variable, level of education (Chan & Woollacott, 2007; van Leeuwen et al., 2009). The addition of this latter variable has been welcomed as it is believed that relationships with education may be especially important due to many attentional tasks involving fluid intelligence. Despite this, checking for differences between meditators and non-meditators on a maximum of three variables is still considered insufficient (Lykins, Baer & Gottlob, 2012).

A study by Lykins et al (2012) attempted to address this criticism by purposefully comparing the performance of meditators with demographically similar non-meditators on attention-based tasks. Lykins et al. conducted checks of group similarity on a total of nine variables: age, gender, ethnicity, years of education, past and present diagnosis of a psychological disorder (depression, anxiety or stress), current practice of yoga, number of months of meditation practice, number of meditation sessions practiced per week, and number of minutes meditated per session. Lykins et al. however still concluded that further similarity checks between the meditators and non-meditators could have been even more appropriate by including personality variables and measures of intelligence (Aron, Orme-Johnson & Brubaker, 1981; Cranson et al., 1991; Dillbeck, Assimakis, Raimondi, Orme-

Johnson & Rowe, 1986). In view of this, administration of a range of individual difference assessments are required in order to help determine both how experienced meditators may differ from novice meditators and control subjects. Furthermore, a range of assessments is needed to elucidate what contribution, if any, such measures might make to lower levels of attentional bias. Another reason for identifying group differences in meditation research is to clarify if attentional processing is truly enhanced by meditation training. The current study therefore aimed to conduct sufficient similarity checks between the meditator and non-meditator groups by taking measures of personality (Costa & McCrae, 1992), meditation training and general demographic information, as well as measures of hunger (Grand, 1968), reward sensitivity (Carver & White, 1994) and eating behaviour (Van Strien, Frijters, Bergers & Defares, 1986) (see Pothos, Tapper & Calitri, 2009; Tapper et al., 2010).

2.1.12 Other design features of the current study

To enhance attentional bias, dieters were screened out of the current study given that previous evidence has shown high restrained current dieters to demonstrate lower food-related processing bias related to high restrained non-dieters (Tapper, Pothos, Fadardi & Ziori, 2008). Research has also shown that subjective hunger should be taken into consideration when investigating attentional bias (Mogg, Bradley, Hyare & Lee, 1998; Placanica, Faunce & Soames, 2002). Tapper, Pothos & Lawrence (2010) for example identified that hunger predicted attentional bias to both appetising and bland food-cues at 100ms cue duration. Hunger was also found to impair disengagement from food-cues (Tapper et al., 2010). Furthermore, a period of fasting prior to completing attentional bias tasks has been shown to increase subjective hunger and attentional bias for food cues (Castellanos et al., 2009). Participants in the current study were therefore asked to fast for at least three hours before taking part (Tapper et al., 2008; Tapper et al., 2010). Furthermore, the current study did not explicitly test task performance before and after meditation. The reason for this was due to traditional accounts of meditation suggesting that the cognitive effects of its practice are maintained outside of the mediation session (Alexander et al., 1989; Goleman, 1976; Kabat-Zinn, 1990). A community sample was also used given that learning to observe internal stimuli mindfully requires more meditation experience than typically found in student samples (Baer et al, 2008). Finally, to obtain a sufficient sized sample, both mindfulness and non-mindfulness (i.e. those practicing another type or meditation) were recruited.

2.1.13 Aims and predictions

The current study aimed to (1) compare data from experienced meditators, novice meditators, and a comparable control group of non-meditators in order to examine links between meditation training and attentional bias for the unhealthy snack, chocolate, and (2) examine the extent to which the effects of mindfulness training on attentional bias were brought about by increases in self-reported mindfulness, attentional control, and self-control ability. Thus, an investigation of predicted mediators was undertaken in an attempt to explain potential links found between mindfulness and attention. Participants completed emotional Stroop (Tapper, Pothos, Fadardi & Ziori, 2008) and dot-probe (Tapper, Pothos & Lawrence, 2010) tasks. Following these tasks participants were asked to complete standardised measures of mindfulness (Baer et al., 2008; Brown & Ryan, 2003), attentional control (Derryberry & Reed, 2002) and self-control ability (Tangney, Baumeister & Boone, 2004). Additional questionnaire measures of personality (Costa & McCrae, 1992), meditation training and general demographic information were also included, as well as measures of hunger (Grand, 1968), reward sensitivity (Carver & White, 1994) and restrained eating (Van Strien, Frijters, Bergers & Defares, 1986) (see Pothos, Tapper & Calitri, 2009; Tapper et al., 2010). Based on the hypothesis that mindfulness meditation training is associated with lower levels of attentional bias, the following predictions were made.

- Meditators would show the best performance on the emotional Stroop and dot-probe tasks compared to non-meditator controls.
- All predictor mediators would be associated with lower attentional bias. Thus it is expected that the effects of meditation experience on attentional bias would be mediated by self-reported mindfulness, attentional control and self-control ability.

Examination of the long-term effects of meditation on attention was carried out by comparing meditators who differed in the level of experience, as measured by practitioner self-assessment, and also minutes, days, months and total hours spent meditating. Meditation experience was also investigated based on the attentional skills practiced by the meditators; focused attention and open monitoring, irrespective of the type of meditation practiced. It was predicted that;

- On tests of selective attention (e.g. emotional Stroop) where participants were required to focus attention on a particular object, novice and experienced meditators would perform similarly.
- On tests which require participants to attend to different areas of a scene (e.g. dot-probe) it was assumed that experienced-mindfulness meditators would demonstrate superior performance compared to novice-concentrative meditators.
- When compared to non-meditating controls, both novice and experienced meditators (irrespective of how the groups were determined) were expected to demonstrate the best performance on the attentional bias measures.
- Both novice and experienced meditator groups would also show stronger correlations between the mediators and attentional bias to chocolate-related stimuli compared to non-meditator controls.

2.2 Method

2.2.1 Power analysis

To determine the total number of participants needed to reach statistical power, a power analysis was conducted using an online sample size calculator (University of Surrey, Guildford). The parameters set for computing power were for a t-test with .80 (80%) power and an alpha level of $p<.05$. To detect a mean difference between groups of 10 milliseconds on the emotional Stroop task (SD = 15; Tapper et al., 2008; Tapper et al., 2009), 37 participants were required per group. An attempt was made to recruit a minimum of 40 participants to statistically ensure full task completion by 37 participants. This was carried out successfully, with the smallest group (non-meditator controls) comprising 38 participants and the largest group (experienced meditators) consisting of 48 participants. Allocation to each group was determined by participant's self-selected level of meditation experience (experienced, novice or non-meditators).

2.2.2 Participants

The study recruited a community sample of 130 participants through the display of flyers at meditation retreats, yoga studios, and community centres located within the South West Wales area. An advert was also placed in a holistic magazine. Additionally, emails were sent to members of meditation groups, to students attending evening adult education classes, and to individuals currently holding memberships at local leisure and fitness centres. In order to achieve a sufficient sample size, flyers and advertisements were worded to attract individuals who were either currently practicing meditation, or who had no experience of meditation, as opposed to *pure* mindfulness meditators.

Of the 130 participants recruited, 49 considered themselves (i.e. self-assessment) to be experienced meditators and 40 considered themselves to be novice meditators. Forty-one reported being non-meditators (i.e. those with no experience of any meditation practice). All participants were native English speakers, over the age of 18, not currently dieting and had normal or corrected-to-normal vision. Participants received a remuneration of £8 for participation and were asked to fast (i.e. consume no food) for three hours prior to taking part in the study. Ethical approval was provided by Swansea University Psychology Department Research Ethics Committee. All participants completed the study in full.[4]

2.2.3 Materials and apparatus

2.2.3.1 Questionnaires

2.2.3.1.1 Baseline characteristics

2.2.3.1.1.1 Screening questionnaire

To check the eligibility of those interested in taking part in the study, participants were asked eight preliminary screening questions over the telephone or via email (see appendix A). The questions ensured that the participants met all criteria of the study (i.e. were 18 years of age or older, had normal or normal-to-corrected vision, did not suffer from epilepsy, were not currently dieting, a native English speaker, and had the ability to fast [no food to be consumed] for a period of three hours). A measure of how many times participants had dieted in the past 12 months was also recorded.

2.2.3.1.1.2 Meditation practice questionnaire

Participants with meditation experience completed a questionnaire designed to assess various aspects of their meditation history, including length of practice in days per week, type of meditation practiced, length of individual meditation sessions in minutes, details of any meditation retreats attended or training undertaken, pattern of meditation use, and motivation for practice (see appendix B). Participants were also asked to provide details of both past and present experiences of yoga, if they had any other activities/hobbies that involved meditative practice techniques, and if they had ever used any specific meditative breathing exercises. An opportunity to express any additional comments or information about their personal meditation practice was also offered to participants at the end of the questionnaire.

[4] For full analysis on how the participant groups were checked for significant differences, see section 2.3.1.5 of the Results.

2.2.3.1.1.3 Demographic questionnaire

All participants were asked questions relating to gender, age, education, occupation, and ethnic background (see appendix C). Participants were further asked to provide any present or historic information relating to being clinically diagnosed with a psychological disorder (e.g. stress or depression), details of any physical condition(s) that may affect what they eat, and if they were currently pregnant. Measures of how much participants liked chocolate and the frequency (per average week) they consumed chocolate was also obtained using a seven-point Likert scale.

2.2.3.1.1.4 Trait self-description inventory

This Likert type short version of the Trait Self-Description Inventory (TSDI; Collis & Elshaw, 1998; Roberts, Zeidner & Matthews, 2001) was used to measure the Big Five personality dimensions of openness, conscientiousness, extraversion, agreeableness, and neuroticism (Tupes & Christal, 1961). TSDI (short version) consists of 50 items in two sections. The first section contains 28 trait descriptive adjectives such as "responsible" to which the participant responds using a seven-point scale where 1 represents "extremely not characteristic of me" and 7 represents "extremely characteristic of me" compared with other individuals. The second section contains 22 statements (e.g. "I worry more than most people") and the participant responds using a nine-point scale where 1 represents "very strongly disagree" and 9 represents "very strongly agree". To enable aggregation of the items with different response scales the appropriate trait and behavioural responses were summed to generate the five composites which represent the Big Five factors. The scale was found to have a Cronbach's α of 0.77

2.2.3.1.1.5 Dutch eating behaviour questionnaire

The Dutch Eating Behaviour Questionnaire (DEBQ; van Strien, 1986) consisted of 33 questions, 13 of which assessed emotional eating, 10 external eating and 10 restrained eating. The DEBQ-emotional subscale measured overeating due to 'confusion between internal arousal states accompanying emotional states and physiological states of hunger and satiety' (van Strien, 1986, p.137) (e.g. "Do you have a desire to eat when you are feeling lonely?"). A subdivision was made between eating in response to diffuse emotional states and eating in response to clearly labelled emotions. The DEBQ-external subscale reflects overeating due to 'hyper-responsiveness to food-related cues in the environment together with unresponsiveness to internal cues of hunger or satiety' (van Strien, 1986, p. 137) (e.g. "If you see or smell something delicious, do you have a desire to eat it?"). The DEBQ-restraint subscale reflects the degree to which one eats less than he or she actually would like to eat (e.g. "Do you try to eat less at mealtimes than you would like to eat?"). Each question was answered on a five-point scale: never, rarely, sometimes, often, and very often. For all indices values, higher values indicated higher levels of emotional, external, and restrained eating. The scale was found to have a Cronbach's α of 0.93

2.2.3.1.1.6 Behavioural inhibition and behavioural approach scale

The BIS/BAS scale (Carver & White, 1994) is a 24-item self-report questionnaire that assesses how people typically react to certain situations. It has two subscales: Behavioural Inhibition (BIS) and Behavioural Approach (BAS). Representative subscale items include: "If I think something unpleasant is going to happen, I usually get pretty worked-up" (BIS) and "When I'm doing something well, I love to keep at it" (BAS). The BAS scale measures the tendency to experience strong positive affect or behavioural approach when cues of reward are present. The BIS scale measures the tendency to experience negative affect or behavioural inhibition when cues of threat are present. Items were rated on a scale from 1 (very true for me) to 4 (very false for me). The scale had a Cronbach's α of 0.88.

2.2.3.1.1.7 Depression anxiety stress scale: short version

The Depression Anxiety Stress Scale (DASS) (Lovibond & Lovibond, 1993) is a 21 item self-report questionnaire designed to measure the severity of a range of symptoms common to depression, anxiety and stress. In completing the DASS individuals are required to indicate the presence of a symptom over the previous week. Each item is scored from 0 (did not apply to me at all over the last week) to 3 (applied to me very much or most of the time over the past week). Responses on the short form version of the DASS were multiplied by two in order to obtain the final score. Higher scores signified a higher severity rating. Severity categories include normal, mild, moderate, severe, and extremely severe. The scale demonstrated a Cronbach's α of 0.93.

2.2.3.1.1.8 Grand hunger scale

The Grand Hunger Scale (Grand, 1968) was used to assess hunger at the time of testing. Participants were asked how hungry they were at the time of testing and how much of their favourite food they could eat at that time. Responses were indicated using visual analogue scales anchored by 'not at all hungry'/'extremely hungry' and 'none at all'/'as much as I could get', respectively.

2.2.3.1.1.9 National adult reading test

The National Adult Reading Test (Nelson, 1991) was administered according to standard procedures. To estimate verbal intellectual functioning, this test requires subjects to accurately read and pronounce 50 irregularly spelt words that become increasingly less familiar (e.g. cough, plumb, exigency, ubiquitous). Performance of the NART was scored as an expression of the number of items correct rather than number of errors.

2.2.3.1.2 Mediator measures

2.2.3.1.2.1 Five facet mindfulness questionnaire

Participants completed the 39-item version of the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The measure assesses five facets of a general tendency to be mindful in daily life: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience. Items were rated on a five-point Likert-type scale ranging from 1 (never or very rarely true) to 5 (very often or always true). The FFMQ has good psychometric properties (i.e. assessing different aspects of mindfulness, internal reliability and the level of mindfulness, test-retest reliability) in community members and meditators (Baer et al., 2006, 2008). The scale had a Cronbach's α of 0.93.

2.2.3.1.2.2 Mindful attention awareness scale

The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) was used to measure participant's frequency and strength of mindfulness. The MAAS assesses the extent to which an individual is attentive to and aware of what is taking place in the present. It consists of 15 items designed to assess a core characteristic of dispositional mindfulness, namely, open or receptive awareness of and attention to moment by moment experiences. Respondents have to indicate how frequently they currently experience each condition, using a six-point Likert scale ranging from 1 (almost always) to 6 (almost never). Respondents rate how often they have experiences of acting on automatic pilot, being preoccupied, and not paying attention. Items include "I could be experiencing some emotion and not be conscious of it until sometime later" and "I tend not to notice feelings of physical tension or discomfort until they really grab my attention". It has a single factor structure and yields a single total score. The MAAS was found to be a reliable instrument with a Cronbach's α of 0.87. Adequate test–retest reliability, convergent, and discriminant validity have also been previously reported (Brown & Ryan, 2003).

2.2.3.1.2.3 Attentional control questionnaire

Individual variations in self-reported ability to control attention and inhibit unwanted distractions were assessed using the Attentional Control Questionnaire (ACQ; Derryberry & Reed, 2002). The scale includes 20 items related to attention focusing (e.g. My concentration is good even if there is music in the room around me), attention shifting (e.g. After being distracted or interrupted, I can easily shift my attention back to what I was doing) and flexible control of thought (e.g. I can become interested in a new topic very quickly if I need to). Ratings were made on a four-point scale (1-almost never, 2-sometimes, 3-often, and 4-always). Scores were calculated by summing ratings across all items. Responses were reversed scored where appropriate. The scale was shown to have good internal reliability (α=.87).

2.2.3.1.2.4 Self-control scale

The Self-Control Scale (Tangney et al., 2004) is a 36-item questionnaire. It aims to assess people's ability to control their impulses, alter their emotions and thoughts and to interrupt undesired behavioural tendencies and refrain from acting on them. Items are endorsed on a five-point scale, where 1 represents 'not at all like me' and 5 represents 'very much like me' and included those such as, "I am good at resisting temptation" and "I allow myself to lose control". The scale was found to have a Cronbach's α of 0.85.

2.2.3.1.2.5 Tellegen absorption scale

Participants completed the Tellegen Absorption Scale (TAS) (Tellegen & Atkinson, 1974), a 34-item inventory derived from Tellegen's Multidimensional Personality

Questionnaire. The TAS is intended to measure a person's propensity to become involved in perceptual and imaginative experiences. An example of a question used on this scale is "If I wish, I can imagine (or daydream) some things so vividly that they hold my attention as a good movie or story does". The version of the TAS employed in this study used a five-point Likert scale, where 0 is labelled 'not at all' and 4 is labelled 'completely' (the ratings relate to how many times an individual had experienced the item in their life time). Previous research shows that this modified TAS scoring (as opposed to the standard version which requested individuals to rate each items using a true or false scale) retains convergent validity. With each questionnaire item measured on a five-point scale, the possible range of scores is between 0 and 136. A higher score reflects a high capacity for absorption. The scale was found to have very good internal reliability (Cronbach's $\alpha = 0.96$).

2.2.3.2 Computer-based tasks

The visual display and response recording for the dot-probe and the emotional Stroop tasks were controlled by Cedrus SuperLab Pro (version 2.0.4) software. Both computer tasks were presented on a Sony laptop computer, with a 15.4 inch screen. Participants responded using a Cedrus RB-730 seven-button response box to ensure millisecond (ms) accuracy.

2.2.3.2.1 Dot-probe task

The dot-probe task, developed by Tapper and Pothos (2009) assessed initial orientation and sustained attention to unhealthy and neutral food words. The stimuli consisted of 58 different colour photographs, 10 of which were of appetising snack foods (in this instance, chocolate), and 10 of which were office (neutral) items (e.g. pencil and stapler). Thus, there were 10 appetising-neutral pairs. Each food and neutral picture was matched as closely as possible for content (e.g. shape, jpeg, size, and colour). The pictures were also matched on familiarity and excitability. The images used in the dot-probe task were chosen based on the findings reported by Tapper and Pothos (2009). In this study participants were asked to rate the level of familiarity of different food-related and office-related pictures using a five-point rating scale where 1 = 'I don't know what this item is' and 5 = 'I recognise this item instantly'.

Excitability was also rated using a five-point rating scale where 1 = 'completely calm' (i.e. relaxed, sluggish, dull, sleepy or unaroused) and 5 = 'completely excited' (i.e. stimulated, frenzied, jittery, wide-awake, or aroused). Pictures were paired based on how well they matched on all factors mentioned above. Examples of pairing of chocolate-related and office-related pictures include: a Cadbury's Flake-a yellow highlighter pen, a Bounty Bar-a blue and white packaged eraser. An additional 10 neutral pictures were matched, forming five neutral-neutral pairs. An additional 28 neutral pictures made up 14 neutral pairs for use as practice and buffer trials. The objective of the practice and buffer trials here was to reduce practice effects on reaction times. No time breaks were given between blocks. There were an equal number of trials in each condition, as a function of picture duration, location of the food picture, and probe location. All trials were randomised for each participant. Participants were seated 100cm from the computer screen.

The design was similar to that used by Bradley et al. (1998, 2003) and by Tapper, Pothos and Lawrence (2010). Each trial commenced with a fixation cross which was displayed for 500ms in the centre of the screen, followed by a pair of pictures presented side by side. The pictures varied in height and width, depending on their shape. There was a distance of 60mm between the fixation cross and the centre of each image. The pictures were displayed for three durations (100, 500, and 2000ms) depending on the experimental block. This allowed for comparisons with previous research using these durations to examine motivation-related biases in initial orienting and maintained attention, respectively. Thus, three sets of dot probe trials were created, one in which the dot probe replaced the pictures very quickly, 100ms, another in which the dot-probe replaced the pictures quickly, 500ms (initial orientation) and another in which the dot-probe replaced the words slowly, after 2000ms (sustained attention). Each picture pair was followed by a probe (a square dot measuring 2mm by 2mm) which appeared in the location of one of the proceeding pictures. Picture and probe locations were counterbalanced for each pair. For food-neutral pairs, congruent trials were those in which the probe replaced the food picture, whereas the incongruent trials were those in which the probe replaced the neutral picture. Participants were instructed to fixate the central cross at the start of each trial and identify the location of the dot-probe (either left or right), as quickly and as accurately as possible by pressing either the white coloured far left-hand key or far right-hand key on the response box. The probe was displayed until the participant made a response. There was an inter-trial interval of 500ms. The task began with ten practice trials. These were followed by instructions informing participants that the real trials were about to commence, four buffer trials (i.e. 'warm-up' trials, the data for which were not analysed), 60 critical trials at 100ms exposure duration, 60 critical trials at 500ms, and 60 critical trials at 2000ms. An attentional bias for food cues were indicated by faster reaction times (RTs) to probes replacing food rather than control (neutral) cues, as RTs are typically faster to probes which appear in attended, as opposed to unattended, locations.

2.2.3.2.2 Emotional Stroop task

A food version of the emotional Stroop task, developed by Tapper and Pothos (2009), was employed to test for attentional biases to chocolate in accordance with previous studies (Faunce, 2002). Participants first viewed either chocolate words (e.g. cadbury, kitkat, ferrero rocher) or neutral, office-related words (e.g. stapler, telephone, drawing pin). Participants were required to identify the colour of the word that appeared on the computer screen by pressing one of four coloured buttons (red, blue, green, yellow) on a response pad (Cedrus R-730) which corresponded to the ink colour of each word. Each trial ran as follows: a fixation point (+) appeared in the centre of the screen for 500ms. A word was then presented in the centre of the screen and remained there until the participant made a response. There was a 1000ms inter-trial interval. Words were matched between categories (chocolate-related and office-related) for number of syllables, word length, familiarity, and representativeness. The words used in the emotional Stroop task were chosen based on the findings reported by Tapper and Pothos (2009). In this study participants were asked to rate the level of familiarity of different food-related and office-related words using a five-point rating scale where 1 = 'not at all familiar' and 5 = 'very familiar'. Representativeness was also rated using a five-point rating scale where 1 = 'not at all representative' and 5 = 'very representative'. Only chocolate-related words and office-related words which were highly matched were used.

All word characters were approximately 8-10mm in height. Both chocolate-related and office-related words were presented on a screen background which was plain white in colour, the same as for the dot-probe task. The font style of the words was

Ariel and the font was size 60. The ink colours used were limited to red, blue, green or yellow. Participants first completed an initial practice phrase consisting of one block of 16 trials. The stimuli in the practice phase were written number words (e.g. one, three, and seven). After the practice block, but before the experimental block, there was also a buffer block of trials containing four trials of number words. The experimental block consisted of 120 trials where each of the 15 chocolate-related words and 15 office-related words were presented in each of the four ink colours. Presentation of the chocolate-related and office-related words was blocked such that participants either first responded to all the chocolate-related words, or first to all the office-related words. This followed the recommendations of Cox et al. (2006). For each participant the order of these blocks was randomised, as was the order of words within the blocks. The rationale was that the greater the attentional bias for chocolate-related information, the longer it would take participants to disengage their attention from a chocolate-related word and identify its ink colour relative to the time required for neutral, office-related words.

2.2.4 Procedure

The study employed a 3 (group: experienced, novice, control) x 4 (attentional bias measure: dot-probe [presentations times 100ms, 500ms and 2000ms] and emotional Stroop) between-subjects design. Participants were allocated to one of the three groups based on self-assessment (i.e. depending on how each participant rated their own level of meditation experience; experienced or novice). Prior to taking part in the study, participants were sent, via email, the study information sheet (see appendix D) and the screening questionnaire (see appendix A). The study information sheet outlined the nature and the procedure of the study whereas the screening questionnaire provided the experimenter with information of the participant's eligibility to take part. At this time, the meditators were also asked to fill out a meditation questionnaire (see appendix B) before arriving at their appointment. Meditators were instructed to complete this questionnaire as if they were providing information about their meditation practice to someone with no prior knowledge of meditation. If inadequate detail had initially been provided, the experimenter obtained more detailed information at the face-to-face appointment.

Participants were tested individually in the laboratory. Each participant provided written consent (see appendix E) before commencing the study. The procedure for the study was identical for all participants. First, the computer tasks (dot-probe and emotional Stroop) were completed. The tasks were counter-balanced for each group; experienced meditators, novice meditators, and non-meditators. Next the participants completed the NART test followed by the eleven questionnaire measures. The order of the questionnaires was based on those most important to the study. The order was as follows; Participant Demographics Questionnaire, Five Facet Mindfulness Questionnaire, Mindfulness Attention Awareness Scale, Attentional Control Questionnaire, Self-Control Scale, Tellegen Absorption Scale, Trait Self-Description Inventory, Dutch Eating Behaviour Questionnaire, BIS/BAS, Depression Anxiety Stress Scale, and Grand Hunger Scale. This order was chosen with the appreciation of possible fatigue effects occurring as the study progressed. Once the study had ended, participants were debriefed (see appendix F) and then given the opportunity to ask the experimenter any questions they may have had. The study took approximately one hour to complete.

2.3 Results

2.3.1 Data cleaning and preliminary analysis

2.3.1.1 Overview of analysis

The distribution of all dependent measure scores were assessed for violations of normality using histograms and Kolmogorov-Smirnov (K-S) tests. Levene's test was used to check for homogeneity of variances. The statistics reported here are for untransformed measures. The evidence of some skewed distributions dictated the use of non-parametric statistics in the preliminary analysis. Self-report data were analysed using grouped repeated measures MANOVA and correlations. Means, standard deviations and frequencies (where appropriate) were calculated for the variables. [5]

2.3.1.2 Computation of measures

In order to calculate attentional bias scores for the dot-probe and Stroop[6] tasks two different methods of computation were used. These are described in the following sections.

2.3.1.2.1 Computing dot-probe scores

An attentional bias score for chocolate was computed by subtracting the mean response times for congruent trials from the mean response times for incongruent corresponding trials. Positive scores indicated attention towards chocolate cues respectively, with higher scores reflecting a stronger bias for chocolate-related information.

2.3.1.2.2 Computing food Stroop scores

To obtain a measure of interference, the difference between average reaction time for trials with chocolate food words minus average reaction time for trials with neutral words (office equipment) was computed for each participant. Higher (more positive) scores indicated more attentional bias towards chocolate.

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[5] Unless otherwise stated, the term 'meditation experience' and all analyses exploring the effects of meditation experience was conducted using this self-assessment categorisation method (i.e. participant's self-assessment of whether they were an experienced, novice, or non-meditator).

[6] The term 'Stroop' is always used in reference to the food version of the emotional Stroop task.

2.3.1.3 Treatment of outliers

Preliminary analysis of the data was conducted to identify outliers. Outliers were investigated for all measures (i.e. both computer tasks and self-report questionnaires).

2.3.1.3.1 Outliers and attentional bias (AB) computer tasks (dot-probe and Stroop)

Treatment of outliers followed a three-stage process. First, errors and outliers were examined and excluded at the individual trial level (i.e. for individual reaction time [RT] scores) (Ratcliff, 1993). This was achieved by removing trials with errors or RTs <100ms or >4000ms. Means and SDs were then calculated for each participant for the nine trial types of the dot-probe task (chocolate incongruent , chocolate congruent and neutral at each of the three exposures, 100ms, 500ms and 2000ms) and for each of the two trial types for the Stroop task (chocolate and control). RTs less than -3.5 and greater than 3.5 SDs from the participants' relevant trial type were discarded. A total of 1% of data were removed in this way from the dot-probe, and a total of 2.66% from the Stroop.

Second, outliers were examined and excluded in relation to attentional bias scores. For each participant, attentional bias (AB) scores for the dot-probe incongruent and congruent chocolate-related foods at each of the exposure times were calculated by subtracting the mean RT for congruent trials from the mean RT for incongruent trials. Also, for each participant, AB scores for the Stroop task chocolate and neutral foods were calculated by subtracting the mean RT for the control trials from the mean RT from the chocolate trials. Outliers here were likely to reflect atypical influences at the participant level (e.g. poor concentration). Such scores violate assumptions of parametric statistical tests (Osborne & Overbay, 2004). AB scores across each of the nine trial types for the dot-probe task and the two trial types for the Stroop task were standardised. Outliers were defined as data below -3.5 and above 3.5 SDs from the mean. Where outliers were detected due to skewness or heteroscedasity, log transformations were investigated. After transformation, the AB scores were again standardised and outliers checked via the process stated previously (i.e. below -3.5 and above 3.5 SDs). Log transformation did not correct the skewed data. As a result, participants who fell outside the 3.5 SD range were removed from the data set and therefore from any further calculations. Outliers were detected for four participants; three outliers at the 100ms dot-probe presentation time and one outlier at 2000ms dot-probe presentation time.)

Third, outliers for the dot-probe and Stroop tasks were detected by calculating error percentage. Outliers were defined as errors above 10% (i.e. the dot-probe totalled 180 trials therefore 10% errors equalled error numbers greater than 18). The Stroop totalled 120 trials, thus 10% errors equalled error numbers greater than 12. No outliers were found using this method for the dot-probe task. One participant was found to exceed 10% errors in the Stroop task (errors = 15). This participant was removed from the data set and therefore from any further calculations.

Outliers were removed in order to avoid biasing subsequent analyses. The number of participants with outliers detected from examination of the dot-probe and Stroop tasks was five (i.e. one from the dot-probe and four from the Stroop), reducing the overall sample size from 130 to 125 participants (48 experienced meditators, 39 novice meditators, and 38 non-meditators).

2.3.1.3.2 Outliers and non-screening self-report measures (DASS excluded)

Outliers were also examined in relation to self-reported questionnaire scores. Self-reported scores for ten questionnaires were standardised. No outliers were detected for any of the measures.

2.3.1.3.2.1 Data screening: depression, anxiety and stress scale (DASS)

The DASS measure was used as a screening questionnaire to identify and exclude participants with certain characteristics (i.e. high levels of depression, anxiety and stress) that may influence their responses on the dot-probe and Stroop tasks (see introduction section 2.1.11.2). The DASS uses five labels (normal, mild, moderate, severe and extremely severe) to categorise participants' level of stress, anxiety and depression.

	Stress				
	Normal	Mild	Moderate	Severe	Extremely Severe
Experienced	42	1	4	1	0
Novice	30	3	4	2	0
Control	25	4	4	4	1

Table 2.1 The number of participants in each DASS category (normal, mild, moderate, severe, and extremely severe) for stress within each of the three groups (experienced meditators, novice meditators, and non-meditator controls) (N=125).

	Anxiety				
	Normal	Mild	Moderate	Severe	Extremely Severe
Experienced	41	3	1	2	1
Novice	23	5	9	1	1
Control	24	3	5	2	4

Table 2.2 The number of participants in each DASS category (normal, mild, moderate, severe, and extremely severe) for anxiety within each of the three groups (experienced meditators, novice meditators, and non-meditator controls) (N=125).

	Depression				
	Normal	Mild	Moderate	Severe	Extremely Severe
Experienced	44	1	1	1	1
Novice	29	7	2	0	1
Control	22	6	6	2	2

Table 2.3 The number of participants in each DASS category (normal, mild, moderate, severe, and extremely severe) for depression within each of the three groups (experienced meditators, novice meditators, and non-meditator controls) (N=125).

As shown in Tables 2.1-2.3, a high number of participants (stress; n=28, anxiety; n=37, depression; n=30) reported above ‘normal’ levels for one or more of these psychological disorders. Excluding all participants from the data with scores above 'normal' for at least one psychological disorder would have reduced the sample size to that which would be challenged in term of its statistical power (n=30).[7]

	AB100	AB500	AB2000	Stroop
Depression (N=125)	-0.11	0.02	-0.02	0.05
Anxiety (N=125)	-0.07	-0.06	0.06	-0.02
Stress (N=125)	-0.02	0.00	-0.07	-0.07

Table 2.4 Pearson product moment correlations showing the relationship between depression, anxiety and stress scores and attentional bias on the dot-probe (presentation times, 100ms, 500ms and 2000ms) and Stroop tasks.[8]

Table 2.4 shows that the majority of the correlations were very close to zero. Only AB at the 100ms dot-probe presentation time was shown to be slightly negatively correlated with depression. No statistically significant associations were however found when depression, anxiety or stress was correlated with AB for the whole sample.

In addition to Pearson r correlation analyses, scatter graphs were also created in an attempt to identify any relationships between stress, anxiety and depression and AB scores. Scatter graphs were carried out in three different ways by looking at 1) the whole sample, 2) just those with 'normal' stress, anxiety and depression scores, 3) just those with scores above 'normal' (i.e. within the clinical range). Scatter graphs were not created for those who scored highly on only one psychological disorder due to the limitation of insufficient sample sizes. From visual interpretation of the graphs, no clear positive or negative correlations were found for any of the psychological disorders and the AB measures for the whole sample, those with 'normal' scores, or those with scores above 'normal'. It was therefore concluded that variation of the levels of these disorders were unlikely to have had any confounding effect of the AB scores.

[7] For this analysis, if an individual scored highly for more than one psychological disorder (e.g. both stress and anxiety), they were counted as n=1, not n=2.

[8] AB100 refers to attentional bias for the dot-probe presentation time, 100ms. AB500 refers to attentional bias for the dot-probe presentation time, 500ms. AB2000 refers to attentional bias for the dot-probe presentation time 2000ms. Stroop refers to attentional bias for the emotional Stroop task.

2.3.1.4 Group demographics

Meditation history and demographic information for the experienced and novice meditator groups were examined. Table 2.5 summarises this information showing, per group, the percentage of participants who currently practiced different attentional control skills (mindfulness and concentrative), the length of time meditation had been practiced and the regularity of the meditators' practice.

Experienced Meditators		**Novice Meditators**	
Male	14	**Males**	8
Female	34	**Females**	31
Age (Mean, SD)	53 (11.57)	**Age (Mean, SD)**	44 (11.97)
White-British (%)	87.5	**White-British (%)**	92.3
Mindfulness (%)	26 (54.2)	**Mindfulness (%)**	24 (61.5)
Concentrative (%)	22 (45.8)	**Concentrative (%)**	15 (38.5)
< 3 years (%)	1 (2.1)	**0-6 months (%)**	10 (25.6)
3-5 years (%)	4 (8.3)	**7-18 months (%)**	5 (12.8)
6-11 years (%)	9 (18.8)	**19-36 months (%)**	5 (12.8)
12-20 years (%)	16 (33.3)	**37-72 months (%)**	8 (20.5)
21-30 years (%)	9 (18.8)	**10-12 years (%)**	7 (17.9)
> 30 years (%)	9 (18.8)	**16-20 years (%)**	2 (5.1)
Regular (%)	40 (83.3)	**> 20 years (%)**	2 (5.1)
Irregular (%)	8 (16.7)	**Regular (%)**	18 (46.6)
< 3 times a week (%)	10 (20.8)	**Irregular (%)**	21 (53.8)
3-7 times a week (%)	25 (52.1)	**< 3 times a week (%)**	13 (33.3)
7-14 times a week	11 (22.9)	**3-6 times a week (%)**	10 (25.6)
More than twice daily (%)	1 (2.1)	**Once a day (%)**	10 (25.6)
Once a fortnight or less (%)	1 (2.1)	**Once a fortnight or less (%)**	6 (15.4)

Table 2.5 Demographic information of the experienced and novice meditator groups.

Table 2.5 shows that over half of both the meditator groups had experience of mindfulness meditation. The novice meditators had less experience of concentrative meditation in comparison to the experienced meditators.

2.3.1.5 Investigation of group differences: checks for group similarity

To ensure that the groups were sufficiently matched on relevant criteria, various statistical checks were carried out. Similarity between groups would allow for confident interpretation that any significant effect found was likely to be caused by the independent variable under investigation. Differences between groups may result in any significant or non-significant effects being influenced by variations between the groups. To assess this, analysis was first conducted to identify any group differences. Secondly, on the basis of group differences being detected, further analysis was carried out to identify if these variable differences were significantly correlated with the main dependent variable, AB.

Characteristic (scale)	Experienced (G1)	Novice (G2)	Control (G3)	p values
Age +	53.0 (11.57)	44.2 (11.97)	52.1 (15.09)	(G1-G2 0.01*a); (G1-G3 0.74a); (G2-G3 0.01*a)
Sex (% females)	70.8	79.5	60.5	0.189c
Education (% yes)	27.1	20.5	15.8	0.441c
Highest level of education ^	2 (1.00-4.00)	2 (1.00-3.00)	3 (2.00-4.25)	(G1-G2 0.391b); (G1-G3 0.129b); (G2-G3 0.019b,*)
Current occupation	27.1, 22.9, 29.2, 0, 4.2, 16.7	15.4, 51.3, 10.3, 5.1, 10.3, 7.7	13.2, 15.8, 23.7, 2.6, 2.6, 42.1	0.001c*
Ethnic group	87.5, 4.2, 4.2, 4.2	92.3, 2.6, 5.1, 0	97.4, 2.6, 0, 0	0.485c
Psychological disorder (% yes)	33.3	33.3	34.2	0.995c
Medical condition (% yes)	4.1	10.3	2.6	0.298c
Currently pregnant (% yes)	2.1	0	0	0.446c
Rating of how much chocolate is liked (1-7) ^	5 (3.00-6.00)	6 (4.00-7.00)	5 (4.00-6.00)	(G1-G2 0.050b*); (G1-G3 0.176b); (G2-G3 0.364b)
Rating of the frequency chocolate is eaten (1-7) ^	3 (2.00-4.00)	3 (2.00-5.00)	4 (2.75-5.00)	(G1-G2 0.153b); (G1-G3 0.024b*); (G2-G3 0.597b)
Number of previous diet attempts (last 12 months) ^	1 (1.00-1.00)	1 (1.00-2.00)	1 (1.00-1.00)	(G1-G2 0.325b); (G1-G3 0.900b); (G2-G3 0.319b)
Number of hours fasted prior to study ^	3 (3.00-3.00)	3 (3.00-3.00)	3 (3.00-3.00)	(G1-G2 0.798b); (G1-G3 0.630b); (G2-G3 0.469b)
First Language English (% yes)	95.8	89.7	97.4	0.298c
British Native (% yes)	89.6	94.9	100	0.112c
Intelligence ^	46.5 (43.00-48.75)	46 (40.00-47.00)	45 (40.00-48.00)	(G1-G2 0.111b); (G1-G3 0.086b); (G2-G3 0.822b)
Stress (0-3) ^	4 (0.050-11.5)	12 (6.00-14.00)	10 (4.00-18.50)	(G1-G2 0.001b*); (G1-G3 0.009b*); (G2-G3 0.613b)
Anxiety (0-3) ^	2 (0.00-5.50)	4 (2.00-10.00)	6 (2.00-10.00)	(G1-G2 0.018b*); (G1-G3 0.005b*); (G2-G3 0.673b)
Depression (0-3) ^	2 (0.00-4.00)	4 (2.00-10.00)	7 (1.50-14.50)	(G1-G2 0.019b*); (G1-G3 0.002b*); (G2-G3 0.188b)
DEBQ - Emotional (1-5) +	27.9 (8.83)	34.72 (11.68)	33.29 (11.65)	(G1-G2 0.003a*); (G1-G3 0.017a*); (G2-G3 0.593a)
DEBQ - External (1-5) +	26.8 (5.72)	31.5 (7.02)	32.3 (6.17)	(G1-G2 0.001a*); (G1-G3 0.001a*); (G2-G3 0.572a)
DEBQ - Restricted (1-5) +	24.5 (8.35)	27.9 (10.01)	26.5 (7.56)	(G1-G2 0.083a); (G1-G3 0.260a); (G2-G3 0.469a)
DEBQ -Total (1-5) +	79.2 (17.33)	94.2 (20.65)	92.1 (18.19)	(G1-G2 0.001a*); (G1-G3 0.001a*); (G2-G3 0.646a)
Openness (OCEAN) (1-9) +	54.0 (9.72)	46.1 (10.93)	30.0 (12.57)	(G1-G2 0.001*a); (G1-G3 0.001*a); (G2-G3 0.001*a)
Conscientiousness (OCEAN) (1-9) +	53.8 (9.77)	50.6 (8.74)	52.9 (10.19)	(G1-G2 0.108a); (G1-G3 0.683a); (G2-G3 0.274a)
Extraversion (OCEAN) (1-9) +	-0.27 (12.87)	-1.00 (11.78)	-0.16 (14.88)	(G1-G2 0.786a); (G1-G3 0.970a); (G2-G3 0.784a)
Agreeableness (OCEAN) (1-9) +	52.7 (8.19)	50.2 (8.69)	48.8 (10.30)	(G1-G2 0.172a); (G1-G3 0.055a); (G2-G3 0.524a)
Neuroticism (OCEAN) (1-9) +	29.4 (12.26)	42.7 (15.91)	42.8 (14.47)	(G1-G2 0.001*a); (G1-G3 0.001*a); (G2-G3 0.983a)
Last time food was eaten ^	10.10 (8.08-13.30)	11.00 (8.15-13.15)	13.15 (8.00-20.00)	(G1-G2 0.824b); (G1-G3 0.150b); (G2-G3 0.271b)
Level of hunger ^	29.50 (5.00-58.75)	48.00 (27.00-74.00)	37.00 (15.75-68.25)	(G1-G2 0.035b*); (G1-G3 0.309b); (G2-G3 0.418b)
Quantity of favourite food +	38.6 (27.05)	51.3 (24.70)	47.3 (24.72)	(G1-G2 0.026a*); (G1-G3 0.128a); (G2-G3 0.483a)
BAS Drive (1-4) +	9.5 (2.77)	10.6 (2.55)	10.7 (2.26)	(G1-G2 0.066a); (G1-G3 0.043a*); (G2-G3 0.901a)
BAS fun seeking (1-4) +	10.56 (2.43)	11.5 (2.72)	10.6 (2.64)	(G1-G2 0.098a); (G1-G3 0.900a); (G2-G3 0.166a)
BAS reward responsiveness (1-4) ^	16.00 (13.25-16.00)	16.00 (11.00-17.00)	12.50 (8.00-16.25)	(G1-G2 0.639b); (G1-G3 0.0330b*); (G2-G3 0.040b*)
BIS (1-4) +	17.5 (3.40)	19.0 (5.38)	17.3 (5.00)	(G1-G2 0.113a); (G1-G3 0.830a); (G2-G3 0.153a)
Experience of yoga (% yes)	91.7	71.8	5.3	0.001*c
Attended a meditation retreat (% yes)	68.7	23.1	0	0.001*c
Meditation training received (% yes)	89.6	87.2	0	0.001*c
Pattern of meditation practice	16.7, 83.3, 0	53.8, 46.2, 0	0, 0, 100	0.001*c

Note: Non-parametric tests were employed where Kolmogorov-Smirnov tests indicated significantly non-normal distributions.

a t-Test, b Mann-Whitney U, c Chi square

* $p < 0.05$

^ median and inter-quartile range, + mean, S.D.

Table 2.6 Similarities and differences of the variables between the experienced, novice and non-meditator control groups.

2.3.1.6 Investigation of group differences: correlations between variables that differed between the groups and AB

In order to explore whether the variables that differed between the groups were likely to have a confounding effect on the results, each variable was correlated with dot-probe (presentation times 100ms, 500ms and 2000ms) and Stroop AB scores across the whole sample (N = 125).

	AB100	AB500	AB2000	Stroop
Age	0.05	-0.09	0.11	0.08
Highest level of education	0.02	-0.01	-0.04	-0.03
Current occupation	0.00	0.09	0.14	0.07
Rating of how much chocolate is liked	-0.10	-0.10	0.04	0.04
Rating of the frequency chocolate is eaten	-0.01	-0.02	-0.05	-0.13
Stress	-0.02	0.00	-0.07	-0.07
Anxiety	-0.07	-0.06	0.06	-0.02
Depression	-0.11	0.02	-0.02	0.05
DEBQ –Emotional	-0.14	-0.01	-0.04	-0.04
DEBQ – External	-0.05	0.02	0.01	-0.05
DEBQ – Total	0.01	-0.05	0.02	0.02
Openness (OCEAN)	0.23*	0.12	-0.12	0.15
Neuroticism (OCEAN)	-0.09	0.01	-0.03	0.09
Level of hunger	0.11	0.11	0.05	-0.14
Favourite food	0.06	0.16	0.01	0.00
BAS Drive	0.13	-0.04	-0.02	-0.10
BAS reward responsiveness	0.06	0.15	-0.22*	-0.09

* $p < 0.05$

Table 2.7 Pearson product moment correlations showing the relationship between the variables which significantly differed between the groups (experienced, novice, and controls) and all measures of attentional bias.

As shown in Table 2.7, Openness was significantly positively correlated with the dot-probe presentation time 100ms. Furthermore, BAS reward responsiveness was significantly negatively correlated with the dot-probe presentation time, 2000ms.

However, given the number of correlations conducted, it was deemed possible that these significant findings were found by chance alone.

2.3.2 Effects of meditation experience on attention (Aim 1)

This section explores the hypothesis that meditators would show the best performance on the dot-probe and emotional Stroop tasks compared to non-meditator controls. This was predicted to be irrespective of whether meditation experience was determined by participant's self-assessment, or the number of minutes, days, months or total hours spent meditating.

2.3.2.1 Comparison of groups with different levels of meditation experience (experienced, n=48, novice, n=39, and no experience controls, n=38) based on practitioner's self-assessment.

In order to identify if different levels of meditation experience (experienced, novice, and no experience as determined by the assessment of the participant) were significantly associated with attentional bias, ANOVA tests were performed for each of the measures (dot-probe task, Stroop task, and self-report questionnaires).

2.3.2.1.1 Dot-probe task

		N	Mean	SD
AB100	Experienced	48	3.79	19.58
	Novice	39	2.34	17.64
	Control	38	-5.12	22.77
AB500	Experienced	48	0.68	23.24
	Novice	39	-1.92	20.41
	Control	38	-1.24	23.09
AB2000	Experienced	48	-3.47	20.87
	Novice	39	0.84	18.08
	Control	38	4.42	20.99

Table 2.8 Comparison of mean attentional bias scores (and SDs) across the different experienced groups (experienced, novice, and no experience controls) for each of the dot-probe presentation times (100ms, 500ms, and 2000ms).

A 3 x 3 mixed ANOVA with attention bias (dot-probe task presentation times, 100ms, 500ms, and 2000ms) as the within-subjects factor and level of meditation experience (experienced, novice, no experience) as the between subject factors revealed no main effect of level of meditation experience, F (2, 122) = 0.271, p = 0.763, $\eta_p^2 = 0.004$, or presentation time, F (2, 244) = 0.316, p = 0.730, $\eta_p^2 = 0.003$. Furthermore, no significant interaction was found between presentation time and level of meditation experience, F (2, 244) = 1.773, p = 0.135, $\eta_p^2 = 0.028$.

2.3.2.1.2 Stroop task

	n	**Mean**	**SD**
Experienced	48	18.63	51.32
Novice	39	19.16	47.26
Control	38	20.67	57.01

Table 2.9 Comparison of mean attentional bias scores (and SDs) across the experienced, novice, and no meditation experience groups for the Stroop task.

A one-way ANOVA was conducted to compare the attentional bias scores of the Stroop task in experienced, novice and no meditation experience conditions. The results showed no significant group effect, F (2, 124) = 0.017, p = 0.983, $\eta_p^2 =$ 0.001.[9] [10]

[9] This analysis was recalculated by (1) removing participants who had previously practiced mindfulness meditation from the data and then comparing AB with the original group (experienced, novice, and controls) and (2) removing eight experienced meditators who reported practicing meditation on an irregular basis and then comparing AB with the original experience group (experienced, novice, and controls). No significant difference was found between the groups for the dot-probe task, F (2, 72) = 2.218, p = 0.116; F (2, 114) = 0.377, p = 0.686 or the Stroop task, F (2, 74) = 0.277, p = 0.759; F (2, 116) = 0.018, p = 0.982 (n values; experienced = 23, novice = 14, controls = 38; experienced = 40, novice = 39, control = 38) respectively.

[10] The dot-probe and Stroop analyses were also repeated by comparing those with meditation experience (i.e. experienced and novice meditators combined, n=87) with those with no meditation experience (n=38). Whilst there was no significant difference in Stroop reaction time scores between the meditation experience and no experience conditions, t (123) = 0.179, p = 0.858, an interaction between presentation time and meditation experience was nearing significance on the dot-probe task, F (2, 246) = 2.931, p = 0.056. Further analyses revealed a significant difference between experience versus no experience at the 100ms presentation time, t (123) = 2.127, p = 0.035. It was however considered possible that this result either reflected a Type 1 error due to the many different analyses conducted, or sample differences as outlined in section 2.3.1.5 between the meditator and non-meditator groups.

2.3.2.2 Investigation of whether meditation experience, determined by the number of times meditation is practiced per week, significantly predicts AB

Level of meditation experience determined by the self-assessment of participants did not show any significant group effect on attentional bias scores (dot-probe and Stroop tasks). Further analysis was therefore carried out with level of meditation experience based on an alternate measure; the number of times meditation was practiced per average week. This was measured as a continuous variable using a correlation analysis.

2.3.2.2.1 Dot-probe and Stroop tasks

To identify if meditation experience was associated with AB scores, each measure of attentional bias was correlated with the number of times meditation was practiced per average week.

N = 125	**AB100**	**AB500**	**AB2000**	**Stroop**
Number of times meditated (per week)	.157	.155	-.144	-.021

Table 2.10 Correlations between meditation experience and attentional bias scores for the whole sample.

Table 2.10 shows that the number of times meditation was practiced per week was not statistically correlated with any AB measure, suggesting that greater or fewer meditation sessions practiced per average week did not impact on AB scores. This finding was inconsistent with the study's predictions which stated that greater meditation practice would be associated with decreased AB. Despite the lack of statistical significance, in support of the pre-stated hypotheses, AB at the dot-probe 2000ms presentation time was negatively correlated with meditation practice. Although contradictory to the hypotheses, AB at the dot-probe presentation time, 100ms and 500ms were shown to be positively correlated with meditation practice. The Stroop measure showed no correlation. This pattern of results (i.e. a positive correlation at 100ms, and a negative correlation at 2000ms) is similar to those reported in previous sections of this results chapter.

2.3.2.3 Investigation of whether meditation experience, determined by the number of minutes meditated per meditation session, significantly predicts AB

Given that level of meditation experience determined by the self-assessment of participants and level of meditation experience, determined by the number of times meditation was practiced per average week did not show any significant group effects on attentional bias scores (dot-probe and Stroop tasks), further analysis was carried out with level of meditation experience based on an alternate measure; the number of minutes meditated per meditation session. This was measured as a continuous variable using correlation analyses.

2.3.2.3.1 Dot-probe and Stroop tasks

To identify if meditation experience was associated with AB scores, each measure of attentional bias was correlated with the number of minutes meditation was practiced per session.

N = 125	**AB100**	**AB500**	**AB2000**	**Stroop**
Number of minutes meditated (per session)	-.018	.043	.023	-.045

Table 2.11 Correlations between meditation experience and attentional bias scores for the whole sample.

Table 2.11 shows that all four correlations were close to zero, indicating that the number of minutes meditation was practiced per session was not significantly correlated with any AB measure. This suggests that shorter or longer meditation sessions practiced did not impact on AB scores. This finding was inconsistent with the study's predictions which stated that longer meditation practice would be associated with decreased AB.

2.3.2.4 Investigation of whether meditation experience, determined by number of months meditated, significantly predicts AB

Further analysis was subsequently carried out with level of meditation experience based on number of months meditated. Again, this was measured as a continuous variable using correlation analyses.

2.3.2.4.1 Dot-probe and Stroop tasks

To identify if meditation experience was associated with AB scores, each measure of attentional bias was correlated with the total number of months meditated.

N = 125	AB100	AB500	AB2000	Stroop
Number of months meditated	.149	-.009	.036	.004

Table 2.12 Correlations between meditation experience and attentional bias scores for the whole sample.

Table 2.12 shows that AB for the 100ms dot-probe presentation time was positively correlated with the number of months meditated. No correlation was shown between length of meditation practice and AB for the 500ms and 2000ms dot-probe presentation times, or for the Stroop task. The total number of months meditated was however not significantly correlated with any AB measure. This suggests that a longer or shorter duration of meditation practice did not impact on AB scores.

2.3.2.5 Investigation of whether meditation experience, determined by the type of attentional control skills used (focused attention or open monitoring) across different practices, significantly predicts AB.

When meditation experience was determined by the type of attentional control skills used, the following hypotheses were made. First, and similar to the hypothesis of previous analyses, it was predicted that both novice and experienced meditators would demonstrate the best performance on the attentional bias measures compared to non-meditator controls. It was however further predicted that on the dot-probe task, experienced meditators would demonstrate superior performance compared to novice meditators whereas on the emotional Stroop task, novice and experienced meditators would perform similarly.

Exploratory analysis was carried out to investigate whether the ease of practicing different types of attentional skills (focused attention or open monitoring) would affect group AB scores across different types of meditations currently practiced. For this analysis, meditation experience was categorised into three groups: those currently practicing mindfulness meditation and thus open monitoring (experienced, n=50), those currently practicing concentrative meditation and thus focused attention (novice, n=37), and those who practice no meditation, thus neither open monitoring nor focused attention (non-meditator controls, n=38). ANOVA tests were performed for each of the measures (dot-probe task, Stroop task, and self-report questionnaires).

2.3.2.5.1 Dot-probe task

		n	**Mean**	**SD**
AB100	Experienced (Mindfulness)	50	3.267	18.94
	Novice (Concentrative)	37	2.964	18.49
	Control (Non-meditator)	38	-5.123	22.77
AB500	Experienced (Mindfulness)	50	0.129	20.61
	Novice (Concentrative)	37	-1.315	23.86
	Control (Non-meditator)	38	-2.981	23.09
AB2000	Experienced (Mindfulness)	50	-3.524	20.57
	Novice (Concentrative)	37	1.148	18.34
	Control (Non-meditator)	38	4.418	21.00

Table 2.13 Comparison of mean attentional bias scores (and SDs) across the different types of meditation practiced for each of the three dot-probe presentation times (100ms, 500ms and 2000ms).

A 3 x 3 mixed ANOVA with attention bias (dot-probe task, presentation times, 100ms, 500ms, and 2000ms) as the within-subjects factor and experience based on the type of attentional skills used by different meditation practices (mindfulness – open monitoring, concentrative – focused attention, non-meditator controls) as between the subject factors revealed no main effect of experience, $F (2, 122) = 0.351$, $p = 0.704$, $\eta_p^2 = 0.006$ or presentation time, $F (2, 244) = 0.329$, $p = 0.720$, $\eta_p^2 = 0.003$. Also, no significant interaction was found, $F (4, 244) = 1.696$, $p = 0.151$, $\eta_p^2 = 0.027$.

2.3.2.5.2 Stroop task

	Mean	SD
Experienced (Mindfulness)	23.17	47.99
Novice (Concentrative)	13.06	51.00
Control (Non-meditator)	20.67	57.01

Table 2.14 Comparison of mean attentional bias scores (and SDs) across the experienced (mindfulness – open monitoring, n=50), novice (concentrative – focused attention, n=37), and non-meditator (n=38) groups for the Stroop task.

A one-way ANOVA was conducted to compare the attentional bias scores of the Stroop task across the three conditions. The results showed no significant group effect, $F(2, 124) = 0.421$, $p = 0.657$, $\eta_p^2 = 0.007$. This finding only partially supported the pre-stated hypotheses.

The above analysis shows that, similarly to when meditation was determined by participant's self-assessment and length and frequency of practice, meditation experience determined by the type of attentional control skills practiced across different meditation practices does not significantly predict any of the AB dependent variables.

2.3.2.6 Exploring whether performance on the dot-probe task between the groups (experienced, novice and controls) was the result of delayed orientation or enhanced disengagement

Previous research has suggested that AB scores obtained in a dot-probe task may reflect a difficulty to disengage from appetitive, food-related stimuli (Tressler, 2008). To explore this, reaction times on congruent and incongruent trials were compared to reaction times on the neutral trials to determine whether the attentional bias scores reflect either delayed disengagement or faster orientation. Faster orientation was expected to be reflected in facilitated responding to congruent trials, whereas difficulty to disengage attention was expected to result in slower reaction times to incongruent trials.

		Experienced (n=48)		Novice (n=39)		Control (n=38)	
		Mean	SD	Mean	SD	Mean	SD
AB100	Incongruent	449.80	74.47	421.91	48.13	460.30	97.82
	Congruent	446.01	74.56	419.58	43.04	465.42	103.39
	Neutral	434.58	64.84	411.87	43.38	448.17	90.50
AB500	Incongruent	456.06	71.47	423.82	42.40	458.65	82.83
	Congruent	455.37	72.35	425.74	50.96	461.63	81.23
	Neutral	440.90	69.40	417.63	46.23	451.87	80.02
AB2000	Incongruent	439.79	65.27	414.18	45.47	451.43	78.07
	Congruent	443.26	70.27	413.34	43.04	447.01	74.65
	Neutral	433.29	63.14	410.01	51.40	442.39	72.35

Table 2.15 Comparison of mean scores (and SDs) for congruent, incongruent and neutral trials across the meditation experience and no meditation experience groups for each of the three dot-probe presentation times (100ms, 500ms, and 2000ms).

Table 2.15 shows that none of the groups showed enhanced orienting. Instead, all three groups displayed delayed disengagement for each dot-probe presentation time (100ms, 500ms and 2000ms). This was indicated by slower mean scores on incongruent trials compared to mean scores on neutral trials, and mean scores on congruent trials that were not faster than mean scores on neutral trials. These findings suggest that meditators and non-meditators alike had greater difficultly detracting their attention away from old (i.e. currently presented) chocolate-related stimuli compared to moving their attention from the neutral stimuli. The results are in accordance with existing literature (Tressler, 2008).[11]

[11] The analysis presented in Section 2.3.2 was calculated with the inclusion of participants with depression, anxiety and stress scores above the population average due to the fact that no significant correlation was found between high levels of these psychological disorders and AB. However, for exploratory purposes the above analysis was re-run with all participants scoring 'severe' or 'extremely severe' on one or more of the psychological disorders removed from the analysis (experienced, n=44, novice, n=33, non-meditators, n=29). All p values for dot-probe and Stroop attentional bias scores remained greater than 0.05. All p values for the self-reported questionnaire measures remained less than 0.05. Thus, no significant changes in the findings were detected. It was therefore concluded that increased certainty that AB scores were not confounded by participants' differing levels of depression, anxiety and stress.

2.3.3 Relationship between predicted mediators and attention (Aim 2)

This section explores the hypotheses that the effects of meditation experience on attentional bias would be meditated by self-reported mindfulness, attentional control and self-control ability. More specifically, it was predicted that both novice and experienced meditators (irrespective of how 'experience' was determined) would show stronger correlations between the mediators and attention bias to chocolate-related stimuli compared to non-meditator controls.

2.3.3.1 Comparing predicted mediators (mindfulness, attentional control and self-control) for the whole sample [n=125] with each AB measure (dot probe 100ms, 500ms, 2000ms, and Stroop).

This section correlates (across the whole sample) predicted mediators (mindfulness, attentional control and self-control questionnaire scores) and AB scores in order to identify any association between meditation and AB.

N = 125	**AB100**	**AB500**	**AB2000**	**Stroop**
FFMQ –observe	.195*	-.067	-.235**	.030
FFMQ – describe	.158	-.002	-.026	.014
FFMQ – act with awareness	.193*	-.105	-.018	-.017
FFMQ – nonjudge	.088	.115	.002	-.092
FFMQ – nonreact	.178*	.054	-.157	.046
MAAS	.170	-.014	.065	.014
ACQ - total scores	.198*	-.090	-.038	.005
ACQ - focus attention	.181*	-.149	-.008	-.010
ACQ - shifting attention	.171	-.013	-.059	.018
TAS	.197*	-.025	-.199*	.093
SCS	.118	.009	.120	-.001

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

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

Table 2.16 Pearson product moment correlations showing the relationship between self-report scores of mindfulness (FFMQ and MAAS), attentional control (ACQ and TAS), and self-control (SCS) on four different measures of attentional bias.

Table 2.16 shows that significant positive correlations were found between the dot-probe presentation time, 100ms and the following factors; FFMQ – observe, r = .195, p = 0.030, FFMQ – act with awareness, r = .193, p = 0.031, FFMQ – nonreact, r = .178, p = 0.047, ACQ – total scores, r = .198, p = 0.027, ACQ – focus attention, r = .181, p = 0.043, and TAS, r = .197, p = 0.027. Negative correlations were found between AB2000 and the factors; FFMQ – observe, r = -.235, p = 0.008 and TAS, r = -.199, p = 0.026. No significant relationship was found between the dot-probe presentation time, 500ms or Stroop AB and any of the self-report scores for mindfulness, attentional control or self-control.[12]

It was hypothesised that increased mindfulness scores (FFMQ and MAAS) would be associated with lower AB (i.e. a negative correlation between these variables was expected). Table 2.16 shows that the results fairly consistently show the opposite of this, with a total of three mindfulness factors on the FFMQ measure (observe, act with awareness and non-react) indicating that lower levels of mindfulness was significantly associated with lower AB. Significant correlations were only found between mindfulness and AB at the dot-probe presentation times 100ms and 2000ms, with FFMQ observe factor being significant at both times. The correlations at the 100ms presentation time were however positive, whereas the correlation at the 2000ms presentation time was negative. This suggests that as mindfulness scores increased, AB when measured at a longer duration was reduced.

Additionally, greater attentional control scores (ACQ and TAS) were predicted to be significantly associated with lower AB. Similarly to mindfulness scores, attentional control scores showed the opposite of what was hypothesised; that lower attentional control was associated with lower AB. Three of the four measures of attentional control (ACQ – total scores, ACQ – focus attention and TAS) showed this finding. Significant correlations were only found between attentional control and AB at the dot-probe presentation time, 100ms. The positive correlation between attentional control, as measured by the TAS questionnaire, was however reversed for AB at the

[12] The TAS measures the tendency for one's entire attentional capacity to become completely involved in experiencing a specific attentional object. Absorption has been found to be associated with openness and mindfulness.

dot-probe presentation time, 2000ms. This suggests that as attentional control scores increased, AB when measured at a longer duration was reduced, creating a significant negative correlation between the variables.

As shown in Table 2.16, self-control was not significantly associated with any AB measure. Self-control scores were also shown to be in the opposite direction to that predicted for all three presentation times on the dot-probe task (i.e. positively correlated). Thus, despite no statistical significance, the findings suggest that lower self-control was associated with lower AB. Self-control scores and AB on the Stroop task was negatively, but not significantly, correlated. This suggests that for this particular AB task, higher levels of self-control were associated with lower AB.

2.3.3.2 Comparing predicted mediators (mindfulness, attentional control and self-control) for the non-meditator sample (n=38) and the meditator sample (n=87) with each AB measure (dot probe 100ms, 500ms, 2000ms, and Stroop).

This section correlates (across the non-meditator and meditator samples) predicted mediators (mindfulness, attentional control and self-control questionnaire scores) and AB scores in order to identify any association between meditation and AB.

	Non-meditators (n=38)				Meditators (n=87)			
	AB100	AB500	AB2000	Stroop	AB100	AB500	AB2000	Stroop
FFMQ –observe	0.073	-0.261	-0.148	-0.041	0.149	-0.024	-0.220*	0.093
FFMQ – describe	0.102	-0.069	0.268	-0.122	0.097	0.003	-0.104	0.102
FFMQ – act with awareness	0.080	-0.221	0.394*	-0.169	0.202	-0.073	-0.161	0.062
FFMQ – nonjudge	-0.014	0.063	0.265	-0.211	0.090	0.125	-0.065	-0.042
FFMQ – nonreact	0.156	-0.238	0.197	0.044	0.131	0.116	-0.214*	0.059
MAAS	0.072	-0.120	0.408*	-0.083	0.168	0.019	-0.050	0.071
ACQ - total scores	0.068	-0.125	0.361*	0.041	0.205	-0.102	-0.186	-0.008
ACQ - focus attention	-0.023	-0.179	0.351*	-0.025	0.239*	-0.163	-0.146	0.006
ACQ - shifting attention	0.151	-0.040	0.295	0.103	0.122	-0.020	-0.175	-0.018
TAS	0.074	-0.286	-0.030	0.098	0.133	0.037	-0.206	0.137
SCS	-0.036	-0.073	0.428**	-0.082	0.148	0.032	0.019	0.047

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

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

Table 2.17 Pearson product moment correlations showing the relationship between self-report scores of mindfulness (FFMQ and MAAS), attentional control (ACQ and TAS) and self-control (SCS) on four different measures of attentional bias.

Table 2.17 shows that, for the non-meditator group, significant positive correlations were found between AB2000 and the following factors; FFMQ – act with awareness, $r = .394$, p = 0.014, MAAS, $r = .408$, p = 0.011, ACQ – total scores, $r = .361$, p = 0.026, ACQ – focus attention, $r = .351$, p = 0.031, and TAS, $r = .428$, p = 0.007. No significant relationship was found between AB100, AB500 or Stroop AB and any of the self-report scores for mindfulness, attentional control or self-control. For the meditator group, a significant positive correlation was found between AB100 and ACQ – focus attention, r = .239, p = 0.026. Significant negative correlations were also found between AB2000 and the factors, FFMQ – observe, r = -.220, p = 0.040 and FFMQ – nonreact, r = -.214, p = 0.047. No significant relationship was found between AB500 or Stroop AB and any of the self-report scores for mindfulness, attentional control or self-control.

As shown in Table 2.17, compared to the non-meditator group, the meditator group show less significant associations between the predicted mediators (mindfulness, attentional control and self-control questionnaire scores) and AB scores. One possibility for these different correlations may be that the meditators are interpreting the questionnaire items differently to the non-meditators.[13]

2.3.3.3 Comparing predicted mediators (mindfulness, attentional control and self-control) for the non-meditator sample (n=38), the novice meditator sample (n=39), and the experienced meditator sample (n=48) with each AB measure (dot probe 100ms, 500ms, 2000ms, and Stroop).

This section correlates (across the non-meditator and meditator samples) predicted mediators (mindfulness, attentional control and self-control questionnaire scores) and AB scores in order to identify any association between meditation and AB.

[13] The above analysis was repeated using the experienced meditator group only (n=48) and the novice meditator group only (n=39). A significant positive association was only found between AB100 and ACQ – focused attention for the novice group, $r = .340$, p = 0.034.

	Non-meditators (n=38)				Novice meditators (n=39)				Experienced meditators (n=48)			
	AB100	AB500	AB2000	Stroop	AB100	AB500	AB2000	Stroop	AB100	AB500	AB2000	Stroop
FFMQ –observe	0.073	-0.261	-0.148	-0.041	0.140	0.071	-0.155	0.0889	0.151	-0.086	-0.249	0.097
FFMQ – describe	0.102	-0.069	0.268	-0.122	0.154	0.266	0.066	0.234	0.042	-0.223	-0.192	0.006
FFMQ – act with awareness	0.080	-0.221	0.394*	-0.169	0.284	-0.055	-0.140	0.003	0.141	-0.121	-0.134	0.111
FFMQ – nonjudge	-0.014	0.063	0.265	-0.211	0.155	0.181	-0.120	-0.131	0.018	0.052	0.052	0.039
FFMQ – nonreact	0.156	-0.238	0.197	0.044	0.214	0.279	-0.252	-0.010	0.063	-0.030	-0.139	0.128
MAAS	0.072	-0.120	0.408*	-0.083	0.250	0.001	-0.048	-0.030	0.111	0.005	-0.007	0.141
ACQ - total scores	0.068	-0.125	0.361*	0.041	0.271	-0.049	-0.152	-0.240	0.145	-0.173	-0.186	0.196
ACQ - focus attention	-0.023	-0.179	0.351*	-0.025	0.340*	-0.234	-0.008	-0.181	0.150	-0.152	-0.228	0.189
ACQ - shifting attention	0.151	-0.040	0.295	0.103	0.140	0.145	-0.258	-0.242	0.106	-0.147	-0.107	0.153
TAS	0.074	-0.286	-0.030	0.098	0.147	0.102	-0.100	0.042	0.114	-0.039	-0.268	0.232
SCS	-0.036	-0.073	0.428**	-0.082	0.279	-0.150	0.029	0.018	0.036	0.137	0.099	0.084

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

Table 2.18 Pearson product moment correlations showing the relationship between self-report scores of mindfulness (FFMQ and MAAS), attentional control (ACQ and TAS), and self-control (SCS) on four different measures of attentional bias.

Table 2.18 shows that, for the non-meditator group, significant positive correlations were found between AB2000 and the following factors; FFMQ – act with awareness, $r = .394$, $p = 0.014$, MAAS, $r = .408$, $p = 0.011$, ACQ – total scores, $r = .361$, $p = 0.026$, ACQ – focus attention, $r = .351$, $p = 0.031$, and TAS, $r = .428$, $p = 0.007$. No significant relationship was found between AB100, AB500 or Stroop AB and any of the self-report scores for mindfulness, attentional control or self-control. For the novice meditator group, a significant positive correlation was found between AB100 and ACQ – focus attention, $r = .340$, $p = 0.034$. No significant correlations were found between self-report scores of mindfulness (FFMQ and MAAS), attentional control (ACQ and TAS), or self-control (SCS) and any measure of attentional bias for the experienced meditator group.

The findings in Table 2.18 suggest a pattern between the meditator and non-meditator groups. This pattern shows that, for the novice and experienced meditators, only positive correlations were found between the predicted meditators and AB100 scores. For the non-meditator group, a few negative correlations were evident between the predicted mediators and AB100 scores, though this pattern was reversed at the later dot-probe presentation time, AB2000 (i.e. the majority of correlations between predicted mediators and AB2000 scores were negative for the meditator groups, but positive for the non-meditator group).

Furthermore, Table 2.18 shows that, compared to the non-meditator group, the meditator groups show less significant associations between the predicted mediators (mindfulness, attentional control and self-control questionnaire scores) and AB scores. Again, a possibility for these different correlations may be that the meditators are interpreting the questionnaire items differently to the non-meditators. A further possibility may be that these findings were caused by high variability in the scores.[14]

[14] To explore the variability between the predicted mediator and AB scores, scatter graphs were created. For some variables, the scatter graphs indicated potential outliers in the data thus, in order to limit the impact of data variability the above analysis was repeated using non-parametric Spearman's r correlations. The Spearman's r correlations showed the same pattern of findings as shown via the Pearson r test.

2.3.3.4 Comparing correlations for the predicted mediators (mindfulness, attentional control and self-control) between the non-meditator sample (n=38) and the experienced meditator sample (n=48) for dot-probe AB100 and AB2000

Previous correlations between predicted mediators and AB scores have shown a pattern between the meditator and non-meditator groups, with meditators showing positive correlations between the mediators and AB100 scores, but negative correlations between the mediators and AB2000 scores. These findings were reversed for the non-meditator control group. To explore whether these correlations significantly differed between the meditator and control groups, each correlation between the predicted mediator and AB100 and AB2000 were individually compared using a Hotelling-Williams test (2-tailed).

	Controls (n=38)		**Experienced (n=48)**		**Difference (p value)**	
	AB100	**AB2000**	**AB100**	**AB2000**	**AB100**	**AB2000**
FFMQ –observe	0.073	-0.148	0.151	-0.249	0.493	0.468
FFMQ – describe	0.102	0.268	0.042	-0.192	0.609	0.000**
FFMQ – awareness	0.080	0.394*	0.141	-0.134	0.592	0.000**
FFMQ – nonjudge	-0.014	0.265	0.018	0.052	0.794	0.088
FFMQ – nonreact	0.156	0.197	0.063	-0.139	0.419	0.013**
MAAS	0.072	0.408*	0.111	-0.007	0.737	0.000**
ACQ - total scores	0.068	0.361*	0.145	0.186	0.498	0.154
ACQ - focus attention	-0.023	0.351*	0.150	-0.228	0.134	0.000**
ACQ - shifting attention	0.151	0.295	0.106	-0.107	0.696	0.002**
TAS	0.074	-0.030	0.114	-0.268	0.726	0.083
SCS	-0.036	0.428**	0.036	0.099	0.550	0.003**

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

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

Table 2.19 Hotelling-Williams test exploring correlations between predictor variables and AB100 and AB2000 scores between the experienced meditator and non-meditator groups.

Table 2.19 shows that the correlations between the predicted mediators and AB100 scores were not significantly different between the experienced meditator and control groups. The majority of correlations between the predicted mediators and AB2000 scores were however significantly different between the two groups. The pattern of results show that for AB2000, with a few exceptions, there were all negative, or near zero, correlations for the experienced meditators, and all positive correlations for the controls. Both meditators and controls showed a similar pattern of results for AB100 (mostly positive, or near zero correlations).

2.3.3.5 Comparing predicted mediators (mindfulness, attentional control and self-control) for the whole sample (N=125) with level of meditation experience (experienced, novice and control).

This section correlates (across the whole sample) predicted mediators (mindfulness, attentional control and self-control questionnaire scores) and level of meditation experience in order to identify any association between these variables.

Measure (scale)	**Experienced**	**Novice**	**Control**
FFMQ - observe (1-5)	3.98 (0.66)	3.89 (0.55)	3.16 (0.72)
FFMQ - describe (1-5)	3.98 (0.62)	3.67 (0.66)	3.28 (0.74)
FFMQ - awareness (1-5)	3.66 (0.63)	3.29 (0.61)	3.20 (0.63)
FFMQ - nonjudge (1-5)	3.92 (0.75)	3.29 (0.94)	3.32 (0.74)
FFMQ - nonreact (1-5)	3.34 (0.60)	2.75 (0.61)	2.67 (0.39)
MAAS (1-6)	4.44 (0.73)	4.07 (0.60)	3.92 (0.73)
ACQ - total (1-4)	60.38 (7.30)	57.31 (8.52)	53.74 (8.95)
ACQ - focus attention (1-4)	26.71 (3.71)	24.26 (4.79)	22.89 (5.17)
ACQ - shifting attention (1-4)	33.67 (4.75)	33.05 (4.88)	30.84 (4.80)
TAS (0-4)	97.98 (21.43)	88.36 (25.57)	58.32 (24.59)
SCS (1-5)	134.77 (12.89)	123.18 (14.42)	122.50 (15.82)

a. Values are means (SDs) unless otherwise stated.

b. Values are based on multivariate tests.

Table 2.20 Mean self-report scores of individuals with different levels of meditation experience (experienced, n=48, novice, n=37, no meditation controls, n=38).

One-way ANOVAs were used to examine the effects of the independent variable (level of meditation experience) on multiple dependent variables (self-reported mindfulness scores, attentional control scores, and self-control scores). Results showed significant group differences for all the factors; FFMQ – observe, $F(2, 124) = 19.440$, $p = 0.001$, Cohen's $d = 0.24$, FFMQ – describe, $F(2, 124) = 11.549$, $p = 0.001$, Cohen's $d = 0.16$, FFMQ – act with awareness, $F(2, 124) = 6.747$, $p = 0.002$, Cohen's $d = 0.10$, FFMQ – nonjudge, $F(2,124) = 8.718$, $p = 0.001$, Cohen's $d = 0.13$, FFMQ – nonreact, $F(2, 124) = 19.558$, $p = 0.001$, Cohen's $d = 0.24$, MAAS, $F(2, 124) = 6.425$, $p = 0.002$, Cohen's $d = 0.10$, ACQ – total, $F(2, 124) = 6.938$, $p = 0.001$, Cohen's $d = 0.10$, ACQ – focus attention, $F(2, 124) = 7.883$, $p = 0.001$, Cohen's $d = 0.11$, ACQ – shifting attention, $F(2, 124) = 3.896$, $p = 0.023$, Cohen's $d = 0.06$, SCS, $F(2, 124) = 10.292$, $p = 0.001$, Cohen's $d = 0.14$, TAS, $F(2, 124) = 31.069$, $p = 0.001$, Cohen's $d = 0.34$.[15]

Tukey HSD post-hoc comparisons of the three groups indicate that experienced meditators reported significantly higher FFMQ-observe (0.001), FFMQ-describe (0.001), FFMQ-act with awareness (0.002), FFMQ-nonjudge (0.002), FFMQ-nonreact (0.001), ACT-total (0.001), ACT-focus attention (0.001), ACT-switching attention (0.021), SCS (0.001), and TAS (0.001) scores compared to those with no meditation experience. Post-hoc tests also show that experienced meditators reported significantly higher FFMQ-act with awareness (0.019), FFMQ-nonjudge (0.001), FFMQ-nonreact (0.001), MAAS (0.042), ACT-focus attention (0.036), and SCS (0.001) scores compared to novice meditators. Furthermore, post-hoc comparisons indicated that novice meditators reported significantly higher FFMQ-observe (0.001), FFMQ-describe (0.030) and TAS (0.001) scores compared to controls. All other comparisons were not significant.[16]

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[15] It is noted that many ANOVA analyses have been conducted. Further analyses which adjust for the effects of multiple analyses were however not conducted given that none of the main analyses, in isolation, reported statistical significance.

[16] Comparing groups based on level of meditation experience (experienced, novice and no experience) was also repeated with participants who did not fast for the full 3 hours before the study removed from the analysis (experienced, n=44, novice, n=35, no experience, n=36). All p values for dot-probe and Stroop attentional bias scores remained greater than 0.05. Analysis of potential covariates showed that only openness ($p = 0.041$), Cohen's $d = 0.04$ and reward drive ($p = 0.017$), Cohen's $d = 0.05$ were significant predictors of attentional bias at the dot-probe presentation time, 100ms. All p values for the self-reported questionnaire measures remained less than 0.05.

2.3.3.6 Comparing predicted mediators (mindfulness, attentional control and self-control) for the whole sample (N=125) with and without meditation experience (experience, no experience).

This section correlates (across the whole sample) predicted mediators (mindfulness, attentional control and self-control questionnaire scores) and meditation experience in order to identify any association between these variables.

Measure (scale)	Control	Experience	*p*-value
FFMQ - observe items (1-5)	3.16 (0.72)	3.94 (0.61)	0.001*
FFMQ - describe items (1-5)	3.28 (0.74)	3.84 (0.65)	0.001*
FFMQ - act with awareness items (1-5)	3.20 (0.63)	3.49 (0.64)	0.018*
FFMQ - nonjudge items (1-5)	3.32 (0.74)	3.64 (0.89)	0.056
FFMQ - nonreact items (1-5)	2.67 (0.39)	3.07 (0.67)	0.001*
MAAS (1-6)	3.92 (0.73)	4.27 (0.69)	0.011*
ACQ - total scores (1-4)	53.74 (8.95)	59.00 (7.97)	0.001*
ACQ - focus attention scores (1-4)	22.89 (5.17)	25.61 (4.38)	0.003*
ACQ - shifting attention scores (1-4)	30.84 (4.80)	33.39 (4.79)	0.007*
TAS (0-4)	58.32 (24.59)	93.67 (23.73)	0.001*
SCS (1-5)	122.50 (15.82)	129.57 (14.71)	0.017*

a. Values are means (SDs) unless otherwise stated.

b. Values are based on multivariate tests

* $p < 0.05$.

Table 2.21 Mean self-report scores of individuals with (n=87) and without (n=38) meditation experience.

T-tests were used to examine the effects of the independent variable (meditation experience) on multiple dependent variables (self-reported mindfulness scores, attentional control scores, and self-control scores). Results showed significant group differences for the factors; FFMQ – observe, $t(123) = 6.222$, $p = 0.001$, FFMQ – describe, $t(123) = 4.254$, $p = 0.001$, FFMQ – act with awareness, $t(123) = 2.390$, $p = 0.018$, FFMQ – nonreact, $t(123) = 3.422$, $p = 0.001$, MAAS, $t(123) = 2.568$, $p = 0.011$, ACQ – total, $t(123) = 3.271$, $p = 0.001$, ACQ – focus attention, $t(123) = 3.014$, $p = 0.003$, ACQ – shifting attention, $t(123) = 2.735$, $p = 0.007$, SCS, $t(123) = 2.417$, $p = 0.017$, TAS, $t(123) = 7.578$, $p = 0.001$. Means revealed that the no meditation experience group had lower self-reported mindfulness, attentional control, and self-control scores compared to the meditator group. No significant group differences was found for the mindfulness factor, FFMQ – nonjudge, $t(123) = 1.926$, $p = 0.056$.

2.3.4 Summary

In relation to Aim 1 of the current study, the results show that meditation experience (experienced, novice, control) was not statistically associated with AB to chocolate-related stimuli, as measured by the dot-probe task. Although non-significant, the mean AB scores indicated that the non-meditator controls showed the least AB at the 100ms presentation time and the most AB at the 2000ms presentation time. These findings were reversed for the experienced meditators. Additional analyses investigating various alternate definitions of 'meditation experience' showed a similar pattern. Furthermore, combining the two meditation experience groups (experienced and novice) to form one meditation experience group (compared to controls) also showed that compared to controls, meditators showed a higher attentional bias on the dot-probe at 100ms, but a lower attentional bias at 2000ms, though again, these results failed to reach statistical significance. No significant association was detected between meditation experience and AB to chocolate-related stimuli using the emotional Stroop task. The majority of mean AB scores were however in line with the pre-stated hypothesis (i.e. experienced meditators showing the least AB and controls the most AB). In relation to Aim 2 of the current study, analysis of the relationship between predicted mediators and dot-probe measures showed significant positive correlations at 2000ms for non-meditators. For meditators, there were no significant correlations between the mediators and the dot-probe measures. There was however a pattern of positive correlations at 100ms and negative correlations at 2000ms. Meditators also showed stronger correlations between the predicted mediators and AB to chocolate-related stimuli compared to controls.

2.4. Discussion

2.4.1 Summary

This study explored links between mindfulness and attentional control by examining differences in attentional bias to chocolate-related stimuli between experienced meditators, novice meditators, and non-meditator controls. The study also examined the extent to which the effects of mindfulness training on attentional bias were brought about by increases in self-reported mindfulness, attentional control, and self-control ability. Meditation experienced was determined by (1) practitioner's self-assessment, (2) the number of times meditation was practiced per week, (3) the number of minutes meditation was practiced per session, (4) the number of months meditation was practiced in total and (5) the type of attentional control skills currently used (focused attention and/or open monitoring). Attentional bias was measured using emotional Stroop and dot-probe (100, 500 and 2000ms durations) tasks, completed after a period of fasting. The main findings demonstrated that meditation experience, irrespective of how it was determined, was not statistically associated with attentional bias to chocolate-related stimuli, as measured by the dot-probe task. Mean attentional bias scores indicated that the non-meditator controls showed the least attentional bias at the 100ms presentation time and the most at the 2000ms presentation time. These findings were however reversed for the experienced meditators. Although, evidence of only small effect sizes suggested that no actual effect of meditation experience on AB was present using the dot-probe. No significant differences between the groups were also found using the emotional Stroop task.

Analysis of the relationship between predicted mediators (self-reported mindfulness, attentional control and self-control scores) and dot-probe measures showed significant positive correlations at 2000ms for non-meditators, with the effect sizes being of large strength (range 0.351 - 0.428). For meditators there were no significant correlations between the mediator and the dot-probe measures, though there was a pattern of positive correlations at 100ms and negative correlations at 2000ms. The effect sizes for this group were however small (range 0.003 - 0.239). Given that none of the results reached statistical significance further research would need to be conducted before inferring a relationship between mindfulness meditation experience and attentional bias to chocolate-related stimuli.

2.4.2 Effects of meditation experience on attention (Aim 1)

2.4.2.1 Dot-probe task

It was hypothesised that both experienced and novice meditators, irrespective of how meditation experience was determined, would perform better on the dot-probe task compared to non-meditator controls. It was also predicted that experienced meditators (determined by practitioner self-assessment and the length of meditation practice [time spent meditating per week, number of total months spent meditating and number of minutes meditated per session]) would significantly impact attentional bias scores, with experienced meditators showing lower levels of attentional bias compared to novice meditators. The findings showed that, irrespective of how meditation experience (i.e. experienced and novice) was determined, there was no significant effect of meditation experience on attentional bias found using the dot-probe task. These results are inconsistent with previous literature which has reported significant associations between attentional control and long term practice of mindfulness meditation (Carter et al., 2005; Slagter et al., 2007; Srinivasan & Baijal., 2007; Zeidan, Johnson, Diamond, David & Goolkasian, 2010).

A possible explanation for the inconsistency between the findings may be due to the diverse range of tasks used to measure attentional control. The majority of tasks used in previous research (e.g. Wilkins' Counting Test) are believed to be capable of measuring only a single component of attention, namely sustained attention (Carter et al., 2005; Brefczynski-Lewis et al., 2007; Tang et al., 2007; Valentine & Sweet, 1999), whereas the dot-probe task is believed to be capable of measuring two components of attention; sustained attention and attention switching (Posner, Snyder & Davidson, 1980). It stands to reason that using different attentional bias tasks which tap into different components of attention would be likely to produce different results. In disagreement with this notion however, Hodgins & Adair (2010) who used similar visual selection attention tasks to the dot-probe (change blindness flickering task, Rensink, O'Regan & Clark, 1997; gorilla video, Simons & Chabris, 1999) found that meditators showed less interference from invalid cues than non-meditators. This study therefore suggests that differences in the type of attentional control test used to measure attentional bias may not be such a plausible explanation for the null findings as first thought. However, unlike the current study, which was conducted within the community, Hodgins & Adair conducted their research in a laboratory. Thus, the findings could be subject to greater demand characteristics and consequently, reduced validity.

Another reason why no differences were found statistically between the experienced meditator, novice meditator and non-meditator group maybe because the 100ms presentation time used in the current study was simply too fast to allow the meditators to make use of their attentional control skills. This may be a potential limitation of the study. Eriken & Hoffman (1972) reported that improvement in the efficiency of attending rapidly to a pre-directed location is often found within a minimum of 150ms after the event occurs at the attended location. It may therefore be argued that 100ms was too short a duration to allow for the accurate detection of attentional bias. There is also evidence to suggest that the detection of targets occurring earlier than expected (e.g. 100ms) involve involuntary shifts of attention, whereas the detection of targets later than expected (e.g. 2000ms) involves voluntary disengagement and switch of attention (Coull, 2004; Rohenkohl, Coull & Nobre, 2011). In future research it would therefore be useful to include an eye tracking measure.

No significant findings between meditation experience and attentional bias scores were found. The descriptive statistics of the dot-probe task did however show some interesting findings in terms of the mean attentional bias scores across the experienced, novice, and non-meditator groups for the different presentation times. Contrary to prediction, at the short 100ms presentation time both meditator groups (experienced and novice) showed higher levels of attentional bias to the chocolate-related stimuli displayed compared to the controls. The experienced meditators showed the greatest attentional bias. Furthermore, at the 500ms presentation time, again contrary to prediction, the novice meditators showed the lowest attentional bias and the experienced meditators the greatest attentional bias. In support of the pre-stated hypotheses however, at the longer 2000ms presentation time, the experienced meditators showed the least attentional bias and the controls the most attentional bias. The findings at the shortest (100ms) and longest (2000ms) presentation times were therefore reversed for the experienced and control groups. These findings suggest that the effect of meditation experience on attentional control is not as simple as maybe believed. Instead meditation experience appears to affect attention differently depending on how long the emotionally motivating stimulus is presented for.

In support of this notion, when meditation experience was determined based on the ease with which attentional controls skills are used across different meditation practices (focused attention [novice-concentrative] or open monitoring [experienced-mindfulness]) the results showed that, at the shorter dot-probe presentation times, (100 and 500ms) the novice-concentrative meditators showed lower attentional bias to chocolate-related stimuli compared to the experienced-mindfulness meditators. However, at the 2000ms duration, the findings were inverted, with the experienced-mindfulness meditators showing the lowest attentional bias compared to the novice-concentrative meditators. Given that both types of meditators practice focused attention it may be unsurprising that, despite the novice meditators showing slightly lower attentional bias at the shorter presentation times, the mean reaction times scores for both meditator groups were fairly similar. At the longer 2000ms duration, the variation in mean reaction time scores between the meditator groups was however greater. Thus, when presented with an emotionally motivating stimulus for an extended period it appears that more than focused attention is required to control attention. Rather, focused attention in addition to open monitoring is needed to prevent attention from becoming distracted, causing higher levels of attentional bias.

In agreement with this, Lutz et al. (2008) argued that unlike novice meditators, experienced mindfulness meditators are able to effectively disengage from distracters and re-orient their attention back to the object of focus. Many others have also found that meditators who practiced open monitoring were able to resist the temptation to 'over invest' attention to a particular stimulus and therefore demonstrated greater emotional flexibility compared to novice meditators who practice concentrative meditations (i.e. only focused attention) (Brefczynski-Lewis et al., 2007; van Leeuwen, Muller & Melloni, 2009; Lutz et al., 2008; McHugh et al., 2010; Slagter et al., 2007). Thus, by being able to monitor attention in addition to achieving sustained attention experienced-mindfulness meditators may have found the dot-probe task less difficult than the novice-concentrative meditators. It could therefore be interpreted that meditation experience, determined by the type of attentional-control skills used, may affect attentional bias by reducing the amount of cognitive effort required to complete attention tasks. Experienced and novice meditators in the discussed literature (e.g. Brefczynski-Lewis et al., 2007) were however mainly determined by the type of meditation practiced (i.e. practitioners considered themselves to be either concentrative or mindfulness meditators). In the current study, experienced and novice meditators were determined by the type of attentional control skills currently used (focused attention and/or open monitoring) irrespective of practice type. This latter grouping method may be unreliable, and consequently have affected the data.[17] Furthermore, it must be reiterated that no significant group effect or interaction was found in the current study; therefore caution must be taken when making assumptions based on the pattern of mean reaction time scores.

In addition to showing no significant effect of meditation experience (experienced versus novice) on attention using the dot-probe task, the results failed to identify how meditation experience may be associated with lower levels of attentional bias to emotionally motivating stimuli. The results showed that, when reaction times on congruent and incongruent trials were compared to reaction times on the neutral trials, both meditators (experienced and novice) and non-meditators displayed delayed disengagement for each dot-probe presentation time (100ms, 500ms and 2000ms). While these findings offer some support to past research (Fox, Russo, Bowles & Dutton, 2001; Yiend & Mathews, 2001; Georgiou et al., 2005; Koster, Crombez, Verschuere & De Houwerm 2006; Salemink, van der Hout & Kindt, 2007; but see Mogg, Holmes, Garner & Bradley, 2008) it fails to explain why meditators and non-meditators alike had greater difficultly detracting their attention away from the presented chocolate-related stimuli. As a result, the current findings do not support studies such as that by Ortner et al. (2007), which demonstrated that participants with more mindfulness experience showed less interference from affective pictures compared to those who had experience of a different meditation or no meditation at all. This may be explained by the fact that mindfulness meditators, experienced or novice, are taught to take time to observe present-moment stimuli carefully and to refrain from reacting to them until they have been explored with nonjudgmental acceptance (Bishop et al., 2004). The time taken to explore the

[17] Further discussion of this point is provided in section 2.4.5.

different experiences (i.e. the presented stimuli) may have been incorrectly recorded by the dot-probe task as higher levels of attentional bias and delayed disengagement amongst the meditator group. In support of this, Hölzel et al. (2007) showed that mindfulness meditators demonstrated a stronger processing of distracting events resulting in increased reaction time scores. It is possible that the dot-probe task which requires speed and accuracy is not where mindfulness training has its largest effect.

In summary, this is the first study to investigate the effects of meditation experience on attention using the dot-probe task. Without any other studies to directly compare to, it is difficult to conclude whether these findings suggest that meditation experience fails to have the proposed beneficial effect on attention, or whether, given the infancy of the dot-probe task in this research context, a lack of significant effects was due to the current design of the task. Thus, further research using the dot-probe task to investigate the relationship between meditation experience and attention control is required before any definitive conclusions can be drawn. Although, given the novelty of the dot-probe task to investigate the effects of meditation experience on attention, it may also be wise to also attempt to replicate previous findings using different attentional bias tasks (Carter et al., 2005; Brefczynski-Lewis et al., 2007; Tang et al., 2007; Valentine & Sweet, 1999). If a replication is found, this will help to explain with greater confidence the effects of meditation experience on attention using the dot-probe task.

2.4.2.2 Emotional Stroop

Two hypothesises were made. First, it was predicted that both experienced and novice meditators (determined by practitioner self-assessment and the length of meditation practice) would perform the best on the emotional Stroop task compared to non-meditator controls as demonstrated by lower attentional bias. Second it was hypothesised that the novice and experienced meditators (determined by the type of attentional control skills currently practiced; focused attention or open monitoring) would perform similarly on the emotional Stroop task given that both novice-concentrative meditators and experienced-mindfulness meditators use focused attention; a skill required to perform optimally on this attentional bias measure. None of these hypotheses were supported. That is, mindfulness training was not related to better performance as evident by lower levels of attentional bias on the emotional Stroop task irrespective of how meditation experience was determined. These findings were in direct contrast to those found previously (Bishop et al., 2004; Lutz et al., 2008; Wenk-Sormaz, 2005). Rather, the current study's findings were in greater accordance with studies showing that meditators and non-meditator controls do not significantly differ in their reaction time scores on the emotional Stroop measure (Anderson et al., 2007; Joesfssona & Brobergb, 2010; van Leeuwen et al., 2009; Lykins, 2009; Moore & Malinowski, 2009; Polak, 2009).

One possibility for the non-significant group differences in the current study is that, as de Ruiter & Brosschot (1994) argued, the emotional Stroop task was not a reliable measure of attentional bias. This is because colour-naming can result in attention either being directed towards or away from emotionally relevant stimuli. Furthermore, it is believed that this is the first study to use the food version of the emotional Stroop task (Tapper & Pothos, 2009) to test for attentional biases to chocolate amongst meditators. Thus, similarly to the dot-probe, the novelty of this task to measure the effects of meditation experience on attentional bias may account for the null findings. Also, previous research has shown that the emotional Stroop is effective at diagnosing an emotional condition as shown by individuals demonstrating an enhanced interference for words specific to their disorder (Foa, Ilai, McCarthy, Shoyer & Murdock, 1993; McNally, English & Lipke, 1993). Whilst effective in identifying lower levels of attentional bias amongst 'problematic eaters', the sample tested in the current study did not fall into this population category. Dieters were also excluded from the current sample which may have affected the findings, especially as attentional biases to this food product have been identified amongst restrained eaters (Cooper & Fairburn, 1992).

2.4.3. Explanation of the null findings and study limitations

There are many possible explanations for why the experienced meditators did not perform significantly better than novice and non-meditator controls on measures of attentional control (dot-probe and emotional Stroop). Whilst some have already been discussed, the following section will outline a number of alternative interpretations. A discussion of some of the study's limitations is also provided.

The null findings may be accounted for by the fact that meditation practice does relate to attentional control, but the behavioural measures used in the current study simply failed to validly measure the intended constructs. The current study aimed to explore differences in attentional bias to emotionally motivating chocolate-related stimuli between individuals with varying mindfulness meditation experience. During the practice of mindfulness, practitioners equally attend to internal stimuli such as, thoughts and feelings, as external stimuli. Both the dot-probe and the emotional Stroop task have been criticised for only assessing the capacity of individuals to sustain and/or shift the focus of their attention between external stimuli (Garavan, 1998). Garavan (1998), for instance, found that exercising the ability to intentionally switch attentional focus from unpleasant (e.g. angry) thoughts to more pleasant ones (e.g. compassion) was more time consuming than switching attention from one external counter to another (e.g. keeping count of red and blue cars that pass you on your way home). Murphy et al. (1999) also concluded that emotive or personally relevant information may pose an increased challenge to attentional control, and subsequently, affect reaction time scores on tasks measuring attentional bias. Consequently, the ability to lower levels of attentional bias in the external environment may be fundamentally different to disorders or behaviours that require the ability to control attention in the internal domain. The type of tasks used in the current study may therefore have inadequately measured meditators' ability to retain attentional control, causing little difference to be identified between meditators with different levels of meditation experience, and also between meditators and non-meditator controls.

Furthermore, the validity of the emotional Stroop task has been questioned in the literature because participants are able to cheat by squinting their eyes, therefore preventing themselves from reading the words (MacLeod, 1991). Despite being aware of this limitation, the emotional Stroop task was used in the current study given that it seems to predict behaviour and behavioural change better than the dot-probe task. It is however possible that this particular task was not the most psychometrically reliable and valid. Alternative measures should therefore be considered for use in future studies. In contrast to the latter explanation, it is possible that meditation practice is not significantly associated with attentional control. Significant associations found in previous research (Carter et al., 2005; Slagter et al., 2007; Srinivasan & Baijal., 2007; Zeidan, Johnson, Diamond, David & Goolkasian, 2010) may instead be simply due to demand characteristics. As an example of this, meditators are often made aware throughout the course of learning a meditation practice of the effects practice *should* produce. It is well known that such non-specific factors can significantly influence study outcomes (e.g. Baskin et al., 2003). Related to this point, the null findings may be due to the unanticipated difference between meditators and non-meditators in motivation to perform at one's highest level of capacity. The current study offered no performance-based incentives therefore internal motivation to perform would be the only factor strongly influencing participants' approach to the tasks. All participants however received a small sum of money as a token of appreciation for taking part. If the meditators believed that the goal of the study was to validate meditation, they might have been extremely motivated to do well and thus aim to complete the tests more quickly and accurately than if they were performing the tests for other reasons. The current study cannot verify this possibility because no measure of motivation was taken. Some have though argued that even if meditators perceive their participation to be more rewarding than controls, performance in attentional bias tasks has been found to be impervious to manipulations of motivation (Olivers & Nieuwenhuis, 2005). Olivers & Nieuwenhuis (2005) found that even after introducing a reward condition in their attentional bias experiment, there was no significant difference in attentional bias scores between the reward and the non-reward groups. In contrast to this, some research has shown that mindfulness meditators are more emotionally stable (Heppner & Kernis, 2007) through being non-judgmentally accepting of all experiences (Bogels, Sijbers & Voncken, 2006; Segal et al., 2002). These combined factors may produce the surprising effect of minimizing striving toward optimal performance in the meditating group.

In further support of the explanation that mindfulness meditation does not have specific attentional control advantages, Anderson et al. (2007) argued that mindfulness may impact *awareness* of the present moment rather than *attention*. The inclusion of the dot-probe task in the current study, which aimed to measure both of these factors, in addition to the emotional Stroop however suggests that this explanation is unlikely. It may instead be questioned whether mindfulness training provides a different type of cognitive advantage than the type of attentional control investigated in this study. In view of this finding, future research might want to focus on evaluating the effects of mindfulness training on other cognitive gains.

Another reason for the null findings may be that the stimuli used in the tasks failed to evoke sufficient levels of *temptation* for some participants, allowing attention to be controlled more easily. For instance, the researcher informally reported that a number of participants expressed a dislike for the type of chocolate used in the tasks (e.g. chocolates from standard brands such as Nestle were used, whereas some preferred more high quality branded chocolate). Some participants may therefore have perceived the so-called 'attractive' food words/pictures as 'unattractive'. As a result of this, a reliable measure of attentional bias was unable to be taken. To identify whether this was a possible explanation for the lack of significant group differences in attentional bias scores, the design of future studies could either tailor the stimuli to each individual after identification of their personal chocolate preference, or experiment by using different chocolate stimuli such as luxury brands (e.g. Green and Blacks or Thorntons). In relation to the former of the two alternatives, thought would have to be given to how the different chocolate stimuli will be sufficiently matched to the control stimuli. Alternatively, future research could explore the effects of different attractive food stimuli such as, crisps or pastries. Also, given the limitations of visual stimuli, future research might extend this type of investigation to different sensory modalities. Early exploratory research into this has recently been published with some promising findings shown (McHugh, Simpson & Reed, 2010).

It is also possible that the meditator group's performance on the emotional Stroop and dot-probe tasks were not superior to that of the non-meditating control group because in the current study they were not asked to enter a mindful state before completing the tasks (Alexander et al., 1989; Goleman, 1976; Kabat-Zinn, 1990). The fact that all participants were able to report on how 'mindful' they were even without meditation experience (i.e. via the mindfulness questionnaires) however contradicts this. Furthermore, all participants were aware that the study was examining the effects of meditation experience and over half of both experienced and novice meditators had some mindfulness training. It may therefore be assumed that individuals with meditation experience were attempting to complete the tasks mindfully is reasonable. For exploratory reasons, a future replication of the study could investigate the effects of meditation of attention by asking individuals to meditate before completing the attentional control tasks (emotional Stroop and dot-probe).

A further possible explanation for the null findings could be related to the type of meditator sample used in the current study. Some of the most promising effects of meditation experience on attentional control have been identified using highly meditative samples. Carter et al. (2005), for example, tested a group of Tibetan monks to measure the impact of mindfulness practice on attentional bias. Recruiting similar practitioners with this intensity of meditation experience was not feasible in the current study. Other studies have however found significant effects using a similar sample to that used in the present study (e.g. Valentine & Sweet, 1999). This particular explanation may therefore be unjustified. It could be argued that the null findings were instead due to the recruited meditator groups being unrepresentative of typical meditator samples used in previous research (Lykins & Baer, 2009). Participants in the current study were, for example, found to have higher levels of psychological distress as evident by the self-reported scores on the Depression Anxiety Stress Scale measure. The current study however investigated the potential effect of high psychological distress and found no reason to suspect that the findings would be compromised.

The null findings may instead have been caused by simply labelling the sample as either experienced, novice or non-meditator controls. These labels may have created the illusion of a greater diversity between the groups in terms of their attentional control abilities than there actually was. For instance, given the lengthy process of mindfulness training, it begs the question; how many experienced meditators were really that different from the novice meditators? Similarly, research has shown that meditation training for as short as 15 minutes has been found to have an effective on behaviour (Arch & Craske, 2006). Thus how different were the novice meditators from the non-meditator controls?

As an additional point, whereas the current study compares meditators with controls and also meditation experience with the attentional bias measures (dot-probe and emotional Stroop) thus yielding useful correlation information (Chan & Woollacott, 2007), these findings do not establish causal direction. Theoretically then it is possible that regular meditation does not lead to better attentional control, or alternatively, those with better attentional control do not choose to meditate regularly. It is also possible that a third unidentified factor causes individuals to have both superior attentional control and meditation experience. Future studies could address this issue by manipulating meditation training in order to directly assess its impact on attentional bias. This could involve training meditative naive participants and then measuring their attentional bias scores at baseline in addition to a week later. In such a study however, the inclusion of experienced meditators would not be possible due to the length of practice needed.

Finally, it must be noted that despite enforcing a more rigorous check of group similarity (i.e. consisting of 35 individual factors) compared to previous research (Lykins et al., 2012), the groups were found to significantly differ on approximately half of the variables examined. As a result of this, it may be concluded that the lack of significant effect found between meditation and attentional bias in the present study was due to individual differences in the sample. This was despite incorporating a greater number of checks for similarities and differences between the groups. An improved design for future replications of the current study may involve purposive sampling on a smaller group of key variables, rather than the post-hoc attempt to see how the groups compared. Ideally, only including participants in the study who were matched sufficiently would have been favoured, however recruiting from a community sample with a target-specific group was a challenge in its own right. The availability of willing meditators and non-meditators to take part in the study was simply not large enough to reject participants on the basis that they were slightly older or less stressed than those who had already participated. It is though undeniable that the impact of the groups being 'significantly different' can have real consequences when it comes to interpreting the data. Those who choose to practice meditation have been identified as being fundamentally distinct from those who do not (e.g. Lutz et al., 2008), and it maybe these factors which effect attention and not meditation per se. In view of this, achieving a perfectly matched group of meditators and non-meditators may not be possible. Also, the presence of these different characteristics may be important in order to identify group differences when measuring attentional bias.

Whilst the latter point is an important one, the fact that two personality variables (Openness and BAS Reward Responsiveness), which differed between the groups, significantly correlated with attentional bias on the dot-probe task begs the question; did they confound the overall findings? Given that multiple tests for group differences and correlation analyses were conducted, it was believed possible that these significant findings were merely Type 2 errors as opposed to being 'true' results. An alternative interpretation is that the differences in reported Openness and Reward Responsiveness between the groups resulted from the meditation. In other words, mindfulness meditation may work by increasing these supposedly 'stable' personality traits. It is however recognised that understanding how meditation may influence these variables cannot be answered using a cross-sectional design such as that used in the current study. It would therefore be worthwhile for future research to conduct further explorations of the relationship between these personality variables, meditation and attentional control in order to confidently answer the earlier posed question.

2.4.4 Predicted mediators: mindfulness, attentional control and self-control (Aim 2)

It has been suggested that decreases in attentional bias to motivationally stimulating stimuli (e.g. tempting foods) maybe the result of meditation training increasing self-reported mindfulness, attentional control and self-control scores (Chambers et al., 2008; Jha et al., 2010; Moore & Malinowski, 2009; Singh et al., 2007, 2003; Tang et al., 2009, 2007; Zeidan et al., 2010). The current study failed to support this. Each self-report measure showed that lower mindfulness, attentional control and self-control were associated with less attentional bias. Whereas positive correlations were found at the dot-probe 100ms presentation time negative correlations were found at 2000ms presentation time. This suggests that as self-report scores on mindfulness, attentional control and self-control increased, attentional bias was lower when measured at a longer duration. Attentional control and self-control were however found to be significantly correlated with mindfulness, supporting that previously found by Walsh et al. (2009). This suggests that low self-report mediator scores may have been associated with low attentional bias due to this significant relationship acting as a confound. An interesting finding was that, compared to the non-meditator group the meditators showed less significant association between the predicted mediators and attentional bias scores. More specifically, a pattern in the findings showed that only non-significant positive correlations were found between the predictor meditators and attentional bias 100ms scores for the novice and experienced meditators. For the non-meditators non-significant negative correlations were evident. This pattern was, like previously reported findings, reversed at the later 2000ms presentation. These results may indicate that the meditators and non-meditators were interpreting the items on the scales differently. Practicing meditation is said to influence all aspects of the practitioner's life, causing their perceptions and evaluations of both themselves and their circumstances to change (Kabat-Zinn, 2003). Compared to the non-meditators, those with meditation experience would therefore have been more likely to answer the items on the measures used in the current study from a 'mindful' perspective (e.g. more positive and accepting). This may not necessarily be a conscious decision, but one which has become automatic through their meditation training.

Even though the findings showed correlations between the predicted mediators and attentional bias 100 and 2000ms scores, closer analysis revealed that at 100ms the scores did not significantly differ between the meditator and non-meditator groups. At 2000ms however, the groups were found to be significantly different with the meditators showing mostly negative, or near zero correlations and the non-meditators showing positive correlations between the predicted mediators and attentional bias. These findings are in line with the pre-stated hypotheses which predicted that meditation would increase self-reported mindfulness, attentional control and self-control scores whilst decreasing attentional bias. Despite this, the study failed to correctly predict that this finding would only be evident when the stimuli were displayed for the longest time duration. Furthermore, irrespective of this controversial pattern of findings, overall the results showed that meditators reported experiencing greater mindfulness, attentional and behavioural control compared to non-meditators. This reported increase was not shown when they were required to exercise these skills. It may therefore be concluded that practicing meditation causes a heightened feeling of control in practitioners, but this does not appear to lead to an actual decrease in attentional bias to motivationally stimulating stimuli. This was evident by both meditators and non-meditators performing very similarly on the dot-probe and emotional Stroop tasks. Despite the fact that no significant differences in mediator scores were found, the higher mindfulness, attentional control and self-control mean scores reported by meditators compared to non-meditators indicates that the self-reported mediator measures chosen were suitable for the purpose of the study.

2.4.5 Determining meditation experience

The current study was original in that it used five different methods to determine meditation experience. These included methods previously used in other meditation studies (e.g. the number of minutes or hours spent meditating; Chan & Woollacott, 2007; Perlman, Salomons, Davidson & Lutz, 2010) and novel methods (e.g. the type of attentional skills used). None of these methods were significantly associated with any attentional bias measure (dot-probe or emotional Stroop). This therefore contradicts other researchers who have suggested that frequency and intensity of meditation practice will show a significant effect on attentional bias (Chambers et al., 2008; Doyon et al., 2002; Lutz et al., 2008). Also, given that no other study has determined meditation experience based on the type of attentional skills practiced, it is difficult to make comparisons to explain why non-significant group differences were found. One reason for this however is that a large percentage (61.5%) of the novice meditators stated they had practiced mindfulness at some point in their lives, albeit not currently. It is therefore possible that the novice-concentrative meditators were very similar in their ability to use attentional control skills to the experienced-mindfulness meditators as they too would have been taught open monitoring in addition to focused attention (Chambers et al., 2009; Rapgay & Bystrisky, 2009). Furthermore, the assumption that all mindfulness meditators practice open monitoring in addition to focused attention and non-mindfulness meditators the opposite maybe criticised for being too simplistic an approach to effectively determine meditation experience.

2.4.6 Further limitations: methodological issues

Whilst the study's limitations have been outlined throughout this discussion section, it is possible that some further aspects such as, the current experimental design or sample tested may be responsible for the null findings. As a cross-sectional study comparing meditation experts with non-meditators or less experienced meditators, it was impossible to blind participants to the nature of the study; in this case, meditation. Another design weakness may be insufficient power (though the sample size for the current study did exceed previous work using the emotional Stroop and dot-probe tasks, Tapper et al., 2008; Tapper et al., 2010) or the length of time it took to complete the study; an average of one hour. Thus, the effort required during the lengthy tasks might have been high, resulting in less optimal performance. Additionally, the time of day and location which participants completed the tasks varied greatly. Again, this may have had a negative effect on the study's findings as a result of fatigue effects. Another methodological limitation is that the study relied heavily on self-reported data (e.g. meditation experience). As a result of this, some of the information provided may have been subject to error given the reliance of accurate memory recall. Moreover, the study cannot confirm that the participants' meditated as often or as irregularly as reported, and also some aspects of mindfulness may be difficult to report on. Future research could overcome these limitations by allowing meditators a sufficient amount of time to accurately and fully record their meditation experience. Alternative ways of assessing mindfulness (e.g. using a mobile phone application to monitor how often meditators complete mindfulness practices; Hudlicka, 2011) could also be explored. Furthermore, whilst the current study aimed to recruit participants from similar meditation centres to try to minimise variability across meditation practice, obtaining only mindfulness meditators was not achieved. It is therefore difficult to conclude from the findings that mindfulness meditation is not significantly associated with greater attentional control by lowering levels of attentional bias. It is instead possible that this is true of meditation practice in general.

2.4.7 Future research

The main findings demonstrated that there was no statistically significant link between meditation experience, attention control and attentional bias to chocolate.

Previous research has however provided evidence that mindfulness meditation can better attention control by lowering levels of attentional bias when practiced both for short (e.g. several days to weeks; Jha et al., 2007; Tang et al., 2010) and long periods (e.g. several months; MacLean et al., 2010) of time. Further investigation is thus warranted to clarify precisely how much mindfulness training is necessary to produce its benefits. Longitudinal studies and randomised controlled trials with larger sample sizes are needed to explore this relationship. In addition to this, despite the findings failing to reach statistical significance, a repeated trend was identified throughout the analysis, showing that experienced meditators performed better on the emotional Stroop and dot-probe tasks when the stimuli were presented at 2000ms. These findings suggest that meditation practice lowers levels of attentional bias to emotionally motivating stimuli but only when attention is directed to stimuli over an extended period of time. To bring greater clarity to these findings, the study could be replicated by including only the 100ms and 2000ms presentation times.

Future studies could also use more sensitive measures of attention. It may, for example, be argued that the dob-probe 'probe' points are quite arbitrary. One way to avoid this would be, as previously stated, to use eye tracking to measure duration of gaze and disengagement without having to guess what time points need to be attended to or avoided. Moreover, the tasks used in the current study (emotional Stroop and dot-probe) aimed to find improvements in a non-clinical sample. This is more difficult to measure than the deficits of, for instance, adults suffering from an attention-related disorder such as ADHD. Replicating the study using a different population may therefore be of some interest to the wider meditation literature. Alternatively, replications of the study could include brain imaging technology in order to provide a more detailed understanding of how mindfulness practice relates to attention (Brefczynski-Lewis et al., 2007). The meditators and non-meditators may have performed similarly on the dot-probe and emotional Stroop tasks because the tasks used were too simplistic, and therefore using more difficult tasks may produce significant links between meditation experience and attention control. Additionally, it may be beneficial to the field of meditation research to have multiple testing over several time periods. An extended design lasting up to 12 weeks with testing every two weeks would yield more detailed information, particularly at what specific point benefits in the ability to control one's attention are seen in the practice of meditation.

Finally, given the null findings it may be useful for future work to identify performance-based tasks that are consistent with other attention qualities than that of attention control (Anderson et al., 2007). In particular, the ability to observe internal experiences (e.g. thoughts and emotions) in a decentered and accepting way is often described as a primary goal of mindfulness training (Segal et al., 2002). Thus, whereas the practice of attentional control did not lead to better performance on the types of tasks examined in the current study, using alternative tasks which measure other qualities of attention may produce more promising results. In support of this, Papies et al (2011) found that mindfulness meditation was significantly associated with lower levels of attentional bias to the emotionally motivating stimulus, chocolate when participants used mindfulness-based cognitive defusion and acceptance strategies (e.g. the mindfulness group were asked to view their thoughts about viewed pictures without suppression or avoidance). Thus, although attentional control maybe a core component in mindfulness meditation it may be the practice of other associated attention-based mindfulness strategies that lead to greater self-control.

2.4.8 Conclusion

Mindfulness meditation is an increasingly popular research topic and the last few decades have seen an explosion in scientific publications dedicated to investigating the effects of meditation on attention (Baijal & Gupta, 2008; Brefczynski-Lewis, Lutz, Schaefer, Levinson & Davidson, 2007; Carter et al., 2005; Jha, Krompinger & Baime, 2007; Chambers, Lo & Allen, 2008). The current findings however failed to support the many previous claims of significant associations between attentional control and mindfulness training using both self-report and behavioural measures (Carter et al., 2005; Moore & Malinowski, 2009; Slagter et al., 2007; Zeidan et al., 2010). Despite this, the findings point to several potentially fruitful directions for future research, serving as a building block which can contribute to a better understanding of how mindfulness is related to changes in the self-control related health behaviour; reducing chocolate consumption.

Chapter Three

A comparison of brief mindfulness strategies for resisting chocolate

3.1 Introduction

3.1.1 Chapter overview

The current chapter aimed to answer the question 'how do mindfulness interventions work?' A dismantling design was used to compare the efficacy of cognitive defusion and acceptance as brief mindfulness-based strategies to change the self-control related health behaviour, resisting chocolate temptation. A literature review of each strategy is outlined. An overview of the different mediator measures is also provided, followed by a brief description of the aims and hypotheses. This study predicted that cognitive defusion works by reducing automaticity, whereas acceptance works by increasing self-control resources. The current study stated two aims related to the investigation of cognitive defusion (Aim 1 & 2) and two aims related to the investigation of acceptance (Aim 3 & 4). For both strategies the aims explored; does the strategy help individuals to reduce their chocolate consumption, and if so, how does the strategy bring about its effects, respectively. The study further aimed to explore whether the effects of the cognitive defusion and acceptance strategies were mediated by self-reported mindfulness, defusion and acceptance (Aim 5). Lastly, the present study aimed to identify any behavioural re-bound effects in the defusion and acceptance groups via a post-study taste-task (Aim 6). The current study therefore had six aims in total.

3.1.2 Cognitive defusion (Aims 1 & 2)

3.1.2.1 What is cognitive defusion?

Cognitive defusion strategies aim to reduce distress from thoughts by training people to focus on their process of thinking rather than on its meaning (Blackledge, 2007). This results in a separation between themselves, metaphorically, and their thoughts (Eifert & Forsyth, 2005; Gregg, Callaghan, Hayes & Glenn-Lawson, 2007; Hayes, Strosahl & Wilson, 1999; Healy et al., 2008). When separation does not occur (i.e. the person is fused with their thoughts) the thoughts are automatically presumed true and worthy of being followed with the appropriate behavioural action. In contrast, when a person is defused from their thoughts they view these thoughts from a detached perspective. As a result of this, such thoughts are less likely to be taken literally and to dominate behaviour (Harris, 2009; Hayes, Luoma, Bond, Masuda & Lillis, 2006; Healy et al., 2008). Instead, the achieved psychological distance from the private experience allows individuals to persist in more favourable behaviours which are consistent with their values and goals. Cognitive defusion is considered distinct from other cognitive processes, such as cognitive restructuring given that defusion strategies are not intended to change the way people think. Rather, individuals are asked to simply notice their thoughts and to see their thoughts as 'merely thoughts' rather than as statements of fact.

3.1.2.2 How is cognitive defusion used as a mindfulness strategy?

Cognitive defusion achieves distance between a person and their thoughts by diverting attention away from the context of the thought and temporarily disrupting the usual connection between the thought and the associated behaviour. Several different defusion strategies based on this notion have been developed for a wide variety of clinical presentations (Hayes & Strosahl, 2004). For example, an individual could label the process of thinking, "I am just having a thought that ....". Alternatively, a negative thought could be observed dispassionately, repeated out loud until only its sound remains and its meaning lost. A thought may also be treated as an external event to be observed by giving it a shape, size, colour, speed, or form. Such procedures attempt to reduce the literal quality of the thought, weakening the tendency to treat the thought as what it refers to (''I am a failure'') rather than what it is directly experienced to be (e.g. the thought ''I am a failure''). Each cognitive defusion strategy operates on the assumption that 'distancing from thoughts, rather than modifying them, can improve behavioural outcomes through minimising literal response to cognitive content' (Kohlenberg, Hayes & Tsai, 1995; Masuda, Hayes, Sackett & Twohig, 2004; Moffitt, Brinkworth, Noakes & Mohr, 2012). Cognitive defusion reduces the believability and behavioural impact of negative thoughts by the relentless emphasis on seeing thoughts for what they are, just thoughts. To illustrate how the distinction between thoughts and the self is achieved, metaphors are used, including the 'mindbus'. During the mindbus exercise the individual is asked to imagine that he/she is the driver of the bus which represents his/her movement towards a particular personal goal. Unhelpful thoughts are conceptualised as passengers on the bus who demand that he/she change course and head in the opposite direction which will not allow them to achieve their planned goal (Heffner et al., 2002). This exercise encourages the ability to allow negative thoughts to be present without acting in accordance with them, and while maintaining movement in the valued direction. The mindbus metaphor also helps the individual to see their previous negative reactions to thoughts and emotions in an automatic and mindless manner, rather than self-controlled and conscious.

3.1.2.3 Cognitive defusion works by changing the perception of thoughts

Many studies have found supportive evidence to suggest that cognitive defusion techniques work by effecting negative self-referential thoughts (Healy et al., 2008; Masuda, Hayes, Sackett & Twohig, 2004; Masuda et al., 2009). Healy et al. (2008) found that participants who used the cognitive defusion technique, "I am just having a thought that ....." in relation to the statement 'my life is pointless' experienced significantly less emotional discomfort and an increased willingness to be further exposed to similar statements. A study which investigated the effectiveness of another commonly used defusion technique (rapid vocal repetition of a one word version of a negative self-referential thought until it loses all meaning) also showed that the defusion condition decreased emotional discomfort and thought believability more than two control conditions (Masuda et al., 2004).

A subsequent study using the same cognitive defusion technique found that the reduction of emotional discomfort was evident between 3-10 seconds of rapid word repetition, whereas the maximum reduction of thought believability occurred after 20-30 seconds of repetition (Masuda et al., 2009). From these findings, Masuda et al. concluded that, whilst the actual experiential exercise of rapid thought repetition is crucial for altering the stimulus function of negative self-referential thoughts and subsequent emotional discomfort, thought believability may be a distinctive functional aspect of cognitive events. Despite these interesting findings, the above studies can be criticised for multiple treatment interference given that participants in the studies outlined received several different interventions and not just those specific to the use of cognitive defusion. Some studies also failed to compare the defusion condition with an active control condition (Masuda et al., 2009). However, a more recent study which evaluated the efficacy of defusion in isolation found similar findings, suggesting that cognitive defusion may indeed work by affecting negative self-referential thoughts irrespective of the noted limitations (i.e. multiple treatment interference and lack of an active control) (Deacon, Fawzym Lickel & Wolitzky-Taylor, 2011).

In view of the above evidence, the current study proposed that cognitive defusion strategies may be useful for changing behaviours, especially those requiring self-control. The reason for this is because people often behave impulsively to avoid feeling discomfort (Anestis et al., 2011) or because they perceive thoughts as facts which need to be followed (Mace, 2007). Mindfulness has been found to reduce impulsivity by improving awareness of internal experience which in turn facilitates monitoring of impulses (Peters, Erisman, Upton, Baer & Roemer, 2011). Mindfulness training has also been found to enhance self-control of volitional behaviours (Singh et al., 2007). Furthermore, it has been argued that in order to control behaviours thoughts often have to be monitored (Baumeister et al., 1994). Cognitive defusion strategies maybe an effective strategy to achieve this.

3.1.2.4 Using cognitive defusion strategies to change self-control related health behaviours

Automatic and controlled processes can come into conflict, such as when a heavy smoker attempting to abstain experiences a strong automatic (i.e. unintentional and difficult to control) appetitive response when offered a cigarette. In such situations the smoker may attempt to self-regulate by controlling the automatic response. Willpower alone is not enough to change the behaviour (Loewenstein, 2000). Instead, techniques which foster self-control skills, such as mindfulness strategies, are required. Research investigating the association between mindfulness and self-control has been widely supported (Baer, Smith & Allen, 2004; Brown & Ryan, 2003; Chan & Woollacott, 2007; Hodgins & Adair, 2010; Jha, Krompinger & Baime, 2007; Zeidan, Johnson, Diamond, David & Goolkasian, 2010). Shapiro & Zifferblatt (1976) for instance suggested that the practice of mindfulness strategies increases a person's ability to identify distracting stimuli and therefore are able to avoid reacting to these stimuli automatically. Furthermore, mindfulness has been found to improve self-control by facilitating an individual's ability to recognise cues, both internal and external (Marlatt, 1994). Marlatt (1994) reported that self-control skills acquired via mindfulness training helped individuals to identify and resist cues which were encouraging of substance use. Linehan (1993) also suggested that such skills aided the individual in recognising the consequences of their behaviour, which as a result may lead to more effective behavioural choices being made. The aforementioned research however mainly focuses on mindfulness as a whole practice. They fail to investigate the individual effects of cognitive defusion on self-control.

Cognitive defusion is used in Acceptance and Commitment Therapy (ACT) (Bach & Hayes, 2002). There exists much support for the clinical effectiveness of ACT which includes cognitive defusion techniques, especially in relation to positively effecting self-control related health behaviours such as smoking cessation (Brown et al., 2008; Gifford et al., 2004), polysubstance abuse (Hayes et al., 2004), and marijuana dependence (Twohig, Schoenberger & Hayes, 2007) (for a comprehensive review, see Hayes, Masuda, Bissett, Luoma & Guerrero, 2004). Additionally, evidence for the effectiveness of ACT has been found for the treatment of different types of impulse control disorders such as Obsessive Compulsive Disorder (Twohig, 2008; Twohig et al., 2006) and Trichotillomania (chronic skin picking and hair pulling) (Twohig & Woods, 2004; Woods et al., 2006). Cognitive defusion is however just one of five components used in ACT, and to date, very few research studies have used a dismantling design to ascertain the individual effects of each ACT component. Instead, most studies have only conducted small scale studies which aim to examine if each component is psychologically present and works in accordance to the theory underlying ACT (Hayes et al., 2006). Thus, empirical evidence to support the efficacy of individual cognitive defusion strategies is limited.

Indirect evidence for the utility of defusion to increase self-control may be derived from chronic pain analog studies involving the Cold Presser Task (Hayes et al., 1999; Takahashi, Muto, Tada & Sugiyama, 2002). Hayes et al. (1999) found that in a cold presser task, participants who practiced a cognitive defusion technique were able to keep their hand in the cold water significantly longer than participants in the participants in the cognitive behavioural therapy or placebo condition. This study, including others using cold presser tasks (Takahashi, Muto, Tada & Sugiyama, 2002) indicate that Acceptance and Commitment Therapy (ACT) rely heavily on defusion strategies to control participant's pain tolerance. It must however be noted that Hayes et al. (1999) also investigated the simultaneous effects of other ACT components, such as acceptance. Thus, it is difficult to conclude that cognitive defusion was effective as an individual component in bringing about this change. Furthermore, findings from ACT intervention studies which use cognitive defusion do not always produce a decrease in symptomatology or a change in behaviour (Bach & Hayes, 2002; Gaudiano & Herbert, 2006) therefore bringing into question the true efficacy of defusion strategies. Current research literature also offers very little supportive evidence on the applied impact of cognitive defusion therefore exploration of the unique effects of cognitive defusion is warranted. Only one study has attempted to investigate the unique effects of cognitive defusion on self-control related health behaviour (Moffitt et al., 2012). Moffitt and colleagues explored the efficacy of cognitive defusion strategies to reduce unhealthy snacking behaviour. The results showed that cognitive defusion was significantly associated with improved self-control ability, though it was acknowledged that further research is needed in order to confirm this given the novelty of the findings.

3.1.2.5 Using cognitive defusion strategies to change unhealthy eating behaviours

There is evidence to suggest that cognitive defusion strategies are useful to help people abstain, or limit the intake of a craved substance (Gifford et al., 2004). These studies however mainly focus on substances such as smoking and drug abuse (Hernández-López, Luciano, Bricker, Roales-Nieto & Montesinos, 2009; Twohig et al., 2007). Less research has focused on exploring the use of cognitive defusion strategies to reduce other craved substances, such as unhealthy food products. Given the modern 'obesogenic environment' many people report difficulty resisting urges to eat high-energy foods (Alsene, Li, Cheverneff & de Wit, 2003). Refraining from consuming high palatable foods requires self-control (Dishman, 1991; Williams, Grow, Freedman, Ryan & Deci, 1996). Hayes et al. (2006) argued that cognitive defusion strategies may be useful to change unhealthy eating behaviours because they are designed to increase willingness to experience internal states (e.g. thoughts) which in turn will prevent them from dictating behaviour (Hayes et al., 2006). Thus, cognitive defusion changes behaviour by targeting experiential avoidance (i.e. engagement in activities to evade discomfort; Wolgast, Lundh & Viborg, 2011).

Several studies have found evidence for ACT interventions incorporating cognitive defusion strategies for managing eating behaviours (Forman, Hoffman, McGrath, Herbert, Brandsma & Lowe, 2007; Forman, Butryn, Hoffman & Herbert, 2009; Gregg et al., 2007; Lillis, Hayes, Bunting & Masuda, 2009; Tapper et al., 2009). Forman et al. (2007), for instance, examined the effectiveness of two types of strategies (control-based and acceptance-based) for coping with food cravings. Participants were randomised to one of three groups, (1) no intervention, (2) instruction in control-based coping strategies, such as distraction or cognitive restructuring, or (3) instruction in acceptance-based strategies, such as defusion techniques (e.g. participants were taught to 'step back from' the craving and to instead see themselves having the craving). Participants were asked to keep chocolates in their possession but instructed not to eat them for 48 hours. The results of Forman's study showed that both of the strategy types examined (control-based and acceptance-based) appeared somewhat effective in helping people to maintain their abstinence from chocolate. The acceptance-based intervention, which included cognitive defusion, was however found to be more effective in promoting abstinence amongst individuals who were highly challenged by cravings (i.e. more susceptible to food). This finding has interesting implications in that, individuals who are likely to be highly susceptible to food, such as overweight and obese people, may benefit from acceptance-based interventions. These findings also suggest that changing unhealthy eating habits may benefit from less emphasis on control-based strategies and instead more emphasis on confronting food urges. Whilst these findings imply that acceptance-based strategies which include cognitive defusion may be effective in changing unhealthy eating behaviour by reducing food intake, the defusion strategy was analysed in conjunction with other mindfulness techniques. As a result of this, again it is very difficult to conclude if it was specifically the defusion strategy which brought about this behavioural change.

As previously stated, exploring the efficacy of cognitive defusion as an individual mindfulness-based strategy to reduce unhealthy food consumption has only been attempted by Moffitt et al. (2012). Moffitt et al. compared the effects of cognitive defusion and cognitive restructuring techniques on the consumption of chocolates. One hundred and ten self-identified chocolate cravers carried a bag of chocolates with them over a seven-day period. Participants were asked to resist eating the chocolates for the duration of the study. Those in the restructuring condition were told that it is possible to resist acting on one's thoughts about food by actively challenging, disputing, and changing these thoughts and replacing them with more helpful thoughts. Those in the defusion group were told that it is possible to resist acting on thoughts about food by distancing themselves from these thoughts, or creating a sense of separateness between them and their thoughts. Each intervention lasted approximately 60 minutes. The findings showed that participants in the defusion group were more likely to abstain from eating the chocolates compared to participants in the restructuring group. Cognitive defusion also led to greater self-reported reductions in external eating and increased personal responsibility for eating behaviours. Moffitt et al. concluded that defusion may exert its effectiveness through its capacity to enable efficient behavioural control even in the presence of very intense and distressing thoughts. Also, from another perspective, cognitive defusion may augment an individual's ability to engage in self-control when making eating choices (Hall & Fong, 2010). Overall, these findings suggest that cognitive defusion can be a brief and simple approach to effectively manage the consumption of unhealthy snack foods. A limitation of Moffitt's study however is that, it fails to identify 'how' the defusion strategy brings about its effects.

One aim of the current study was therefore to expand on the existing literature by investigating how cognitive defusion brings about behavioural change specifically in relation to the self-control related health behaviour, reducing chocolate consumption. The study predicted that cognitive defusion works by disrupting automatic links between thoughts and behaviours, thus breaking the habit of automatic responding. In support of this, Hayes et al. (1999) stated that 'defusion works by breaking down the tight equivalence classes and dominant verbal relations that establish stimulus functions through verbal means' (p.74). To understand the mechanics of how this is predicted to work, first a description of habits is outlined.

3.1.2.6 What are habits and how are they formed?

Verplanken & Aarts (1999) defined habits as 'learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states' (p104). In order for a habit to develop, practice is required. Lally et al. (2010) reported that level of practice ranges between 18-254 days; indicating considerable variation in how long it takes for habits to develop. Bargh (1994) defined the concept of automaticity as 1) occurring outside awareness, 2) difficult to control, 3) mentally efficient, and 4) unintentional. The last component is defined in terms of being goal directed as opposed to being consciously planned (Aarts & Dijksterhuis, 2000). Habits are created and maintained under the influence of reinforcement, with behaviours with positive outcomes more likely to be repeated than those with negative outcomes. Habits thus serve some goal. For instance, a habit of eating a balanced diet serves the goal of health, whereas a habit of exercising may give a physical sensation of fitness.

Another important feature in the definition of habits is that it is a form of automaticity which is triggered by specific cues. These cues can be related to many factors, though the majority of studies suggest that the performance of habitual behaviour is guided by situational or environmental cues (Adriaanse, de Ridder & de Wit, 2009; Graybiel, 1998; Ji & Wood, 2007; Tucker & Ellis, 2004; Wood & Neal., 2009). Traditionally, investigations into habit formation were largely behaviourist. It was believed that habits form due to associative learning causing a stimulus (cue) - response (S-R). Automaticity underlies habits and it is this automaticity between context cues and actions which arise intentionally or unintentionally on a day to day basis. Initially the S-R pattern needs to be encoded in procedural memory, although once formed the habitual response becomes primed by cues in the performance context. Over time, the mental association between the situation and the behaviour is strengthened. With the co-occurrence between the situation and the behaviour, the association is strengthened to the extent that whenever the situation is encountered the behaviour is performed automatically, therefore without awareness and with limited control (Aarts & Dijksterhuis, 2000; Bargh, 1994; Bargh & Gollwitzer, 1994; Verplanken, 2006).

3.1.2.7 Breaking existing habits

Numerous studies within the literature demonstrate how habits are formed and how they affect behaviour (Aarts & Dijksterhuis, 2000; Danner, Aarts & De Vries, 2008; Verplanken & Aarts, 1999), though relatively little is known about ways to change habits once they have formed. Some suggest that existing habits can be broken by changing the performance cue. This is achieved by altering the situations in which the behaviour is performed by acts of stimulus control. In order to quit smoking, for example, a smoker may remove items from their home that remind them of the behaviour (Prochaska et al., 1988). Whilst people often use stimulus control as a means to change behaviour, changing performance cues has not been found to be very helpful when attempting to break existing habits. The main reason for this is that people cannot easily identify relevant performance cues for habits (Quinn, Pascoe, Wood & Neal, 2010).

Another self-control technique useful for breaking existing habits is to identify cues and exert control in order to reduce unwanted habitual responses. This is more readily known as vigilant monitoring. Vigilant monitoring is thought to be more successful than the previously mentioned strategy, stimulus control, given the difficulty of detecting triggering cues (Quinn et al., 2010). It has been found however, that vigilant monitoring is most successful when the cued response is not only inhibited, but replaced by a new response (Quinn et al., 2010; Wood & Neal, 2007). Thus another useful self-control technique is counter-conditioning. Counter-conditioning aims to inhibit habits by enabling the individual to replace the cued response with another more helpful response. Research shows that a lot of smokers make use of this technique, for instance engaging in physical exercise when having the urge to smoke (Prochaska et al., 1988). The use of counter-conditioning has also been significantly associated with successful cessation (Sun et al., 2007). In view of the discussed research, it is possible that vigilant monitoring is a helpful strategy for identifying when the habitual behaviour is cued, and that counter-conditioning helps people to substitute an alternative habit for the old unwanted habit.

The current study offered a different approach for breaking existing habits. Unlike previous studies (Verplanken & Wood, 2006), it is argued that cues which trigger automatic behaviour in many instances may be cognitive rather than environmental. An individual, for example, thinks 'I need something sweet' and responds accordingly by automatically reaching for the biscuit tin. Thus, instead of changing the environment to break existing habits, it is alternatively proposed that focus needs to be placed on changing an individual's response to their thoughts. Cognitive defusion strategies may achieve this by teaching individuals to become aware of their thoughts and to identify thought cues which are counter-intentional (i.e. those contrary to one's goal). For instance, a person may intend to eat less chocolate, but experience the thought; 'I'm stressed. I need chocolate!'. Being aware of the counter-intentional cues enables the individual to distance themselves from them by using the defusion strategy to see their thoughts as 'just thoughts'. To my knowledge, no other studies have directly examined whether cognitive defusion brings about its effects by breaking existing habits. It is however predicted that the defusion strategy works by heightening awareness of and attention to inner experiences (i.e. thoughts) which act as cues, thus interrupting the automaticity between the cue and the behaviour. An aim of the current study was to test this theory.

3.1.2.8 Association between habits, cues and self-control related health behaviours

Research into self-control related behaviours mainly focus on addiction treatment. Much evidence has been found to suggest that addictive behaviours become automatic with repeated practice and therefore form habits (Tiffany, 1990). According to Tiffany, addictive behaviours (e.g. drug-use) are performed when triggered by cues. Addictive behaviours become so highly automatic through repetition that these individuals will only experience conscious urges and cravings if this automatic behaviour is prevented in some way, such as in those attempting abstinence. Tiffany's theory of cue reactivity has also been applied to other self-control related health behaviours, such as eating behaviour (e.g. Fedoroff, Polivy & Herman, 1997; Green, Rogers & Elliman, 2000; Nederkoorn & Jansen, 2002; Sobik, Hutchison & Craighead, 2005). Overduin & Jansen (1996) found that individuals reported greater food cravings during the presentation of a food cue when food-deprived. The current study explored the relationship between food thoughts and eating behaviour. A more in depth literature review of the association between habits, cues and unhealthy eating is therefore provided.

3.1.2.9 Association between habits, cues and eating behaviours

Eating is often an automatic behaviour (Diliberti, Bordi, Conklin, Roe & Rolls, 2004; Kral, Roe & Rolls, 2004; Levitsky & Youn, 2004; Meyers, Stunkard & Coll, 1980; Rolls, Roe & Meengs, 2006; Painter, Wansink & Hieggelke, 2002; Wansink, Painter & Lee, 2006). In support of this, studies have shown that people are generally not aware of how much they eat. Diliberti et al. (2004), amongst others

(Levitsky & Youn, 2004; Rolls et al., 2006) found that people given larger portions than normal did not believe they had eaten any more, nor did they report greater fullness than participants who had eaten normal-sized portions. Research has also shown that people tend to eat food which is within easy access to them (Painter et al., 2002; Wansink et al., 2006) or simply because time is indicative of a 'meal time' (e.g. 12pm being lunch time) as opposed to eating because of feeling hungry (Tuomisto, Tuomisto, Hetherington & Lappalainen, 1998). Eating habits have therefore proven to be an important predictor of eating behaviour (Brug, de Vet, de Nooijer & Verplanken, 2006; Honkanen, Olsen & Verplanken, 2005; Verplanken, 2006; Verplanken, Herabadi, Perry & Silvera, 2005).

Adriannse, de Ridder & Evers (2011) also reported that snack consumption was related to the habit of snack eating and restraint. This provides support for the consumption of unhealthy snacks without conscious awareness. Characterising eating as an automatic behaviour however does not mean that human beings cannot bring eating under volitional control. Although, unlike continued eating, refraining from eating requires great effort (Wansink, 2006). Overconsumption of unhealthy foods may therefore be supported by over learned automatic behaviours and by unconscious responses to the subjective experience of food cravings. In support of this, Wills, Isasi, Mendoza & Ainetter (2007) found that high self-control was related to lower intakes of high-fat foods. Vohs & Heatherton (2000) also reported that poor self-control is associated with people breaking diets more readily. Lack of control over eating behaviour (often characterised by the consumption of highly palatable desserts and snack foods) has also been associated with an unawareness of eating (Wolkoff et al., 2011). In addition to this, loss of control has been related to inaccurate estimates of food intake (Wansink & Sobal, 2007), particularly recall of sweet food consumption (Wolkoff et al., 2011).

Unhealthy eating behaviour has been found to be 'cued' by a number of factors, including negative emotions (Conner, Fitter & Fletcher, 1999; Dubé, LeBel & Lu, 2005) and social situations (Herman & Polivy, 2005). Some have however argued that unhealthy eating is not directly related to specific situational cues. Rather cues for eating unhealthily more often reflect internal states or subjective cues (e.g. being bored or feeling sad). If these motivational cues are consistently related to unhealthy eating behaviour then it may be possible to change unhealthy eating habits by making individuals aware of these cues and to identify them for what they are; just cues. Research has shown promise in terms of reducing unhealthy snack consumption by influencing motivational cues (Adriannse et al., 2009), though these studies have mainly focused on using implementation intentions. Significantly less research has been conducted on the effectiveness of cognitive defusion strategies to change unhealthy eating habits by identifying and breaking the critical cue-behaviour link.

To summarise, eating is a behaviour that can become a habit and can be triggered by cues. The current study proposed that these cues can be internal and cognitive defusion strategies may be useful to break unhealthy eating habits by allowing individuals to become aware of their thought cues and to describe them accordingly. To date, research on the effectiveness of cognitive defusion strategies to break habits is very limited. A description of those which do exist is provided.

3.1.2.10 Using cognitive defusion to break habits

A study conducted by Ostafin & Marlatt (2008) found evidence to suggest that mindfulness works by decoupling the relation between automatic appetitive responses and substance use behaviour, namely excessive drinking. This study however argued that this break in automaticity was due to greater participant acceptance, not cognitive defusion. Interestingly, possessing an awareness of thoughts and feelings was not hypothesised to reduce drinking behaviour. Ostafin & Marlatt argued that this was because awareness might actually increase the association between affective associations and alcohol behaviour. In agreement with this notion, alcohol expectancies have been shown to more strongly predict alcohol use in participants who are more aware of their internal experience (Bartholow, Sher & Strathman, 2000). This study however evaluates the effectiveness of 'mindfulness' to break automatic behaviour and not cognitive defusion strategies specifically. A single study has previously stated that it explores the effectiveness of cognitive defusion to break links between thoughts and behaviour. Conducted by Tapper et al. (2009) it was speculated, based on qualitative post-hoc analyses, that the cognitive defusion component of the mindfulness intervention was most successful at bringing about behavioural change in terms of both exercise and healthy eating. Caution must however be taken when interpreting these results given that the effectiveness of cognitive defusion was again analysed in conjunction with other ACT strategies, including acceptance and values. More research is therefore needed.

3.1.3 Conclusion of literature review

3.1.3.1 Summary

Some behaviours develop into habits (Ronis et al., 1989; Verplanken & Aarts, 1999), thus are readily performed with little awareness and high automaticity. Breaking these habits is difficult, especially for behaviours which require self-control to inhibit immediate rewards for long term gratification such as, reducing unhealthy eating in favour of improving health (Prochaska et al., 1988; Quinn, Pascoe, Wood & Neal, 2010). The performance of habitual behaviours is often triggered by the presence of cues, with the majority of research focusing on the effects of environmental cues (Adriaanse, de Ridder & de Wit, 2009; Graybiel, 1998; Ji & Wood, 2007; Tucker & Ellis, 2004; Wood & Neal., 2009). Whilst traditional methods for trying to change automatic behaviours (e.g. removing the cue) have been of some success (Prochaska et al., 1988) the current study suggests that cognitive defusion strategies may also be useful to break existing habits. It was predicted that the defusion strategy works by disrupting the automatic link between the cue and the behaviour (i.e. reducing automaticity) (Bartholow, Sher & Strathman, 2000; Ostafin & Marlatt, 2008; Tapper et al., 2009). Very little research has been carried out to investigate the efficacy of cognitive defusion to change self-control related health behaviours and therefore highlights the need for further research in this area. Considering the effects unhealthy eating has on health it is important to develop a more in-depth knowledge of how cognitive defusion strategies work. Having an understanding of how cognitive defusion changes self-control related health behaviours will also be beneficial for developing more informed interventions aimed at reducing unhealthy habits, and thus decrease health-risk factors associated with the overconsumption of food containing high levels of fat and sugar.

3.1.4 Measuring reductions in automaticity

To explore if cognitive defusion works by breaking automatic links between thought cues and behaviours, a measure of automaticity was required. The standard method used to measure habits is to record the frequency with which a behaviour has been performed in the past. This type of measure is consistent with the view that behaviour can be guided by automatic processes outside of conscious awareness. However a noted problem of this method is that, although past performance frequency appears to be an effective predictor of future behaviour, this relation is not necessarily informative about habits (Eagly & Chaiken, 1993). Whilst repetition of behaviour is certainly part of the automatic process, repeated behaviour need not be a habit, for example cooking lunch for a spouse (Ajzen, 2002). Thus, behavioural frequency is not necessarily a valid measure of habit. Furthermore, it fails to measure whether habits are automatic responses to specific cues. Given the noted limitations associated with measuring habits in terms of behavioural frequency, researchers now favour the use of the Self-Report Habit Index (SRHI). The SRHI was developed by Verplanken & Orbell (2003) as an alternative measure of habit strength by asking individuals to report on a number of qualities of habitual behaviour which are easy to conceptualise (e.g. history of repetition, lack of control, and lack of awareness). The SRHI consists of a 12-item scale and has been used to measure a variety of habits, including eating behaviours (e.g. fruit and snack food consumption) (Verplanken, 2004; Verplanken & Orbell, 2003). The SRHI was used in the current study given that this measure of habit strength has shown high test-retest reliability (Verplanken & Orbell, 2003) and high internal reliabilities for health behaviours (De Bruijn et al., 2008, 2009), including food intake (Brug et al., 2006; De Bruijn et al., 2007).

3.1.5 Acceptance (Aims 3 & 4)

3.1.5.1 What is acceptance?

This strategy encourages the acceptance of thoughts and feelings, both pleasant and unpleasant, without the need to change or control them (Baer & Krietemeyer, 2006). By doing so, individuals build up a degree of tolerance for uncomfortable feelings allowing undesired thoughts and emotions to be explicitly invited, welcomed and easily accepted. The aim of teaching people to accept internal events is to give them the freedom to use their energies more effectively instead of investing them in trying to control thoughts and feelings. This enables individuals to pursue their goals, *despite* any difficult thoughts or feelings. Some researchers label acceptance as an emotion control strategy and therefore it is often compared to strategies aimed at regulating emotions, such as suppression, distraction or reappraisal (Aldao, Nolen-Hoeksema & Schweizer, 2010; Dunn, Billotti, Murphy & Dalgleish, 2009; Hofmann & Asmundson, 2008; Liverant, Brown, Barlow & Roemer, 2008; Szasz, Szentagotai & Hofmann, 2011). Acceptance however is not a strategy which aims to change emotions. The emphasis on the active nature of acceptance as a deliberate yielding experience defines acceptance as a qualitatively different form of control (Decter, 2010).

3.1.5.2 How is acceptance used as a mindfulness strategy?

During the practice of mindfulness acceptance, individuals are encouraged to simply observe their feelings and accept their presence, rather than try to control or eliminate them. One acceptance technique used is called 'urge surfing' (Marlatt & Kristeller, 1999). Urge surfing uses the imagery of a wave to help a person gain control over their impulses to avoid feeling uncomfortable. The person is first taught to label internal sensations and cognitive preoccupations as an urge, and then to foster an attitude of unattached, curious observation of the experience. This technique encourages the identification and acceptance of urges, rather than acting on or attempting to struggle against them using suppression or avoidance strategies. 'Urge surfing' allows thoughts and feelings experienced by individuals to be seen simply as arising events that will pass with time. In support of the effectiveness of this technique Bowen & Marlatt (2009) found that, among participants who wanted to change their smoking behaviour, those who practiced the urge surfing technique smoked significantly fewer cigarettes over a seven-day period compared to those in the control group. The groups did not differ significantly on measures of urges. Bowen & Marlatt therefore concluded that mindfulness acceptance strategies may not initially reduce urges, but they may change an individual's response to them.

3.1.5.3 Acceptance works by increasing tolerance of uncomfortable experiences

The empirically demonstrated benefit of acceptance is that it decreases the aversive properties of negative private events and increases an individual's willingness and ability to engage in difficult activities while experiencing them (Eifert & Heffner, 2003; Levitt, Brown, Orsillo & Barlow, 2004). Thus, acceptance increases a person's ability to tolerate uncomfortable thoughts and feelings. In support of this, Felder, Zvolensky, Eifert & Spira (2003) conducted a study to explore whether practicing mindfulness acceptance techniques had an effect on the tolerance to exposed carbon dioxide (CO_2) enriched air. Participants were randomly assigned to either a computerised acceptance-based condition or a suppression condition. The acceptance-based condition taught participants to observe their feelings and to let go of any struggle with them during the exposure to the CO_2 enriched air. The suppression condition was instructed to suppress their feelings during the CO_2 inhalation. The findings showed that, those who scored highly on the experiential avoidance measure in the suppression condition but not the acceptance condition reported greater levels of anxiety relative to those with low experiential avoidance.

Eifert & Heffner (2003) found similar outcomes, with participants in an acceptance condition demonstrating less behavioural avoidance, fewer negative thoughts and greater willingness to experience the CO_2 inhalation procedure again compared to an emotional control condition (i.e. controlling psychological experiences by abdominal breathing) or a no-instruction condition. These findings have also been successfully replicated using a brief acceptance task. Levitt, Brown, Orsillo & Barlow (2004) reported that the acceptance group showed significantly greater levels of willingness to participate in the CO_2 inhalation for a second time and lower levels of anxiety than those in suppression or distraction conditions when the techniques were only taught using a 10 minute audiotape. These findings suggest that acceptance works by encouraging individuals to cope with uncomfortable thoughts and feelings, allowing them to sit with this discomfort without trying to control or change it in any way. Acceptance is therefore believed to reverse the depleting effects of avoiding uncomfortable situations. A positive association between avoidance and self-control is widely documented, with evidence showing that acceptance strategies foster self-control abilities (Alberts, Martijn, Greb, Merckelbach & De Vries, 2007). In view of this, the current study proposed that acceptance strategies may by effective at changing self-control related health behaviours.

3.1.5.4 Using acceptance strategies to change self-control behaviours

Similarly to cognitive defusion research, the application of psychological acceptance is most often considered within substance abuse literature (Bowen, Witkiewitz, Dillworth & Marlatt, 2006; Davis, Fleming, Bonus & Baker, 2007). The overuse of substances is generally conceptualized as an attempt to moderate emotions or bodily states that have been evaluated as aversive. Often, substance users report great difficulty in controlling their urges (e.g. see McKay, Franklin, Patapis & Lynch, 2006).Whereas traditional control-based strategies aim to directly reduce undesirable emotions, thoughts and cravings, acceptance strategies instead attempt to changes one's intention to control these experiences. Ostafin & Marlatt (2008) suggested that having an accepting attitude towards one's experience would moderate the relation between automatic alcohol motivation and hazardous drinking. In support of this, among fifty undergraduate drinkers it was found that mindful acceptance of current experience reduced unhealthy drinking behaviour. Acceptance strategies have also been used to change other self-control related health behaviours, including reducing chronic pain symptoms (Geiser, 1992). Acceptance of pain includes responding to pain-related experiences without attempts at control or avoidance, particularly when these attempts have limited the patient's quality of life (McCracken & Eccleston, 2005). Hayes et al. (1999) found that subjects in the acceptance group demonstrated greater tolerance of pain compared to the control-based and placebo groups. Many others have supported this (McCracken, 1998; McCracken, Spertus, Janeck, Sinclair & Wetzel, 1999; Viane, Crombez, Eccleston, Devulder & De Corte, 2004). The use of acceptance to change self-control related behaviours is promising. An aim of the current study was therefore to expand this literature by exploring whether acceptance strategies are effective at changing the self-control related health behaviour; resisting chocolate temptation.

3.1.5.5 Using acceptance strategies to change unhealthy eating behaviours

There is a growing body of research suggesting that mindfulness and its related constructs are relevant to understanding the development and maintenance of dysfunctional eating behaviours (e.g. eating disorders such as anorexia and binge eating). Such behaviours are characterized by experiential avoidance and a strong desire to maintain control over eating-related behaviours, urges, thoughts, and feelings (Corstorphine et al., 2007, Merwin & Wilson, 2009, Merwin, Zucker, Lacy

& Elliot, 2010; Orsillo & Batten, 2002). However, control-related strategies have found to increase as opposed to decrease these unhealthy eating behaviours. A small number of case studies and pilot studies have suggested that mindfulness acceptance might be effective for the treatment of eating disorders (Anderson & Simmons, 2008, Baer et al., 2005, Juarascio et al., 2010, Kristeller et al., 2006; Safer, Telch & Chen, 2009). Kristeller & Hallett (1999), for instance, found promising reductions in binge eating among participants practicing an acceptance strategy. Furthermore, Heffner, Sperry, Eifert & Detweiler (2002) reported that acceptance-based therapies were effective in the treatment of anorexia. Despite these positive findings, unfortunately these studies fail to identify if it was the acceptance strategy alone which brought about this change. In fact, very little data have been collected to determine whether improvements in acceptance are related to changes in eating behaviour. Moreover, the main focus of research explores the effects of mindfulness strategies on eating pathologies (Heffner et al., 2002; Kristeller & Hallett, 1999). There is limited research on the effects of these strategies on general unhealthy eating behaviour (e.g. overconsumption of snack foods). Some studies (see section 3.1.2.5) have found evidence for acceptance-based strategies in changing eating behaviours (Forman et al., 2007). Although, as already stated, these studies evaluate the efficacy of many different acceptance-based strategies and not acceptance alone. Additionally, not one of these studies has attempted to explain *how* acceptance strategies change self-control related behaviours.

In view of this, like for the cognitive defusion strategy the current study aimed to provide some insight into the unanswered question; how do acceptance strategies work? Again, this question was explored in relation to the self-control related health behaviour, reducing chocolate consumption. The study predicted that acceptance works by increasing a person's ability to sit with uncomfortable feelings without trying to control or change it in any way. As a result of this, it was believed that acceptance strategies may change self-control related health behaviours by increasing a person's self-control capacity due to freeing up greater self-control resources. To understand the mechanics of how this works, first a description of the term 'self-control capacity' is outlined.

3.1.5.6 What is self-control capacity?

Self-control refers to the capacity for altering one's own responses, especially to bring them into line with standards such as ideals, values, morals, and social expectations, and to support the pursuit of long-term goals (Baumeister et al., 2007). Self-control is also referred to 'willpower', thus implying a kind of strength or energy (Baumeister et al., 2007). Baumeister and colleagues posit that self-control capacity is limited therefore exerting self-control in one domain depletes resources and increases chances of self-control failure in other tasks requiring self-control thereafter (Baumeister, Schmeichel & Vohs, 2007; Baumeister, Vohs & Tice, 2007). The basic approach to testing the depleted-resource hypothesis is to have some participants perform a first self-control task, while others perform a comparable but neutral task, and then all perform a second, unrelated self-control task. If self-control consumes a limited resource, then it is expected that performing the first task should deplete the person's resource, leaving less available for the second task. As a result, the person will perform more poorly on the second task relative to the first task. The idea that self-control has limited energy resource has been widely supported (see Hagger, Wood, Stiff & Chatzisarantis, 2010 for a meta-analysis).

Early laboratory evidence for depleted resources in self-control was reported by Muraven, Tice & Baumeister (1998) and Baumeister, Bratslavsky, Muraven & Tice (1998). In one study, participants who were instructed to suppress their emotions while watching an emotional video performed significantly worse on a subsequent self-control task compared to participants who did not control their emotions during the video. Suppressing a forbidden thought has also been found to weaken people's ability to stifle laughter afterwards (Baumeister et al., 2007). In another study by Baumeister, Bratslavsky, Muraven & Tice (1998) participants were given a bowl of radishes and a bowl of attractive looking cookies. Some participants were instructed to eat only from the radishes whereas others were invited to eat the cookies. This manipulation was found to undermine subsequent persistence with unsolvable puzzles. Participants who refrained from eating cookies (and thus exerted self-control) spent relatively less time at solving the puzzles than participants who were allowed to eat the chocolates and cookies. Ludwig & Stark (1974) also found that alcoholics who were trying to quit drinking were poorer at regulating their moods, thoughts, and attention in comparison with those not currently trying to break such an addiction. This was because the repeated efforts of self-control required to resist temptation depleted the person's self-control capacity. All of the aforementioned studies point toward the conclusion that self-control resources are limited, resulting in the energy used for the initial self-control attempt (i.e. suppression of emotions to avoid discomfort) to deplete resources for later self-control attempts.

There are far-reaching consequences of self-control failures. Compared to individuals with higher self-control resources, individuals with low self-control resources have been shown to break their diets more readily (Vohs & Heatherton, 2000), give into alcohol temptation more easily (Muraven, Collins & Nienhaus, 2002), manage their emotions less efficiently (Muraven, Tice & Baumeister, 1998), and spend more money on impulse (Vohs & Faber, 2007). Thus, to name just a few, poor self-control is significantly associated with obesity, crime and drug use (for overviews, see Baumeister, Heatherton & Tice, 1994; Vohs & Baumeister, 2011). It is therefore important to identify ways to improve self-control even when resources are depleted. One aim of the current study was to test the idea that a brief mindfulness-based acceptance strategy can avoid the deleterious effects of self-control depletion.

3.1.5.7 How can self-control capacity be increased?

As previously discussed, the availability of energy (i.e. self-control) is depleted by exertion and must be replenished before the full measure of energy is available again. Self-control capacity therefore resembles a muscle that becomes fatigued by exertion and becomes less able to function (Baumeister & Heatherton, 1996; Baumeister, Heatherton & Tice, 1994). Research has however shown that it is possible to improve self-control capacity with exercise over time (Schweitzer & Sulzer-Azaroff, 1988). Thus it is suggested that a decrease in self-control strength is not permanent, and therefore can be improved. These improvements typically take the form of resistance to depletion in the sense that performance at self-control tasks deteriorates at a slower rate. Furthermore, it is believed that this increased self-control strength should generalise to any and all tasks that require self-control. Hence, the particular self-control task being practiced is unimportant, providing it requires the individual to override or inhibit a response. There is much research which has provided evidence that practicing self-control leads to a general increase in self-control capacity (Gailliot, Plant, Butz & Baumeister, 2007). Muraven, Baumeister & Tice (1999) found that individuals who exerted self-control over their eating habits for two weeks performed better on a task that required overriding physical discomfort. Other research has shown that people who practiced self-control by exercising (Oaten & Cheng, 2006) also exhibited better self-control. Exposure to food temptations in a supportive environment has further shown to result in better self-control in a subsequent eating task (Geyskens, Dewitte, Pandelaere & Warlop, 2008; Kroese, Evers & de Ridder, 2009).

Despite such suggestive findings, this prior research has several noteworthy shortcomings. For instance, laboratory controlled exertions of self-control often show decrements, not increments (Baumeister et al., 1998; Muraven et al., 1998). The reason for this is that the confines of typical laboratory experiments allow little opportunity for self-control to gain in strength. Furthermore, research has shown that if participants are told that they will need to exert self-control later, they often curtail current performance more severely than if no such demands are anticipated (Muraven, Shmueli & Burkley, 2006). Additionally, there is evidence to suggest that people can exert self-control despite depleted resources if there is a high enough reward, such as cash incentives (Muraven & Slessareva, 2003). These aforementioned factors question the accuracy and reliability of Baumeister's strength model of self-control. Thus, caution needs to be taken when interpreting the findings of self-control studies especially as more recently, researchers have found that reduced self-control after a depleting task is more of a reflection of people's beliefs about the availability of willpower rather than true resource depletion (Job, Dweck & Walton, 2010).

It cannot however be ignored that there are several studies which support the theory that self-control capacity can be increased by identifying procedures which moderate or even counteract the effects of self-control depletion (Gailliot et al., 2007; Webb & Sheeran, 2003). Richards & Gross (2000), for example, argued that construing a potentially emotional situation, in a way that decreases its emotional relevance, consumed considerably less resources than strategies that aim to regulate one's emotional reactions during the occurrence of an emotional event. Others have suggested that control strategies are important when exerting self-control to delay a gratifying reward (Mischel, 1974; Mischel & Ebbesen, 1970). Self-control capacity has also been enhanced by the formation of implementation intentions (Webb & Sheeran, 2006). The current study however proposed a new hypothesis; that mindfulness-based acceptance strategies are effective at preventing the depletion of self-control resources and thus allow people to resist eating the unhealthy snack food, chocolate.

3.1.5.8 Using acceptance strategies to increase self-control capacity

Some studies have suggested that the brief practice of general mindfulness may counteract the deleterious effects of self-control depletion (Hayes, Strosahl & Wilson, 1999). This pattern of results has also been observed in other studies (Martijn, Tenbult, Merckelbach, Dreezens & De Vries, 2002). With the exception of Masedo & Esteve (2007), no study has examined self-control costs nor attempted to assess any other possible self-control benefits of acceptance-based interventions. Although, more recently, Alberts, Schneider & Martijn (2012) showed that participants who accepted their negative emotions (based on mindfulness) outperformed both participants who suppressed their emotions and control-group participants on a subsequent self-control task. This supports the notion that acceptance-based coping is more efficient in terms of resource usage and relies less on self-control compared to suppression. Despite this new evidence, the empirical research which examines how the practice of mindfulness-based acceptance strategies relates to one's ability to control behaviour is very limited. One aim of the current study was therefore to offer further insight and support to this research area. It was predicted that acceptance strategies work by increasing self-control resources, due to less energy being used to control uncomfortable feelings associated with refraining from eating a tempting snack. In other words, acceptance strategies may help individuals resist chocolate by freeing up self-regulatory resources that would otherwise have been used for regulating chocolate cravings

3.1.6 Conclusion of literature review

3.1.6.1 Summary

When faced with an uncomfortable situation people often try and change or control it in order to decrease the level of discomfort experienced. Achieving emotional control (e.g. trying to control or change uncomfortable feelings) however requires effort, and therefore is thought to draw on self-control resources (Muraven et al., 1998). Self-control resources are needed to change self-control behaviours, such as resisting the temptation to eat unhealthy snack foods. Research has shown that self-control resources (or, self-control capacity) can be depleted when more than one task which requires self-control is completed within close proximity. For instance, if a person successfully resists a glass of wine with their meal but then is handed the dessert menu, they are less likely to resist a dessert because they had used up the self-control resources to resist the wine. Thus, self-control is believed to be a limited resource (Muraven et al., 1998). As a result of this, learning to accept rather than regulate difficult emotions may result in the increased availability of self-control resources for self-control related health behaviours, including resisting chocolate (Alberts, Schneider & Martijn, 2012). Very little research has been carried out to investigate the efficacy of acceptance to increase self-control capacity and consequently, change self-control related health behaviours. Further research is therefore needed. Understanding how acceptance strategies work will not only increase our knowledge on how they can be used to change self-control behaviours, but also the effect of doing so on other situations that require self-control. Furthermore, this research will help to develop more effective health-based interventions.

3.1.7 Measuring self-control resources

Researchers have used many different self-control tasks to measure self-control capacity. Some tasks require participants to suppress thoughts about a white bear after planting the idea of that thought (Wegner, Schneider, Carter & White, 1987). Other tasks require participants to break a habit (Baumeister, De Wall, Ciarocco & Twenge, 2005; Muraven et al., 1998) or resist temptation (Baumeister et al., 1998). Measures of self-control capacity also exist in the form of measuring persistence in an unsolvable task (Baumeister et al., 1998) or performance on a hand-grip task which requires physical stamina (Muraven et al., 1998). The latter is perceived as a validated procedure for assessing self-control (Muraven et al., 1998) in which participants are asked to squeeze together a hand-grip for as long as possible both before and after completing another task that also requires self-control resources (such as emotion control or resisting a tempting food). The length of time the individual can keep the hand-grip squeezed together for the second time is generally less than the first time since they will have used up some of their self-control resources during the intervening task. The extent of this reduction is taken as an indication of the amount of self-control resources used up, with smaller reductions indicating reduced vulnerability to fatigue. The current study measured self-control using a hand-grip task (Muraven et al., 1999). The hand-grip task was completed both before and after a five-minute intervening task whereby participants were asked to refrain from a bowl of eating chocolate placed in front of them.

3.1.8 The current study

3.1.8.1 Addressing the research gaps

3.1.8.1.1 Cognitive defusion

The present research was designed to explore how cognitive defusion works to reduce chocolate consumption. Existing research suggests that mindfulness strategies may be helpful for changing such behaviours (Hayes et al., 2006; Wolgast, Lundh & Viborg, 2011). It is however unknown if it is cognitive defusion strategies which are effective, or how they bring about their effects. There is some suggestion that cognitive defusion breaks automatic links between cognitive cues and behaviour by increasing awareness of the cue and by encouraging the perception of thoughts as 'just thoughts' (Ostafin & Marlatt, 2008). The current research was novel in that there remains a lack of understanding in the literature in terms of how cognitive defusion strategies (1) change self-control behaviours, (2) change specifically, unhealthy eating behaviour, and (3) break pre-formed habits. The present study was also one of only a few which aimed to identify the unique effects of cognitive defusion in achieving behavioural change as opposed to its effects when combined with several different acceptance-based strategies. Furthermore, it was one of the first to suggest that habits are cued by cognitive cues as opposed to environmental cues. Snack consumption has increased significantly in recent years (Zizza, Siega-Riz & Popkin, 2001). Thus, as a means of tackling the overconsumption of sweet high fat foods, the current study proposed that interventions should focus on influencing thought cues in order to change unhealthy eating behaviour.

3.1.8.1.2 Acceptance

In addition to cognitive defusion, the present research was designed to explore if a brief mindfulness acceptance strategy can reduce chocolate consumption, and if so, how? Present research fails to offer an explanation as to how acceptance strategies specifically bring about these effects. There is some suggestion that acceptance strategies work by freeing up self-control resources. This research is however very limited and knowledge of how acceptance changes unhealthy eating behaviours lacks sufficient depth and scope for any valid conclusions to be drawn. The current research was novel in that it aimed to investigate how acceptance strategies (1) change self-control behaviours, (2) change specifically, unhealthy eating behaviour, and (3) increase self-control resources. The present study was also one of only a few which aimed to identify the unique effects of acceptance strategies in achieving behavioural change as opposed to its effects when combined with several different acceptance-based strategies.

3.1.8.2 Considerations of the current study

The current study examined the effects of two mindfulness-based strategies on ability to resist chocolate over a five-day period. Cognitive defusion and acceptance strategies were compared with a control strategy, relaxation. At baseline, the control group was tested for similarity with the mindfulness groups.

3.1.8.2.1 Why cognitive defusion and acceptance strategies?

Only one study has attempted to explore the effects of an individual cognitive defusion strategy on resisting chocolate (Moffitt et al., 2012). It was therefore considered important to develop this research further because of its novelty. Furthermore, cognitive defusion and acceptance strategies were chosen based on their ease of separation from mindfulness practices and their ability to be investigated in their unique form.

3.1.8.2.2 Why resisting chocolate?

The self-control related behaviour, resisting chocolate, was chosen because resisting the temptation to eat chocolate is a difficult endeavour and if not controlled, can lead to a multitude of negative health consequences (Erskine & Georgiou, 2011). Chocolate was also chosen since most individuals' report great liking for chocolate and it is also a food that elicits strong cravings (e.g. Rozin et al., 1991). Given that training to reduce food consumption should only affect eating behaviour of those experiencing strong impulses to indulge in that food type (Houben & Jansen, 2011), the study recruited participants who expressed an interest in reducing their chocolate intake.

3.1.8.2.3 Why a 'brief' training period?

The current study explored *individual* mindfulness-based strategies. Thus, the training period required to teach participants their allocated strategy was significantly reduced from the traditional eight-weeks (Kilpatrick et al., 2011) to minutes (approximately 30 minutes). Although very few studies have explored the *brief* training effects of mindfulness strategies on self-control functioning, the findings of those which do are promising (Erisman & Roemer, 2010; Hooper, Davies & McHugh, 2011; Moffitt et al., 2012).

3.1.8.2.4 Why a relaxation control?

Many wrongly assume that mindfulness and relaxation are strongly related and therefore bring about similar effects (Sharpe, Nicholson Perry, Rogers, Refshauge & Nicholas, 2012). In an attempt to demonstrate this misassumption, mindfulness studies often measure the efficacy of mindfulness in comparison to relaxation interventions. These relaxation interventions typically require the participant to tense and relax different muscle groups throughout the body (Benson, 1975; Bernstein & Borkovec, 1973). The findings of these studies have shown to be inconsistent (Jain et al., 2007; Steffens, 2009). Empirical research is therefore needed to compare individual mindfulness strategies with relaxation to determine its potential efficacy and specificity in changing health behaviours. The current study aimed to achieve this by exploring the effects of the mindfulness strategies cognitive defusion and acceptance in comparison to a relaxation control strategy to reduce chocolate consumption. Relaxation was also chosen as a control strategy because it was considered important for all groups to be *active*. The purpose of this was to avoid any potential placebo effects.

3.1.8.2.5 Why check for group differences?

The current study aimed to identify whether participants in the mindfulness (cognitive defusion and acceptance) and control (relaxation) groups were sufficiently similar on factors that may influence chocolate consumption other than the independent variable under investigation (i.e. mindfulness strategies). The effect of age was measured given that older individuals have reported having values which linked to more negative consumption of saturated fats and sugar compared to younger individuals (Drewnowski, Renderson, Driscoll & Rolls, 1997). Gender differences were measured because chocolate has been found to be more highly craved by women (Weingarten & Elston, 1991) and that chocolate is a more preferable choice of comfort food to women compared to men (Wansink, Cheney & Chan, 2003). Differences in level of study was considered an important factor given that undergraduates are more likely than postgraduates to be (1) new to the university lifestyle and social freedom, (2) new to living away from home, and (3) responsible for food preparation and financial management. These have been found to be the most common reasons which affect food choices in a young student population (Beasley, Hackett & Maxwell, 2004; Brevard & Ricketts, 1996; Nicklas et al., 2001; Pan et al., 1999; Papadaki & Scott, 2002; Papadaki et al., 2007).

Measures of how much chocolate is liked, how frequently chocolate is eaten, and level of motivation to reduce chocolate intake were also taken given that the temptation to eat chocolate has been found to be associated with these factors (Finlayson et al., 2007; Mela, 2006; Rodriguez et al., 2007). In addition to this, similarity was checked against the participant's level of openness(Costa & McCrae, 1992; Schmutte & Ryff, 1997). Presently there is no research which demonstrates an association between the personality trait, openness, and chocolate consumption. However, cognitive defusion and acceptance strategies both encourage a willingness, or openness, to notice and accept thoughts and feelings. In view of this, it was considered possible that the effects of the mindfulness strategies may be moderated by this trait, thus checking for group similarity would allow for confident interpretation of how the defusion and acceptance strategies bring about their effects. Furthermore, participants were tested for similarity between their external, emotional and restrained eating behaviours (Van Strien, Frijters, Bergers & Defares, 1986). This was because each of these behaviours has been found to significantly affect the consumption of high fat, energy dense sweet snack foods (de Lauzon et al., 2004; Elfhag, Tholin & Rasmussen, 2008; Macht, 2008; Macht & Mueller, 2007; Oliver, Wardle & Gibson, 2000; Wallis & Hetherington, 2004). Research has also shown that compared to non-dieters, dieters ignore internal cues such as hunger and satiety, which assist in the control of food consumption (Herman & Polivy, 1975; Rogers & Hill, 1989). As a result, dieters and restrained eaters often report increased food consumption compared to non-dieters.

3.1.8.2.6 Why was the current study conducted during only weekdays?

The study was conducted from Monday to Friday. These five consecutive week days were selected to give participants a sufficient amount of time to use their strategy whilst also limiting respondent burden in terms of diary completion. Also, it has been found that people change their eating habits on the weekend (Hart, Raynor, Osterholt, Jelalian & Wing, 2011). Thus, weekends days were avoided in order to decrease variability in the data. Furthermore, completing the study over the weekend may have made it more difficult for participants to keep the bag of chocolates with them at all time.

3.1.8.3 Measures of chocolate consumption

To measure chocolate consumption the study employed two separate dependant measures: diary and bagged chocolates.

3.1.8.3.1 Diary

The main purpose of the diary was to obtain a measure of chocolate intake. To prevent recall bias, participants were asked to record each product at the time of eating. Dovey (2010) argued in favour of this recording technique because it limits difficulties associated with impaired memory. Some methodological issues with using diaries however include inaccuracies or missing data with participants failing to recall all relevant entries. Further difficulties include, ensuring that participants follow the correct guidelines for completing the diary, keeping the diary in their possession, and controlling for the affect that keeping a diary may make participants' aware of their unhealthy eating habits or inability to complete the task (i.e. to resist eating chocolate). As a result, entries maybe withheld. This would be portrayed unfavourably by the researcher. To overcome some of these issues, participants were informed of the importance of recording all entries accurately and in full. The diary was also designed so that it could be manipulated easily to fit into a participant's bag or clothing pocket, therefore increasing the likelihood that the diary would be carried around with them.

The various difficulties involved in the use of a self-monitoring diary have made some researchers question the consistency and reliability of the data derived from such methods (Todd, Hudes & Howes Calloway, 1983). However, in certain studies, the use of diaries is the only appropriate option. For the present study for instance, it would have been impractical to provide participants with weighing equipment both due to cost and the level of demand placed on the participant. Diaries have also been successfully used to measure eating behaviour (Schlundt, 1995), thus it was considered appropriate to also use this method in the current study (Gersovitz et al., 1978; Tomiyama, Mann & Comer, 2009). As an example, Gersovitz et al. asked participants to keep a seven-day diary of the amount of food consumed. The findings showed good agreement between the amount of food recorded in the diary by the participants and the actual amount of food consumed. This study was one of many which demonstrate a high degree of validity when tested empirically. In further support of the use of diary measures, Schlundt (1995) argued that accurate self-monitoring is possible if the diary was designed carefully and was appropriate to the research. It was believed that the diary used in the current study was designed in such a manner.

To summarise, the lack of control in diary studies does highlight problems related to accurately measuring food consumption. The use of diaries does however allow participants to record what foods are eaten with easy and simplicity. The lack of control that is exerted over participants taking place in a diary study also allows for more flexible generalisation of this behaviour within a real-life setting. The current study aimed to measure chocolate consumption and it was considered that a dairy measure was most appropriate to obtain this data.

3.1.8.3.2 Bagged chocolates

As previously noted, there are many difficulties related to self-report measures when assessing dietary intake. In view of this, an additional measure of 'bagged chocolate' was included to add weight to the current study's findings. Using a similar measure, Forman et al. (2007) explored the effectiveness of two strategies (acceptance-based and control-based) for coping with food cravings. Participants were given transparent boxes of chocolate Hershey's Kisses for a period of 48 hours and were instructed to refrain from eating them. Each chocolate were given an identifying mark. The findings showed that a high abstinence rate of 91% was obtained. Forman et al. concluded that this was expected because of the explicit instructions given to participants (i.e. to try to resist chocolate) and therefore they were likely to possess a desire to create a positive impression on the researcher. Low consumption in similar tasks has also been reported by Stirling & Yeomans (2004).

To improve the bagged chocolate measure used by Forman et al. (2007) the current study made three minor adjustments. First, a bag was used as opposed to a box to allow the chocolates to be carried with ease (i.e. a bag can be more easily manipulated than a box). Second, Hershey's Kisses were changed for Mars Celebrations. Hershey's Kisses contain only one type of chocolate, whereas Mars Celebrations consist of eight different varieties. The variation in chocolates provided in the current study aimed to increase chocolate temptation. It was believed that eight varieties as opposed to one were likely to tempt a large percentage of the sample. Whereas Hershey's Kisses could not offer any temptation to those individuals who did not like the particular chocolates provided, in the current study, if an individual did not like one of the Celebrations in the bag then they had another seven different chocolate types to be tempted by. Third, although participants were given 12 chocolates, they were told that the bag contained a total of 14 chocolates. The purpose of this was to make it easier for participants to eat some of the bagged chocolates because they may think that the researcher had counted the chocolates incorrectly. This also aimed to reduce floor effects. Despite these modifications, similar to Forman et al. the chocolates were surreptitiously marked to ensure that substitutions can be identified, and presented in a transparent container.

3.1.9 Additional hypothesised mediator measures (Aim 5)

In addition to the main mediator measures (SRHI questionnaire and hand-grip task) secondary mediator measures were taken with the aim of further identifying how the cognitive defusion and acceptance strategies change the self-control related health behaviour, resisting chocolate. Four questionnaires were employed at baseline and follow-up to measure three hypothesised mediators. These included general trait mindfulness measures (Five Facet Mindfulness Questionnaire, FFMQ, Baer et al., 2006; Philadelphia Mindfulness Scale, PHLMS, Cardaciotto et al., 2008), a measure of cognitive defusion (Experiences Questionnaire, EQ, Fresco et al., 2007) and a measure of acceptance (Food Acceptance and Action Questionnaire, FAAQ, Juarascio et al., 2011). Given that very limited research has been conducted on exploring the individual effects of cognitive defusion and acceptance strategies, no specifically designed questionnaires to measure mindfulness-based defusion and acceptance were available. The measures by Fresco and Juarascio et al. were therefore considered the most suitable for use in the current experiment.

3.1.10 Taste-task (Aim 6)

The current study also tested for behavioural rebound by measuring the amount of chocolate consumed by the participant in the laboratory following the five-day period of abstinence. Behavioural rebound refers to a tendency to engage in higher levels of a behaviour following a period of abstinence. Binge eating, for example, has been shown to follow periods of dieting (Polivy & Herman, 1985). This is important since any dieting or healthy eating strategy that results in behavioural rebound is unlikely to be associated with long term success. The last aim of the current study was therefore to support an existing study by Hooper et al. (2012). This study employed a brief taste test at the end of a period of abstinence to measure any behavioural rebound effect in terms of chocolate eating. A bowl of 40 'Minstrel' chocolates were placed on the desk in front of the participant and the number remaining was counted once the participant had completed the experiment. The results showed no evidence of behavioural rebound effects amongst the mindfulness group at the end of the abstinence period. In view of these findings, it was predicted that there would be an abstinence of rebound effects as demonstrated by the cognitive defusion and acceptance groups consuming the least number of chocolates at the taste test compared to the control group. This finding was important in order for the cognitive defusion and acceptance strategies to have applied utility.

3.1.11 Aims and hypotheses

Existing research suggests that mindfulness strategies may be helpful for self-control related health behaviours, such as resisting tempting foods (Brown et al., 2008; Gifford et al., 2004). It is however less clear *which* strategies are effective, or how they bring about these effects. The current study examined six different aims. Aim 1 and 3 explored whether the cognitive defusion and acceptance strategies were effective in helping individuals to reduce their chocolate consumption. Aim 2 and 4 explored how the defusion and acceptance strategies bring about their effects. The potential mediators, automaticity and self-control were explored. Aim 5 further investigated whether the effects of the cognitive defusion and acceptance strategies were mediated by self-reported mindfulness, defusion and acceptance. Aim 6, via a post-study taste-task, aimed to identify any behavioural re-bound effects evident in the defusion and acceptance groups.

Despite the study being mainly exploratory in nature, the following hypotheses were made:

- If cognitive defusion and acceptance strategies are effective at helping individuals resist chocolate, lower levels of chocolate consumption were expected amongst these two groups, relative to a relaxation control group, over the five-day study period.
- If cognitive defusion brings about these effects by reducing the extent to which chocolate is consumed automatically, reductions in automaticity (as assessed by the SRHI) were expected amongst the cognitive defusion group relative to the control group, together with positive correlations between levels of automaticity reported at follow-up and the amount of chocolate consumed.
- If acceptance brings about its effects by increasing the availability of self-control resources (as assessed by the hand-grip task), increases in self-control ability amongst the acceptance group were expected relative to the control group and negative correlations between self-control ability at follow-up and amount of chocolate consumed.

- If the cognitive defusion and acceptance manipulations result in general increases in mindfulness, significantly greater increases in mindfulness (as assessed by the FFMQ PHLMS, EQ and FAAQ) were expected between baseline and follow-up in these groups compared to the control group.
- An absence of behavioural rebound effect was expected in the acceptance and cognitive defusion groups.

3.2 Method

3.2.1 Participants

Participants (N = 135) were students at Swansea University (96 females, 39 males). They had a mean age of 20.45 years (SD = 2.39) and were able to speak and read English fluently. Participants were recruited by the display of posters around the University campus (see appendix G). An email containing the poster's content was also sent to undergraduate and postgraduate students currently registered at the University. All participants met the inclusion criteria which were; to enjoy eating chocolate, have a desire to reduce the amount of chocolate currently consumed, over 18 years of age, not pregnant, no current or previous history of suffering from an eating disorder, and the ability to eat chocolate due to good health (i.e. does not suffer from high cholesterol, diabetes etc). These criteria were assessed by means of a simple screening questionnaire with yes-no response options for each criterion (see appendix H). As a token of appreciation, participants received a small payment of £10 on receipt of the first and second sets of questionnaires, and after attendance of both appointment sessions. The study received ethical approval from Swansea University's Psychology Department Research Ethics Committee. All participants completed the study in full.

3.2.2 Design and randomisation

The study employed a mixed-subjects design with three conditions (cognitive defusion, acceptance and relaxation-control). Laboratory measures were taken at baseline and follow-up (after five days). Participants were alternatively allocated to either an intervention or a control condition using a single blind randomisation protocol. The time of day (morning or afternoon) each participant was able to attend session one was also taken into account during the randomisation process. This was to ensure that each group consisted of a similar number of morning and afternoon appointments (each group had 14 participants who attended morning appointments and 31 participants who attended afternoon appointments). Only eligible participants were entered into the randomisation process. It was acknowledged that full attendance of a two part study can be difficult to achieve. A number of features were therefore incorporated into the design of the study to both maximise attendance and minimise the impact of nonattendance (i.e. incomplete data). First, the study was run over a five day period with participants able to choose their appointment times. Same time appointments at both sessions were not compulsory. Participants were also able to vary the time they attended session two if other commitments intervened (e.g. change in academic timetable). Sessions were available on both days (Mondays and Fridays) from 8am until 6pm. Second, participants were able to choose the week they wanted to take part (the study was run for a total of eight weeks). Third, via email, participants were reminded on several occasions prior to, and during, the study of their appointment dates and times.

3.2.3 Materials and apparatus

3.2.3.1 Questionnaires completed prior to attending session one (baseline) only.

3.2.3.1.1 Demographic questionnaire

Measures of age, gender, level of study (i.e. undergraduate or postgraduate) and weight-loss behaviour (i.e. if currently dieting to lose weight) were completed (see appendix I).

3.2.3.1.2 Chocolate questionnaire

Using Likert scales, participants were asked to provide ratings of; how much chocolate is liked (1 = I hate it, 7 = I love it), how often chocolate is eaten (1 = never, 7 = everyday) and the level of desire to reduce the amount of chocolate consumed (1 = not very much, 5 = very much) (see appendix J).

3.2.3.1.3 Trait self-description inventory

This Likert type short version of the Trait Self-Description Inventory (TSDI; Collis & Elshaw, 1998; Roberts, Zeidner & Matthews, 2001) was used to measure one of the Big Five personality dimensions; openness (Tupes & Christal, 1961). TSDI (short version) consists of 50 items in two sections, the first containing 28 trait descriptive adjectives such as 'contemplative' to which the participant responds using a seven-point scale where 1 represents "extremely not characteristic of me" and 7 represents "extremely characteristic of me" compared with other individuals. The second section contains 22 statements (e.g. 'I have a lot of intellectual curiosity') and the participant responds using a nine-point scale where 1 represents "very strongly disagree" and 9 represents "very strongly agree". Only questions relating to openness were given to the participants to complete (nine questions in total; five questions from section one, and four questions from section two). To enable aggregation of the items with different response scales the appropriate trait and behavioural responses were summed to generate the required composite, openness. This questionnaire was shown to have high internal reliability. with a Cronbach alpha score of .84.

3.2.3.1.4 Dutch eating behaviour questionnaire

The DEBQ (Van Strien, 2002) is designed to assess emotional eating (eating in response to emotional states), external eating (eating in response to food-related cues) and restrained eating (attempts to limit food intake). It contains 33 statements each rated by participants as never/rarely/sometimes/often/very often. The DEBQ is a standardised questionnaire that was shown to have good reliability (Cronbach alpha .93).

3.2.3.2 Questionnaires completed prior to attending both sessions one (baseline) and two (follow-up).

3.2.3.2.1 Five facet mindfulness questionnaire

Participants completed selected sections of the 39-item version of the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). These measured two of the five facets assessing a general tendency to be mindful in daily life: non-judging of inner experience, and non-reactivity to inner experience. Items were rated on a five-point Likert-type scale ranging from 1 (never or very rarely true) to 5 (very often or always true). The FFMQ had acceptable internal reliability at baseline (Cronbach alpha .73) and follow-up (Cronbach alpha .74).

3.2.3.2.2 Philadelphia mindfulness scale

The Philadelphia Mindfulness Scale (PHLMS; Cardaciotto, Herbert, Forman, Moitra & Farrow, 2008) is a self-report measure assessing level of mindfulness as defined by its two key constituents, present-moment awareness and non-judgmental acceptance. Items were rated on a five-point Likert scale ranging from 0 (never) to 4 (very often) according to the frequency that the item was experienced within the past week. Cronbach alpha scores of the measure at baseline and at follow-up were both .85, indicating moderate to high internal reliability of this questionnaire.

3.2.3.2.3 Experiences questionnaire

To assess decentering (i.e. defusion), the 20-item experiences questionnaire (EQ; Fresco et al., 2007) was used. Decentering is defined by Fresco et al. (2007) as the ability to regard thoughts and feelings as temporary and transit. The EQ focuses on three facets of decentering: the ability to view one's self as separate from one's thoughts, the ability to non-judgementally observe one's negative experiences without habitually reacting, and the capacity for self-compassion. Items are rated on a five-point Likert scale (1 = never, 5 = all the time). Items include, 'I can observe unpleasant feelings without being drawn to them' and 'I can slow my thinking at times of stress.' Coefficient alphas of the measure at baseline and at follow-up were .79 and .81 respectively, which indicated moderate to high internal reliabilities of this questionnaire.

3.2.3.2.4 Self-report habits index

This 12-item scale breaks down the habit construct into a number of features (i.e. lack of awareness, automaticity) (Verplanken, 2005). This measure was used because it has the ability to monitor habit strength independently of actual behavioural frequency and has the benefit of being previously used to investigate a variety of health behaviours. The SRHI uses a five-point response scale ranging from 1 = disagree to 5 = agree, thus items were scored such that higher scores indicated greater habit. The items of each respective SRHI were averaged to obtain an overall score. Coefficient alphas of the measure at baseline and at follow-up were .89 and .92 respectively, which indicated high internal reliabilities of this 12-item questionnaire. A correlation of .255 ($p = 0.003$) between baseline and follow-up measures also indicated high test-retest reliability .255 ($p = 0.003$).

3.2.3.2.5 Food acceptance and action questionnaire

The Food Acceptance and Action Questionnaire (Juarascio et al., 2011) measures the degree to which a person avoids food-related internal experiences (i.e. cravings). The FAAQ is a 10-item questionnaire rated on a seven-point Likert scale. Higher scores indicate greater acceptance of motivations (e.g. cravings) to eat (Juarascio et al., 2011). This questionnaire showed low to moderate internal consistency at baseline (Cronbach alpha score .43) and follow-up (Cronbach alpha score .64).

3.2.3.3 Questionnaires completed at session two (follow-up) only.

3.2.3.3.1 Strategy adherence and acceptability

To measure strategy adherence and acceptability (see appendix K), participants were asked post-intervention to answer the following three questions: "How many times did you use the strategy? (cognitive defusion, acceptance, or control) (1 = not at all, 4 = always), "How helpful did you find the strategy in helping you to cope with your chocolate cravings?" (1 = not at all helpful, 5 = extremely helpful), and "How effective did you think the strategy was in helping you to resist eating chocolate?" (1 = not very effective, 5 = extremely effective). Participants were also asked to rate, using the same five-point Likert scale (1 = not very effective, 5 = extremely effective), how effective they predicted the strategy to be immediately after being taught the strategy five days previously. Finally, participants were asked if they had applied the strategy to help them deal with any other situations (e.g. everyday life situations, such as work or family) in addition to using it to help them resist eating chocolate.

3.2.3.3.2 Cravings

An average rating of distress caused by chocolate cravings was measured using a five-point Likert scale (1= not at all distressing, 5 = extremely distressing) (see appendix L).

3.2.3.3.3 Suspicion probe

To explore participants' suspicion about the main aims of the study, a brief questionnaire was completed (see appendix M). Questions consisted of "Do you think you were in an intervention or control group?", "Did you notice anything unusual about the chocolate in the bag?", "How many chocolates were in the bag?" and " Other than the amount of chocolate consumed, do you have any other ideas about what is being investigated in this study?".

3.2.3.4 Measures of chocolate consumption

3.2.3.4.1 Bag of chocolates

Participants were given a transparent bag of chocolates (Mars Celebrations) at the end of session one (baseline) to keep in their possession at all times over the five days. The bag contained 14 chocolates in total (three mars, three snickers, two bounty, one galaxy, one galaxy caramel, two milkyway, one twix, and one malterser). Mars Celebrations were chosen because they offered a variety of chocolates, thus were likely to appeal to a range of taste preferences. The bag was collected at session two (follow-up) and the chocolates individually counted to provide a measure of chocolate consumption. Chocolates returned without an identifying mark (one corner removed) were assumed to have been substituted for an eaten chocolate and were not counted.

3.2.3.4.2 Chocolate diary

As a measure of 'other' chocolates and chocolate-related products consumed (i.e. not those from the bag), participants were provided with a chocolate diary (see appendix N). Participants were asked to record in the diary the type of chocolate/chocolate-related product eaten, the product brand, the size (in grams) and the overall portion (i.e. half, quarter) consumed. If participants were unaware of the size of the product they were advised to describe the size in as much detail as possible (e.g. equivalent in size to another product, or was a snack size bar etc). Where information was not available food weights were obtained from food labels or other manufacturer's data. Total consumption was calculated by summing the number of chocolate products, in grams, eaten over the five-day period. Each chocolate or chocolate-related product (taking into account the actual portion size consumed) was weighed as a whole food item, despite some items containing less than 100% chocolate (e.g. a chocolate chip cookie).

3.2.3.4.3 Taste-task

A brief taste-task was employed at the end of the abstinence period (i.e. after the five-day period) to measure any behavioural rebound effects in terms of chocolate eating once chocolate consumption was again permitted. This was the final task completed by participants at session two. Twenty-five chocolates (Cadbury Twirl Bites) were placed in a bowl on the table in front of the participant. Participants were made aware that they had successfully completed the experiment and therefore while the researcher went to collect their payment they were free to eat as many chocolates as they wished. Participants were left alone for three minutes. The chocolates were counted once the participant had received payment and been debriefed.

3.2.3.5 Measure of self-control ability

3.2.3.5.1 Hand-grip task

In order to measure self-control, a standard commercially available hand-grip exerciser was used. The hand-grip consisted of two foam coated handles connected by a metal spring. Squeezing the handles together compressed the spring. Participants were asked to squeeze the hand-grip exerciser for as long as they were able to. In order to furnish a measure of when the person stopped, the experimenter inserted a single piece of A5 paper between the two handles when the subject squeezed them together, and the handles held it in place. When the participant began to relax his/her grip, the paper would fall. The experimenter started a stopwatch to time the performance as soon as the paper was placed between the handles. When the paper fell, this indicated to the experimenter that the participants had released their grip and the time was stopped. Next, participants were presented with a bowl containing Cadbury milk chocolate buttons. Participants were asked to keep looking at these chocolates (i.e. give them their full attention) for a total of three minutes, but were not permitted to eat any. Once this time was over, the hand-grip task was repeated. To prevent participants from aiming towards a specific goal, participants were not given feedback (during or after the task) about their performance, nor were they allowed to talk or look at the stopwatch during the performance.

3.2.3.6 Intervention

The intervention drew on two mindfulness concepts (cognitive defusion and acceptance) previously employed in ACT interventions (Hayes & Smith, 2005; Hayes et al., 1999). These concepts were adapted to the context of resisting temptation, specifically, how to cope with chocolate cravings. Each mindfulness strategy created one intervention group. The teaching of each strategy included reading through a written booklet which explained the concept in full using relevant information, metaphors and practice exercises (see appendices O and P to view the material used to teach the two mindfulness strategies). The practice exercises lasted for five minutes. Participants in the cognitive defusion group were taught that resisting the temptation to eat chocolate may be made easier if thoughts which may sabotage intentions were perceived as 'just thoughts'. Participants in the acceptance group were taught that resisting the temptation to eat chocolate maybe made easier if any attempt made to control (i.e. suppress, ignore, battle against) uncomfortable feelings and thoughts linked to the craving was avoided. Thus, instead of attempting to control cravings, participants were asked to simply acknowledge their internal experiences (i.e. thoughts and feelings) and to accept them as they are without trying to change them in any way. Participants were told that acceptance aids in the ability to experience the cravings without taking the usual actions (e.g. eating the desired food) that may reduce the unpleasant experience of wanting something forbidden. Questions were encouraged throughout session one to ensure that the strategies were understood. As an additional check of their level of understanding, participants were also asked to complete a short multiple choice questionnaire. This questionnaire required them to choose the correct response option (choice of four options) related to the question, "When you have a craving to eat chocolate, according to the technique we taught you, should you…" All participants reported a good understanding of the concept. At the end of the session, participants were given the written teaching aids to take away with them and told that they should refer back to the information if they need to over the study period.

3.2.3.7 Control

Participants in the control group were taught a simple muscle relaxation. The muscle relaxation strategy involved physically tensing and then physically relaxing one of three body parts either, the hands, stomach or thighs. Participants were free to practice the strategy using the body part which felt most comfortable for them. The researcher encouraged participants to keep tensing and relaxing the muscles continually throughout the experienced craving either until the intensity of the craving significantly reduced or stopped completely. Additionally, as much as possible, the intervention and control teaching materials were created and presented using similar wording and formatting (see appendix Q). All three groups had equal participant to research contact time.

3.2.4 Procedure

The study was carried out over a period of five consecutive days (Monday-Friday). Participants were informed that the purpose of the study was to teach them a strategy which may help them resist the temptation to eat chocolate (i.e. to not give into their cravings). Each participant was tested individually. After registering their interest to take part in the study, participants were required to complete a series of questionnaires prior to attending session one (baseline). The questionnaires were completed on-line via SurveyMonkey. The majority of the questionnaires required the participant to provide answers relating to their behaviour 'over the last week'. As a result of this, the questionnaires were only sent (i.e. a link by email) to participants one week before their scheduled session one appointment. The questionnaires took between 30-45 minutes to complete.

At session one, after providing written consent (see appendix R), participants first completed the hand-grip task. On completion of this task, the researcher taught the participants their allocated strategy (cognitive defusion, acceptance, or relaxation). Before leaving the session, participants were given a transparent bag containing individually wrapped chocolates. Participants were told by the researcher that there were 14 chocolates in the bag, when actually the bag contained only 12 chocolates. Each chocolate had been surreptitiously marked (one corner removed) so as to detect substitutions of eaten chocolates. Participants were instructed to keep the chocolates with them (i.e. in their possession) at virtually all times for the next five-days. Participants were told to "try their best" not to eat the chocolates in the bag or any other chocolate or chocolate-related product during the study period. Participants were also told that resisting chocolate is difficult and that they may find that they cannot always manage this. If so, participants were told to simply make of note of what they had eaten in the chocolate diary provided.

The participants were left to practice their strategy over the study period without intervention from the researcher. Only on day four (Thursday) did the researcher contact the participants by email in order to provide them with the new link to access the second set of questionnaires via SurveyMonkey. The participants were asked to complete these questionnaires before they attended their session two appointment the following day. At session two, the participants once again completed the hand-grip task before answering questions related to how much chocolate was consumed, adherence to and rated effectiveness of the strategy. Participants also completed a suspicion probe questionnaire. Before the end of the session, the researcher counted the number of chocolates returned in the bag, in addition to going through the information provided in the diary with the participants to ensure that all information was recorded in full and without error. Participants were also asked to rate using a five-point Likert scale (1 = not at all sure, 5 = very sure) how sure they were that they had not missed out any details from the diary. Next, the participants were told that the study had now been successfully completed. As a result of this, chocolate consumption was once again permitted. Unbeknown to the participants, this indicated the start of the taste-task. On completion of this task, the number of chocolates consumed were counted and recorded. Lastly, the participants received payment, thanked for taking part and debriefed fully (see appendix S). A brief outline of the procedure is shown in Figure 3.1.

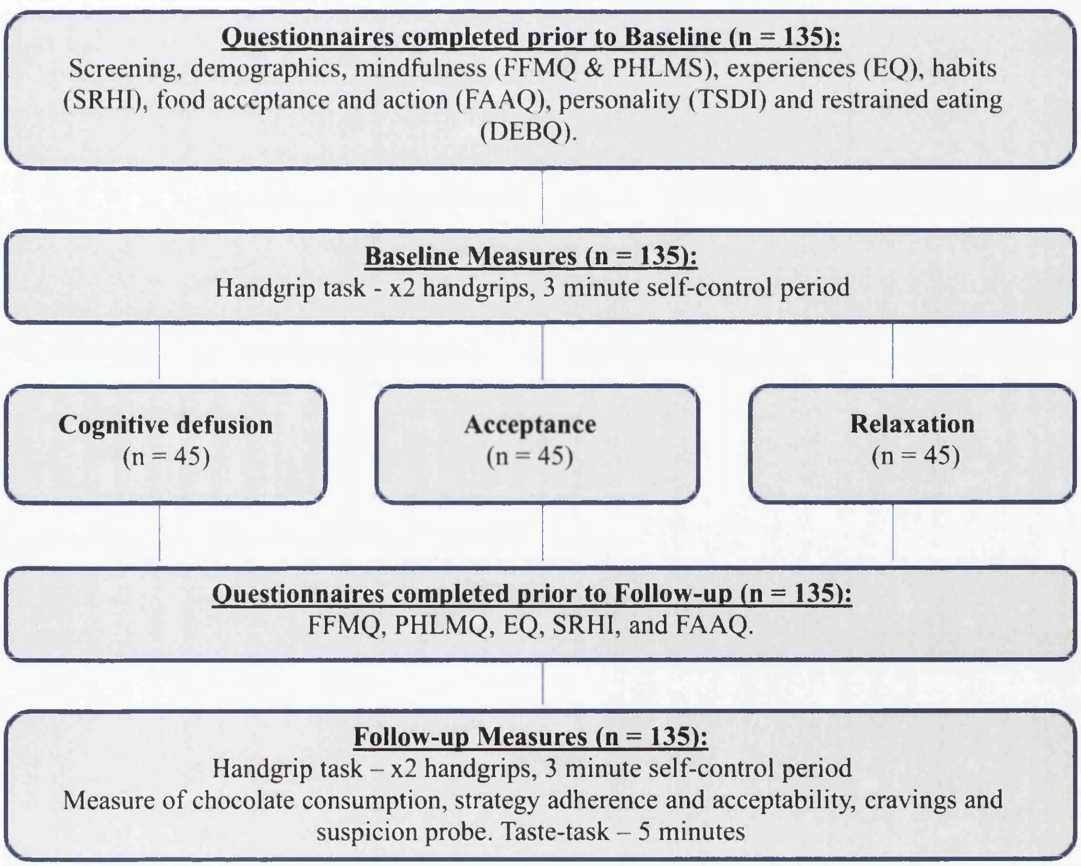

Figure 3.1 A brief outline of the study procedure.

3.3 Results

3.3.1 Data screening

3.3.1.1 Non-adherence to using the taught strategy

In response to the chocolate craving measure, two participants from the relaxation group reported having no chocolate cravings during the previous five-days. Since participants were only asked to use their strategy when they were tempted to eat chocolate, these two participants would not have had an opportunity to employ their given strategy and were excluded from subsequent analyses, yielding an n of 135 (cognitive defusion, n = 45, acceptance, n = 45, control, n = 45).

3.3.1.2 Suspicion probe

An additional participant in the acceptance group had chocolates missing from the bag but stated that a housemate must have eaten them. Data for this participant were excluded from the analysis of bagged chocolate. This resulted in 135 participants for the chocolate diary measure (n = 45 in all groups) and 134 participants for the bagged chocolate measure (n = 45 in the defusion and control groups, n = 44 in the acceptance group).

3.3.1.3 Removal of outliers

Outliers were detected by identifying scores above or below 3.5 standard deviations (SDs) from the mean. None of the sample reported chocolate intake (as measured by the chocolate diary) +/- 3.5 SDs from the mean. No outliers were also found for any questionnaire measure at either baseline or follow-up using this identification method.

3.3.1.4 Summary

From the different data screening processes carried out, two participants (both from the relaxation group) were removed from the dataset. This reduced the original sample size n = 137 to n = 135. One participant from the acceptance group was also removed from analyses of the bagged chocolates (N = 134).

3.3.2 Group demographics

3.3.2.1 Check for group similarity

To ensure that the groups were sufficiently similar on relevant criteria, various statistical checks were carried out. Similarity between groups would allow for confident interpretation that any significant effect found was likely to be caused by the independent variable under investigation. Differences between groups may result in any significant or non-significant effects being influenced by variations between the groups. To assess this, analysis was first conducted to identify any group differences. Secondly, on the basis of group differences being detected, further analysis was carried out to identify if these variable differences were significantly correlated with the main dependant variable, chocolate consumption. Means and standard deviations for all variables used to check for group similarity are included in Table 3.1. The analysis was compared by looking at the mindfulness groups individually.

Characteristic (Scale)	Defusion (G1) (n=45)	Acceptance (G2) (n=45)	Control (G3) (n=45)	p values
Age [+]	20.11 (2.29)	20.58 (2.08)	20.67 (2.76)	(G1-G2 0.315[a]); (G1-G3 0.301[a]); (G2-G3 0.863[a])
Sex (% females)	71.0	71.0	71.0	1.000[c]
Current level of study (% undergrads)	91.0	87.0	93.0	(G1-G2 0.272[b]); (G1-G3 0.060[b]); (G2-G3 0.416[b])
Rating of how much chocolate is liked (1-7) ^	7 (6.00-7.00)	7 (6.00-7.00)	7 (6.00-7.00)	(G1-G2 0.265[b]); (G1-G3 0.095[b]); (G2-G3 0.539[b])
Rating of how much chocolate is eaten (1-5) ^	6 (5.00-7.00)	6 (4.50-6.00)	5 (4.00-6.50)	(G1-G2 0.801[b]); (G1-G3 0.313[b]); (G2-G3 0.405[b])
Rating of want to reduce chocolate (1-5) ^	4 (3.00-5.00)	4 (3.00-4.50)	4 (3.00-4.00)	0.551[c]
Currently dieting (% yes)	13.0	20.0	9.0	0.312[c]
Openness (OCEAN) (1-9) [+]	45.38 (10.30)	42.02 (13.01)	41.07 (11.38)	(G1-G2 0.178[a]); (G1-G3 0.063[a]); (G2-G3 0.712[a])
DEBQ – emotional (1-5) [+]	3.14 (0.90)	2.95 (0.92)	2.69 (0.90)	(G1-G2 0.308[a]); (G1-G3 0.020[a]*); (G2-G3 0.192[a])
DEBQ – external (1-5) [+]	3.60 (0.62)	3.63 (0.72)	3.53 (0.76)	(G1-G2 0.862[a]); (G1-G3 0.606[a]); (G2-G3 0.522[a])
DEBQ – restricted (1-5) [+]	2.66 (0.87)	2.65 (0.93)	2.49 (0.83)	(G1-G2 0.963[a]); (G1-G3 0.356[a]); (G2-G3 0.398[a])

Non-parametric tests were employed where K-S tests indicated significantly abnormal distributions. [a] t-Test, [b] Mann-Whitney U, [c] Chi square

* $p < 0.05$ ^ median and inter-quartile range, [+] mean, SD

Table 3.1 Scores for the variables used to check for group similarity, N = 135 (cognitive defusion, acceptance and control).

Table 3.1 shows that there were no significant differences in baseline characteristics across the three groups, with the exception of emotional eating (as measured by the DEBQ) which was significantly higher in the defusion compared to the control group. To identify whether this variable was likely to have a confounding effect on the results, DEBQ-emotional eating was correlated with both measures of chocolate consumption across the whole sample. Across all groups, levels of emotional eating showed no significant association with either of the two chocolate measures (chocolates from the bag [n = 134], r = 0.136, other chocolate (diary) [n = 135], r = -0.023). It was therefore concluded that this group difference would be unlikely to act as a covariate.

3.3.2.2 Task adherence

3.3.2.2.1 Abstinence from chocolate

A greater number of participants in the defusion group (73%) successfully remained abstinent from chocolate during the five-day period according to the bagged chocolate and diary measure compared to the acceptance (55%) and relaxation-control (55%) groups. A chi-square test however revealed that the percentage of participants who remained abstinent did not significantly differ between the defusion, acceptance and relaxation-control groups, χ^2 (2, N = 135) = 3.113, p = 0.211.

3.3.2.2.2 Possession of bagged chocolate

Participants followed instructions around keeping the chocolates with them at 'virtually all times'.

	Defusion (n=45)	**Acceptance (n=45)**	**Relaxation (n=45)**
Virtually all times (% yes)	93.0	91.0	98.0

Table 3.2 Reported percentage of time the bagged chocolates were kept in the participants' possession for the mindfulness and non-mindfulness control groups.

A chi-square test revealed that the percentage of participants who adhered to the instruction of keeping the bagged chocolates in their possession did not significantly differ between the defusion, acceptance and relaxation-control groups, χ^2 (2, N = 135) = 1.860, p = 0.395. For the participants who did not keep the chocolates with them at virtually all times, reasons such as, generally forgot, unable to fit into handbag and inappropriate place to take the bag of chocolates (e.g. gym) were given. The time the chocolates were not in the participant's possession ranged between 1-8 hours.

3.3.2.2.3 Accuracy of recorded diary entries

Participants were asked to report how sure they were that they had accurately and fully recorded all chocolate products consumed during the five-day period in the diary provided. All participants in all three groups reported being 'very sure' that they had completed the diary in full and there were no unrecorded entries of chocolate consumption.

3.3.3 Effects of mindfulness (cognitive defusion and acceptance) on chocolate consumption (Aims 1 & 3)

The following analyses relate to aims 1 and 3 of the current study. These aims explored whether the cognitive defusion and acceptance strategies were effective at reducing chocolate consumption (i.e. do they work?).

The effects of the mindfulness strategies (cognitive defusion and acceptance) on chocolate consumption relative to the control strategy (relaxation) for both measures (diary and bagged chocolates) were compared across the three groups. The diary measured chocolate consumption in grams whereas the bagged chocolates measured chocolate consumption in terms of the overall number of chocolates eaten. For the diary measure, if participants failed to provide either the exact product weight, or enough detail for the researcher to calculate the number of grams consumed accurately, the required information was obtained from food labels or manufacturer's websites.

3.3.3.1 Diary

Table 3.3 compares chocolate consumption for groups practicing different mindfulness (cognitive defusion, acceptance) and non-mindfulness (relaxation) strategies. Chocolate consumption as recorded by the diary provides a measure of all 'other' chocolates and chocolate-related products (i.e. non-bagged chocolates).

	Other chocolates (grams)			
	Mean	SD	Minimum	Maximum
Defusion	13.22	30.80	0.00	136.25
Acceptance	48.22	108.23	0.00	567.70
Relaxation	37.47	68.10	0.00	348.00

Table 3.3 Comparison of mean chocolate consumption (SDs, minimum and maximum scores) across the three groups (mindfulness [cognitive defusion, n = 45 and acceptance, n = 45] and controls [relaxation, n = 45]) for the diary measure.

A series of two Mann-Whitney U tests were carried out to compare the amount of other chocolate consumed in the mindfulness (cognitive defusion and acceptance) and non-mindfulness (control-relaxation) groups. Non-parametric tests were used due to the data showing skewed distributions. These showed a borderline significance for chocolate recorded in the diary ($z = -1.933$, $p = 0.053$, cohen's $d = -0.46$) with participants in the defusion group consuming less than those in the control group. There was no significant difference found between the acceptance group and the relaxation-control group for the diary measure of chocolate consumption ($z = -0.027$, $p = 0.979$, cohen's $d = 0.12$).

3.3.3.2 Bagged chocolates

Table 3.4 compares the number of chocolates consumed from the bag for the groups practicing different mindfulness (cognitive defusion, acceptance) and non-mindfulness (relaxation) strategies.

	Number of bagged chocolates consumed			
	Mean	SD	Minimum	Maximum
Defusion (n = 45)	0.02	0.15	0.00	1.00
Acceptance (n = 44)	0.27	0.95	0.00	5.00
Relaxation (n = 45)	0.69	2.08	0.00	10.00

Table 3.4 Comparison of mean chocolate consumption (SDs, minimum and maximum scores) across the three groups (mindfulness [cognitive defusion and acceptance] and controls [relaxation]) for the bagged chocolate measure.

A series of two Mann-Whitney U tests also showed a significant difference between the cognitive defusion group and the control group for the number of chocolates eaten from the bag ($z = -1.998$, $p = 0.046$, cohen's $d = -0.45$). There was no significant difference found between the acceptance group and the control group for this measure of chocolate consumption (chocolates from the bag, $z = -0.711$, $p = 0.477$, cohen's $d = -0.26$).

3.3.3.3 Total amount of chocolate consumed (bagged and non-bagged chocolate combined)

To measure the total amount of chocolate consumed (in grams) across the three groups, both chocolate consumption measures were combined. First the total number of bagged chocolate eaten was re-coded from the total number eaten to the total amount of chocolates eaten in grams at the individual level. Chocolates from the bag each weighted an average of 9.5 grams.

	Total grams of chocolate consumed
Defusion (n = 45)	13.43 (31.28)
Acceptance (n = 45)	51.78 (111.43)
Relaxation (n = 45)	44.02 (75.56)

Table 3.5 Comparison of the mean (and SD) total chocolate consumption ('other' chocolate and bagged chocolate) in grams across the three groups (mindfulness [cognitive defusion, acceptance] and non-mindfulness [relaxation]).

Mann-Whitney U tests showed no significant differences between the cognitive defusion and control group (z = -0.827, p = 0.408, cohen's *d* = -0.53) or between the acceptance and control group (z = -0.803, p = 0.422, cohen's *d* = 0.08) for the total number of chocolates consumed (in grams) across both consumption measures.

3.3.4 Associations between predicted mediators and chocolate consumption (Aims 2 & 4)

The following analyses relate to aims 2 and 4 of the current study. These aims explored *how* the cognitive defusion and acceptance strategies brought about their effects. Two potential mediators were explored; automaticity and self-control.

3.3.4.1 Predicted mediator 1: Automaticity

The section explored the pre-stated hypothesis that cognitive defusion works by disrupting automatic links between chocolate-related thoughts and chocolate consumption. If true, it was expected that those in the defusion group would show greater reductions in automaticity (as measured by the SRHI questionnaire) relative to the relaxation control group.

First automaticity scores between the cognitive defusion and control groups were compared at baseline and follow-up. Changes in automaticity scores were calculated by subtracting baseline scores from follow-up scores. Secondly, automaticity scores at baseline were correlated (across the mindfulness and non-mindfulness samples) with the measures of chocolate consumption (chocolates from the bag and other chocolate) in order to identify any association between these variables.

	Baseline (S1)		**Follow-up (S2)**		**Difference (S1-S2)**	
	Defusion M (SD)	**Relaxation M (SD)**	**Defusion M (SD)**	**Relaxation M (SD)**	**Defusion M (SD)**	**Relaxation M (SD)**
SRHI	3.45 (0.84)	3.39 (0.78)	2.14 (0.99)	2.61 (1.01)	1.31 (1.14)	0.78 (1.02)

Table 3.6 Mean and standard deviations. Group differences (cognitive defusion, n=45, control, n=45) between automaticity scores at baseline and follow-up.

A 3x2 mixed ANOVA with group (cognitive defusion, control) and time (baseline, follow-up) as the independent variables and automaticity as the dependent variable were conducted. The findings showed a significant main effect of time on automaticity (SRHI) scores, $F (1, 132) = 131.592$, $p = 0.001$, $\eta_p^2 = 0.50$, with means indicating an overall reduction in automaticity between baseline and follow-up ($M = 3.41$, $SD = 0.84$ and $M = 2.33$, $SD = 0.98$ respectively). No significant effects of group, or significant time-group interactions were however evident (SRHI; group, $F (2, 132) = 1.145$, $p = 0.321$, $\eta_p^2 = 0.02$, time-group, $F (2, 132) = 2.803$, $p = 0.064$, $\eta_p^2 = 0.04$). A trend was though evident towards a significant interaction for the SRHI. Follow-up t-tests using change scores were therefore carried out. The findings showed significantly greater reductions in automaticity in the defusion group ($M = -1.31$, $SD = 1.14$) compared to the control group ($M = -0.78$, $SD = 1.02$), $t (88) = 2.33$, $p = 0.022$. Across the whole sample, SRHI score at follow-up showed significant (Spearmans) correlations with both diary chocolate consumption ($r = .21$, $p = <.05$) and chocolates from the bag ($r = .20$, $p = <.05$) indicating that lower levels of automaticity were associated with less chocolate consumption. [18]

To explore the association between chocolate consumption (number of chocolates eaten from the bag and other chocolates consumed) and automaticity scores at baseline, a Spearmans r correlation test were performed. A non-parametric test was used due to scatter plots showing outliers causing the data to be skewed.

Mediators (baseline)	**Bagged chocolates (N=134)**	**Other chocolates (N=135)**
SRHI	0.092	0.102

Table 3.7 Spearmans r correlation showing the relationship between measures of chocolate consumption and baseline self-report scores of habitual behaviour (SRHI).

Table 3.7 shows that there were no significant correlations between automaticity and chocolate consumption.

[18] Full mediation analysis was not conducted because the group by time effect on automaticity only showed a 'trend' towards significance. As a result of this, the initial criteria were not meant, rendering subsequent analyses redundant. It was therefore concluded that true mediation could not be claimed.

3.3.4.2 Predicted mediator 2: Self-control

The section explored the pre-stated hypothesis that acceptance works by freeing up self-control resources that would otherwise have been used for regulating chocolate cravings. If true, it was expected that those in the acceptance group would show increased self-control ability (as measured by the hand-grip task) relative to the relaxation control group.

3.3.4.2.1 Calculating self-control by comparing the overall hand-grip score at session one with the overall hand-grip score at session two.

It was predicted that grip time for time 2 (T2) at baseline would be shorter compared to time 1 (T1) in the same session due to ego depletion. Overall grip time at follow-up was however predicted to be longer for each group compared to overall grip time at baseline due to practice effects. Acceptance was hypothesised to positively influence self-control. It was therefore predicted that the acceptance group would be subject to less ego depletion (i.e. there would be less of a time difference between hand-grip T1 and hand-grip T2 at follow-up) compared to the control group. This prediction was based on the assumption that practicing the acceptance strategy would be more beneficial to improving self-control given that participants in this group would have exercised 'sitting with difficult situations' for five-days previously. Self-control, as measured by hand-grip performance in the current study, may become increasingly both mentally and physically 'difficult' as the grip time increased and therefore become a situation which is difficult or uncomfortable to remain in.

To investigate the above hypothesis, the mindfulness group (acceptance) were compared individually with the control group. A measure of self-control was achieved by subtracting the second hand-grip (T2) score from the first hand-grip (T1) score at session one (S1) and session two (S2), leaving a single hand-grip measure for both baseline and follow-up. A positive overall score would suggest that the hand-grip was held for a shorter amount of time at T2 compared to T1 of the same session. A negative overall score would suggest that the hand-grip was held for a longer amount of time at T2 compared to T1 of the same session.

	Hand-grip (S1)		Hand-grip (S2)		Difference S2-S1	
	Mean	SD	Mean	SD	Mean	SD
Acceptance (n=45)	16.38	58.02	10.97	33.71	5.41	39.30
Control (n=45)	6.64	37.17	7.33	22.21	-0.68	35.15

Table 3.8 Comparison of mean hand-grip times (and SDs) across the two groups (mindfulness [acceptance] and control [relaxation]) at baseline and follow-up.

A 3x2 mixed ANOVA with group (acceptance and control) and time (baseline, follow-up) as the independent variables and self-control as the dependent variable was conducted. The results showed no significant main effect of time, $F(1, 132) = 0.480$, $p = 0.490$, $\eta_p^2 = 0.004$, or group, $F(1, 132) = 0.609$, $p = 0.545$, $\eta_p^2 = 0.009$. Furthermore, no significant interaction was found between group and time, $F(2, 132) = 2.129$, $p = 0.123$, $\eta_p^2 = 0.031$. These results suggest that, overall, participants in both the mindfulness and the control groups scored similarly on the hand-grip task. The mean findings are however beginning to show a trend in support of the pre-stated hypothesis for the acceptance group, despite the differences failing to reach statistical significance.

3.3.4.2.2 Comparing baseline self-control hand-grip scores with chocolate consumption measures.

This section correlates (across the whole sample) the predicted mediator, self-control scores and chocolate consumption in order to identify any association between these variables. Significant negative correlations were expected if self-control was associated with chocolate consumption.

Spearmans r correlation tests showed there was no significant correlation between baseline self-control hand-grip scores and either measure of chocolate consumption (chocolates from the bag [n=134], r = 0.000, other chocolates [n=135], r = 0.038).

3.3.5 Additional hypothesised mediators: Self-report measures of mindfulness, defusion and acceptance (Aim 5)

The following analyses relate to aim 5 of the current study. This aim explored secondary mediators (as measured by self-report questionnaires) in order to identify how the cognitive defusion and acceptance strategies bring about their effects.

This section first compares the scores of the predictor mediators between the cognitive defusion, acceptance and control groups at baseline and follow-up. The change in mediator scores was calculated by subtracting baseline scores from follow-up scores for each individual mediator. Secondly, the predicted mediators (mindfulness, defusion and acceptance and awareness scores) at baseline were correlated (across the mindfulness and non-mindfulness samples) with the measures of chocolate consumption (chocolates from the bag and other chocolate) to identify any association between these variables.

	Baseline (S1)			Follow-up (S2)			Difference (S1-S2)		
	Defusion	**Acceptance**	**Relaxation**	**Defusion**	**Acceptance**	**Relaxation**	**Defusion**	**Acceptance**	**Relaxation**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**
FFMQ - nonjudge	2.91 (0.94)	3.16 (0.79)	3.24 (0.82)	3.02 (0.78)	3.36 (0.80)	3.41 (0.84)	0.11 (0.65)	0.19 (0.67)	0.17 (0.45)
FFMQ - nonreact	3.00 (0.65)	3.05 (0.67)	3.23 (0.63)	3.10 (0.68)	3.14 (0.63)	3.13 (0.60)	0.10 (0.53)	0.09 (0.51)	-0.09 (0.49)
PHLMS - awareness	36.60 (4.72)	34.31 (5.98)	35.60 (5.79)	35.73 (4.88)	33.60 (6.08)	35.33 (6.09)	-0.87 (4.25)	-0.71 (3.20)	-0.27 (4.75)
PHLMS - acceptance	33.84 (7.28)	32.89 (7.79)	33.24 (7.06)	34.00 (7.10)	30.20 (7.73)	32.02 (5.83)	0.16 (6.28)	-2.69 (4.95)	-1.22 (4.45)
Experiences	33.40 (6.00)	32.80 (6.40)	35.27 (6.14)	36.24 (6.78)	34.82 (6.47)	36.78 (5.43)	2.84 (6.26)	2.02 (4.68)	1.51 (4.26)
FAAQ – total	38.31 (7.49)	39.11 (8.34)	40.44 (7.61)	41.84 (6.79)	43.38 (7.45)	42.67 (5.93)	3.53 (6.80)	4.27 (7.09)	2.22 (5.46)
FAAQ - willingness	24.93 (4.79)	25.24 (4.87)	25.91 (4.44)	29.18 (5.46)	28.31 (4.94)	28.84 (4.08)	4.24 (5.31)	3.07 (5.49)	2.93 (3.85)
FAAQ - acceptance	13.38 (5.89)	13.87 (5.29)	14.53 (4.66)	12.67 (4.22)	15.07 (5.04)	13.82 (4.57)	-0.71 (4.82)	1.20 (4.14)	-0.71 (4.04)

Table 3.9 Group differences (cognitive defusion, n=45, acceptance, n=45, control, n=45) between predictor mediator scores at baseline and follow-up.

A series of 3x2 mixed ANOVAs with group (cognitive defusion, acceptance and control) and time (baseline, follow-up) as the independent variables and mediator scores as the dependent variables were conducted. For the FFMQ-nonjudge variable, a significant effect of time was found, $F(1, 132) = 9.496$, $p = 0.003$, $\eta_p^2 = 0.67$. However, no significant effect of group, $F(1, 132) = 2.818$, $p = 0.063$, $\eta_p^2 = 0.41$, or time-group interaction, $F(2, 132) = 0.211$, $p = 0.810$, $\eta_p^2 = 0.003$ was evident. For the FFMQ-nonreact variable, no significant effect was shown for either time, $F(1, 132) = 0.973$, $p = 0.414$, $\eta_p^2 = 0.005$, group, $F(2, 132) = 0.553$, $p = 0.576$, $\eta_p^2 = 0.008$, or time-group interaction, $F(2, 132) = 2.033$, $p = 0.135$, $\eta_p^2 = 0.03$. Similarly, non-significant findings were found for the variable, PHLMS-awareness; time, $F(1, 132) = 3.008$, $p = 0.085$, $\eta_p^2 = 0.02$, group, $F(2, 132) = 2.103$, $p = 0.126$, $\eta_p^2 = 0.03$ and time-group interaction, $F(2, 132) = 0.257$, $p = 0.774$, $\eta_p^2 = 0.004$. However, for the PHLMS-acceptance variable, a significant effect of time, $F(1, 132) = 7.574$, $p = 0.007$, $\eta_p^2 = 0.05$, and a significant time-group interaction, $F(2, 132) = 3.259$, $p = 0.042$, $\eta_p^2 = 0.05$ was found. No significant effect of group was evident, $F(2, 132) = 1.439$, $p = 0.241$, $\eta_p^2 = 0.02$. A series of three repeated-measure t-tests showed significantly greater reduction in self-reported mindfulness at follow-up compared to baseline in the acceptance group, $t(44) = 3.645$, $p = 0.001$. No significant differences in mindfulness scores were however found between baseline and follow-up in either the defusion group, $t(44) = 0.166$, $p = 0.869$, or the relaxation-control group, $t(44) = 1.842$, $p = 0.072$.

Significant effects of time were also found for the measures of defusion (experiences questionnaire), $F(1, 132) = 23.089$, $p = 0.001$, $\eta_p^2 = 0.15$, food acceptance and awareness, FAAQ-sum, $F(1, 132) = 35.746$, $p = 0.001$, $\eta_p^2 = 0.21$, and FAAQ-willingness, $F(1, 132) = 64.616$, $p = 0.001$, $\eta_p^2 = 0.33$. No significant effects of group, or significant time-group interactions were found for any of these measures (experiences; group, $F(2, 132) = 1.721$, $p = 0.183$, $\eta_p^2 = 0.25$, time-group, $F(2, 132) =- 0.771$, $p = 0.465$, $\eta_p^2 = 0.01$, FAAQ-sum; group, $F(2, 132) = 0.638$, $\eta_p^2 = 0.01$, $p = 0.530$, time-group, $F(2, 132) = 1.145$, $p = 0.321$, $\eta_p^2 = 0.02$, FAAQ-willingness; group, $F(2, 132) = 0.245$, $p = 0.785$, $\eta_p^2 = 0.004$, time-group, $F(2, 132) = 0.962$, $p = 0.385$, η_p^2

= 0.01). Furthermore, no significant effect of either time, $F(1, 132) = 0.039$, $p = 0.843$, $\eta_p^2 = 0.00$, or group, $F(2, 132) = 1.314$, $p = 0.272$, $\eta_p^2 = 0.02$ was found for FAAQ-acceptance. However, the interaction between time and group almost reached statistical significance, $F(2, 132) = 2.898$, $p = 0.059$, $\eta_p^2 = 0.04$. A series of three repeated-measure t-tests showed no significant improvements in self-reported acceptance of motivations to eat (i.e. cravings) in the defusion group or the relaxation-control group at follow-up compared to baseline (respectively; t (44), 0.990, p = 0.328; t (44), 1.180, p = 0.244). Differences in acceptance scores at follow-up compared to baseline for the FAAQ-acceptance measure were however bordering on statistical significance in the acceptance group, t (44) = 1.943, p = 0.058.

To explore the association between chocolate consumption (number of chocolates eaten from the bag and other chocolates consumed) and mediator scores at baseline, Spearmans r correlation test were performed. A non-parametric test was used due to scatter plots showing outliers causing the data to be skewed.

Mediators (baseline)	Bagged chocolates (N=134)	Other chocolates (N=135)
FFMQ-nonjudge	-0.058	-0.069
FFMQ-nonreact	0.040	0.102
PHLMS-awareness	-0.022	-0.012
PHLMS-acceptance	0.059	0.057
Experiences	0.065	0.087
FAAQ-sum	-0.012	-0.014
FAAQ-willingness	0.029	-0.039
FAAQ-acceptance	-0.043	-0.002

Table 3.10 Spearmans r correlations showing the relationship between measures of chocolate consumption and baseline self-report scores of mindfulness (FFMQ and PHLMS), defusion (Experiences) and acceptance and awareness (FAAQ).

Table 3.10 shows that there were no significant correlations between any of the predicted mediators and chocolate consumption.

3.3.6 Differences in the amount of chocolate consumed at the taste-task between mindfulness and non-mindfulness groups (Aim 6)

The following analyses relate to aim 6 of the current study. This aim tested for any behavioural rebound (as measured by a post-study taste-task) effects between the groups.

	Taste-task			
	Mean	SD	Minimum	Maximum
Defusion (n=45)	2.27	2.96	0.00	13.00
Acceptance (n=45)	3.58	3.32	0.00	15.00
Relaxation (n=45)	3.80	4.62	0.00	21.00

Table 3.11 Descriptive statistics for the number of chocolates eaten across the three groups (cognitive defusion, acceptance, and control).

A one-way AVOVA however revealed no significant group (cognitive defusion, acceptance, control) difference in the amount of chocolates consumed at the taste-task, $F(2, 134) = 2.254$, $p = 0.109$ (defusion – relaxation, cohen's $d = -0.39$, acceptance – relaxation, cohen's $d = -0.05$).

Mann-Whitney U tests revealed there was no significant difference between the number of chocolates eaten by the cognitive defusion and control groups ($z = -1.683$, $p = 0.092$) or between the acceptance and control groups ($z = -0.428$, $p = 0.669$). A significant difference was however found in the amount of chocolate consumed at the taste-task between the two mindfulness groups ($z = -2.188$, $p = 0.029$). The mean values show that the acceptance group ($M = 3.58$) consumed more chocolates than the cognitive defusion group ($M = 2.27$). Thus the reduced chocolate consumption in the defusion group did not appear to result in a behavioural rebound effect.

3.3.7 Secondary investigations of the data

3.3.7.1 Strategy adherence

The number of times the taught strategy (cognitive defusion, acceptance or relaxation) was used in relation to the number of chocolate cravings experienced over the five-day period was calculated for each group.

	Defusion (n=45)	**Acceptance (n=45)**	**Relaxation (n=45)**
Sometimes	20.0	20.0	38.0
Nearly always	60.0	51.0	51.0
Always	20.0	29.0	11.0

Table 3.12 Percentage of strategy used in the mindfulness and non-mindfulness groups.

Table 3.12 shows that the majority of participants (60-80%) in the three groups used their taught strategy 'nearly always' or 'always' when they experienced a chocolate craving. Mean ratings of strategy use were significantly higher amongst those in the acceptance group ($M = 3.09$, $SD = 0.70$), compared to the control group ($M = 2.73$, $SD = 0.65$), $t(88) = 2.49$, $p = 0.015$. Differences between the defusion group ($M = 3.00$, $SD = 0.64$) and the control group approached significance; $t(88) = 1.96$, $p = 0.054$, but there were no significant differences between the acceptance and defusion groups, $t(88) = 0.628$, $p = 0.532$.

3.3.7.2 Study's helpfulness at reducing chocolate consumption.

All participants were asked to rate how helpful they found their participation in the study in terms of reducing their chocolate consumption using a five-point Likert scale (1 = not at all helpful, 5 = extremely helpful).

	Defusion (n=45)	Acceptance (n=45)	Relaxation (n=45)
Not at all helpful	0.0	4.0	2.0
A little helpful	4.0	7.0	20.0
Moderately helpful	36.0	38.0	42.0
Very helpful	51.0	47.0	34.0
Extremely helpful	9.0	4.0	2.0

Table 3.13 Percentage of reported helpfulness of study participation in reducing chocolate consumption by the mindfulness and non-mindfulness groups.

Statistically, no significant differences in the reported helpfulness of the study was found between either the defusion and acceptance groups, t (88) = 1.465, p = 0.146 or the acceptance and relaxation groups, t (88) = 1.453, p = 0.142. A significant different was however reported between the defusion and relaxation groups, t (88) 3.109, p = 0.003. The means indicated that the defusion group (M = 3.64, SD = 0.71) found their participation in the study to reduce their chocolate consumption more helpful than the control group (M = 3.13, SD = 0.84).

3.3.7.3 Suspicion probe

In order to check level of suspicion about the study, participants were asked to (1) guess which group (intervention or control) they thought they had been assigned to, (2) say if they noticed anything unusual about the bagged chocolates, (3) recall how many individual chocolates were given to them in the bag and (4) if they had any ideas about what the study aimed to explore in addition to helping them reduce chocolate consumption.

	Defusion (n=45)	Acceptance (n=45)	Relaxation (n=45)
Guessed group (% correct)	89.0	76.0	62.0
Unusual about chocolates (% yes)	0.0	0.0	0.0
Number in the bag (% correct)	24.0	27.0	7.0
Ideas about study aims (% yes)	47.0	29.0	36.0

Table 3.14 Suspicion probe percentage scores across the mindfulness and non-mindfulness groups.

To explore possible placebo effects, the proportion of participants who believed they had been allocated to an experimental group was compared across the three conditions. Table 3.14 shows that a greater number of participants in the control group believed that they were in the intervention condition compared to the number of participants in the mindfulness groups who believed that they were in the control condition. A chi-squared analysis statistically supported the observed differences between the groups, $\chi^2(2, N = 135) = 28.79$, $p = 0.001$. Thus whilst it is not possible to entirely rule out placebo effects, had these had a significant impact one would have also expected reduced chocolate consumption in the acceptance group relative to the control group. As shown in Table 3.3, this was not consistently the case.

All participants in the three groups failed to notice anything unusual about the chocolates in the bag (i.e. they failed to notice the distinctive mark). The majority of participants in the mindfulness groups and the control group incorrectly reported the number of chocolate in the bag given to them at baseline. Participants were told by the researcher that the bag contained 12 chocolates, which was incorrect (the bag contained 14 chocolates). This finding therefore suggests that only a small percentage of the sample actually paid conscious attention to the bag of chocolates by counting the chocolates for themselves. Fewer participants in the control group (7%) compared to the mindfulness groups (defusion = 24%, acceptance = 27%) guessed the number of bagged chocolates correctly. A chi-square test revealed that the percentage of participants who correctly reported the number of chocolates in the bag did significantly differ between the groups, $\chi^2 (2, N = 135) = 6.955$, $p = 0.031$.

Table 3.14 also shows that approximately a third in the acceptance and control groups made some attempt to identify what the study was investigating in addition to what they already knew. This figure increased to nearly half for participants in the cognitive defusion group. None of the sample made suggestions which were completely accurate (i.e. suggested ideas which were directly related to the study's hypotheses). Most were either related to the information given to participants at the start of the study (e.g. effectiveness of the strategy and resisting chocolate temptation) or unrelated to the study (e.g. nutrition and participants' honesty). Ten participants did however suspect that the study was a measure of willpower or self-control. One participant also correctly identified that the study was comparing changes in questionnaire scores from baseline to follow-up. As previously stated, whilst it is not possible to entirely rule out placebo effects, had these had a significant impact one would have also expected reduced chocolate consumption in the acceptance group relative to the control group. As shown in Table 3.3, this was not consistently the case. A chi-square test revealed that the percentage of participants who made an attempt to guess the study's aims did not significantly differ between the groups, $\chi^2 (2, N = 135) = 3.113$, $p = 0.211$.

3.3.7.4 Effects of mindfulness (cognitive defusion and acceptance) on chocolate consumption when also practiced in other situations.

To identify if the participants applied their taught strategy to help resist temptation in other situations (i.e. in addition to helping to resist eating chocolate) a simple yes/no measure was taken. The researcher did not tell participants to either apply, or not apply, the strategy to any other tempting situations. If the strategy was applied to other situations, the participant had done so of their own accord. For the cognitive defusion group (n = 45), 23 participants (51%) and the acceptance group (n = 45), 27 participants

(60%) said that they did apply the strategy to other situations. It was speculated that there would be a greater decrease in the amount of chocolate consumed by the mindfulness groups when the strategy was also applied to other situations compared to those who only used the strategy to resist eating chocolate. Applying the strategy to other situations was believed to reduce chocolate consumption due to participants have a better understanding of the strategy and an increased practice of using it.

	Strategy applied to other situations					**Strategy not applied to other situations**				
		Bagged chocolates		**Other chocolates**			**Bagged chocolates**		**Other chocolates**	
	n	Mean	SD	Mean	SD	n	Mean	SD	Mean	SD
Defusion	23	0.04	0.21	19.60	37.72	22	0.00	0.00	6.55	20.13
Acceptance	27	0.19	0.68	51.89	133.4	17	0.41	1.28	42.72	55.49

Table 3.15 Comparison of mean (and SDs) chocolate consumption across the groups (mindfulness and controls) depending on whether the strategy was applied to other situations.

An independent t-test using the mindfulness groups only (n = 90; applied to other situations, n = 50, not applied to other situations, n = 40) was carried out to identify if applying the mindfulness strategy to other situations would show a significant group difference in the amount of chocolate consumed. No significant difference was found between the groups (cognitive defusion and acceptance) for either measure of chocolate consumption; chocolates from the bag, t (87) = 0.405, p = 0.686, or other chocolates, t (88) = 0.825, p = 0.412.

3.3.7.5 Group differences in the perceived effectiveness of the strategies (cognitive defusion, acceptance, control).

Analysis was carried out to investigate whether one particular strategy was rated more effective at follow-up compared to baseline between the different groups. The baseline measure was obtained by asking the participants at follow-up how effective they thought the strategy would be in helping them to resist eating chocolate when it was first taught to them five-days previously.

	n	Effectiveness (S1)		Effectiveness (S2)	
		Mean	SD	Mean	SD
Defusion	45	3.04	1.13	4.13	0.76
Acceptance	45	2.71	1.08	3.82	1.01
Relaxation	45	2.84	1.04	3.40	1.01

Table 3.16 Comparison of mean (and SDs) effectiveness ratings across the three groups (cognitive defusion, acceptance, and control) for the different strategies use at baseline and follow-up.

A 3x2 mixed ANOVA with group (cognitive defusion, acceptance, control) and time (baseline, follow-up) as the independent variables and effectiveness ratings as the dependent variable was carried out. The results showed a significant effect of time, $F(1, 132) = 54.630$, $p = 0.001$, and group, $F(2, 132) = 5.135$, $p = 0.007$. No significant time-group interaction was evident, $F(2, 132) = 2.135$, $p = 0.122$.

Further independent t-tests were performed to identify if the perceived effectiveness of the strategies at baseline was significantly different between the groups (cognitive defusion, acceptance, and controls). The tests revealed no significant difference between effectiveness scores and any of the groups; cognitive defusion and acceptance, $t(88) = 1.433$, $p = 0.155$, cognitive defusion and control, $t(88) = 0.873$, $p = 0.385$, acceptance and control, $t(88) = 0.596$, $p = 0.553$.

3.3.7.5.1 Association between effectiveness scores and chocolate consumption

Baseline effectiveness scores were correlated with both chocolate consumption measures (chocolates from the bag and other chocolate) to investigate if there was any significant association between the variables. Pearson's r correlation tests showed no significant correlations; effectiveness scores and chocolates from the bag, $r = -0.081$, effectiveness and other chocolates consumed, $r = -0.095$. The correlations were however in accordance with the assumption that, the greater the perceived effectiveness of the strategy the less amount of chocolate consumed.

3.3.8 Summary

To summarise, the findings show that the practice of the mindfulness strategy, cognitive defusion, was effective at reducing the amount of chocolate consumed over a five-day period compared to the practice of the non-mindfulness strategy, relaxation. Also, there was preliminary support for the theory that the defusion strategy works by interrupting automatic links between specific thoughts and chocolate consumption. This was evident by those who employed the defusion strategy experiencing relatively greater reductions in the extent to which chocolate consumption was automatic. Reductions in automaticity are also significantly associated with lower levels of chocolate consumption. There were no significant differences in chocolate consumption between the acceptance and control groups. A trend was however beginning to appear in the findings indicating that acceptance maybe positively associated with the mediator, self-control. There was no evidence of behavioural rebound effects at the end of the abstinence period.

3.4 Discussion

3.4.1 Summary

The current study had six aims. Aims 1 and 3 explored whether two mindfulness strategies (cognitive defusion and acceptance respectively) were helpful for changing the self-control related health behaviour; reducing chocolate consumption. Aims 2 and 4 explored how these strategies brought about their effects over a five-day period. The potential mediators, automaticity and self-control, were investigated. It was hypothesised that if the cognitive defusion and acceptance strategies were effective at helping individuals resist chocolate, lower levels of chocolate consumption would be evident in these two groups relative to the relaxation control group. If cognitive defusion brought about these effects by reducing the extent to which chocolate was consumed automatically, it was also predicted that a reduction in automaticity (as assessed by the SRHI) would be shown amongst those in the cognitive defusion group compared to those in the control group, together with positive correlations between levels of automaticity reported at follow-up and amount of chocolate consumed. Likewise, if acceptance brought about its effects by increasing the availability of self-control resources (as assessed by the hand-grip task), it was predicted that an increase in self-control ability would be shown in the acceptance group relative to the control group, together with negative correlations between self-control ability at follow-up and amount of chocolate consumed. The study further aimed to explore whether the effects of the cognitive defusion and acceptance strategies were mediated by self-reported mindfulness, defusion and acceptance (Aim 5). Finally, for the acceptance and cognitive defusion strategies to have applied utility, the study tested for behavioural rebound effects (Aim 6).

The main findings demonstrated that compared to the control group, those in the cognitive defusion group ate significantly less chocolate from the bag ($p = 0.046$), and less chocolate according to the diary measure ($p = 0.053$). In support of the hypotheses, there was evidence that these changes were brought about by reductions in the extent to which chocolate consumption was automatic. There were no significant differences in chocolate consumption between the acceptance and control groups. The study failed to find any evidence that the cognitive defusion task influenced general levels of mindfulness. There were, however, overall increases in some forms of mindfulness across all groups (non-judging of inner experiences, decentering). The taste-task employed at the end of the requested period of abstinence showed no significant differences in chocolate consumption between the three groups, suggesting an absence of rebound effects amongst the cognitive defusion group. These findings demonstrate the impact of a mindfulness-based strategy (cognitive defusion) on health-related behaviours that require self-control over an extended period and could help individuals eat a healthier diet by reducing the consumption of a high sugar, high fat snack food.

3.4.2 Effects of mindfulness (cognitive defusion and acceptance) on chocolate consumption (Aims 1 & 3)

Chocolate consumption was measured using observations (bagged chocolates) as well as self-report (diary). The results showed that the cognitive defusion task significantly reduced the amount of chocolate consumed by participants outside the laboratory over a five-day period compared to the control group. These findings support previous research such as that by Gifford et al. (2004) who found mindfulness-based interventions, which included defusion strategies, useful to help people abstain or limit the intake of a craved substance. It also supports many other studies which have shown that cognitive defusion is an effective strategy for managing eating behaviours (Forman, Hoffman, McGrath, Herbert, Brandsma & Lowe, 2007; Forman, Butryn, Hoffman & Herbert, 2009; Gregg et al., 2007; Lillis, Hayes, Bunting & Masuda, 2009; Tapper et al., 2009). Although, given that the aforementioned literature typically combines the exploration of the effects of cognitive defusion with other mindfulness-based strategies (e.g. acceptance) it is difficult to conclude the true effectiveness of the defusion strategy, as opposed to mindfulness-interventions more generally. The current study however, via the use of a dismantling design, allowed for cognitive defusion to be explored as an individual strategy. As a result of this, compared to previous research (Forman et al., 2007; Forman et al., 2009; Tapper et al., 2009) the present findings offer a clearer understanding of which mindfulness-based strategies are effective at changing this self-control related health behaviour. It also allows for a definite conclusion to be made about the effectiveness of the defusion strategy whilst offering additional support to Moffitt et al. (2012) who explored the unique effects of cognitive defusion on chocolate consumption. Similarly to Moffitt et al. the current study concludes that cognitive defusion can be a brief and simplistic approach to efficiently manage the consumption of unhealthy snack foods.

In contrast to the cognitive defusion strategy, significantly lower levels of chocolate consumption were not evident amongst those practicing the acceptance strategy. The findings suggest that the participants accepted the urge to eat chocolate but then gave into it. The current study therefore fails to support existing literature which showed that accepting internal experiences is associated with improved health behaviour (Ostafin & Marlatt, 2008). In contrast to the current study however, past research has focused mainly on limiting alcohol consumption and pain reduction (Geiser, 1992; Hayes et al., 1999; Ostafin & Marlatt, 2008). Thus, whilst acceptance strategies may be effective for changing those specific self-control related health behaviours, its effectiveness may not have the capability of being generalised to other health behaviours, including resisting chocolate temptation. The current finding also fails to support studies showing that mindfulness-based acceptance strategies are effective for the treatment of dysfunctional eating behaviours (e.g. binge eating) (Anderson & Simmons, 2008, Baer et al., 2005, Juarascio et al., 2010, Kristeller et al., 2006; Safer, Telch & Chen, 2009). It may however be unfair to discuss the current findings in relation to these aforementioned studies given that the current sample did not have eating behaviours that would be deemed as *dysfunctional.* Rather, the current sample had *unhealthy* eating behaviours (i.e. overconsumption of chocolate) and this difference may have had a significant effect on the findings. Furthermore, contrary to the current study, the previously discussed research (e.g. Geiser, 1992; Hayes et al., 1999; Kristeller et al., 2006) failed to identify the effects of acceptance as a single mindfulness strategy which also may account for the null results. It is also possible that in the present study, participants in the acceptance group simply did not receive sufficient teaching and/or practice at the strategy to make it effective (see section 3.4.3.2 for a more comprehensive discussion of this point).

3.4.3 Association between predictor mediators and chocolate consumption (Aims 2 & 4)

3.4.3.1 Automaticity

The current study hypothesised that cognitive defusion may work by interrupting automatic links between specific chocolate-related thoughts (e.g. 'I need something sweet') and chocolate consumption, thus breaking the habit of automatic responding. The results provided support for the pre-stated hypothesis since those who employed the defusion strategy experienced greater reductions in the extent to which chocolate consumption was automatic compared to the acceptance and relaxation-control groups. Across all three groups lower levels of automaticity at follow-up were also significantly associated with lower levels of chocolate consumption, providing further support for the view that targeting snacking automaticity may be a helpful behaviour change strategy.

It is possible that the cognitive defusion strategy reduced automaticity via the processes of vigilant monitoring (i.e. paying increased attention to internal thought-cues to be able to inhibit the behaviour) and counter-conditioning (i.e. replacing the cued response with another more helpful response) (Papies, Stroebe & Aarts, 2008; Prochaska et al., 1988; Sun et al., 2007). Vigilant monitoring was used to help the participants to identify when the behaviour (i.e. eating chocolate) was cued, and counter-conditioning was used to substitute the unwanted behaviour (i.e. eating chocolate) for the behaviour, describing their thoughts. In relation to the latter point, it is arguable that, as well as the defusion strategy, the acceptance and relaxation control strategies also used these processes (vigilant monitoring and counter-conditioning). Thus, whilst this explanation of the findings may account for why an overall reduction in automaticity scores was found across all three groups, it fails to explain why the defusion strategy was found to be more effective. It therefore appears that vigilant monitoring and counter-conditioning cannot be responsible for the differences in the amount of chocolate consumed between the groups. Rather, another factor may be having an effect. One such possibility is that the defusion strategy works by increasing the accessibility of goals (i.e. strengthening links between the cue and competing goals; Neal, Wood, Labrecque & Lally, 2012). Further investigation of this is advised.

3.4.3.2 Self-control

It was predicted that acceptance strategies may work by helping individuals resist chocolate by freeing up self-control resources (as assessed by the hand-grip task) that would otherwise have been used for regulating chocolate cravings. Despite equivalent levels of strategy adherence to the cognitive defusion, those in the acceptance group failed to show a reduction in chocolate consumption relative to controls. The findings therefore do not support previous studies which have shown that the practice of mindfulness-based acceptance counteracts the deleterious effects of self-control depletion (Alberts et al., 2012; Masedo & Esteve, 2007). It is possible that in the present study participants simply did not receive sufficient practice at this strategy to make it effective. Schweitzer & Sulzer-Azaroff (1988), for instance, suggests that whilst it is possible to improve self-control capacity with exercise, this process does require time. Muraven et al. (1999) also reported that individuals who exerted self-control over their eating habits performed better on an acceptance-based task (over-riding physical discomfort) but only after a period more than twice the length of the current study (two weeks). In further support of this, Alberts et al. (2010) showed that food cravings amongst overweight and obese individuals were only reduced after an acceptance based intervention lasting seven weeks. Other studies conducted over shorter periods have also shown increases in food cravings in response to acceptance strategies (e.g. Hooper et al., 2012).

It is however important to note that participants in the acceptance condition in the current study did not show a significant increase in chocolate consumption relative to the control group over the five-day period. Thus any increase in chocolate cravings experienced by this group did not appear to be associated with increased consumption. This is relevant since one of the aims of mindfulness strategies is to reduce the extent to which individuals act upon their thoughts and feelings, thus making it possible to resist chocolate *despite* cravings. Contrary to the possibility that in the present study participants simply did not receive sufficient practice at this strategy to make it effective, Levitt et al. (2004) reported significant benefits of the acceptance strategy in changing self-control related health behaviours even after the task has been practiced very briefly (10 minutes). Although, Levitt and colleagues tested participants with panic and anxiety disorders using a self-control test, namely exposure to CO_2. This may have been perceived as threatening to the individual's general health or well-being if the task caused them to experience a panic or anxiety attack. The current study used a non-clinical sample and a self-control task (hand-grip) which may not have been perceived as threatening (i.e. not performing well on the hand-grip task may not have been associated with an increased temptation for chocolate). Consequently, the participants in Levitt's study may have tried to utilise the acceptance-strategy in a more effortful manner than those in the current study, thus demonstrating the effects of the acceptance strategy more clearly.

An alternative explanation for the null findings is that acceptance strategies are not suitable for enhancing health-related behaviours that require self-control. One reason is that acceptance requires the participant to focus on their feelings. Paradoxically, since feelings are linked to the stimuli the participant is trying to resist, this may actually make self-control more difficult (Metcalfe & Mischel, 1999; see also Kavanagh et al., 2005). It is possible that acceptance strategies may be more helpful where the participant is trying to create new habits (e.g. participate in physical activity) rather than break old ones (van't Riet et al., 2011). It is also a feasible suggestion that the participants simply did not understand the 'urge surfing' metaphor (Marlatt & Kristeller, 1999). In the current study participants were taught the strategy at the baseline session and then left to implement this strategy over the five-day period without any reminders. Research has however demonstrated the effectiveness of this strategy when the concept of 'urge surfing' was repeated throughout the intervention phase (Brown & Marlatt, 2009). It is therefore considered worthwhile to re-run the present study but to provide participants with repeated instruction (e.g. emails sent throughout the study period) of the taught strategy. Future research may also consider exploring the effect of alternate metaphors to help reduce chocolate consumption (e.g. 'leaves on the stream' Harris, 2009).

3.4.4 Other self-report mediators (Aim 5)

In the current study a number of questionnaires were included to identify general impacts of the manipulations on mindfulness (Five Facet Mindfulness Questionnaire, FFMQ, Baer et al., 2006; Philadelphia Mindfulness Scale, PHLMS, Cardaciotto et al., 2008; Experiences Questionnaire, EQ, Fresco et al., 2007; Food Acceptance and Action Questionnaire, FAAQ, Juarascio et al., 2011). It was predicted that if the cognitive defusion and acceptance manipulations resulted in general increases in mindfulness, significantly higher self-reported mindfulness scores (as assessed by the FFMQ PHLMS, EQ and FAAQ) would be evident between baseline and follow-up in these groups compared to the control group. Contrary to prediction, the study failed to find any evidence that the cognitive defusion task or the acceptance task influenced general levels of mindfulness. Given that the tasks were specific to chocolate consumption it is perhaps not surprising that the effects did not generalise beyond this. There were, however, overall increases in some forms of mindfulness across all groups (non-judging of inner experiences, decentering). It is possible that these effects occurred as a result of participants monitoring their chocolate consumption by recording what they ate in their diary. It would be interesting to explore this in future research. It should also be noted that these increases were coupled by an overall reduction in acceptance of food cravings across all three groups and a reduction in acceptance in the acceptance group only. Again, whether these are temporary or more long-term effects of monitoring and/or trying to resist chocolate would also need to be explored in future studies. All four mindfulness questionnaires have however been reported to have high internal consistency (i.e. test re-test reliability) (FFMQ, Veehof et al., 2011; PHLMS, Cardaciotto, 2005; EQ, Carmody, Baer, Lykins & Olendzki, 2009; FAAQ, Juarascio et al., 2011). Thus, the reliability of the measures neither explains the significant changes in these measures across all groups nor indicates whether these changes are related to the study manipulations.

3.4.5 Taste-task (Aim 6)

The current study tested for behavioural rebound by measuring the amount of chocolate consumed by the participant in the laboratory following the five-day period of abstinence. The findings showed no evidence of behavioural rebound effects, thus offering support to previous research recently conducted by Hooper et al. (2012). In view of this finding, it was concluded that amongst those in the cognitive defusion group, participants did not appear to compensate for their chocolate abstinence by increasing their intake later on, thus has applied utility. This finding suggests that cognitive defusion is more effective at changing the self-control related health behaviour compared to other strategies (e.g. thought suppression and cognitive restructuring) which have been widely criticised for producing rebound effects (Forman et al., 2013; McNally & Ricciardi, 1996; Salkovskis & Campbell, 1994).

3.4.6 Limitations

It is important to acknowledge the limitations of the current study. One such limitation is that, although differences between the cognitive defusion and control groups for the bagged chocolate reached statistical significance, group differences for the diary measure showed only a trend towards significance ($p = 0.053$). As a result, the findings should be treated with caution. Another limitation is that, whilst the hand-outs given to the intervention and control groups were matched as far as possible, in order to accurately reflect the cognitive defusion and acceptance strategies, and the ways in which they intend to be used in practice, differences were inevitable. Indeed, one potentially important difference is that in the five minute practice exercise only participants in the cognitive defusion group were asked to think about recent plans and thoughts in relation to chocolate (or to imagine future thoughts if no such plans came to mind). Participants in the control group were instead asked to think about a recent situation in which they had felt stressed (or to imagine future stressful events if no recent events came to mind). Participants in the acceptance group were asked to visualise their favourite type of chocolate in front of them. Thus it is possible that being asked specifically to think about chocolate-related thoughts at baseline is what brought about the lower levels of chocolate consumption in the cognitive defusion group, rather than the cognitive defusion strategy that was employed over the five-day period. Arguably, thinking about chocolate-related thoughts is an important component of the cognitive defusion strategy since it is one way in which the individual may be encouraged to see themselves as different from their thoughts. It is however possible that thinking about chocolate-related thoughts also prompted participants to engage in action planning in relation to their chocolate consumption. Given the evidence for the efficacy of action planning for behaviour change (e.g. Gollwitzer & Sheeran, 2006) this may in turn have been responsible for the reduced chocolate consumption. Since action planning can impact upon habits (e.g. Holland et al., 2006) it might also account for the reduced automaticity amongst the cognitive defusion group in this study. It would be helpful to include an additional control in future studies to help rule out this possibility. It would also be informative to conduct additional studies that control for different aspects of the cognitive defusion strategy to help further pinpoint the exact elements that help bring about change, versus those elements that may be less important.

Additionally, since the diary measure included in the study relied on self-report, it is possible that it was subject to social desirability bias. Although the participants were blind to group allocation, therefore such effects should have been minimal. Furthermore, in contrast to this criticism, previous research has demonstrated the successful use of diaries to measure eating behaviour (Gersovitz et al., 1978) and high validity of such measures when tested empirically (Schlundt, 1995). It is difficult to avoid self-report measures when assessing dietary intake, so the inclusion of the bagged chocolate measure in this study adds weight to the findings. Another shortcoming of the present study may be its limited generalisation or interpretability of the effects. The current study was conducted on a group of adults who were motivated to reduce their chocolate consumption. It is unclear whether the cognitive defusion strategy would be as effective in less motivated people. Furthermore, whilst it is not outside the realm of possibility that demand effects could have driven some of the study's effects, it is believed that this is highly unlikely. Participants, for instance, were probed for suspicion at the end of the study. Very few participants expressed suspicion of what the hypotheses were, suggesting that there is a low likelihood of demand effects.

Finally, the procedure of measuring self-control via the hand-grip task may also be considered a limitation of the current study. In an attempt to accurately record the length of time the hand-grip was squeezed, a single piece of paper was placed in between the handles to signal release of pressure causing the paper to fall. Participants were also instructed to hold the hand-grip in an upright position (e.g. not tilted to the side so that the paper would be supported by the side of the hand-grip). Despite these instructions, some participants had to be reminded to adhere to them whilst completing the task. As a result of this, slight movement of the paper signalling a release of grip was not always immediately detected by the researcher. This brings into question the reliability of using the hand-grip to measure self-control capacity (Muraven et al., 1998). Future studies may therefore benefit from using alternate measures of self-control capacity other than physical endurance (e.g. delayed outcomes or persistence at unsolvable anagram tasks, see Fujita, Trope, Liberman & Levin-Sagi, 2006).

3.4.7 Future research

The findings observed in relation to practicing the cognitive defusion strategy and improvements in reducing chocolate consumption is limited to the conclusion that there were significant group differences, given that a baseline measure of chocolate consumption was not taken. Including a baseline measure of chocolate consumption in future replications of the current study would help explore whether cognitive defusion also significantly reduces chocolate consumption relative to previous levels of chocolate intake. Such findings may then transfer to broader weight management attempts and also be extended to other health-related situations that require self-control, such as smoking cessation, alcohol consumption and safe sex. To verify this, in addition to including a baseline measure of chocolate consumption, future research would also need to include a measure of weight loss, and replicate the study using different sample groups. Furthermore, despite the current findings suggesting that cognitive defusion works by reducing automaticity, future research would benefit from exploring other measures of automaticity (e.g. lexical decision tasks, Webb & Sheeran, 2007) alongside other potential mediators (Neal et al., 2012).

Given the brevity of the intervention training in the current study, the findings for the cognitive defusion strategy are promising. The length of the chocolate challenge (i.e. abstinence period) used in the present study was only five days. Whilst this is an improvement over the 48-hour restriction period employed in similar previous research (e.g. Forman et al., 2007), it is difficult to make conclusions regarding the sustainability or maintenance of any behavioural changes observed. Thus to be confident of the utility of the cognitive defusion strategy for intervention, its effects would need to be demonstrated over a longer period. Although, prior to this, it is advised that a replication of the study using only the cognitive defusion strategy and control strategies is conducted to validate the effectiveness of this strategy in terms of resisting chocolate temptation. For instance, before the study is extended, certain weaknesses of the study's design could be addressed. One study weakness was the choice of measures used to assess automaticity. In the current study, the SRHI failed to measure whether habits were automatic responses to specific thought cues. Thus, future research could tailor the SRHI to specific chocolate-related thoughts reported by the participants rather than to eating chocolate in general. Another design weakness was the inclusion of only one control group (relaxation). Previous research has shown that simply monitoring behaviour can cause a significant change (Quinn et al., 2010). The diary measure used in the current study required all participants to monitor their eating behaviour and therefore may have been the cause of changes in chocolate consumption. Future studies should include a 'monitoring-only' control group to rule out any possibility that changes in unhealthy eating behaviour were the result of behavioural monitoring.

3.4.8 Conclusion

The current study attempted to identify whether two mindfulness strategies (cognitive defusion and/or acceptance) were helpful for changing the self-control related health behaviour; reducing chocolate consumption, and to understand how they brought about their effects. The findings supported the view that mindfulness-based cognitive defusion has advantages over mindfulness-based acceptance for short-term abstinence from chocolate. The findings also showed the cognitive defusion strategy works by interrupting automatic links between chocolate consumption and thoughts that cue chocolate consumption. Although, given that there is very little prior research exploring the individual effects of cognitive defusion on chocolate consumption (Moffitt et al., 2012) further research is needed to confirm the reliability of these findings. Thus follow-on studies should aim to both replicate and extend the exploration of how cognitive defusion is effective in helping people to resist chocolate temptation. It is believed that the present research highlights the importance of distinguishing between different types of mindfulness strategies and separating out their effects on behaviour. This is important since determining exactly which mindfulness strategies are helpful for which situations should help enhance both the efficacy and cost efficiency of mindfulness-based intervention. This study therefore provides an important step towards acquiring an understanding of which mindfulness strategies help change unhealthy eating behaviour, and identifying how they work.

Using a brief mindfulness-based cognitive defusion strategy to reduce chocolate consumption. A further exploration of effects and mediators.

3.5 Introduction

3.5.1 Purpose of the study

The previous study (Study Two) showed that the practice of the defusion strategy significantly reduced chocolate consumption. The first aim of the current study was therefore to demonstrate the reliability of the previous study by replicating the findings. Study Two also showed support for the hypothesis that cognitive defusion works by interrupting automatic links between chocolate consumption and thoughts that cue chocolate consumption. The second aim of the current study was therefore to further investigate this possibility by exploring the effects of the defusion strategy on measures of automaticity, alongside other potential mediators (strengthening links between the cue and competing goals, Neal et al., 2012; Webb & Sheeran, 2007). The purpose of this was to identify more specifically how cognitive defusion changes the self-control related health behaviour, resisting chocolate. It was predicted that cognitive defusion may work by either (a) reducing automatic links between chocolate-related thoughts and chocolate consumption, and/or (b) increasing the accessibility of competing goals in response to chocolate-related thoughts.

3.5.2 Cognitive defusion reduces automatic links between thoughts and behaviour

It was predicted that the cognitive defusion strategy may reduce chocolate consumption by interrupting a persons' automatic reaction to eat chocolate when experiencing chocolate-related thoughts. It is possible that this was achieved by the defusion strategy teaching individuals to become aware of thought cues and to describe them as 'just thoughts'. As outlined in section 3.1.2.10, there is some indication that mindfulness-based cognitive defusion strategies maybe effective at disrupting automaticity between internal states (e.g. thoughts) and self-control related health behaviours (Bartholow et al., 2000; Ostafin & Marlatt, 2008; Tapper et al., 2009). These findings are however only suggestive and no clear conclusions can be drawn given that cognitive defusion was analysed in conjunction with other mindfulness-based strategies. The previous study (Study Two) was the first to demonstrate the efficacy of the mindbus defusion strategy in breaking existing thought-behaviour responding. In order to test this finding further it was acknowledged that more robust measures of automaticity were needed. The current study therefore utilised Lexical Decision Tasks (LDTs), in addition to modified Self-Report Habit Index (SRHI) measures to explore the hypothesis that cognitive defusion reduces automatic links between chocolate-related thoughts and chocolate consumption. An overview of the new automaticity measures is provided.

3.5.3 New automaticity measures

3.5.3.1 Lexical decision tasks

The lexical decision task (LDT) is the classic and most frequently used task for semantic priming research and was first developed in the early 1970s (Meyer & Schvaneveldt, 1971). The task requires participants to identify letter strings as either words (i.e. found in an English language dictionary) or pronounceable non-words by pressing the corresponding key on a response box. Throughout a sequence of trials, two semantically related stimuli are subsequently presented, though only one (the target) is processed consciously, whereas the other (the prime) is processed unconsciously (Greenwald, Klinger & Schuh, 1995; Jacoby, Lindsay, Toth & Jeffrey, 1992; Reingold & Merikle, 1988). Thus primes are said to be *subliminal* with responses to the prime being deemed 'automatic' (Moors & De Houwer, 2006). The main dependent variable of interest is the difference in speed and/or accuracy between the conditions defined by the prime-target relationship within each trial. Typically, mean reaction latencies (error rates) in related or congruent trials are lower compared with those in unrelated or incongruent trials. Studies using LDTs have found that subliminally presented stimuli have a considerable influence on behaviour (Bargh, Chen & Burrows, 1996; Chen & Bargh, 1997; Dijksterhuis & Bargh, 2001; Greenwald, Draine & Abrams, 1996; Neuberg, 1988; Packard, 1957) although the scientific literature is not wholly consistent. For instance, after examining over 150 articles and 200 academic papers on subliminal priming Pratkanis & Aronson (1992) found no clear evidence of subliminal priming effects.

These negative findings may however be explained by the incorrect use of priming techniques. Strahan, Spencer & Zanna (2002) proposed that subliminal priming will only be effective when used to prime goal-relevant cognitions, thus subliminally priming people with the concept of thirst should activate thirst-related cognitions. However, priming thirst-related cognitions did not always change behaviour. Thus it may be possible that being primed with goal-relevant cognitions will only lead to behavioural change when the individual is motivated to pursue the goal (Strahan et al., 2002). Another possibility why not all priming studies have shown positive results may be because the apparent automaticity of behaviour can be accounted for by different strategic efforts of participants. The increased speed and accuracy of responding may have been due to participants being aware that a prime was followed by a semantically related target. As a result, participants may generate expectations about specific targets appearing after certain primes, and if expected targets appear then they react faster compared to the unrelated trials (Wentura & Degner, 2010). Others however have disputed this claim (Neely, 1997).

Despite the aforementioned criticisms, LDT are deemed by the majority to be highly reliable and valid in semantic priming research and as a measure of automaticity (e.g. Webb & Sheeran, 2007). In view of this, the current study used a specifically designed LDT to further explore how cognitive defusion strategies work by changing unhealthy eating behaviours.

3.5.3.2 Modified self-report habit index

The current study used SRHI measures to explore whether habit strength was a possible moderator between chocolate-related thought cues and chocolate consumption given that; research has shown strong habits to elicit greater behavioural automaticity when in the presence of cues compared to habits of low or moderate strength (e.g. Danner, Aarts & de Vries, 2008; Lally, Van Jaarsveld, Potts & Wardle, 2010). Self-Report Habit Index questionnaires (Verplanken & Orbell, 2003) used in the previous study (see section 3.1.4) measured automaticity by simply asked participants to rate how true each statement was for them in relation to the behaviour 'eating chocolate'. SRHI measures in the current study were however modified in that the participants were asked to rate how true each statement was for them in relation to either the behaviour 'eating chocolate when I need something sweet', 'eating chocolate when I need a treat' or 'eating chocolate when I need an energy boost'. The reason for this was because pilot studies demonstrated that the thought-cues 'need something sweet', 'need a treat' and 'need an energy boost' were most strongly associated with chocolate consumption (see whole of section 3.6 for full details of the pilot studies). It was predicted that this modification to the SRHI measures would allow for a more reliable and sensitive investigation of whether cognitive defusion strategies work by interrupting automaticity links between chocolate-related thoughts and chocolate consumption.

3.5.4 Cognitive defusion increases the accessibility of competing goals in response to chocolate-related thoughts

As an additional possibility to interrupting automatic links, the current study proposed that cognitive defusion strategies may reduce chocolate consumption by increasing the accessibility of competing goals in response to chocolate-related thoughts. This may be achieved by the defusion strategy encouraging the awareness of chocolate-related thoughts (i.e. internal cues) which in turn promotes the awareness of conflicting goals (e.g. wanting to lose weight).

3.5.4.1 What are goals?

Bargh (1990) defined goals as cognitive structures which can be triggered (i.e. primed) by cues in the environment, causing an automatic associative link to be formed between them. Thus, if goals are mental representations, it is logical to suggest that they can vary in their level of accessibility (Bargh, 1990). Accessibility is defined as the retrieval of goal information from long-term to short-term memory. This retrieval process can be achieved without conscious awareness. Once accessible, the goal is now said to be 'primed' and therefore able to be used to assist individuals in responding to stimuli presented to them (Bruner, 1957). The accessibility of goals can be influenced by both internal (i.e. thoughts) and external (i.e. environmental) cues.

3.5.4.2 Increasing goal accessibility

There exists a vast amount of experimental evidence for the priming of goals. Chartrand & Bargh (1996) subliminally primed participants with either goal or control words and found that only the primed goal words influenced participant behaviour. Similar findings were also found by Fitzsimons & Bargh (2003). Furthermore, Shah & Kruglanski (2002) conducted a study whereby participants were asked to respond to words related to education and health goals (e.g. 'educated' and 'knowledgeable'; 'strong' and 'fit') by indicating as fast and accurately as possible whether a target word represented a characteristic or a trait. Unknown to participants, subliminal priming of words representing the means for achieving each of these goals (e.g. 'read' and 'exercise') were presented on each trial prior to the target word. The results showed that participants' responses to target words representing the education and fitness goals were faster following subliminal primes representing a means corresponding to a given goal than following a control word. Shah and Kruglanski therefore concluded that these faster reaction times were evidence of the goal's accessibility being strengthened by subliminal exposure to the cues. The above studies clearly illustrate that primed goals can increase goal accessibility. This has been further supported by Shah (2003).

In addition to implicitly priming a goal, without awareness of the mediating processes that give rise to the goal's accessibility, research has shown that cues which are incompatible with a goal can also trigger alternative goals. This in turn sets in motion processes that override temptation (Fishbach, Friedman & Kruglanski, 2003). For instance, a chocolate may seem attractive, but health goals incompatible with eating the chocolate should be triggered to counteract the value assigned to the chocolate. Chocolate in this case would strengthen the accessibility of a health goal to counteract the goal of eating the snack food. Thus, rather than increased chocolate consumption occurring when chocolate is present, Fishbach et al. would predict an increase in healthy eating. It was however argued that such a counteractive effect would only be evidenced if the health goal was important to the individual and if chocolate was associated with the incompatible goal of 'being healthy'. In support of these assumptions, Fishbach et al. (2003) found that the temptation of a fatty food triggered the goal of being health conscious in a person's eating behaviour. The procedure of Fishbach's study involved dieters spending time in one of three situations: a room with popular fatty foods (temptation prime), a room with weight-watching magazines (diet [i.e. goal] prime), and a room with general interest magazines (neutral prime). All participants were asked to choose a reward for participating between a chocolate bar and an apple. The findings showed that the participants who were food primed and diet primed were more likely to choose the apple rather than the chocolate bar compared to control participants. This study demonstrates the effect of priming tasks on strengthening the accessibility of goals when in the presence of cues.

3.5.4.3 Using cognitive defusion to increase goal accessibility

To date, no literature or evidence exists in terms of exploring whether cognitive defusion works by increasing the accessibility of competing goals. Thus, the current study was the first to investigate this possibility. To measure the effects of cognitive defusion on goal accessibility a LDT (similar to that used to explore if cognitive defusion works by reducing automaticity) was utilised. The only difference between the goal accessibility and automaticity LDTs was that the target words used to measure the current possibility related to commonly identified goals for wanting to reduce chocolate consumption (i.e. health or weight) rather than the word 'chocolate'. The efficiency of using LDTs to measure goal accessibility has been previously supported (Webb & Sheeran, 2007).

3.5.5 Conclusions of literature review

3.5.5.1 Summary

There is evidence to suggest that LDTs are effective at measuring behavioural automaticity (Bargh, Chen & Burrows, 1996; Moors & De Houwer, 2006) and goal accessibility (Chartrand & Bargh, 1996; Fishbach et al., 2003). SRHI questionnaires are also considered reliable measures of habit strength (Verplanken & Orbell, 2003). These two measures were therefore utilised in the current study in order to further explore the effects and mediators of cognitive defusion strategies.

3.5.6 The current study

The current study was a partial replication of Study Two in that (1) the cognitive defusion strategies were compared to relaxation-control strategies, and (2) the intervention was conducted over a short period of five-days. Again, participants were asked to keep a bag of chocolates in their possession and to refrain from eating any chocolate or chocolate-related products (see section 3.2 for full details of the methodology used in Study Two). The current study differed from Study Two in that a baseline measure of chocolate consumption and a second, monitoring-only, control strategy (as opposed to the mindfulness-acceptance strategy) were included. A baseline measure was also incorporated into the design of the current study to allow for any changes in chocolate consumption to be identified. Study Two did not record prior levels of consumption, only group differences. The baseline measure consisted of the same chocolate diary as that used in the previous study. A monitoring control group was included in order to identify whether simply monitoring behaviour has an effect on chocolate consumption. Previous literature suggests that people are less likely to engage in self-control related behaviours when they are monitoring relevant behaviours, and vice versa (Baumeister, 2002; Polivy et al., 1986). Polivy et al. (1986), for example, amongst others (Baumeister et al., 1994; Hull, 1981) found that when behaviour is monitored, people are better able to resist temptation. The addition of this control group allowed for a more confident interpretation that it was the cognitive defusion strategy that was bringing about a change in unhealthy eating behaviour.

3.5.6.1 Aims and predictions

The first aim of the current study was to replicate the findings shown in Study Two; that the defusion strategy was effective as reducing chocolate consumption. The second aim was to further understand *how* mindfulness-based cognitive defusion strategies reduce chocolate consumption. It was hypothesised that cognitive defusion works by either reducing automaticity between chocolate-related thoughts and chocolate consumption (i.e. weakens cue [thoughts] – response [chocolate] links), or by increasing the accessibility of competing goals in the presence of the cue (i.e. strengthens cue [thought] – goal [health/weight] links). To date, no studies have examined the role of defusion strategies in reducing the automatic link between thought cues and behaviour, or in terms of increasing goal accessibility. The current study was therefore mainly exploratory however the following predictions were made.

- If the cognitive defusion strategy works by reducing automaticity between thoughts and behaviour, slower (longer) reaction time scores were expected following the semantically related prime in the LDT amongst those in the defusion group compared to those in the control groups. It was also expected that those in the cognitive defusion group would show lower SRHI scores at follow-up compared to baseline.
- If the cognitive defusion strategy works by increasing the accessibility of competing goals in the presence of the cue (i.e. strengthens cue [thought] – goal [health/weight] links), faster (shorter) reaction time scores were expected following the semantically related prime in the LDT amongst those in the defusion group compared to those in the control groups.
- In line with earlier evidence (Danner, Aarts & de Vries, 2008; Lally, Van Jaarsveld, Potts & Wardle, 2010) it was hypothesised that habit strength would moderate the relationship between chocolate-related cues and chocolate consumption. As a result, it was predicted that individuals who scored most highly on the SRHI measures would demonstrate a greater decrease in RTs in the LDT measuring automaticity.

3.6 Pilot studies

Given the novelty of this research, it was considered important to ensure that the design of each measure (SRHI and LDTs) used to explore the hypotheses was both appropriate and valid. Three separate pilot studies, in addition to a larger preliminary study were therefore conducted.

3.6.1 Pilot study one

To ensure maximum strength of automaticity and goal accessibility between chocolate-related thoughts and chocolate consumption, a pilot study was conducted in order to identify (1) which thought-cues people most commonly experience when eating, or nearly eating (i.e. trying to resist temptation) chocolate, and (2) the most frequently reported reason for wanting to reduce chocolate consumption. The findings from this pilot study assisted in the overall design of the current study and also determined which thought-cues where included in the automaticity and goal accessibility measures (SRHI and LDTs).

3.6.1.1 Method

3.6.1.1.1 Participants

Data were collected from 20 participants (10 males, 10 females) to identify food-related thoughts experienced immediately before eating, or nearly eating (i.e. temptation resisted) a chocolate or chocolate-related product. All participants were students from Swansea University and met the inclusion criteria which comprised a desire to reduce current levels of chocolate consumption, a fluent English speaker, not pregnant, not suffering past or present from an eating disorder and having no medical condition that affected what could and could not be eaten (e.g. high cholesterol, diabetes, hypoglycaemia, or food intolerances). Participants either took part voluntarily, or if a psychology student, received four course credits after attending both sessions. The study received ethical approval from Swansea University's Psychology Department Research Ethics Committee.

3.6.1.1.2 Design

The study employed a between-subjects design with two conditions (resist, non-resist). The resist group was asked to try to resist the temptation to eat chocolate over the three-day study period. The non-resist group was not asked to resist eating chocolate, but instead instructed to eat normally over the three days (i.e. participants in this group were free to eat as much chocolate as they typically would). Participants were alternately allocated to either the resist or non-resist condition.

3.6.1.1.3 Materials and apparatus

3.6.1.1.3.1 Chocolate and thought-cue diaries

The design of the diaries was separated into two parts (see appendices T and U). The first part required the participant to keep a record of all chocolate and chocolate-related products they had eaten, or felt like eating, but resisted, for three consecutive days (Tuesday-Thursday). Example lists of chocolate and chocolate-related products were provided. There was a separate diary sheet (i.e. A4 page) for each of the three days. There was also a different diary for 'chocolate eaten' and 'chocolate felt like eating'. The diaries (chocolate eaten, chocolate felt like eating) were compiled as a single document, though in order to make the diaries visually distinctive they were printed on different coloured paper (pink for 'chocolate eaten' and green for 'chocolate felt like eating'). The purpose of this was to try and reduce errors made when recording the different dietary information. The 'chocolate eaten' diary asked participants to record the time the chocolate was eaten, the type of chocolate/chocolate-related product eaten, the product brand, the size (in grams) and the overall portion (i.e. half, quarter) consumed. The 'chocolate felt like eating' diary asked participants to record the time they experienced the desire to eat chocolate and the type of chocolate/chocolate-related product they wanted to eat. Both diaries further asked participants to state using a yes/no response if they experienced any food-related thoughts immediately before eating, or nearly eating, the chocolate or chocolate-related product. The second part of the diary required the participant to record the content of these thoughts below the dietary entry. Examples of food-related thoughts were listed.

At the start of each diary there was also an example page provided in order to show participants how to fill in the diaries correctly. Participants were advised that if they needed more space they should write on the reverse of the diaries. They were also notified that it was important that all details were recorded honestly and accurately. The diaries given to both groups (resist, non-resist) were identical. The resist group was however additionally told that resisting the temptation to eat chocolate can be difficult, so even though they were asked to try to not eat any chocolate or chocolate-related product they were not to worry if they did. They were simply asked to record what they had eaten in the 'chocolate eaten' diary provided.

3.6.1.1.4 Procedure

The study was carried out over five consecutive days (Monday-Friday). On Monday, the researcher met with the participants by individual appointments during which written consent was obtained. During this session, the participant was given their chocolate and thought-cue diaries and shown how to fill them in correctly. Participants were also informed to which group (resist, non-resist) they had been allocated.[19] This session took approximately 15 minutes to complete. Before leaving the session, participants were asked to keep the diaries in their possession at all times over the next three days (the diaries were not required to be completed on either Monday or Friday). On Friday, participants once again met with the researcher. At this session, the diary was returned and the information recorded in the diaries briefly discussed to ensure that all information was recorded in full and without error. This session lasted no longer than 15 minutes and was concluded by thanking the participant for taking part. All participants were debriefed fully.

[19] Participants were unaware of the other condition to which they had not been allocated.

3.6.1.2 Results

3.6.1.2.1 Descriptive statistics

Chocolate consumption and food thoughts were measured using food and thought-cue diaries completed over three consecutive days. Two participants failed to return their diaries at the follow-up appointment. The data for these participants were therefore unavailable, yielding an n of 18 (resist, n = 9, non-resist, n = 9). The sample consisted of an equal ratio of males and females (resist: male = 4, female = 5; non-resist, male = 5, female = 4).

3.6.1.2.2 Identified chocolate-related thought cues

The purpose of recording the chocolate consumption data (e.g. type and weight of chocolate eaten) was to prompt participants to identify the thoughts they experienced immediately before eating, or nearly eating, a chocolate or chocolate-related product. As such, the chocolate consumption data were not analysed. Analysis was however carried out on the thought-cue data.

Analysis of the different thought-cues reported by the resist and non-resist groups failed to show much variation, apart from some thoughts in the former group expressed in relation to reasons for chocolate being resisted (e.g. "I remembered that I was taking part in the study"). The thought-cue data related to reasons for eating, or wanting to eat, chocolate for both groups were therefore analysed collectively.

3.6.1.2.3 Most commonly identified thought-cues

In order to identify the most common thought-cues, each thought was first categorised under a context relevant heading. For example, the thought "[chocolate] was being passed around. Everyone was having some" was categorised under the heading "others eating", whereas the thought "last day and I felt a bit stressed" was categorised under the heading "relax". There were 16 categories formulated in total. All category headings consisted of a single word or short phrase which people would easily associate with 'chocolate'. Next, the total number of thoughts in each category were summed, giving a total for each of the 16 categories. The total number of thoughts experienced within each category was also separately calculated for males and females. Sometimes the food thoughts experienced related to two or more of the thought-cue categories (e.g. the thought "helped as a distracter with writing essay in the library" was included under both the headings 'take a break' and 'bored'). Whilst both of these categories were entered into the overall total, only one entry per category, per participant, was included in the overall summation of the data (i.e. if a participant had reported three times that they had eaten or nearly eaten chocolate for reasons related to stress, this was reported as one under the stress category, not three). Calculating the frequency of the thoughts experienced using this method allowed for increased reliability when attempting to identify the most common thought-cues (i.e. the most common thought-cue were identified fairly across the whole sample as opposed to being attributable to just one or two participants).

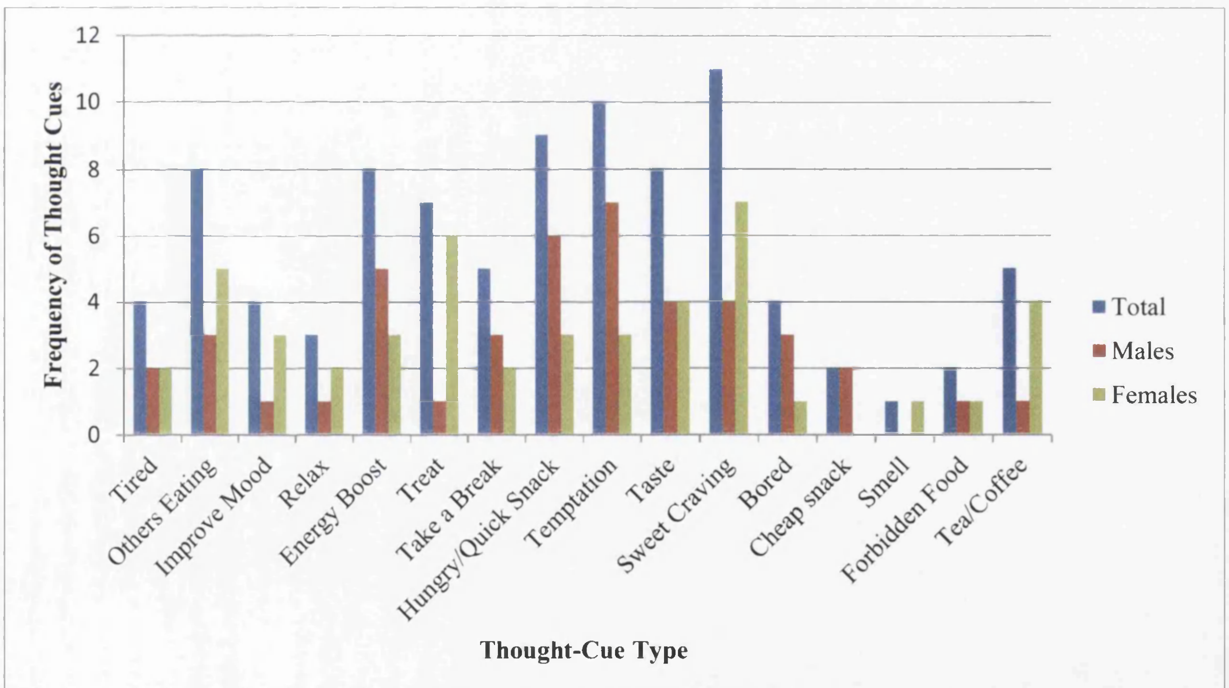

Figure 3.2 Different types of thought-cues and the frequency of each reported by males and females and across the whole sample (N = 18).

The frequency data in Figure 3.2 shows that more participants experienced thought-cues about 'sweet craving', 'temptation', and 'hungry/quick snack'. Others including, ‘energy boost’, ‘taste’, ‘others eating’ and ‘treat’ were also reported by at least seven participants. Males appeared to report thought-cues related to ‘temptation’, ‘hungry/quick snack’ and ‘energy boost’ more frequently than females. Females experienced more thought-cues related to ‘sweet craving’, ‘treat’ and ‘others eating’.

3.6.1.2.4 Method of choosing five thought-cue categories

From the seven highest reported thought-cues shown in Figure 3.2, an attempt was made to identify five (a more manageable number to include in SRHI and LDT measures) which most people would commonly associate with ‘chocolate’. When choosing the five thought-cue words/short phrases, their appropriateness to being used with the mindfulness cognitive defusion strategy was also taken into consideration. As ‘sweet craving’ was the highest reported thought-cue it was considered important that this was included as one of the chosen five. However, a decision had to be made on whether to use the word ‘sweet’ or ‘craving’. Given that this category was related more to participants wanting something tasting ‘sweet’ after a meal, or as a snack, over actually ‘craving’ chocolate, the word ‘sweet’ was the preferred selection. The categories ‘temptation’, ‘hunger/quick snack’ and ‘taste’ were considered to be similar and related to ‘sweet craving’ therefore were not selected for this reason. Including categories which were too similar in meaning was something that was avoided.

The remaining highest frequency categories were ‘energy boost’ and ‘treat’. Both were included due to their high frequency. The fact that they were also similar to some of the other lower frequency categories such as, ‘tired’, ‘bored’ and improve mood’ also led to them being chosen (i.e. if these lower frequency categories were merged with ‘energy boost’ or ‘treat’ their already high frequency would have been even greater). The next obvious category to choose based on frequency rating was ‘others eating’. This category was however rejected on the basis that this short phrase could be applied to many things other than chocolate. It was therefore considered that this cue was too vague in its contextual meaning to be used. Instead the next highest reported thought-cue was included, which was ‘take a break’.

Given that the chosen thought-cues needed to allow the use of the defusion strategy to work effectively, out of the remaining 16 categories, 'relax' was deemed the top category choice. The word 'relax' was changed to 'stressed' due to the fact that it was 'stress' which appeared to be directly causing participants to eat, or nearly eat, chocolate whereas relaxation was the by-product of the behaviour. The word 'stressed' was therefore considered a stronger category heading to describe the thought-cue than that originally used.

3.6.1.2.5 Identified goals

Each participant who took part in this pilot study wanted to reduce their current intake of chocolate. The study aimed to identify the goals participants had in terms of why they wanted to reduce their chocolate consumption.

3.6.1.2.5.1 Reasons for wanting to reduce chocolate consumption

Using the same sample of participants (N = 18), each was asked the question: "Why do you want to reduce the amount of chocolate you currently consume?" Figure 3.3 shows the different reasons given and their rate of frequency reported across the whole sample. Gender differences were also analysed.

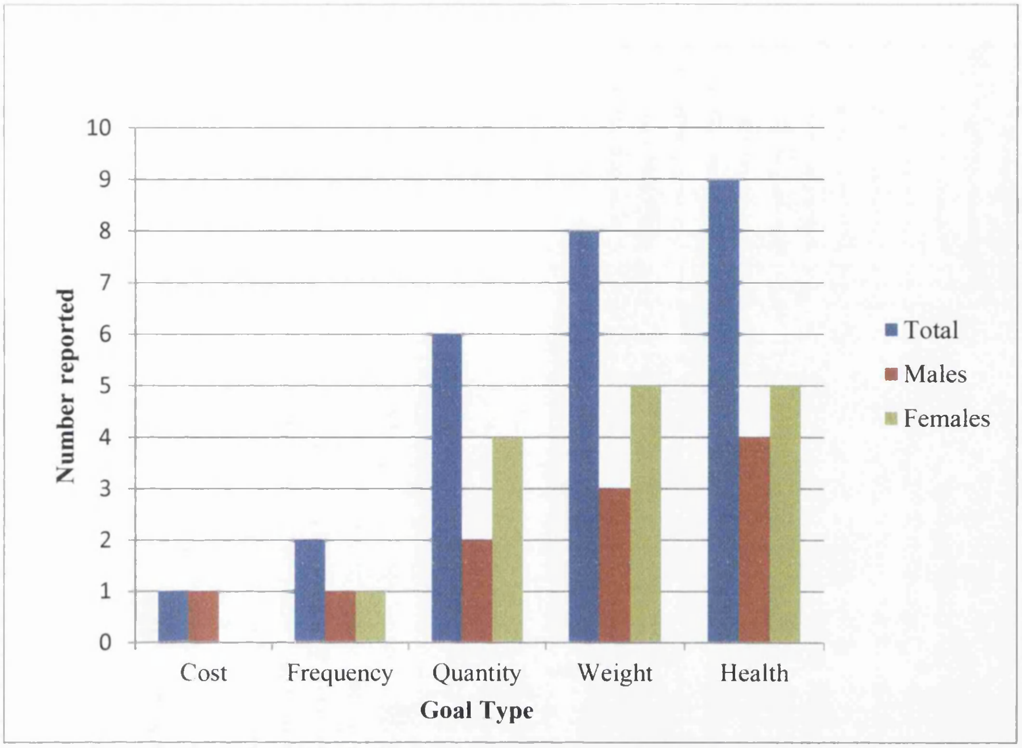

Figure 3.3 Types of goals and the number of each goal reported by males and females and across the whole sample (N = 18).

Figure 3.3 shows that there were five goals identified in total; cost (e.g. spending too much on money on chocolate), frequency (e.g. chocolate eaten too often), quantity (e.g. too much chocolate eaten), weight (e.g. increased fat), and health (e.g. can cause diabetes). The two most commonly identified goals were weight and health. Females reported these equally as reasons for wanting to reduce chocolate consumption. Males reported these goals slightly less, but were still the highest reported goals across the five identified. Frequency and quantity were considered to be underlying factors related to both weight and health. Given their high frequency ratings, these two goals (weight and health) were chosen for use in the current study.

3.6.1.2.6 Main observations

The main findings were that in the sample tested, the most common chocolate-related thought-cues were associated with needing something sweet, needing a treat, needing an energy boost, taking a break and being stressed. The most frequently reported reasons for wanting to reduce chocolate consumption were linked to health and weight factors. Males reported slightly different thought-cues and goals compared to females. To limit variation in the data it was therefore suggested that only females should be recruited in the current study (Study Three).

3.6.2 Pilot study two

Given the small sample size of Pilot Study One (N = 20), the aim of the second pilot study was to check the strength of association between the previously identified chocolate-related thought cues and the word 'chocolate'. Thus, the purpose of Pilot Study Two was to confirm the reliability of the findings from Pilot Study One prior to the SRHI and LDTs being constructed. The study involved a large sample of participants completing a series of different word association tasks.

3.6.2.1 Method

3.6.2.1.1 Participants

The study involved 280 students (86 males, 194 females) from Swansea University. Participants were recruited via opportunity sampling. This was achieved using three methods; by inviting the participation of 1) students seated within large open work areas in the University's library, 2) students attending psychology lectures, and 3) psychology PhD students available within the research department. Over half (n = 180) of the sample was recruited via method 1. The study had no specified inclusion criterion and participants took part on a voluntary basis. The study received ethical approval from Swansea University's Psychology Department Research Ethics Committee.

3.6.2.1.2 Design

The study employed a between-subjects design with 14 conditions. The conditions either included single words (chocolate, sweet, treat, energy boost, take a break, relax, stressed, energy) or short phrases (need something sweet, need a treat, need an energy boost, need a break, need to relax, need energy). Participants were allocated to one of the 14 conditions using a single blind randomisation protocol. A total of 20 participants completed each condition. The identity of participating individuals was safeguarded via the use of numerical identification codes.

3.6.2.1.3 Materials and apparatus

3.6.2.1.3.1 Word association task

For each condition of the word association task a single sheet of A4 paper was used (see appendix V). At the start of the word association task participants were asked to state their gender by circling the correct corresponding letter (i.e. F for female and M for male). Next was written the statement "Please list in the space below all single words or short phrases that you associate with the word/short phrase .... Please take as much time as you need". Relevant examples were provided for each condition to illustrate what was meant by a 'single word' or 'short phrase'. For example, for the 'chocolate' word condition 'craving' was given as a relevant example of a single word whereas 'on a diet' was given as a relevant example of a short phrase.

3.6.2.1.4 Procedure

Prior to giving written consent, participants were verbally briefed about what the study entailed. Specifically participants were told, "You will be asked to list as many single words or short phrases that you personally associate with a particular word or short phrase that will be highlighted in bold on the sheet of paper given to you". It was emphasised to participants that any associations made should be meaningful to them as opposed to being general associations. Participants were left alone to complete the task. No time limit was enforced. The researcher collected the completed word association sheets and participants were verbally debriefed, thus informed of the intentions and purposes behind the research being carried out. Finally, the participants were thanked for taking part in the study.

3.6.2.2 Results

Each of the 14 conditions (either single words or short phrases) was completed by 20 different participants (i.e. no participant completed more than one of the conditions).

3.6.2.2.1 Measuring associations

In order to measure participants' association between thought-cues and chocolate, the number of times the word chocolate was recorded for each individual thought-cue was summed (i.e. the higher the recalled frequency, the greater the perceived strength of association). Only if the specific word 'chocolate' had been recorded was it included in the analysis. Other words related to chocolate (e.g. sugar, sweets, candy) were not included. The reason for this was because the current study only utilised the word 'chocolate' as stimuli in a lexical decision task. By limiting the analysis to the direct recall of the word 'chocolate' it was hoped that any associations found between the thought-cues and chocolate would be more reliable than measuring associations with chocolate-related terms.

3.6.2.2.2 Associations between identified thought-cues and the word 'chocolate'

Based on the findings of Pilot Study One, five thought-cues were explored. These were; sweet, stressed, energy boost, take a break, and treat.

	Chocolate Association
Condition	**Yes (%)**
Sweet	13 (65)
Stressed	2 (10)
Energy boost	8 (40)
Take a break	1 (5)
Treat	15 (75)

Table 3.17 Frequency of associations between the different thought-cues and the word 'chocolate' (sample total, N = 100; total per condition, n = 20).

Table 3.17 shows that more participants made associations between 'chocolate' and the words, Treat (75%) and Sweet (65%). A large number of participants also associated 'chocolate' with Energy boost (40%). Conversely, only a small number of participants associated 'chocolate' with Take a break (5%) and Stressed (10%).

Given that very few participants associated 'chocolate' with the word, 'stressed' yet some association to the opposing term 'relaxing' was evident (i.e. three participants wrote down this word during the word association task when presented with the word 'stressed'), it was decided that additional investigations were required in order to test the association between 'relax' and 'chocolate'. Furthermore, some participants (n = 3 out of 8 who specifically wrote down energy boost in association with chocolate during the word association task) were noted to associate the piloted term 'energy boost' with the chocolate bar 'Boost'.[20] In order to rule out the possibility that chocolate was associated with this thought-cue due to the word 'boost' priming the participants' association response, the thought-cue 'energy boost' was changed to 'energy'.

All participants were told at the beginning of the study to record any single word or short phrase that *they* associated with the thought-cue they had been allocated. However, in an attempt to identify more personal associations between the thought-cues and the word chocolate, four of the original thought-cues (sweet, energy boost, take a break, and treat), in addition to the two new thought-cues (relax and energy) were re-piloted (using different participants) by writing the thought-cue in the style of a short phrase. Each phrase started with the word 'need' (e.g. need something sweet, need a treat, need energy). The word 'stressed' had been excluded based on previous data and was therefore not re-piloted.

[20] In the word association task, these participants wrote on their A4 sheet that they associated the thought-cue 'energy boost' which the Cadbury chocolate bar 'Boost'. It was thought that the association was not a result of energy boost being associated with chocolate, but that the association was caused by the thought-cue and this specific chocolate bar consisting of the same word; Boost.

	Chocolate Association
Condition	**Yes (%)**
Relax	2 (10)
Energy	1 (5)
Need something sweet	15 (75)
Need an energy boost	7 (35)
Need a break	1 (5)
Need a treat	15 (75)
Need to relax	2 (10)
Need energy	2 (10)

Table 3.18 Frequency of associations between the modified thought-cue names and the word 'chocolate' (total sample, N = 160; total per condition, n = 20).

Table 3.18 shows that very few participants reported an association between the additional piloted thought-cues, relax and energy (both when written as a single word and as a short phrase), and the word 'chocolate'. The thought-cues, 'Need something sweet' (75%), 'Need an energy boost' (35%), and 'Need a treat' (75%) were reported by the most number of participants when written as short phrases in comparison to when written as single words. Whilst 'sweet', when written as a short phrase ('need something sweet'), was associated with chocolate by slightly more participants than when written as a single word ('sweet' = 13, 'need something sweet' = 15), 'energy boost' was associated with chocolate by slightly less participants when written as a short phase ('need an energy boost') compared to when written as single words ('energy boost' = 8, 'need an energy boost' = 7). Similarly to 'take a break', the association between 'need a break' and chocolate was only reported by a small number of participants ('take a break' = 1, 'need a break' = 1).

3.6.2.2.3 Gender differences

Analyses were carried out to explore whether associations between the different thought-cues and the word 'chocolate' were affected by gender.

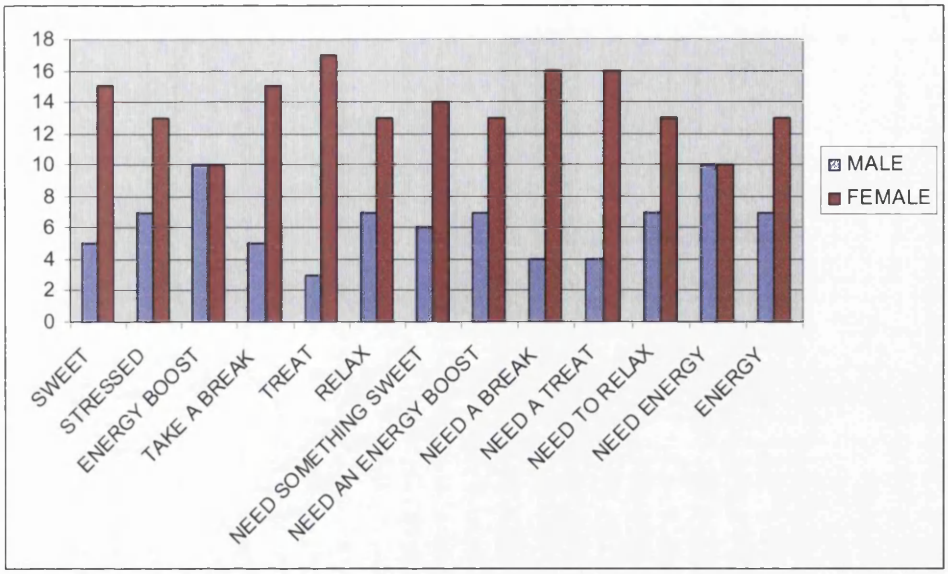

Figure 3.4 Effects of gender on the association between thought-cues and chocolate (i.e. the number of males and females to link chocolate with each single word and short-phrase thought-cue).

A chi-square test revealed that there was no significant difference in the percentage of males and females who reported associations between the different thought cues and chocolate ($\chi^2 = 12.68$, df = 12, p = 0.393).

3.6.2.2.4 Association between the word 'chocolate' and identified thought-cues

To determine whether the associations made between the thought-cues and chocolate could be reversed, 20 participants were given the word 'chocolate' and asked to list as many single words or short phrases that they associated with that word. The purpose of this was predominately for exploratory purposes only given that it was recognised that participants may not necessarily associate an identified thought-cue (e.g. treat) when presented with the word 'chocolate' despite possibly making an association when presented the other way around. The aim of this test condition was also to identify any associations with chocolate which had not been detected in previously conducted pilot studies.

	Chocolate Association
Condition	**Yes (%)**
Sweet	9 (45)
Treat	6 (30)
Energy	1 (5)
Relax	2 (10)
Stressed	0 (0)
Break	2 (10)

Table 3.19 Frequency of associations between chocolate and thought-cues (N=20).

Table 3.19 shows that when presented with the word 'chocolate' as opposed to a thought-cue, more participants recorded the cues 'Sweet' and 'Treat'. The other four thought-cues were recorded by very few participants. Also, compared to Tables 3.17 and 3.18, it appears that participants found it easier to associate chocolate to a thought-cue than to associate a thought-cue to chocolate. No novel associations with the word 'chocolate' were identified when compared to results from previous pilots studies.[21]

3.6.2.2.5 Main observations

The main finding was that a higher number of participants reported an association between three of the five identified thought-cues in Pilot Study One (sweet, treat and energy boost) and the word 'chocolate', thus demonstrating the reliability of the findings in the previous pilot study. Interestingly, more participants reported an association with the word 'chocolate' when the thought-cues were written as a short sentence (e.g. need something sweet) as opposed to as a single word (e.g. sweet). Similarly to Pilot Study One, a higher number of females identified an association between the thought-cues and the word 'chocolate' compared to males, though no statistically significant gender

[21] The thought-cues 'take a break' (75% recall) and 'need a break' (60% recall) were found to be strongly associated with the chocolate bar, 'KitKat'. It was considered a possibility that the association had been derived from participants being aware of the well-advertised KitKat slogan ('Have a break, have a KitKat') as opposed to them making a genuine personal association between the word 'break' and 'chocolate'. In view of this, entries making reference to chocolate in this way were not included in part of the analysis.

differences were evident. The findings also showed that both the thought-cues 'sweet' and 'treat' were most frequently associated with the word 'chocolate' when participants were asked to list as many personal associations with the word 'chocolate' instead of the thought-cue. Energy was only associated with 'chocolate' by a few participants. However, based on the moderate number of participants who had reported an association between 'energy' and chocolate, as shown in Pilot Study One and Pilot Study Two, it was decided that it would remain as one of the main identified thought-cues in the current study. In view of these findings, the current study used the three replicated thought-cues written as short phrases (i.e. 'need something sweet', 'need a treat', and 'need an energy boost') to measure automaticity and goal accessibility in the SRHI and LDT measures. A decision to invite only females to participate was finalised.

3.6.3 Pilot study three

The aim of this pilot study was to determine if a subliminal priming procedure using the identified thought-cues from Pilot Studies One and Two as primes was indeed, subliminal. Thus, the purpose of Pilot Study Three was to measure subliminal priming effects by identifying if participants could consciously see the thought-cues displayed in a lexical decision task. Furthermore, this pilot study aimed to explore whether the use of short thought-cue phrases (e.g. 'need something sweet'), and the length of cue presentation time had an effect on participants' ability to consciously process the cues' displayed.

3.6.3.1 Measuring subliminal priming

Measuring subliminal priming typically involves the researcher asking the participant if they were able to recognise the flash (i.e. the mask replaced by the prime and then subsequently by the target word) presented on the screen. If appropriate, the researcher may also ask the participant if they were able to identify certain strings of letters as words or non-words. This is known as a 'subjective' measure (Cheesman & Merikle, 1985). Subjective measures of awareness rely on participants' self-reports of their perceptual experiences or conscious processing (e.g. they will be asked questions such as 'did you recognise the word presented to you?'). Pilot Study Three utilised the same measuring design as that used by Cheesman & Merikle (1985).

3.6.3.2 Use of short-phrase primes

Whilst the majority of studies which have investigated the effects of semantic priming have shown convincing evidence that the meaning of a single word can be processed unconsciously (Bargh, Chen & Burrows, 1996; Dijksterhuis, Bargh & Miedema, 2000), very few studies have investigated the priming effects of a short sentence (Draine & Greenwald, 1998). Draine & Greenwald predicted that a short two-word sentence (e.g. 'not evil' or 'not fair') would be processed unconsciously and therefore it would be possible to obtain subliminal priming effects based on these phrase meanings. Contrary to prediction, their findings failed to show any evidence for unconscious processing of two-word sentence. Instead, the pattern of priming was determined by single-word components of these phrases. Draine & Greenwald therefore concluded that the cognitive unconscious is restricted to semantic processing of single, morphologically simple words and that more complex grammatical operations may require increased energy from working memory. Others have supported this, arguing that the priming effects of critical sentences may possibly result from activation triggered by any one of the phrase words (Balay & Shevrin, 1988; Fudin, 1986; Greenwald, 1992). This conclusion is reinforced by the failure to obtain phrase-level priming effects even with visible primes using relatively long (150ms) prime-target stimulus-onset asynchronies (SOAs; the time between the prime and the target word). From this study it is suggested that the context of a sentence is very difficult to process automatically and instead requires slow, conscious cognitive resources (Wason, 1959; Gough, 1965; Slobin, 1966). An alternate explanation could be that the semantics of a short sentence fall within the processing capabilities of unconscious systems, but the syntactic operations of combining the word 'not' with an adjective does not.

In contradiction to Draine & Greenwald's findings, others have shown that the repetition of subliminal short phrases is effective (Conway & Bekerian, 1987; Sharkey & Mitchell, 1985; Wentura & Brandtstädter, 2003; Wentura & Greve, 2004, 2005; West &

Stanovich, 1982) especially in relation to changing self-control related health behaviours, such as improving the success rates of people trying to quit smoking (Palmatier & Bronstein, 1982). Several additional experiments have also offered support to the notion that the unconscious is capable of processing complete sentences (Bronstein & Rodin, 1983; Kaplan, Thornton & Silverman, 1985). Such findings have, in part, been accounted for due to singular words being too unspecific to trigger priming effects compared to the use of sentences. Cohen & Farley (2008) also argued that a priming effect is found when using short sentence primes because humans have the ability to consciously process 40-60 pieces of information which is equivalent to this type of prime. Cohen & Farley did though also state that this is reaching the upper limits of a human's cognitive capacity. Despite these findings, the literature on appropriate length of subliminal primes is inconsistent therefore no clear conclusions can be drawn. However, based on the greater association between short phrase chocolate-related thought-cues (e.g. 'need a treat') and chocolate in Pilot Study Two compared to single word cues (e.g. 'treat'), it was considered important to pilot the subliminal effects of these short phrases. The short-phrases were each a total of three words. A mask (i.e. a procedure used to prevent participants from becoming fully aware of the priming event and/or the prime content) was also included in the lexical decision task. This was included because some have argued that when using a multi-word prime, the critical stimuli should always be presented using masking procedures in order to ensure that any measurable behavioural influences of the stimuli are indeed unconscious (Greenwald, 1992).

3.6.3.3 Display time of the cues

Previous studies have failed to explore the effects of a three-word short phrase in terms of semantic priming. Thus, with no other research to compare with, it is difficult to predict how long such cue phrases should be displayed for in order to allow for a priming effect to occur, yet still avoiding any conscious processing of the phrase itself. Calculating the correct presentation duration used in past lexical decision tasks have been based on assessing the time it takes for a word to be processed when reflected in its eye-pause (i.e. fixation time which is approximately 200-250ms). It has been identified that silent reading involves even more automatic word recognition (approximately 100 ms) and also that many words can be processed during a single fixation, but typically they are thought to be processed by the end of the fixation (Wentura & Degner, 2010). Based on single word cues, current research has reported displaying the cues anywhere between 10 and 40 ms (Li, Paller & Zinbarg, 2008). The current study used three word cue phrases. It was therefore considered appropriate to use a longer presentation time of 50ms given the increased length of the cue compared to a single word and thus the longer time needed for sufficient processing. Furthermore, 50ms, although being at the top-end of the range, would still allow the phrase to be processed before the fixation time lapsed.

3.6.3.4 Method

3.6.3.4.1 Participants

Data were collected from a total of 21 participants (8 males, 13 female) with a mean age of 21.48 (SD = 5.71). Participants were either students from Swansea University or friends or family members of the experimenter. All participants took part voluntarily, had normal or corrected vision and were able to read English fluently. Participants were recruited via opportunity sampling. The study received ethical approval from Swansea University's Psychology Department Research Ethics Committee.

3.6.3.4.2 Design

The study employed a between-subjects design with three conditions. The conditions differed in terms of the critical cue phrase presented in the lexical decision task. The three phrases consisted of 'need something sweet', 'need a treat', and 'need an energy boost'. Participants were alternately allocated to one of the three conditions using a single blind randomisation protocol.

3.6.3.4.3 Materials and apparatus

3.6.3.4.3.1 Lexical decision task

A sequential priming paradigm adapted from Webb & Sheeran (2007) was used to measure the strength of association between the critical cue phrases and the target word (chocolate). The visual display and response recording for the lexical decision task were controlled by Cedrus SuperLab Pro (version 2.04) software. The task was presented on a Sony laptop computer with a 15.4 inch screen. Participants were seated 100cm from the computer screen. For the first six participants tested (age; M = 23.00, SD = 7.92), an experimental trial consisted of the following sequence of events; (1) presentation of a fixation cross in the centre of the screen for 1500 ms, (2) presentation of the prime phrase for 33ms, (3) presentation of a mask consisting of a row of 20 crosses (length of the longest prime phrase) for 225 ms, (4) presentation of a word/non-word until the participants responded, and finally, (5) presentation of a blank screen for 2000 ms as an inter-trial interval. The SOA was therefore set at 275ms. All trials were presented in a constant order. It was believed that the cue phrases were presented sufficiently fast so as to be outside of participants' conscious awareness (Strahan et al., 2002). The results from the initial data analysis (n = 6) however revealed that the 33ms presentation time of the prime was too long (i.e. participants reported seeing part of the cue phrases). As a result of this, the task was amended by shortening the prime presentation time to 17ms. The rest of the sequence for the experimental trials remained unchanged. All words/phrases displayed were placed on the central vertical and horizontal axis. Words were presented in black, bold, size 35, Arial and lowercase font on a white background. Characters were between 4-6mm tall. All target words and non-words were matched to the word 'chocolate' based on word length. The non-words were pronounceable and obtained from a validated database (Rastle, Harrington & Coltheart, 2002).

The task commenced with a practice run consisting of eight trials. Next, participants completed the primed lexical decision task which consisted of one block of 20 trials (not randomised), including 1 critical trial, 9 neutral-word trials, and 10 non-word trials. On the critical trial, the word 'chocolate' was shown after being preceded by one of the critical cue phrases. These cue phrases were generated from the results of Pilot Studies

One and Two. Two control trials were also included. One control trial presented the critical cue phrase (e.g. need something sweet) followed by a word matched to chocolate (e.g. aeroplane). The other control trial presented a cue phrase matched to a critical cue phrase (e.g. need something heavy) followed by the target word, 'chocolate'. The neutral and non-words were preceded by both the critical and neutral cue phrases. All words and non-words were presented twice. The cue phrases were displayed four times in total, twice for each of the word trials, and twice for each of the non-word trials. Participants responded using a Cedrus RB-730 seven-button response box. Button 1 (far left) was pressed to indicate a non-word and button 7 (far right) was pressed to indicate a word. The labels 'NW' and 'W' were placed above the corresponding buttons to remind the participant of which buttons to press.

3.6.3.4.3.2 Written recall tasks

Two written tasks (see appendix W) were completed after the lexical decision task. The purpose of these was to identify whether the subliminal priming procedure was indeed subliminal. At the start of the first task participants were asked to state their age and gender. Next, they were asked to write down any words/phrases they had seen during the computer task using an open-ended response format. The task specifically stated "In the space below, please list any words or short phrases you saw immediately BEFORE the row of X's were displayed during the computer task. If you did not see any words or short phrases, please leave the space blank". The second written task required participants to choose which of the seven phrases listed they had been exposed to during the lexical decision task. Only one of the phrases listed (the critical cue phrase) was previously presented to the participants, though they were not informed of this. Instead the task stated "Using the list of short phrases below, please circle which one(s) you saw immediately BEFORE the rows of X's were displayed during the computer task. If you did not see any of the short phrases listed, please circle the response 'none of the above'. The first of these written tasks were identical for each condition. The second of these written tasks differed between the conditions in order to include the condition specific critical cue phrase.

3.6.3.4.4 Procedure

Participants were told that the purpose of the study was to identify how well individuals are able to recognise words compared to non-words. They were also made aware that they would be asked to recall any words or short phrases they saw immediately before the row of X's (i.e. the mask) were displayed. After given written consent, participants completed one of the three lexical decision tasks. The task lasted between 2-3 minutes. Next, participants completed the two written tasks one after the other. Before leaving, the participants were verbally debriefed and thanked for their participation.

3.6.3.5 Results

3.6.3.5.1 Initial stages of choosing an appropriate cue presentation time

Initially a test was carried out to explore whether the cue phrases were identifiable at a longer duration of 50ms display by two participants completing the lexical decision task. In the written recall tasks both participants correctly reported seeing all of the cue phrases, including the phrase as a whole (e.g. need a lift) as opposed to only one or two phrase words displayed in the computer task. As a result of this, the task was repeated but this time the cues were presented at 33ms and then at 17ms.

3.6.3.5.1.1 Cue phrases presented for 33ms.

Six participants (3 males, 3 females) completed one of the three lexical decision tasks in which the cue phrases were presented at 33ms. Each of the three tasks were completed by two different participants. The results from the open-recall written task showed that 4 of the 6 participants (3 females and 1 male) reported seeing between 1 and 4 of the cue phrase words. This included a combination of both the first and third words in the phrase, though predominately the last word seemed to be most consciously recalled. Only one of the four participants correctly identified the critical cue phrase in the second forced choice written task.

3.6.3.5.1.2 Cue phrases presented for 17ms.

With part of the cue phrases being correctly identified when displayed for 33ms, it was decided that this presentation time should be reduced. Displayed at the new time of 17ms (this was the maximum display time capacity of the laptop used) the study was repeated using a new sample of 15 participants (5 males, 10 females). Each of the three tasks was completed by five participants. The results from the open-recall written task showed that 5 of the 10 participants (all female) reported seeing between 1 and 5 of the cue phrase words. Again, the majority of the words consciously recalled were the last word of the phrase. All of the five participants correctly identified the critical cue phrase in the second forced choice written task, though some also reported that they thought they saw some other phrases listed which were not actually displayed in the task. As a result, these findings informed follow-on studies (i.e. the preliminary study and the current study [Study Three]) to use the reduced display time of 10ms in an attempt to conceal the cues from conscious awareness.

3.6.3.5.2 Main observations

The findings from this pilot study showed that cue presentation at 50, 33, and 17ms failed to prevent conscious awareness of the short phrase primes. This finding was contrary to previous semantic priming literature (Li, Paller & Zinbarg, 2008), though this is the first study to explore the effects of a three-word prime. Thus, with no other research to compare to, it was considered important to amend the design of the priming paradigm so that they meet the suggestions of these findings. This entailed reducing the presentation time of the prime cues for the shorter duration of 10 ms and subsequently using a different computer for the delivery of the LDT in order to allow for the correct functioning of this new display time.

3.6.4 Preliminary study

The aim of this preliminary study was to test the validity of the final design for the main study (Study Three) based on the findings from Pilot Studies One, Two and Three. Both the SRHI and LDT measures were included.

3.6.4.1 Method

3.6.4.1.1 Participants

The study employed a student sample of 54 participants (21 males, 33 females) recruited by sending an email to the undergraduate and postgraduate population at Swansea University. The mean age of the sample was 23.5 years (SD = 5.66). Of the 54 participants recruited, nine reported that they were currently dieting in an attempt to lose weight. All participants were over the age of 18, were able to read English fluently, had normal or corrected vision and also had a desire to reduce their current chocolate intake. None had taken part in any previous study conducted by the researcher. Participants received either a remuneration of £5 or one psychology course credit for taking part. Ethical approval was provided by Swansea University Psychology Department Research Ethics Committee.

3.6.4.1.2 Design

The study employed a mixed-subjects design with two conditions (gender and dietary status).

3.6.4.1.3 Materials and apparatus

3.6.4.1.3.1 Demographic questionnaire

All participants were asked to state their age, gender and dietary status. Participants were further asked to provide a reason for why they wanted to reduce their current intake of chocolate (see appendix X).

3.6.4.1.3.2 Self-report habit index

Habit strength was measured using the self-report habit index (SRHI; Verplanken & Orbell, 2003). The SRHI consisted of 12 items. For the purpose of this preliminary study, the questionnaire was adapted in such a way that it referred to the habit of eating chocolate in response to the thoughts ‘need something sweet’, ‘need a treat’ and ‘need an energy boost’. Thus, three SRHI questionnaires were completed by each participant. Participants indicated their response on a seven-point scale ranging from 0 (completely *disagree*) to 4 (completely *agree*). Each of the SRHI measures were found to have the same high internal reliability score (coefficient alphas = .94).

3.6.4.1.3.3 Locus of control scale

The locus of control scale (Rotter, 1966), commonly called the I-E scales was administered in its original 23-item forced choice (between two alternatives, 'a' or 'b') format (plus 6 filler items). For example, item 3 states; "a. One of the major reasons why we have wars is because people don't take enough interest in politics. b. There will always be wars, no matter how hard people try to prevent them". Responses of non-filler items were summed with a higher score signifying a greater external locus of control. Within the preliminary study, the LOC scale was used merely as a filler task.

3.6.4.1.3.4 Lexical decision task

The lexical decision tasks were the same as those used in Pilot Study Three (see section 3.6.3.4.3.1) except that the block of 20 trials were randomised. Cue phrases were also only displayed for the duration of 10ms. In order to achieve this, a different computer (desktop) which had a refresh rate of 100htz, was used. The dependent variable was the mean reaction time in response to the critical trial compared to the mean reaction time in response to the two control trials. Only trials to which participants responded correctly were used in the analysis.

3.6.4.1.3.5 Cue-phrase recall task

The same open-ended task as Pilot Study Three (see section 3.6.3.4.3.2) was used to identify if the cue-phrases presented during the lexical decision tasks were consciously processed (see appendix W).

3.6.4.1.4 Procedure

Prior to taking part in the study, participants read the study information form (see appendix Y) and provided written consent (see appendix Z). Participants were tested individually in the laboratory. First, three SRHI questionnaires were completed. The order in which the SRHI questionnaires were completed was randomised for each participant. Next, participants completed the demographic questionnaire, followed by a filler task (locus of control scale). The purpose of the filler task was to try and prevent the participants from correctly guessing the aim of the study. Participants then completed three lexical decision tasks. Participants completed the three LDTs in the same order as they completed the three SRHI questionnaires. Lastly, the participants completed the cue phrase recall task. At the end of the study the participants were debriefed (see appendix AA), thanked for taking part and received payment. The study took approximately 15 minutes to complete.

3.6.4.2 Results

3.6.4.2.1 Participants

In total 54 students participated. After excluding four participants because they correctly identified either one or two cue words displayed in the lexical decision tasks, the final sample totalled 50.

3.6.4.2.2 Lexical decision task: computing scores

Three lexical decision tasks were completed. The target word ('chocolate') and the matched neutral target word ('aeroplane') were used in all tasks, though the critical cues (either 'need something sweet', 'need a treat', or 'need an energy boost') differed. The matched neutral word cues (e.g. need a holiday) also differed depending on the critical cue used. The non-words were identical for all three tasks.

Trial combinations	**Prime**	**Target**
Critical cue-critical response association	*need something sweet*	*chocolate*
Critical cue-neutral response association	*need something sweet*	Neutral
Neutral cue-critical response association	Neutral	*chocolate*
Filler trials	Neutral	Neutral

Table 3.20 Example of prime-target combinations used to measure dependent variables.

Evidence of a priming effect was determined by measuring cue-response association strength. Cue-response association strength was indexed by participants' response latencies to the target word 'chocolate' when it was preceded by the critical cue (either 'need something sweet', 'need a treat', or 'need an energy boost'). Strength of the neutral cue (e.g. 'need something small') and the target word ('chocolate') was also measured (control one), in addition to the strength of the critical cue (e.g. 'need something sweet') and the neutral target word ('aeroplane') (control two). The latter two cue-response associations acted as control trials. To obtain a measure of automaticity, the reaction time score (ms) for the critical trial (i.e. critical cue paired with the target word) was compared with both control trials. Lower reaction times indicated strong cue-response association strength (i.e. greater behavioural automaticity).

3.6.4.2.3 Lexical decision task: treatment of outliers

For both critical and control trials across each task, errors and outliers were examined and excluded at the individual level (i.e. for individual reaction time [RT] scores). This was achieved by removing trials with errors (i.e. pressed the 'non-word' key when presented with a word or pressed the 'word' key when presented with a non-word). Across the whole sample (n = 50), four individual trials (out of 486) were errors (0.82%). An additional check for outliers (i.e. reaction time scores lower than 100ms or greater than 4000ms; Mogg, Bradley & Williams, 1997) was also conducted. No such outliers were detected. Means and SDs were then calculated for each participant for the three experimental trials (1 critical, 2 controls). Participants who responded +/- 3.5 standard deviations from the mean were discarded (Ratcliff, 1993). In total, 13 individual trials (out of 486) were identified as outliers (+/- 3.5 SDs), thus 2.67%. To avoid depleting the sample size to that which would not be experimentally viable, the participants were not removed from the data entirely but instead removed as individual values within the dataset. Outliers were removed in order to avoid biasing subsequent analyses.

3.6.4.2.4 Strength of cue-response association

3.6.4.2.4.1 Analysis of individual reaction time scores for critical and control trials across each of the three lexical decision tasks.

The mean and SDs calculated for each trial type (critical trial, control one, and control two) are displayed in Table 3.21.

Trial types	**n**	**Mean**	**SD**
Sweet Critical	49	598.08	275.29
Control one	49	535.92	160.50
Control two	50	612.78	233.43
Treat Critical	49	604.33	274.46
Control one	50	596.82	247.28
Control two	47	629.72	297.16
Energy Boost Critical	49	609.18	300.88
Control one	48	609.40	274.62
Control two	48	585.88	179.60

Table 3.21 Mean response latencies and standard deviations comparing the critical trial with the control trials individually across the three lexical decision tasks (sweet, treat and energy boost).

A series of within-subject t-tests comparing the strength of cue-response association between the critical trial and each of the control trials were carried out for each lexical decision task (sweet, treat and energy boost). The results showed no statistically significant difference between any of the cue-response pairs analysed; sweet: critical-control one, t (47) = 1.173, p = 0.247, cohen's *d* = 0.28, critical-control two, t (48) = 0.103, p = 0.918, cohen's *d* = -0.06; treat: critical-control one, t (48) = 0.522, p = 0.604, cohen's *d* = 0.03, critical-control two, t (45) = 0.423, p = 0.674, cohen's *d* = -0.09; energy boost: critical-control one, t (46) = 0.775, p = 0.442, cohen's *d* = -0.00, critical-control two, t (46) = 0.037, p = 0.971, cohen's *d* = 0.09.

3.6.4.2.4.2 Analysis of averaged reaction time scores for critical and control trials across the three tasks.

The mean and SDs calculated for each trial type (critical trial, control one, and control two) are displayed in Table 3.22.

Trial types	**n**	**Mean**	**SD**
Critical	47	590.24	207.56
Control one	48	571.19	149.65
Control two	45	600.32	156.03

Table 3.22 Mean response latencies and standard deviations comparing the averaged reaction times of the critical trial with the control trials across the three lexical decision tasks (sweet, treat, energy boost).

Within-subject t-tests comparing the strength of cue-response association between the critical trial and each of the control trials revealed no significant difference between the critical trial and control one, $t\ (44) = 0.171$, $p = 0.865$, cohen's $d = 0.11$, or between the critical trial and control two, $t\ (42) = 0.479$, $p = 0.634$, cohen's $d = -0.05$.

3.6.4.2.5 Relationship between self-report measure of automaticity and RT scores

Self-Report Habit Index (SRHI) measures were employed to obtain a second measure of automaticity (with the first measure of automaticity being RT scores on the lexical decision tasks). Bivariate correlations (Pearson) between cue-response association strength (control two trial minus the critical trial; i.e. critical cue-neutral response minus critical cue-critical response) and the three sets of SRHI scores (need something sweet, need a treat, need an energy boost) were calculated for each lexical decision task separately and shown in Table 3.23. A calculation of the control two trial minus the critical trial was used instead of raw RT scores in order to control for some participants responding faster than others overall. It was predicted that higher SRHI scores would be significantly positively correlated with reaction time performance on the critical trial (control two minus critical) of the corresponding lexical decision task.

Strength of Cue-Response (RT)	n	SRHI score		
		Sweet	*Treat*	*Energy*
Sweet - Control two minus Critical	49	-0.248	.	.
Treat - Control two minus Critical	46	.	-0.116	.
Energy Boost - Control two minus Critical	47	.	.	0.006

Table 3.23 Pearson correlations between the RT score of the critical trial (control two minus critical) for each individual lexical decision task and SRHI scores for the corresponding critical cue (either sweet, treat, or energy boost).

Table 3.23 shows that none of the variables correlated significantly. These findings suggest that self-reported habit scores and RT scores on the critical trials (control two minus critical) failed to act as complimentary measures of automaticity. This was contrary to prediction. Furthermore, only the relationship between performance on the lexical decision task and the SRHI for 'energy boost' was in the predicted direction. The correlation was however extremely small, effectively indicating no correlation between the variables.[22]

[22] The correlation analysis was also repeated by including 1) only SRHI items measuring automaticity (i.e. items 2,3,5,8 and 10), 2) participants highest SRHI score across the three measures (sweet, treat, and energy boost) and the RT of the critical trial (control two minus critical) which corresponded to the SRHI scale of which the highest level of automaticity was scored, and 3) the latter repeated but including only SRHI items measuring automaticity. None of the correlations reached statistical significance. Correlations ranged between -0.299 to 0.526. Furthermore, to rule out the possibility that the insignificant findings were cause by chocolate consumption not being an automatic behaviour in response to the different thought cues for many of the participants, the analysis was conducted by including only participants who indicated high automaticity (i.e. scored above 24 on the SRHI; Lally, Van, Jaarsveld, Potts & Wardle, 2010). The new n values for the thought cues were; sweet = 29, treat = 32, energy boost = 27. Again, no significant correlations were evident between SRHI scores (above 24 only) and the strength of the cue-response (RT, control two minus critical trial). Correlations ranged between -0.150 and 0.247.

3.6.4.2.6 Repetition of section 'strength of cue-response association' including only those participants who scored over 24 on the SRHI measures.

3.6.4.2.6.1 Analysis of individual reaction time scores for critical and control trials across each of the three lexical decision tasks.

Given that there were no significant differences found when comparing the strength of the cue-response association between the critical and the control trials across the whole sample, the data were re-analysed using only those who reported high automaticity for the behaviour, eating chocolate. It was acknowledged that the non-significant differences previously reported may be due to the fact that, for some participants, eating chocolate was not automatic. Thus, including those individuals who reported high automaticity was expected to provide more reliable and informative findings.

The mean and SDs calculated for each trial type (critical trial, control one, and control two) are displayed in Table 3.24.

Trial types	**n**	**Mean**	**SD**
Sweet Critical	29	621.14	330.08
Control one	29	511.72	149.37
Control two	29	573.52	178.41
Treat Critical	31	610.26	300.22
Control one	32	594.63	229.02
Control two	30	648.97	318.05
Energy Boost Critical	26	611.08	311.77
Control one	26	607.81	286.89
Control two	26	567.35	152.37

Table 3.24 Mean response latencies and standard deviations comparing the critical trial with the control trials individually across the three lexical decision tasks (sweet, treat and energy boost) including only those who scored highly (24 or above) on the SRHI measures.

A series of within-subject t-tests comparing the strength of cue-response association between the critical trial and each of the control trials were carried out for each lexical decision task (sweet, treat and energy boost). The results showed significant differences between; sweet: critical-control one, t (28) = 2.164, p = 0.041, cohen's $d = 0.43$, and treat: critical-control one, t (31) = 2.030, p = 0.051, cohen's $d = 0.06$. No significant differences were found between the following paired analyses: sweet: critical-control two, t (28) = 1.001, p = 0.325, cohen's $d = 0.18$; treat: critical-control two, t (31) = 0.684, p = 0.499, cohen's $d = -0.13$; energy boost: critical-control one, t (26) = 1.993, p = 0.057, cohen's $d = 0.01$, critical-control two, t (26) = 0.919, p = 0.366, cohen's $d = 0.18$, though the critical-control one trial analysis for 'energy boost' was nearing significance.

3.6.4.2.6.2 Analysis of averaged reaction time scores for critical and control trials across the three tasks.

The mean and SDs calculated for each averaged trial type (critical trial, control one, and control two) are displayed in Table 3.25.

Trial types	**n**	**Mean**	**SD**
Critical	27	604.85	185.32
Control one	31	574.35	162.49
Control two	24	589.79	162.08

Table 3.25 Mean response latencies and standard deviations comparing the averaged reaction times of the critical trial with the control trials across the three lexical decision tasks (sweet, treat, energy boost) including only those who scored highly (24 or above) on the SRHI measures.

A within-subject t-tests comparing the strength of cue-response association between the critical trial and each of the control trials revealed no statistically significant difference between the critical trial and control one, t (34) = 1.008, p = 0.321, cohen's $d = 0.18$, or between the critical trial and control two, t (32) = 0.098, p = 0.923, cohen's $d = 0.09$.

3.6.4.2.7 Reasons for wanting to reduce chocolate consumption

Participants were asked to provide a reason for why they wanted to reduce the amount of chocolate they currently consume. Analysis of this qualitative data showed that the reasons could be categorised under three distinct headings; health (n = 41), weight (n = 18) and cost (n = 8). Some participants provided more than one reason, thus their answer was categorised under each related heading. Three participants failed to provide 'actual' reasons for wanting to reduce chocolate consumption, instead only general statements about their chocolate eating habits were provided (e.g. I frequently eat chocolate and want to reduce eating it to only once a week).

3.6.4.2.8 Effects of sex and dietary status on self-report and behavioural automaticity scores.

Analyses were carried out to identify the effects of participant sex and dietary status on self-report (SRHI) and behavioural automaticity scores (lexical decision task RTs).

Females (n=31)	***Currently Dieting (n=7)***	***Not Dieting (n=24)***
SRHI-Sweet	26.43 (11.96)	29.33 (10.89)
SRHI-Treat	26.14 (11.28)	28.33 (11.82)
SRHI-Energy	25.00 (9.92)	25.70 (11.01)
Critical Trial-Sweet	485.57 (88.08)	614.33 (316.42)
Critical Trial-Treat	575.29 (202.43)	546.75 (211.77)
Critical Trial-Energy	514.71 (89.94)	586.04 (258.59)
Males (n=19)	***Currently Dieting (n=2)***	***Not Dieting (n=17)***
SRHI-Sweet	17.50 (4.95)	25.65 (12.55)
SRHI-Treat	18.00 (4.24)	26.06 (11.40)
SRHI-Energy	20.00 (1.41)	21.29 (12.16)
Critical Trial-Sweet	652.50 (81.32)	616.13 (367.06)
Critical Trial-Treat	590.00 (29.70)	705.19 (373.19)
Critical Trial-Energy	665.00 (155.56)	678.25 (414.46)

Table 3.26 Means (and SDs) on the SRHI and critical trial RT measures according to sex and diet status.

A 2-way MANOVA (with the three individual SRHI measures and critical trial RT scores for sweet, treat and energy boost) showed no significant main effects of sex (SRHI-sweet, $F(1, 46) = 1.621$, $p = 0.210$; SRHI-treat, $F(1, 46) = 1.162$, $p = 0.287$; SRHI-energy, $F(1, 46) = 1.261$, $p = 0.268$; critical trial-sweet, $F(1, 46) = 0.231$, $p = 0.633$; critical trial-treat, $F(1, 46) = 0.368$, $p = 0.547$; critical trial-energy, $F(1, 46) = 0.745$, $p = 0.393$) or diet status (SRHI-sweet, $F(1, 46) = 1.127$, $p = 0.294$; SRHI-treat, $F(1, 46) = 0.984$, $p = 0.327$; SRHI-energy, $F(1, 46) = 0.032$, $p = 0.860$; critical trial-sweet, $F(1, 46) = 0.032$, $p = 0.860$; critical trial-treat, $F(1, 46) = 0.031$, $p = 0.860$; critical trial-energy, $F(1, 46) = 0.074$, $p = 0.787$) on any measure. There were insufficient number is each cell (males = 19, females = 31, dieting = 9, not dieting = 41) in order to carry out further tests for interactions.[23]

3.6.4.2.9 Main observations

The main findings from this preliminary study suggested that the analysis of the strength of cue-response association was partially supported. Only when presented with the cues 'need something sweet' and 'need a treat' did participants respond significantly faster on the critical trial compared to the control two trial. These findings suggest that participants responded more automaticity when the critical cue (e.g. need something sweet) preceded the word 'chocolate' compared to when the critical cue preceded a neutral word (e.g. aeroplane). None of the participants responded significantly faster to the critical trial compared to the control two trial. Reaction time scores were however relatively similar across all trial types. Furthermore, the findings showed no significant relationship between the SRHI measure and reaction time scores on the LDTs, suggesting that habit strength did not correlate with the LDT measure of automaticity. Further investigation is needed to confirm this. The results also suggested that the SRHI and LDT may be measuring two different things given that contrary to prediction, higher SRHI scores were not significantly positively correlated with reaction time performance

[23] For exploratory purposes only, the analysis was repeated but looking at both males (n=19) and current dieters (n=9) despite the reduced sample sizes. The findings were more varied compared to when these participants were excluded from the analysis. It was therefore suggested that only females should be recruited to follow-on studies.

on the critical trial (control two minus critical) of the corresponding lexical decision task.

Despite this preliminary study not producing findings consistent with predictions, the sample size used in this preliminary study was considerably smaller than that used in the main study (Study Three). The recruitment criteria were also made more stringent to avoid variation within the data. In view of these changes, the originally designed SRHI and LDT measures was used in Study Three in an attempt to answer the question; how does a mindfulness-based cognitive defusion strategy work?

3.7 Reminder of the aims and hypotheses of the current study

The first aim of the current study (Study Three) was to demonstrate the reliability of the previous study by replicating the findings. Study Two showed support for the hypothesis that cognitive defusion works by interrupting automatic links between chocolate consumption and thoughts that cue chocolate consumption. The second aim of the current study was to further investigate how cognitive defusion changed the self-control related health behaviour, resisting chocolate. This was achieved by exploring the effects of the defusion strategy on other measures of automaticity, alongside other potential mediators (Neal et al., 2012; Webb & Sheeran, 2007). It was hypothesised that cognitive defusion works by either (a) reducing automatic links between chocolate-related thoughts and chocolate consumption (i.e. weakens cue [thoughts] – response [chocolate] links), and/or (b) by increasing the accessibility of competing goals in the presence of the cue (i.e. strengthens cue [thought] – goal [health/weight] links).

3.8 Method

3.8.1 Participants

Female students (N = 113) from Swansea University who expressed an interest in reducing their chocolate intake took part in a study on 'chocolate eating'. Only those who met the inclusion criteria (i.e. female adults who were not pregnant or suffering from a medical condition which affected what could and could not be eaten) were invited to participate. On attendance of all four sessions, participants received a payment of £20. The study received ethical approval from Swansea University's Psychology Department Research Ethics Committee.

3.8.2 Design and randomisation

The study employed a mixed-subjects design with three conditions (cognitive defusion, relaxation, and monitoring [task only]). Laboratory measures were taken at four separate sessions, conducted over a two week period. Participants were alternatively allocated to either the intervention or one of two control conditions using a single blind randomisation protocol.

3.8.3 Materials and apparatus

3.8.3.1 Questionnaires completed during Session 1 only (week one).

3.8.3.1.1 Demographic

Participants completed a demographics questionnaire asking for information regarding age and diet status (see appendix BB).

3.8.3.1.2 Behavioural goals

Two measures of behavioural goals were completed (see appendix CC). The first required an open response ("please give the main reason why you want to reduce the amount of chocolate you currently consume") whereas the second required a closed response ("out of these two options [health and weight] which most closely relates to the reason why you want to reduce the amount of chocolate you currently consume?"). The purpose of these measures was to identify participants' primary motivational factor for wanting to reduce their chocolate intake.

3.8.3.2 Questionnaires completed during Session 3 only (week two)

3.8.3.2.1 Need for affect scale

Maio and Esses's (2001) Need for Affect scale comprises 26 items. The scale ranges from -3 (strongly disagree) to +3 (strongly agree) and is used to rate the extent to which participants' agree with items such as "I would prefer not to experience either the highs or lows of emotion" and "I feel like I need a good cry every now and then". The scale can be divided into measuring a person's level of motivation to approach emotions and a person's level of motivation to avoid emotions. A score on this scale was calculated by first, reverse scoring the negatively keyed items, and second summing the scores for the 13 items assessing motivation to approach emotions and the 13 items assessing the motivation to avoid emotions separately. Higher scores represented higher levels of the attribute. To obtain a total NFA score, the scores from the 'approach' subscale were subtracted from the 'avoidance' subscale. The questionnaire was found to have only moderate internal consistency, with a Cronbach alpha score of .66.

3.8.3.3 Questionnaires completed during Sessions 3 and 4 (week two)

3.8.3.3.1 Self-report habits index

Habit strength regarding eating chocolate in response to either 'needing something sweet', 'needing a treat' or 'needing an energy boost' was assessed with the self-reported habit index (SRHI) (Verplanken & Orbell, 2003). The scale comprises 12 items. An example item measuring habit was "Eating chocolate when I need something sweet is something I do without thinking". All items were measured on a five-point scale ranging from 'I completely disagree' (0) to 'I completely agree' (4). Coefficient alphas of the measure at baseline and at follow-up were .75 and .90 respectively, which indicated moderate to high internal reliabilities of this 12-item questionnaire. The items of each respective SRHI were summed to obtain an overall score.

3.8.3.4 Questionnaires completed during Session 4 only (week two)

3.8.3.4.1 Need for cognition

The need for cognition scale (Cacioppo, Petty & Kao, 1984) uses 18 items to assess individual's tendency to engage in and enjoy thinking. Participants used a scale from -4 (very strong disagreement) to +4 (very strong agreement) to rate the extent to which they agree with items such as "I only think as hard as I have to" and "I really enjoy a task that involves coming up with new solutions to problems". A score on need for cognition was first calculated by reverse scoring the negatively keyed items. Next, the final score for each participant was calculated by tallying the individual scores from each of the 18 questions. Higher scores indicated a greater need for cognition. This questionnaire was found to have extremely poor internal consistency (Cronbach alpha score .32).

3.8.3.4.2 Suspicion probe

To explore participants' suspicion about the main aims of the study, a brief questionnaire was completed (see appendix DD). Questions consisted of "Do you think you were in an intervention or control group?", "Did you notice anything unusual about the chocolate in the bag?", "How many chocolates were in the bag?" and " Other than the amount of chocolate consumed, do you have any other ideas about what is being investigated in this study?". The suspicion probe used in the current study was the same as that used in Study Two.

3.8.3.4.3 Measure of strategy adherence

To identify participant adherence to using the taught strategy to help them resist eating chocolate, participants were asked the question; "How much did you use the strategy?" Responses were made using a Likert scale ranging from 1 (not at all) to 4 (always) (see appendix EE).

3.8.3.4.4 Self-reported strategy evaluation

Participants were asked to rate how helpful they found their participation in the study in terms of reducing their chocolate consumption using a five-point Likert scale (1 = not at all helpful, 5 = extremely helpful) (see appendix FF).

3.8.3.4.5 Additional adherence questions

Participants were asked to report the extent to which they kept the bagged chocolates in their possession over the five-days (1= not at all or hardly at all, 3 = nearly all the time). Additionally, participants were asked how sure they were that they had not missed any entry from the diary measures using a five-point scale ranging from 1 (not at all sure) to 5 (very sure) (see appendix GG).

3.8.3.5 Measures of chocolate consumption

The current study used the same two measures of chocolate consumption as those used in Study 2 (number of chocolates eaten from the bag and total amount of chocolate, in grams, recorded in the diary; see section 3.2.3.4.2). This study however used two chocolate diaries in total, one completed during week one and one completed during week two. The only difference between the diaries was that the diary completed during week one instructed the participant to eat chocolate as they 'normally' would (i.e. not to change their chocolate eating habits as a result of taking part in the study), whereas the diary completed during week two instructed participants to try to resist eating any chocolate or chocolate-related product, recording items only where they failed to resist eating chocolate.

3.8.3.6 Lexical decision tasks

The study employed two LDTs. One aimed to identify if different critical cues (i.e. thoughts) prime behavioural responses to the word 'chocolate'. The other aimed to identify the strength of the association between these thoughts and goals for reducing chocolate consumption. There were three different versions of the critical cue prime task (need something sweet, need a treat, need an energy boost). For the goals task, there were six different versions, one for each of the critical cues corresponding to weight and one for each of the critical cues corresponding to health. The critical cues and behavioural goals used in the LDTs were chosen based on the findings of pilot studies previously conducted (see section 3.6). Participants completed only one version of each LDT which related most closely to them as an individual. The automaticity LDT was determined by participant's highest score on the SRHI measures (prime; need something sweet, need a treat, or need an energy boost). For the automaticity LDT, 'chocolate' was always used as the target word. The goal LDT was determined by participant's highest score on the SRHI measures (prime) and the option selected on the closed goals measure (target word; health or weight).

3.8.3.6.1 Chocolate prime tasks

The lexical decision tasks used were similar to those used in Pilot Study Three and the Preliminary Study (i.e. three individual tasks differing by the critical prime cue displayed, either 'need something sweet', 'need a treat', or 'need an energy boost'; see sections 3.6.3 and 3.6.4) except that each task consisted of three blocks of 20 trials. There was one critical trial (i.e. the target word was shown after being preceded by the critical cue prime phrase [critical cue-critical response]), two control trials (control one – a matched target word was shown after being preceded by the critical cue prime phrase [critical cue-neutral response]; control two - the target word was shown after being preceded by a matched cue prime [neutral cue-critical response]), seven neutral trials (a neutral matched target word was shown after being preceded by a matched neutral cue prime) and ten non-word trials (a neutral matched non-word target was shown after being preceded by a matched neutral cue prime). Thus 3/60 of the trials were critical with 50% words and 50% non-words. The purpose of the 51 filler trials which were unrelated to the target words (i.e. critical cues) was to disguise the tasks' purpose. All trials were randomised within blocks and ran continuously (i.e. without any time breaks between blocks). Each task commenced with eight practice trials, followed by four buffer trials. There was a 'participant controlled' time break between the practice and buffer trials.

3.8.3.6.2 Goal tasks

The goals LDTs were the same as the chocolate prime tasks except that the target words, filler words and non-words were changed. The target word was either 'weight' or 'health' and all filler and non-words were matched accordingly in length.

See appendix HH for a detailed description of the different trials included in the chocolate prime and goal LDTs.

3.8.3.7 Intervention

The intervention drew on the mindfulness concept, cognitive defusion. The same written booklet, metaphor (e.g. mindbus) and practice exercise as that used in Study Two (see section 3.2.3.6) were employed.

3.8.3.8 Control

Two different control groups were used. In one group participants were taught the same muscle relaxation technique as that used in Study Two (see section 3.2.3.7). This technique aimed to help participants resist eating chocolate by taking the stress out of cravings and also by helping them to be in a physical and mental state whereby they are better able to deal with difficult situations. In the other group participants were told to simply monitor their chocolate eating behaviour. This strategy was also taught to the relaxation and defusion groups. Participants were told that although they should try their best to not eat chocolate resisting temptation is difficult, therefore if they do not always manage this they should record what chocolate or chocolate-related product they consumed in the chocolate diary provided. The purpose of this was to see if writing down what they had eaten helped them to resist temptation when they next experienced a chocolate craving. In order to match the control groups teaching material with the intervention groups teaching material, written instruction booklets were given to all participants (see appendices O, defusion; Q, relaxation and II, monitoring only). The relaxation group also completed a practice exercise in a similar manner to the defusion group (i.e. five minutes whereby they were asked to utilise the strategy). As a practice exercise was not considered appropriate for the monitoring only control group, these participants were given the same length of time (measured using a stopwatch) to complete a word search and anagram task. The words used in these tasks were the same as some of those used in the relaxation condition.

3.8.4 Procedure

The study was conducted over a 12-day period. Participants met with the researcher on each Monday and Friday. The study commenced on Monday of week one and concluded on Friday of week two. Participants were divided into three groups (cognitive defusion n = 56, relaxation n = 24, monitoring n = 28).

3.8.4.1 Week one – Monday (Session 1)

Participants first completed a written consent form (see appendix JJ). Next, participants were asked to provide demographic information (e.g. age and diet status) and also a reason for why they wanted to reduce their current chocolate intake. This acted as a measure of behavioural goals (i.e. what is driving them to reduce their chocolate consumption). Both an open and a closed response was required, with the open response being completed first. Following this, participants were given a 'chocolate diary' and provided with both verbal and written instructions (i.e. an example page) on how to fill it in correctly. Their task was to record all chocolate and chocolate-related products consumed over the next five days (Monday-Friday). Participants were told to eat 'normally' during this period, therefore not to change their chocolate eating habits as a result of taking part in the study.

3.8.4.2 Week one – Friday (Session 2)

At this session, participants returned their chocolate diary. The researcher discussed each recorded entry with the participant to ensure that all the information had been recorded honestly and accurately. Further details were obtained from the participant where product details were vague or incomplete.

3.8.4.3 Week two – Monday (Session 3)

At the beginning of this session, participants completed a series of questionnaires. These consisted of three Self-Report Habit Index (SRHI) measures and the Need for Affect Scale (NAS). The order of the SRHI measures was counterbalanced within participants. The NAS acted as a filler task. The purpose of this was to distract the participants from making a connection between the SRHI measures and the lexical decision tasks. The NAS was also completed in order to allow the researcher sufficient time to score the three SRHI measures. The highest scored SRHI measure determined which critical prime lexical decision task was selected for each participant.[24] The goals lexical decision task was selected based on which of the closed responses (health or weight) was circled by the participant. The two LDTs were completed in a counterbalanced order within participants. Next, participants were taught their allocated strategy (cognitive defusion, relaxation, monitoring) which they had been randomly allocated. Once the practice exercise has been completed and the task for the next five-days had been explained fully, participants were given a small bag of chocolates and instructed to keep these chocolates in their possession as much as possible until the end of the study. A second chocolate diary was also given to participants.

3.8.4.4 Week two – Friday (Session 4)

First, participants completed three SRHI measures. These were the same measures as those completed at Session 3. Next, a filler task, the Need for Cognition Scales (NFC), was completed prior to the completion of the two lexical decision tasks. Again, the LDTs were the same as those completed at Session 3. All questionnaires and LDTs were performed in an identical order to those at the Monday session. Lastly, the number of bagged chocolates was counted and recorded and each diary entry discussed again to ensure that the information was reported in full and without error. Participants also answered questions related to strategy adherence, in addition to completing a suspicion

[24] If a participant scored equally on more than one SRHI measure (e.g. a participant scored 21 for 'need something sweet', 21 for 'need a treat' and 16 for 'need an energy boost') the first high score measure completed in the counterbalanced order was used to determine which lexical decision task was selected. In other words, if the participant received the three SRHI measures in the counterbalanced order; need a treat, need something sweet and need an energy boost, and scored the same on the 'treat' and 'sweet' SRHI measures, then the 'need a treat' version of the LDT would have been completed.

probe measure. Before leaving, participants received payment, were thanked for taking part, and debriefed fully (see appendix KK).

3.9 Results

3.9.1 Data screening

3.9.1.1 Non-adherence to using the taught strategy

Two participants in the relaxation group reported that they did not use the taught strategy *at all* when they experienced a chocolate craving during week two of the study. Given that the study aimed to explore the effectiveness of using the different strategies on resisting chocolate temptation, these two participants did not allow for this to be investigated, and were excluded from subsequent analyses (N = 111; cognitive defusion, n = 57, relaxation-control, n = 26, no-task control, n = 28).[25]

3.9.1.2 Suspicion probe

The suspicion probe data showed that two participants (one from the defusion group and one from the relaxation group) noticed that the corners had been cut on the bagged chocolates. These participants were therefore excluded. This resulted in 111 participants for the chocolate diary measure (n = 57 in the defusion group, n = 26 in the relaxation group and n = 28 in the no-task group) and 109 participants for the bagged chocolate measure (n = 56 in the defusion, n = 25 in the relaxation group, and n = 28 in the no-task control group). Being aware of these identification marks may have caused the participants to guess that the number of chocolates eaten from the bag was being monitored, and thus, a main dependant variable of the study.

3.9.1.3 Removal of outliers

Outliers were first detected by identifying scores above or below 3.5 standard deviations (SDs) from the mean. One participant in the relaxation group was removed from the sample due to their chocolate intake being 3.5 SDs above the mean (as measured by the chocolate diary during week two). No outliers were found for any questionnaire measure at either baseline or follow-up using this identification method. This resulted in 108

[25] Smaller control samples were recruited in comparison to the defusion sample given that it was anticipated that some analyses of the data would consist of the two control groups being combined, thus equalling similar numbers in both the experimental and control groups.

participants in total (n = 56 in the defusion group, n = 24 in the relaxation group and n = 28 in the no-task group).

Outliers were also detected by looking at the Lexical Decision Task (LDT) data. The treatment of outliers followed a four-stage process to ensure that the data accurately represented *typical* reaction time (RT) scores whilst still retaining a sufficient sample size to ensure the study was adequately powered. First, at the individual level (i.e. for individual RT scores) errors (i.e. incorrect responses, such as a 'word' being recognised as a 'non-word') were removed. Across the whole sample (N = 108) 50 individual trials (out of a total 4068) were errors (1.2%). The mean percentage of errors across participants was 1.23% (range 1 [2.78%] – 4 [11.11%]). For the 36 individual trials across both the prime and the goal LDTs (i.e. 18 trials for the prime task [9 for baseline and 9 for follow-up] and 18 trials for the goal task [9 for baseline and 9 for follow-up]), 77 participants made no errors, 28 participants made one error, 4 participants made two errors, 2 participants made three errors, and 2 participants made four errors. Although errors were removed from the dataset and thus, from subsequent analyses, because the number of errors made were fairly low and consistent across the sample, no participants (i.e. complete data for the LDT amongst those who made errors) were excluded.

Second, individual trials with RTs <100 or >4000 ms were identified given that extremely low RTs cannot be valid in a lexical decision task, and extremely high RTs tend to reflect lapses of attention or a second thought about the decision. All participants scored between 100 and 4000 ms, therefore no outliers were detected using this process.

Third, means were calculated at the individual level for each trial type for the chocolate-prime and goal-target tasks at both baseline and follow-up (baseline; chocolate-prime - critical trial, chocolate-prime - control trial one, chocolate-prime - control trial two, goal-target - critical trial, goal-target - control trial one, goal-target - control trial two; follow-up; chocolate-prime - critical trial, chocolate-prime - control trial one, chocolate-prime - control trial two, goal-target - critical trial, goal-target - control trial one, goal-target - control trial two). No participants were found with extreme mean RTs (i.e. less or greater than 3.5 SDs) on the critical or control trials of the LDT, therefore no data were removed.

Fourth, the number of trials removed for each of the nine trial types (critical trial, control trial one, and control trial two, each repeated three times) for the two tasks (chocolate-prime and goal-target) at both time points (baseline and follow-up) were identified. The data showed that only one participant had 33% of data removed (i.e. exclusions of critical trial scores, not including filler trials), whereas the rest of the sample had 22% or less data removed from the different trial types. This suggested that there was sufficient data available for the majority of the sample therefore no data was justified for exclusion.

In addition to identifying outliers, histograms were created to check the normal distribution of the LDT data (i.e. reaction time scores). Histograms of participants' mean reaction latencies showed that the data were satisfactorily normally distributed, with no detrimental skewness evident.

3.9.1.4 Summary

From the different data screening processes carried out, five participants were removed from the dataset in total (4 from the relaxation group and 1 from the defusion group). This reduced the original sample size N = 113 to N = 108 (defusion, n = 56; relaxation, n = 24; no-task, n = 28).

3.9.2 Group demographics

Demographic information was examined to inform of any noteworthy baseline group differences which may affect later analysis.

3.9.2.1 Age and diet status

Demographic data for the sample were first examined for differences in gender and diet status using independent t-tests and chi-square tests of independence.

	Defusion (n=56)	Relaxation (n=24)	No task (n=28)
Age (M, SD)	22.75 (6.45)	21.92 (5.73)	21.50 (4.10)
Currently dieting (% yes)	7.0	8.0	11.0

Table 3.27 Mean and standard deviations of age and percentage of diet status for the different groups.

For each of the three groups, participants' age and current diet status were shown to be very similar. In support of this observation, three independent t-tests showed no significant difference in age between any of the groups (defusion – relaxation, $t(78) = 0.547$, $p = 0.586$; defusion – no-task, $t(82) = 0.934$, $p = 0.353$; relaxation – no-task, $t(50) = 0.305$, $p = 0.762$). Chi-square analysis also showed no significant group differences in diet status, $\chi^2(2, N = 108) = 0.312$, $p = 0.856$. The majority of participants were in their early to mid-twenties and not on a diet (i.e. not actively trying to lose weight by changing their eating habits).

3.9.2.2 Task adherence

3.9.2.2.1 Abstinence from chocolate

More than half (58.9%) of the participants in the defusion group, 41.6% of participants in the relaxation group and 53.6% of participants in the no-task group successfully remained abstinent from chocolate during the second week of the study. This was according to the bagged chocolate and diary measure.

3.9.2.2.2 Possession of bagged chocolates

Participants followed instructions around keeping the bagged chocolates with them at 'virtually all times'.

	Defusion (n=56)	Relaxation (n=24)	No Task (n=28)
Most of the time	13.0	17.0	29.0
Nearly all the time	87.0	83.0	71.0

Table 3.28 Reported percentage of time the bagged chocolates were kept in the participants' possession for the mindfulness and non-mindfulness control groups.

Table 3.28 shows that the majority of participants across all three groups kept the bagged chocolates in their possession nearly all of the time during week two of the study. No participants in either the mindfulness or control groups reported that they keep the chocolates with them 'not at all or hardly at all'. All returned chocolates in the bags still contained the distinctive mark (i.e. indicating that no chocolates had been substituted).

3.9.2.3 Accuracy of recorded diary entries

Participants were asked to report how sure they were that they had accurately and fully recorded all chocolate products consumed during week two in the diary provided. The majority of participants in all three groups reported being 'very sure' they had completed the diary in full and there were no unrecorded entries of chocolate consumption (cognitive defusion, 93%; relaxation, 92%; no-task, 93%). The remainder of the participants in the three groups reported being 'fairly sure' that all chocolate-products consumed had been recorded. Reasons including being under the influence of alcohol, not having access to the diary at the time of eating, or simply forgetting, were given. These participants were still included in the analysis given that they were mostly sure that the diary was completed in full, but were erring on the side of caution as they had been asked to rate *honestly* how sure they were that everything eaten was recorded.

3.9.3 Main analyses

3.9.3.1 Effects of cognitive defusion on chocolate consumption (Aim 1)

To identify any effects of the cognitive defusion strategy on chocolate consumption relative to the control strategies (relaxation and no-task), chocolate intake for both measures (diary and bagged chocolates) were compared across the three groups. The diary measured chocolate consumption in grams whereas the bagged chocolates measured chocolate consumption in terms of the overall number of chocolates eaten. For the diary measure, participants were asked to record accurate gram weight of the chocolate or chocolate-related product consumed by looking at the products' packaging. If exact gram weight was not given, participants were asked to provide the name, approximate size and brand of the product, allowing the research to obtain the gram weight from the brand website, or from supermarkets (e.g. Tesco).

Given that the data showed positive skewed distributions for both measures of chocolate consumption (bagged chocolate and diary), all analyses were conducted using non-parametric tests.

3.9.3.1.1 Diary

Table 3.29 compares chocolate consumption for groups practicing different mindfulness (cognitive defusion) and non-mindfulness (relaxation and no-task) strategies at baseline and follow-up. Chocolate consumption as recorded by the diary provides a measure of all 'other' chocolates and chocolate-related products (i.e. non-bagged chocolates).

	Week one (baseline)				Week two (follow-up)				Change scores			
	Mean (SD)	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum	Mean	SD	Minimum	Maximum
Defusion (n=56)	581.49	430.09	66.00	2536.00	25.18	47.93	0.00	234.50	556.71	412.94	66.00	2471.00
Relaxation (n=24)	656.26	451.16	166.50	2093.00	52.01	70.26	0.00	283.00	604.25	451.55	94.50	2055.00
No-task (n=28)	506.39	284.99	157.10	1357.25	52.54	94.81	0.00	390.00	453.84	283.29	70.10	1216.75

Table 3.29 Comparison of mean (and SD) chocolate consumption in grams (diary measure) across the three groups (mindfulness [cognitive defusion] and controls [relaxation and no-task]) at baseline and follow-up.

Mann-Whitney U tests showed no significant difference in terms of baseline chocolate consumption between the groups; defusion – relaxation, z = -0.866, p = 0.386, cohen's *d* = -0.17; defusion – no-task, z = -0.432, p = 0.666, cohen's *d* = 0.21; relaxation – no-task, z = -1.101, p = 0.271, cohen's *d* = 0.40. At follow-up, all three groups consumed less chocolate than at baseline. The relaxation group was shown to consume the greatest amount of chocolate and the defusion group the least amount of chocolate. When looking at the difference in the amount of chocolate consumed at follow-up compared to baseline, contrary to prediction, the most reduction was evident for the relaxation group (-546.34). More in line with the pre-stated hypotheses, the least reduction in chocolate consumption was evident for the no-task group (-469.29).

Using change scores, two Mann-Whitney U tests were carried out to explore if the identified reduction of 'other' chocolate consumed at follow-up compared to baseline significantly differed between the mindfulness (cognitive defusion) and control (relaxation, no-task) groups. The results showed no significant difference between either the defusion and relaxation groups (z = -0.441, p = 0.659, cohen's *d* = -0.11) or between the defusion and no-task groups (z = -0.925, p = 0.355, cohen's *d* = 0.29). These results suggest that practicing mindfulness (defusion) and non-mindfulness (relaxation and no-task) strategies had a similar effect on chocolate consumption and therefore fail to support the pre-stated hypothesis.[26] However, participants were told during week two of the study (follow-up) to resist chocolate, whereas they were told to 'eat normally' during week one (baseline). These change score analyses may therefore be concealing the effects of the defusion task given that consumption was not compared under the same conditions (i.e. like for like). As a result, Mann-Whitney U-tests were conducted to identify if there were any significant differences between the groups in terms of the amount of 'other' chocolates consumed at follow-up only. The results showed no significant difference between the defusion and no-task groups (z = -1.220, p = 0.223, cohen's *d* = -0.36). A trend towards significance was however shown between the defusion and relaxation groups (z = -1.822, p = 0.068, cohen's *d* = -0.45) with the relaxation group

[26] Non-significant findings were also found when the analysis was re-calculated with the control groups (relaxation and no-task) combined (n = 52), z = -0.341, p = 0.733.

consuming more chocolate at follow-up (M = 52.01, SD = 70.26) relative to the defusion group (M = 25.18, SD = 47.93).

3.9.3.1.2 Bagged chocolates

Table 3.30 compares the number of chocolates consumed from the bag for groups practicing different mindfulness (cognitive defusion) and non-mindfulness (relaxation and no-task) strategies at follow-up.

	Number of bagged chocolates consumed			
	Mean	**SD**	**Minimum**	**Maximum**
Defusion (n = 56)	0.82	2.36	0.00	14.00
Relaxation (n = 24)	1.75	3.50	0.00	14.00
No-task (n = 28)	1.00	2.37	0.00	11.00

Table 3.30 Comparison of mean (and SD) chocolate consumption (bagged chocolates) across the three groups (mindfulness [cognitive defusion] and controls [relaxation and no-task]) at baseline and follow-up.

Two Mann-Whitney U tests were carried out to compare the number of chocolates eaten from the bag in the mindfulness (cognitive defusion) and the control (relaxation, no-task) groups. These showed a non-significant difference between the defusion and relaxation groups (z = -1.788, p = 0.074) and between the defusion and no-task groups (z = -0.703, p = 0.482). This suggests that the defusion strategy did not significantly help to reduce the amount of chocolates consumed compared to the control strategies (relaxation and no-task), and thus the pre-stated hypothesis were not supported.[27]

3.9.3.1.3 Total amount of chocolate consumed (bagged and non-bagged chocolate combined)

To identify the overall amount of chocolate consumed (in grams) across the three groups, both measures of chocolate consumption ('other' chocolates and bagged

[27] Non-significant findings were also found when the analysis was re-calculated with the control groups (relaxation and no-task) combined (n = 52), z = -1.468, p = 0.142.

chocolates) were summed. To calculate this, first the total number of bagged chocolates eaten was re-coded from the total number of chocolates eaten to the total amount of chocolates eaten in grams at the individual level. Chocolates from the bag each weighed approximately 9.5 grams.

	Total grams of chocolate consumed
Defusion (n = 56)	32.98 (64.39)
Relaxation (n = 24)	67.85 (92.69)
No-task (n = 28)	62.04 (109.13)

Table 3.31 Comparison of mean (and SD) total chocolate consumption ('other' chocolate and bagged chocolates) in grams across the three groups (mindfulness [cognitive defusion] and controls [relaxation and no-task]).

Using Mann-Whitney U tests, statistically significant differences were not found between the defusion and no-task control groups ($z = -1.162$, $p = 0.245$, cohen's $d = -0.32$). The finding between the defusion and the relaxation group was however nearing significance ($z = -1.879$, $p = 0.060$, cohen's $d = -0.44$).

3.9.3.2 Effects of group on automaticity and goal accessibility (Aim 2)

Given that the analyses using change scores did not show a significant reduction in chocolate consumption by the defusion group compared to the control groups it is difficult to accurately explore how cognitive defusion works to reduce chocolate consumption. However, when consumption of 'other chocolates' (i.e. diary measure) at follow-up only was explored, a trend towards significance in the predicted direction was evident. Thus investigations were still carried out to identify any effects the different groups (mindfulness and non-mindfulness) had on levels of automaticity and goal accessibility. Each is explored individually; first, automaticity, and second, goal accessibility.

3.9.3.2.1 Automaticity

Automaticity was measured in two ways; 1) using reaction time scores (RTs) on a Lexical Decision Tasks (LDT) and 2) responses given on Self-Report Habit Index (SRHI) questionnaires.

3.9.3.2.1.1 Lexical decision task

This LDT aimed to explore the hypothesis that cognitive defusion works by reducing automatic links between chocolate-related thoughts and chocolate consumption (chocolate-prime task). The task included one critical trial and two control trials. The critical trial consisted of the critical cue being paired with the critical prime. Control trial one consisted of the critical cue being paired with the neutral prime. Control trial two consisted of the neutral cue being paired with the critical prime. For this chocolate-prime task, the critical cue was the word 'chocolate' and the critical cues were either 'need something sweet', 'need a treat' or 'need an energy boost'. Further details of the LDTs can be found in sections 3.6.3.4.3.1, 3.6.4.1.3.4 and 3.8.3.6.

	Group			
Prime Type	**Defusion**	**Relaxation**	**No-task**	**Total %**
Sweet	43.0	42.0	43.0	42.59
Treat	30.0	54.0	36.0	37.03
Energy boost	27.0	4.0	21.0	20.38

Table 3.32 Percentage of participants who completed each prime-type LDT for the mindfulness and non-mindfulness groups.

A chi-square test revealed that statistically, the percentage of participants who completed the LDT containing the critical prime 'need something sweet', 'need a treat' or 'need an energy boost' did not significantly differ between the defusion and control (relaxation, no-task) groups, χ^2 (4, N = 108) = 6.836, p = 0.145.

3.9.3.2.1.1.1 Chocolate-prime task

Given that there was no difference between the two control groups for chocolate consumption, in order to make the interpretation of the results more clear the following analyses for the chocolate-prime task were conducted with the control groups collapsed to form a single control group.

	Defusion (n=56)	Controls (n=52)
	Mean (SD)	**Mean (SD)**
Baseline		
Critical Trial	506.14 (142.82)	527.55 (187.59)
Control Trial One	512.23 (173.22)	493.63 (147.10)
Control Trial Two	564.37 (190.85)	551.97 (203.41)
Follow-up		
Critical Trial	440.90 (69.35)	474.68 (138.13)
Control Trial One	456.59 (76.32)	472.97 (169.17)
Control Trial Two	478.46 (80.69)	491.59 (134.01)

Table 3.33 Means and standard deviations of RTs for the critical and control trials in the chocolate-prime LDT at baseline and follow-up for the mindfulness and combined control groups.

A 2 (time; baseline, follow-up) x 2 (group; defusion, control) x 3 (trial type; critical, control one, control two) repeated measures ANOVA showed no significant main interaction between time, trial type and group, $F(2, 212) = 0.193$, $p = 0.825$, $\eta_p^2 = 0.002$, time and group, $F(1, 106) = 0.911$, $p = 0.341$, $\eta_p^2 = 0.009$, trial type and group, $F(2, 212) = 1.624$, $p = 0.200$, $\eta_p^2 = 0.015$, or time and trial type, $F(2, 212) = 1.854$, $p = 0.159$, $\eta_p^2 = 0.017$. There was also no significant main effect of group, $F(1, 106) = 0.182$, $p = 0.671$, $\eta_p^2 = 0.002$ though, a significant main effect of time, $F(1, 106) = 19.915$, $p = 0.001$, $\eta_p^2 = 0.158$ and trial type, $F(2, 212) = 10.823$, $p = 0.001$, $\eta_p^2 = 0.093$ was evident. The means indicated that RTs increased at follow-up (M = 468.37) compared to baseline (M = 526.04). It is though probably that these findings represent practice effects. Furthermore, mean RTs on the critical and control one trials were similar (M = 486.81, M = 485.87 respectively). RTs on the control two trial was however slower in comparison (M = 521.59) suggesting that the control two trial was responsible for the main effect of trial type evident. Post-hoc analyses using repeated measure t-tests supported this assumption, showing significant differences between critical-control two trials, $t(107) = 3.819$, $p = 0.001$ and control one-control two trials, $t(107) = 3.752$, $p = 0.001$. No significant difference was evident between critical-control one trials, $t(107) = 0.384$, $p = 0.702$.

In summary, the findings show that practicing a mindfulness strategy (cognitive defusion) did not significantly improve RTs on the LDT compared to a control strategy (relaxation or no-task). Thus, the findings suggest that levels of automaticity in the defusion group were not weakened given that higher RTs, which represent slower automaticity following relevant chocolate-related primes, were not evident. A significant main effect of trial type was also found to be caused by participants recognising the word 'aeroplane' (i.e. neutral word) slower when preceded by the critical prime 'chocolate'.

3.9.3.2.1.2 Self-report habit index scores

As previously stated, the hypothesis that the defusion strategy works by reducing automaticity was measured in two ways; 1) LDTs and 2) Self-Report Habit Index questionnaires. The following analysis explores the latter of these two methods. Each participant completed three SRHI measures at baseline. These were then repeated at the follow-up time point. The SRHIs were tailored specifically to the behaviours; eating chocolate when I need something sweet, eating chocolate when I need a treat, and eating chocolate when I need an energy boost.

	Defusion (n=56)	**Relaxation (n=24)**	**No-task (n=28)**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Baseline			
Sweet	32.34 (8.28)	30.38 (9.51)	36.12 (7.30)
Treat	31.20 (8.36)	32.21 (9.41)	33.82 (8.24)
Energy boost	25.73 (10.57)	24.46 (12.29)	28.75 (11.42)
Follow-up			
Sweet	27.77 (8.71)	26.17 (9.51)	29.21 (10.93)
Treat	26.96 (10.27)	26.00 (10.60)	28.89 (11.50)
Energy boost	22.82 (11.14)	19.25 (11.28)	26.07 (13.30)

Table 3.34 Means and standard deviations of scores for the three self-report habit index measures at baseline and follow-up for the mindfulness and non-mindfulness groups.

A 2 (time; baseline, follow-up) x 3 (group; defusion, relaxation, no-task) x 3 (SRHI; sweet, treat, energy boost) repeated measures ANOVA also showed no significant main interaction between time, prime and group, $F (4, 210) = 1.401$, $p = 0.235$, $\eta_p^2 = 0.001$, time and group, $F (2, 105) = 0.244$, $p = 0.784$, $\eta_p^2 = 0.004$, prime and group, $F (4, 210) = 0.716$, $p = 0.582$, $\eta_p^2 = 0.004$ or time and prime, $F (2, 210) = 2.272$, $p = 0.106$, $\eta_p^2 = 0.044$. There was also no significant main effect of group found, $F (2, 105) = 1.937$, $p = 0.149$, $\eta_p^2 = 0.003$ though, a significant main effect of time, $F (1, 105) = 28.86$, $p = 0.001$, $\eta_p^2 = 0.224$ and prime, $F (2, 210) = 35.04$, $p = 0.001$, $\eta_p^2 = 0.369$ was evident. The means indicated that SRHI scores decreased at follow-up (M = 25.97) compared to baseline (M = 25.97). This was in line with the pre-stated predictions. Mean SRHI scores for each prime (sweet, treat, and energy boost) also showed the most reduction for the 'energy' prime (M = 24.55) compared to the 'sweet' prime (M = 30.33) or the 'treat' prime (M = 29.68). A series of post-hoc repeated measure t-tests also inferred that the main effect of prime was represented by a greater decrease in automaticity amongst those who reported an association between the thought-cue 'need an energy boost' and chocolate. This was demonstrated by significant differences between the primes; sweet-energy boost, $t (107) = 7.876$, $p = 0.001$ and treat-energy boost, $t (107) = 5.905$, $p = 0.001$. No significant differences were found between the primes, sweet-treat, $t (107) = 1.290$, $p = 0.200$.

In summary, these findings suggest that practicing a mindfulness strategy (cognitive defusion) did not significantly decrease self-reported automaticity scores compared to a control strategy (relaxation or no-task). A reduction in automaticity was evident at follow-up compared to baseline for all groups, though more so amongst participants who reported eating chocolate in response to needing an energy boost.[28]

The null findings presented previously may have resulted from links between these chocolate-related thoughts (need something sweet, need a treat, and need an energy boost) and behaviour simply not being automatic for some participants. In view of this, the above analysis was repeated but this time using only the SRHI measure which each participant had scored most highly on at baseline.

[28] These findings remained evident even when a bonferroni correction was applied.

	Defusion (n=56)	Relaxation (n=24)	No-task (n=28)
	Mean (SD)	**Mean (SD)**	**Mean (SD)**
Baseline			
Highest SRHI score	35.23 (7.10)	34.33 (8.59)	37.71 (7.36)
Follow-up			
Highest SRHI score	27.96 (9.35)	26.38 (10.45)	29.68 (12.02)

Table 3.35 Means and standard deviations of the most highly scored self-report habit index measure at baseline and follow-up for the mindfulness and non-mindfulness groups.

A 2 (time; baseline, follow-up) x 3 (group; defusion, relaxation, no-task) repeated measures ANOVA showed no significant time x group interaction, $F(2, 105) = 0.070$, $p = 0.932$, $\eta_p^2 = 0.001$ or main effect of group, $F(2, 105) = 1.365$, $p = 0.260$, $\eta_p^2 = 0.025$. A significant main effect of time, $F(1, 105) = 55.12$, $p = 0.001$, $\eta_p^2 = 0.344$ was however evident. The means indicate a reduction in automaticity at follow-up (M = 28.06) compared to baseline (M = 35.68). The findings also suggest that practicing the defusion strategy did not significantly decrease self-reported automaticity scores compared to a control strategy (relaxation or no-task). It may therefore be concluded that excluding data suggestive of low automatic links between the tested thoughts and behaviour had no different effect on the overall findings compared to when this data was included in the analysis. The null findings therefore seem unlikely to be caused by some participants having non-automatic links between thoughts and behaviours. In summary, from analysis of the SRHI measure the scores suggest that the cognitive defusion strategy is not reducing automaticity between thoughts and behaviours.

3.9.3.2.2 Goal Accessibility

Goal accessibility was only measured using a LDT.

3.9.3.2.2.1 Lexical decision task

This LDT aimed to explore the hypothesis that cognitive defusion works by increasing the accessibility of competing goals in response to chocolate-related thoughts (goal-target task). Similarly to the LDT measuring 'automaticity', the task included one critical trial and two control trials. The critical trial consisted of the critical cue being paired with the critical prime. Control trial one consisted of the critical cue being paired with the neutral prime. Control trial two consisted of the neutral cue being paired with the critical prime. For this goal-target task, the critical cue was either the word 'health' or 'weight'. The critical cues were the same as those used in the chocolate-prime task (either 'need something sweet', 'need a treat' or 'need an energy boost'). Again, further details of the LDTs can be found in sections 3.6.3.4.3.1, 3.6.4.1.3.4 and 3.8.3.6.

3.9.3.2.2.1.1 *Goal-target task*

Again, given that there was no difference between the two control groups for chocolate consumption, in order to make the interpretation of the results more clear the following analyses for the goal-target task were conducted with the control groups collapsed to form a single control group.

	Defusion (n=56)	**Control (n=52)**
	Mean (SD)	**Mean (SD)**
Baseline		
Critical Trial	485.23 (104.01)	497.24 (130.99)
Control Trial One	473.93 (78.39)	485.83 (129.58)
Control Trial Two	506.58 (124.13)	518.40 (159.43)
Follow-up		
Critical Trial	465.66 (90.71)	474.75 (92.14)
Control Trial One	468.24 (84.21)	468.01 (90.83)
Control Trial Two	464.46 (66.77)	485.43 (127.45)

Table 3.36 Means and standard deviations of RTs for the critical and control trials for the goal-target LDT ([health or weight cue) at baseline and follow-up for the mindfulness and combined control groups.

A 2 (time; baseline, follow-up) x 2 (group; defusion, control) x 3 (trial type; critical, control one, control two) repeated measures ANOVA showed no significant main interaction between time, trial type and group, $F (2, 212) = 0.363$, $p = 0.696$, $\eta_p^2 = 0.007$, time and group, $F (1, 106) = 0.013$, $p = 0.182$, $\eta_p^2 = 0.001$, trial type and group, $F (2, 212) = 0.231$, $p = 0.794$, $\eta_p^2 = 0.004$ or time and trial type, $F (2, 212) =$

2.180, $p = 0.116$, $\eta_p^2 = 0.038$. There was also no significant main effect of group found, $F(1, 106) = 0.507$, $p = 0.478$, $\eta_p^2 = 0.005$ though, a significant main effect of time, $F(1, 106) = 7.488$, $p = 0.007$, $\eta_p^2 = 0.066$ and trial type, $F(2, 212) = 3.309$, $p = 0.038$, $\eta_p^2 = 0.046$ was evident. The means indicated that RTs decreased at follow-up ($M = 470.90$) compared to baseline ($M = 494.31$). Although again, it is probably that these findings represent practice effects. Furthermore, mean RTs for all three trial types (critical, control one and control two) were fairly similar ($M = 480.52$, $M = 473.89$, $M = 493.41$ respectively). RTs on the control two trial was however the slowest relative to the critical and control one trial. Post-hoc analyses using repeated measure t-tests to compare the critical and control trials showed only a significant difference between control one-control two trials, $t(107) = 2.217$, $p = 0.029$. No significant difference was evident between either the critical-control one trials, $t(107) = 1.174$, $p = 0.243$ or the critical-control two trials, $t(107) = 1.528$, $p = 0.129$.

In summary, the findings show that practicing a mindfulness strategy (cognitive defusion) did not significantly improve RTs on the goal-target LDT compared to a control strategy (relaxation or no-task). Thus, the findings suggest that accessibility of goals in the defusion group were not strengthened given that lower RTs, which represent higher accessibility following relevant chocolate-related primes, were not evident. A significant main effect of trial type was also suggestive of participants responding more slowly to a neutral word (e.g. family) when primed with a critical cue (e.g. need something sweet) than when a critical cue was primed with a neutral cue (e.g. need some money).

3.9.4 Exploratory analyses

Whilst it is acknowledged that additional analyses of the data increases the risk of type 1 error, due to the novelty of the current research it was considered important to investigate the data fully given that the findings may usefully inform future studies and predictions. Exploratory analyse of 1) automaticity as a potential mediator and 2) associations between automaticity and chocolate consumption were therefore conducted.

3.9.4.1 Exploring baseline automaticity as a potential mediator

Previous analyses suggested that a weak association between the thought-cues and chocolate consumption was unlikely to have a negative impact on the overall findings, though the effects of group on automaticity and goal accessibility were not in the predicted direction. It was therefore considered worthwhile to look at the SRHI scores and to categorise participants into two groups; those who scored more highly on the SRHI measure, and those who scored lower on the SRHI measure. Both categories were based on the SRHI measure that determined which LDT each participant completed. The divide between high and low levels of automaticity (i.e. habit strength) was based on baseline SRHI median split of 36 for the whole population. If a participant scored the median (36) they were categorised in the high automaticity group. To increase the sample size, the control groups (relaxation and no-task) were combined. The main purpose of this analysis was to see if those with high habit strength showed what was initially predicted in terms of the pattern of RTs for the chocolate-prime LDT.

3.9.4.1.1 Effects of high levels of self-reported automaticity on task performance between the mindfulness and non-mindfulness groups.

	High Automaticity	
	Defusion (n=27)	**Controls (n=32)**
Baseline	**Mean (SD)**	**Mean (SD)**
Critical Trial	475.60 (106.63)	523.47 (174.17)
Control Trial One	500.53 (119.35)	502.95 (163.34)
Control Trial Two	577.28 (248.81)	579.46 (246.64)
Follow-up		
Critical Trial	441.31 (74.58)	485.98 (147.80)
Control Trial One	456.06 (58.26)	483.66 (167.98)
Control Trial Two	479.41 (92.03)	512.96 (154.25)

Table 3.37 Mean and standard deviations (SDs) for baseline and follow-up RT scores for the prime LDT whereby the defusion and control (relaxation and no-task combined) were divided into high automaticity based on SRHI median split scores.

A 2 (time; baseline, follow-up) x 2 (group; defusion vs. controls) x 3 (trial type; critical, control one, control two) repeated measures ANOVA was conducted using high automaticity participants only. A time x trial type x group interaction was expected. The findings however showed no significant interaction between or time, trial type and group, F (2, 114) = 0.242, p = 0.786, time and group, F (1, 57) = 0.195, p = 0.661, trial type and group, F (2, 114) = 1.002, p = 0.370, or time and trial type, F (2, 114) = 2.226, p = 0.113. Unlike group, F (2, 56) = 1.127, p = 0.331, a significant effect of both time, F (1, 57) = 6.155, p = 0.016 and trial type, F (2, 114) = 12.902, p = 0.001 was evident.

The means indicated that RTs increased at follow-up (M = 478.06) compared to baseline (M = 527.29). Though, it is again possible that these findings represent practice effects. Mean RTs for the critical and control one trials were fairly similar (M = 483.55, M = 486.44 respectively). RTs on the control two trial was however slower in comparison (M = 538.03). Post-hoc analyses using repeated measure t-tests to compare the critical and control trials showed significant differences between the critical-control two trials, t (58) = 4.260, p = 0.001 and control one-control two trials, t (58) = 3.807, p = 0.001. No significant difference was evident between the critical-control one trials, t (107) = 1.174, p = 0.243.

In summary, these findings suggest that practicing a mindfulness strategy (cognitive defusion) did not significantly improve RTs on the chocolate-prime LDT compared to a control strategy (relaxation or no-task) when only high automaticity participants were included in the analysis. Overall, the findings were very similar to those which compared RTs on the chocolate-prime LDT scores the whole sample (i.e. including both low and high automaticity participants). These results therefore suggest that possessing stronger links between the thought-cues and chocolate did not significantly affect performance on the LDT.

3.9.4.2 Associations between automaticity and chocolate consumption

To explore whether chocolate consumption was associated with levels of automaticity, correlations between the SRHI measures and chocolate consumption and between LDTs and chocolate consumption (at baseline) were carried out. Separate correlations were conducted for the chocolate-prime and goal-target LDTs.

The main purpose of this analysis was to see whether, a) higher levels of chocolate consumption at baseline were associated with higher levels of automaticity at time 1 (baseline), b) a greater reduction in automaticity was associated with a greater decline in chocolate consumption as shown via the chocolate-prime LDT, and c) a greater increase in the accessibility of goal-related thoughts was associated with a greater decline in chocolate consumption as shown via the goal-target LDT.

SRHI Automaticity (baseline)	**Chocolate consumption (baseline)**
Sweet	.063
Treat	.048
Energy boost	.165
Highest scored SRHI	.093

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

Table 3.38 Pearson's correlations between baseline SRHI scores for the three individual measures (sweet, treat, and energy boost) in addition to the SRHI which participants scored most highly on and baseline chocolate consumption.

Across the whole sample, SRHI scores at baseline showed no significant (Pearsons) correlations with the baseline diary chocolate consumption measure. The positive direction of the correlations however suggested that at baseline, higher levels of chocolate consumption were associated with higher levels of automaticity. The findings failed to reach statistical significance.

Furthermore, across the whole sample, baseline RTs for the critical trial on the chocolate-prime LDT ($r = -.106$) and goal LDT ($r = -.129$) showed no significant (Pearsons) correlation with the baseline diary chocolate consumption measure. However, both correlations were in the predicted negative direction. This suggests that respectively; (1) higher RTs, represented by decreased automaticity, and (2) lower RTs, represented by increased accessibility of competing goal cues (when primed which chocolate thoughts [e.g. need something sweet]) was associated with a reduction in the amount of chocolate consumed.

To explore whether 1) a reduction in automaticity (SRHI and chocolate-prime LDT) and 2) an increase in accessibility (goal-target LDT) was associated with a greater decline in chocolate consumption (diary measure), change scores were calculated by subtracting baseline scores from follow-up scores for each measure.

SRHI Automaticity (change scores)	**Chocolate consumption (change scores)**
Sweet	-.067
Treat	-.143
Energy boost	-.060
Highest scored SRHI	-.145

Table 3.39 Pearson's correlations between change scores for SRHI scores for the three individual measures (sweet, treat, and energy boost) in addition to the SRHI which participants scored most highly on and chocolate consumption.

Table 3.39 shows that SRHI change scores were negatively associated with chocolate consumption change scores. Contrary to prediction, these findings suggest that higher automaticity was associated with a greater decline in chocolate consumption. The findings again failed to reach statistical significance.

Using change scores, no significant correlations (Pearsons) were also found between either the critical trial on the chocolate-prime LDT and chocolate ($r = 0.131$), or the critical trial on the goal LDT and chocolate ($r = 0.090$). Both correlations were positive. Whilst this suggests that a greater reduction in automaticity was associated with a decline in chocolate consumption, it does not suggest that a greater increase in accessibility was associated with the same behavioural outcome. All findings however failed to reach statistical significance.[29]

[29] The LDT analysis conducted in sections 3.9.3 and 3.9.4 were repeated using a more conservative approach. This approach consisted of only including participants who completed all nine trials correctly for each of the LDTs (chocolate-prime and goal-target). The nine trials consist of the critical trial and the two control trials. Each trial type was completed three times for each LDT, totalling nine experimental trials. It was thought that by having more accurate RT data, the loss of power from the reduced sample size would be outweighed. Similar, non-significant findings were shown for all analyses.

3.9.5 Secondary investigations of the data

3.9.5.1 Strategy adherence

Participants in the cognitive defusion and relaxation groups were taught a strategy which they were told to use whenever they were tempted to eat chocolate during week two of the study. The number of times the taught strategy (cognitive defusion and relaxation) was used in relation to the number of chocolate cravings experienced was calculated for each group.

	Defusion (n=56)	Relaxation (n=24)
Sometimes	21.0	13.0
Nearly always	47.0	62.0
Always	32.0	25.0

Table 3.40 Percentage of strategy use in the defusion and relaxation groups.

A chi-square test revealed that the percentage of participants who used their strategy either sometimes, nearly always or always did not significantly differ between the defusion and relaxation control groups: $\chi^2 (2, N = 80) = 1.85$, $p = 0.40$.

3.9.5.2 Study's helpfulness at reducing chocolate consumption

All participants were asked to rate how helpful they found their participation in the study in terms of reducing their chocolate consumption using a five-point Likert scale (1 = not at all helpful, 5 = extremely helpful).

	Defusion (n=56)	Relaxation (n=24)	No-task (n=28)
Not at all helpful	0.0	8.0	0.0
A little helpful	7.0	8.0	7.0
Moderately helpful	23.0	38.0	14.0
Very helpful	52.0	33.0	61.0
Extremely helpful	18.0	13.0	18.0

Table 3.41 Percentage of reported helpfulness of study participation in reducing chocolate consumption by the mindfulness and non-mindfulness groups.

No significant differences in the reported helpfulness of the study was found between the defusion and no-task groups, $t (82) = 0.477$, $p = 0.634$. A significant different was however reported between the defusion and relaxation groups, t (78) 2.125, $p = 0.037$ and between the relaxation and no-task groups, t (50) = 2.144, $p = 0.037$. The means indicated that the defusion group (M = 3.80, SD = 0.82) found their participation in the study to reduce their chocolate consumption more helpful than the relaxation group (M = 3.33, SD = 1.09). The no-task group (M = 3.89, SD = 0.79) however reported greater helpfulness of the study compared to the relaxation group.

3.9.5.3 Suspicion probe

In order to check level of suspicion about the study, participants were asked to recall how many individual chocolates were given to them in the bag and if they had any ideas about what the study aimed to explore in addition to helping them reduce chocolate consumption.

	Defusion (n=56)	**Relaxation (n=24)**	**No Task (n=28)**
Number in the bag (% correct)	23.0	13.0	14.0
Ideas about study aims (% yes)	27.0	21.0	46.0

Table 3.42 Suspicion probe percentage scores across the mindfulness and non-mindfulness groups.

A chi-square test revealed that the percentage of participants who correctly reported the number of chocolates in the bag did not significantly differ between the defusion and control (relaxation, no-task) groups, $\chi^2 (2, N = 108) = 1.727$, $p = 0.422$. Furthermore, a chi-square test revealed that the percentage of participants who made an attempt to guess the study's aims did not significantly differ between the defusion and control (relaxation, no-task) groups: $\chi^2 (2, N = 108) = 4.769$, $p = 0.092$.

3.9.6 Brief summary

The current study first aimed to address the questions; does practicing the cognitive defusion strategy reduce chocolate consumption, and second, if so, how does it work? Two separate hypotheses were explored. The first predicted that cognitive defusion works by reducing automatic links between chocolate-related thoughts and chocolate consumption. The second predicted that cognitive defusion works by increasing the accessibility of competing goals in response to chocolate-related thoughts. The results of this study failed to show any effects of practicing the cognitive defusion task for five-days on either consumption, the habit questionnaires (SRHI) or the LDTs (chocolate-prime and goal-target) compared to the control tasks (relaxation and no-task). The findings also showed that chocolate-related thoughts were not automatically linked with chocolate consumption as predicted. The findings failed to replicate those previously reported in Study Two (see section 3.3). Thus, the current study did not show evident that the cognitive defusion strategy is effective for changing the self-control related health behaviour, resisting chocolate.

3.10 Discussion

3.10.1 Summary

The first aim of the current study was to demonstrate the reliability of Study Two by replicating the findings that, practicing a mindfulness-based cognitive defusion strategy significantly reduces chocolate consumption. The second aim of the current study was to further investigate how the defusion strategy brought about its effects. Two possibilities were explored, (1) cognitive defusion works by interrupting automatic links between chocolate consumption and thoughts that cue chocolate consumption, and/or (2) cognitive defusion works by strengthening links between the cue and competing goals. The main findings showed that contrary to Study Two, practicing the cognitive defusion strategy for a five-day period did not show any significant effect on chocolate consumption as measured by either the chocolate diary or the bagged chocolates. The results also failed to show any effects of the cognitive defusion task on the self-report habit index (SRHI) questionnaire or the priming tasks. The defusion strategy was therefore not found to be effective at changing the self-control related behaviour, unhealthy eating. Furthermore, its effects were not evident to be brought about by either reducing behavioural automaticity or increasing goal accessibility. Caution is however needed when drawing such conclusions given that it is difficult to explain how cognitive defusion works when it did not help people resist temptation in the first instance. More research is therefore needed to establish the conditions under which cognitive defusion strategies assist self-control related health behaviours, as well as identify the mechanisms of change.

3.10.2 Effects of cognitive defusion on chocolate consumption (Aim 1)

As in Study Two chocolate consumption was measured using both observations (bagged chocolates) and self-report (diary). The same period of abstinence (five-days) was also completed. The findings of the current study however did not support those previously reported in Study Two. For instance, there were no significant group differences found between the defusion and control groups for either the number of chocolates eaten from the bag, or the total number of 'other grams' eaten as measured by the chocolate diary[30]. The current study also did not extend previously conducted research in this area (e.g. Moffitt et al., 2012). One reason for the inconsistency between findings may be due to the inclusion of a baseline measure of chocolate consumption. The lack of a baseline measure was considered a limitation of Study Two. This is because only differences in chocolate consumption between the mindfulness and non-mindfulness control groups could be identified, as opposed to significant reductions in chocolate consumption across the groups using change scores. Although, it is possible that completing the baseline consumption measure, in addition to the second chocolate diary measure (completed during week two) in the current study caused participants to become fatigued and bored with the task. Consequently, the self-report data in the second chocolate diary may have been subject to greater inaccuracies, thus causing non-significant findings to be found.

Participants were also not asked to refrain from eating chocolate or chocolate-related products during the baseline period (i.e. week one of the study). Instead, they were asked to 'eat normally' and to simply record any chocolate consumed during that period in the chocolate diary provided. Whilst this gave a measure of their *normal* chocolate intake, it failed to provide a baseline measure of consumption when attempting to *resist* chocolate. Thus, consumption was not measured under the same conditions. As a result, analysing the data using change scores may have concealed any additional effects of the defusion task. In support of this, non-parametric tests using only the data from the follow-up diary measure showed a trend towards significance between the defusion and relaxation groups in terms of the amount of 'other' chocolates consumed. More specifically, those who practiced the defusion task were evident to consume less chocolate than those who practiced the relaxation task. It would therefore be worthwhile to include a baseline consumption measure in future research whereby participants are asked to refrain from eating chocolate or chocolate-related products during this period.

An additional limitation of including the baseline diary measure is that, asking people to record their consumption of 'unhealthy foods' has been found to impact their consumption of that food (Rennie, Coward & Jebb, 2007). The baseline diary measure may therefore not accurately reflect *actual* consumption, but an

[30] The diary analysis was conducted using change scores (i.e. consumption at follow-up minus consumption at baseline)

already reduced level of consumption. Consequently, this reduction of 'normal' chocolate consumption would have made the behaviour more difficult to change and therefore account for the null findings in Study Three compared to Study Two.

Despite the noted limitations, the inclusion of the baseline chocolate diary was useful for identifying that the means and standard deviations for this consumption measure were very similar for both the defusion and control groups. This suggests that those allocated to the defusion group did not consume particularly unhealthy quantities of chocolate at baseline (i.e. whilst eating normally), or as previously discussed, these reports of consumption may be under-estimates of their *normal* intake. The cognitive defusion task, which aimed to help them resist chocolate temptation, may therefore have been less effective for those in the defusion group compared to those in the relaxation and no-task groups. In view of this, it is possible that the findings were subject to floor effects and thus account for the inconsistent findings between the studies (Study Two and Study Three). Another explanation for the inconsistency between the current findings and those previously reported in Study Two may be due to subtle differences[31] in the sample, such as their motivation for participating. Compared to Study Two[32] a higher payment (£20) was awarded due to the increased duration and demands of the study (e.g. attendance of four sessions over a two-week period compared to two sessions over a five-day period). The current study's sample may therefore have been more highly motivated by the financial reward of participating rather than the reward of changing their eating behaviours.

The current study also assumed that focusing on goals would increase a person's intention to engage in the activities that would help to achieve the goal. Some researchers have however reported that staying focused on goals for too long will negatively affect the experience of these activities and thus make it far more likely that the goals will not be achieved (Fishbach & Choi, 2012). In other words, people's intrinsic motivation to pursue their goal decreases. In support of this, Fishbach & Choi found that after three days participants who focused on the long-term goal of dental flossing (e.g. reducing tooth decay) flossed significantly less than participants

[31] For an overview of all the differences between the studies, see appendix LL

[32] A payment of £10 was awarded to participants in Study Two.

who focused on what it was like to floss (e.g. the feeling of cleanliness). It was concluded that when embarking on a health goal people should beware of focussing on their goal too long. It is therefore possible that the null findings were the result of the defusion task placing too much emphasis on the person to keep focused on their goal over a period of time. Ultimately, this was detrimental to their goal of resisting chocolate temptation from being achieved. Whilst this explanation is feasible, it fails to account for the significant differences in levels of chocolate consumption between the defusion and control groups demonstrated in Study Two.

3.10.3 How cognitive defusion works. Exploration of potential mediators (Aim 2)

The findings from the previous study (Study Two) were not replicated (i.e. the defusion strategy was not shown to be significantly effective at reducing chocolate consumption compared to the control strategies). It is therefore very difficult to explain how cognitive defusion brings about its effects. However, given that trends towards significance were shown between the defusion and relaxation groups for the diary and bagged chocolate measures, exploratory investigations were carried out to identify any effects the different strategies (defusion and controls) had on levels of automaticity and goal accessibility.

3.10.3.1 Automaticity

Based on the evidence from Study Two, it was predicted that cognitive defusion reduces chocolate consumption by interrupting a person's automatic reaction to eat chocolate when experiencing chocolate-related thoughts. Contrary to this, the current study showed that cognitive defusion did not significantly decrease self-reported automaticity scores (as measured by the SRHI) relative to either control strategy (relaxation or no-task) at follow-up compared to baseline. Furthermore, when exploring baseline automaticity as a potential moderator (i.e. comparing participants who scored high on the SRHI with those who scored low on the SRHI) the findings again showed no significant group difference between performance on the lexical decision task (i.e. individuals who scored most highly on the SRHI measure did not demonstrate a greater decrease in RT). This challenges the possibility that the null findings were caused by some participants simply not possessing an automatic link between the chocolate-related thoughts and chocolate consumption. Although, since the analysis to test this was carried out using a median split, there is still some possibility that the null findings were caused by a weak thought-cue-behaviour association at baseline. The SRHI does not have a pre-defined cut-off to identify behaviour as being habitually strong or habitually weak (Lally et al., 2010). Thus, caution is needed when interpreting analyses based on the categorisation of participants into high and low automaticity groups using SRHI scores.

Practicing the cognitive defusion strategy also did not significantly affect reaction time (RT) scores on the Lexical Decision Task (LDT) compared to the control strategies. More specifically, mean reaction time scores did not significantly differ between the defusion and control groups. The results therefore failed to support the pre-stated hypothesis which stated that higher RTs (i.e. slower responses) would be evident following a relevant prime, representing lower automaticity for the defusion group compared to the control groups. Similarly to Pratkanis & Aronson (1992) the latter findings showed no clear evidence of subliminal priming effects on behaviour. One explanation for this finding is that some of the participants may have been consciously aware of the primes, causing them to respond more quickly and accurately in trials when it was followed by a semantically related target (e.g. need something sweet – chocolate). The primes were however presented for an extremely short duration (10 ms) thus rendering this explanation unlikely. The reverse argument would be that the 10 ms presentation time of the primes was not a sufficient amount of time to process the three-word sentence (see section 3.10.4 for a further discussion of this point). Given that the current study was the first to explore the effects of a three-word prime, further investigation needs to be undertaken in order to explore this possibility.

3.10.3.2 Goal accessibility

It was alternatively proposed that the defusion strategy works by increasing the accessibility of competing goals in response to chocolate-related thoughts. Similarly to the automaticity LDT, there were no significant group differences in mean RT scores (i.e. lower RTs [faster responding] was not evident in the defusion group compared to the control groups following a relevant prime), suggesting that practicing the cognitive defusion strategy did not significantly strengthen goal accessibility compared to either of the control strategies (relaxation or no-task). This finding fails to extend previous literature which has found that subliminally priming participants with goal words significantly influences participant behaviour (e.g. Fitzsimons & Bargh, 2003; Shah & Kruglanski, 2002; Shah, 2003). Furthermore, the null findings do not offer additional support to a previous study by Fishbach et al. (2003) who reported that, priming individuals with health goals incompatible with eating chocolate strengthens the accessibility of the goal to counteract the behaviour. Fishbach et al. argued that such a counteractive effect would only be evidenced if the health goal was important to the individual. Given that the current study matched the goal cues (health or weight) presented in the LDT to each participant as best as possible, it therefore unlikely that this would be a valid explanation for the null findings.

3.10.4 Study limitations and future research

It is important to note that there are a number of limitations in the current study and thus, many opportunities for future research. First, given that the findings from Study Two were not replicated, the current study questions the efficacy of a brief mindfulness-based cognitive defusion strategy to reduce chocolate consumption. Future research therefore needs to explore whether a brief cognitive defusion intervention is a reliable strategy for changing this self-control related health behaviour. Thus will help to identify whether Study Two was simply a spurious result, or whether there are specific factors that moderate the effects of the strategy in order to allow it to work. One possibility would be to refine the measures of automaticity and goal accessibility used in the current study. For example, each could be made more specific to the participants by letting them identify their own personal critical cues as opposed to asking participants to choose from a fixed number of options (e.g. which thought-cue and health goal is most true of you?). Whilst careful thought in relation to the design and the logistics of achieving this would be needed, this change may be advantageous because for many behaviours including unhealthy eating, identifying critical cues are challenging as these cues are often a reflection of subjective internal states (Adriaanse et al., 2009). Identification of these subjective internal states as critical triggers for unhealthy behaviours requires substantial introspection, which some people are believed to lack (Nisbett & Wilson, 1977). The current study may therefore be criticised for limiting the strength of the defusion strategy's effects. It is however important to note that various pilot studies were previously conducted to explore the reliability of the three critical cues used in the current study (need something sweet, need a treat, and need an energy boost) to trigger the automaticity of eating chocolate using the advised diary method (Adriaanse et al., 2009). In view of this, it is believed that the current study used the best methods, albeit within its parameters, to obtain reliable results.

Irrespective of the latter discussion point, the need to modify the automaticity measures (SRHI and LDT) is acknowledged, especially as the results of the current study suggest that each were measuring different things. For instance, contrary to predictions, in the preliminary study and also the current study, higher SRHI scores were not found to be significantly positively correlated with reaction time performance on the critical trial (e.g., need something sweet – chocolate) of the corresponding LDT. Other measures of automaticity, such as Implicit Association Tasks (Greenwald, McGhee & Schwartz, 1998) should therefore be explored in future studies. Alternatively, the LDTs could be repeated but instead include a greater number of trials. In the current study, the critical and control trials were presented three times per task (automaticity and accessibility). The reason for repeating the trials was to increase the chance of obtaining at least one RT score for all participants (i.e. allowing for two errors being made). The inclusion of further trials would have extended the duration of the current study to one which was likely to cause participants to become fatigued and distracted and thus negatively impacted their performance on the tasks. Increasing the repetition of trials in future studies would however make the data more reliable in that the RT scores would be more representative for each individual (i.e. in the current study, those with only a single RT score was deemed unrepresentative of their performance). Excluding these participants from the data analysis was not possible given that the sample size would have been significantly reduced and consequently, under powered. Furthermore, a greater number of trials would allow for the exclusion of RT scores within 100 and 4000ms (i.e. not considered to be outliers) that might have been due to brief lapses in participant concentration. Due to the limited number of trials used in the current study, all RT scores were included. Thus, it is possible that some mean scores were skewed by extremely fast or slow responses.

Despite the previously conducted pilot studies showing that a short three-word sentence (e.g. need a treat) was associated more with chocolate than a single word (e.g. treat) (see section 3.6.2), future research may benefit from reducing the complexity of the current study by repeating the automaticity and goal accessibility tasks using singular cues. The main reason for this is that previous research has shown that a short two-word sentence was not processed unconsciously (Draine & Greenwald, 1998). Instead, Draine & Greenwald (1998) found that the pattern of priming was determined by single-word components of these phrases. Many others have supported this (Balay & Shevrin, 1988; Fudin, 1986; Greenwald, 1992). Thus, it is possible that automatically processing the whole three words was very difficult and as a result, some participants were only primed by one part of the sentence (e.g. beginning, middle or end). If the primed word was either the first (e.g. 'need') or second (e.g. 'something'), it is unsurprising that no priming effect was found in either the automaticity or goal accessibility LDTs as these words did not contain the main cue prime (e.g. 'sweet'). Furthermore, some argue that in order for more than one cue word to be unconsciously processed, the cue needs to be presented slowly (Gough, 1965; Li et al., 2008; Slobin, 1966; Watson 1959).

Based on the findings of the pilot studies (see section 3.6.3) the three-word phrases were presented for 10ms. As previously stated, due to the speed of the cue presentation, it is again possible that only part of the three-word phrase was unconsciously processed. These findings contrast with past research which has shown that the unconscious is capable of processing complete sentences (Bronstein & Rodin, 1983; Cohen & Farley, 2008; Kaplan et al., 1985). One way to reduce the complexity of the current priming tasks is to use the same method as Papies, Aarts & Stroebe (2007) and de Witt Huberts and colleagues (in revision). In both these studies sentence primes were presented word by word, with each word remaining on the screen for a longer duration of 200ms. With these studies consistently showing a significant priming effects between restrained eaters and hedonic thoughts, it may be worthwhile for future research to explore the effects of changing the display of the sentence primes in this way. Furthermore, given the novelty of this research and the inconsistency in the existing literature on both the appropriate length of the cue and the duration of its presentation, additional exploratory investigations are needed before it can be reliably applied to help understand how the cognitive defusion strategy works to change unhealthy eating behaviour.

Another limitation is that the present study included a mixed sample of dieters (i.e. those actively trying to lose weight) and non-dieters. It is possible that dieting moderated the association between strength of cue and behavioural response. It would therefore be interesting to conduct a follow-up of the present study but with dieters only. Being more selective in those recruited to the study may also help to further understand how the defusion strategy changes self-control related health behaviours. Taking the prediction that cognitive defusion may bring about its effects by strengthening accessibility between the thought-cue and competing goals as an example, research has shown that keeping in mind one's higher-order goal greatly facilitates self-control by preventing dieters from processing food cues entirely in pleasurable terms (e.g. Hofmann, Van Koningsbruggen, Stroebe, Ramanathan & Aarts, 2010; Papies, Stroebe & Aarts, 2007; Papies, Stroebe & Aarts, 2008; Shah, Friedman & Kruglanski, 2002; Stroebe, Mensink, Aarts, Schut & Kruglanski, 2008; Van Koningsbruggen, Stroebe, Papies & Aarts, 2011). In the aforementioned studies, priming dieters with a dieting goal reduced attentional bias to palatable food, and increased their perceptual processing of healthy food objects. Others have also shown that environmental diet primes helped dieters, but not non-dieters, control their eating behaviour, making them more likely to choose a healthy snack food (e.g. apple) over an unhealthy snack food (e.g. chocolate bar) (Fishbach, Friedman & Kruglanski, 2003) and also consume less high-calorie snack foods (Anschutz, Van Strien & Engels, 2008; Papies & Hamstra, 2010). In view of this it might be inferred that increased accessibility of health goals for the cognitive defusion strategy is achieved by the task reminding dieters of their higher-order goal of dieting.

Partially related to the previous point, future research could also extend the current study by investigating whether the cognitive defusion task increased the accessibility of health goals is associated with hedonic ratings (see Connell & Mayor, 2013). Connell & Mayor, for instance, found that increasing health goals is only effective in decreasing expected pleasure derived from unhealthy junk foods for people who harbor positive affect towards junk food brands. It is therefore likely to be counterproductive for people who harbor negative affect towards junk food brands. Replications of the current study may benefit from including a measure of hedonism about chocolate brands (e.g. 'is comforting', 'is delicious') following the priming tasks. Finally, the current study is limited in that it only explored the effects of cognitive defusion on two individual mediators; automaticity and goal accessibility. It is advised that future research would benefit from considering other potential mediators (e.g. number of cravings experienced).

3.10.5 Conclusion

In conclusion, the current study failed to replicate the findings from Study Two, therefore questioning the efficacy of a brief mindfulness-based cognitive defusion strategy (i.e. the mindbus task) to reduce chocolate consumption. It is possible that the inconsistency between the findings were due to a number of changes made to the design of the original study (e.g. inclusion of a baseline measure of chocolate consumption). The current study also did not further develop our understanding of how the cognitive defusion strategy brings about its effects given that, (1) levels of automaticity in the defusion group were not shown to be weakened and lower SRHI was also not found, and (2) accessibility of goals in the defusion group were not shown to be strengthened. Due to the fact that the current study did not show any significant effect of the defusion strategy on chocolate consumption, it was difficult to draw any reliable conclusion from these results. Future studies could be improved by modifying the LDTs and by enforcing even more stringent criteria during the recruitment process. An exploration of alternative mediators and moderators was also suggested.

3.11 General discussion (studies 2 & 3)

3.11.1 Limitations and future research

In addition to those previously discussed, there are a number of limitations present in Studies Two and Three. First, similar to past research (e.g. Forman et al., 2007; Stirling & Yeomans, 2004) low consumption of the bagged chocolate was evident in both studies. Despite the use of a transparent bag to allow the participants to see the chocolates and be tempted by them, in future work it may be more desirable to ask participants to regularly look at the chocolates in addition to keeping them in their possession. Although not officially recorded in the data, some participants reported that despite having the bagged chocolates in their possession, they actively avoided looking at the chocolates and instead kept them 'out of sight' (e.g. in their rucksack or coat pocket). As a result of this, the purpose of asking participants to carry the bagged chocolates with them over the five-day period (i.e. to increase levels of temptation) might not have been as effective as initially thought. Second, the findings from the current studies were based on self-reported snacking behaviour and previous research has shown that individuals have a tendency to underreport their caloric intake (e.g. Muhlheim, Allison, Heshka & Heymsfield, 1998; Rennie, Coward & Jebb, 2007). Using a more objective measure of eating behaviour in future studies is therefore advised (e.g. weight loss amongst dieters). It is however important to note that food diaries are considered the most sophisticated naturalistic eating measures currently available (De Castro, 2000).

Third, the short period of time (five-days) in which chocolate was resisted may also be considered a limitation. For instance, some participants stated on completion of the study that they were able to resist temptation because they knew that they could resume eating chocolate in only a few days. This may account for the low levels of chocolate consumption evident in both Study Two and Three. In view of this, it is suggested that the research is repeated but over an extended period. Furthermore, the study was only conducted over weekdays (i.e. Monday-Friday). Weekend days (i.e. Saturday and Sunday) were excluded in order to reduce variability in the data whilst also limiting respondent burden in terms of diary completion. However, with respect to future research, including weekend days may help to explore the reliability of individual mindfulness-based strategies more widely, thus also encompassing changing eating behaviours. Hart et al. (2011), for instance, found that there are a number of differences in individual's eating habits on weekends compared to weekdays, with weekends being a greater risk for increased intake of fat, non-nutrient dense snack foods, and reduced fruit and vegetables. Finally, whereas the current studies were not designed to evaluate the effects of mindfulness-based strategies on weight loss, the inclusion of weight loss measures (e.g. BMI) would be helpful to test the effectiveness of these strategies on health issues associated with a reduction in unhealthy eating behaviours. Future studies could also focus on monitoring the regulation of intake of a range of unhealthy snack foods (e.g. sweets, biscuits, cakes, crisps) as opposed to the promotion of abstinence from a single food (chocolate). This may prove useful given that participants often reported substituting chocolate and chocolate-related products for other high sugar, high fat snack foods.

3.11.2 Conclusion

Although the findings from Study Two were not replicated in Study Three, the current studies are two of only a few (Moffitt et al., 2012) which have specifically aimed to explore the effects of individual mindfulness strategies on reducing chocolate consumption. The null findings demonstrated in Study Three should therefore not be perceived as negative. Rather, the findings from both studies should collectively be viewed as a positive step forward in understanding how brief mindfulness-based interventions work and how they bring about their effects. Whilst it is acknowledged that further research is needed to confirm the effects of cognitive defusion on chocolate consumption, and to identify more precisely how it brings about its effects, the teaching and practice of the cognitive defusion strategy is easy to implement and imposes few demands on practitioners. Thus, the relatively simple nature of the strategy means it could, in the future, be usefully incorporated into existing weight loss and healthy eating interventions. As a result, cognitive defusion may prove to have clinical use. This is important especially as many health problems (e.g. obesity, addiction, and inactivity) require self-control in order to bring about behavioural change. The findings from the current studies also demonstrate the benefits of using a dismantling design to distinguishing between different types of mindfulness strategies and separating out their effects on behaviour. Compared to more traditional mindfulness-based interventions which incorporate several mindfulness strategies (Bowen et al., 2009; Brewer et al., 2009; Hayes, Strosahl & Wilson, 1999; Kabat-Zinn, 1990; Linehan, 1993; Segal, Williams & Teasdale, 2002) it is believed that the identification of individual strategies to help change specific self-control related health behaviours will facilitate the establishment of targeted and cost-effective mindfulness interventions. In conclusion, the current research provides a useful building block on which to further develop knowledge and understanding of how mindfulness-based interventions work and how they bring about their effects.

Chapter Four

Effects of a brief cognitive defusion task on chocolate craving

4.1 Introduction

4.1.1 Chapter overview

The study described in the present chapter aimed to explore an alternative explanation to those investigated in Chapter Three (decreasing automaticity and/or increasing goal accessibility) for how the mindfulness-based strategy *cognitive defusion* changes unhealthy eating behaviours. It is proposed that cognitive defusion decreases chocolate consumption by reducing chocolate cravings. An investigation of the effects of a brief cognitive defusion task (the 'mindbus') on chocolate cravings was therefore conducted. It was hypothesised that this strategy may reduce cravings by limiting working memory (i.e. loading the visuo-spatial sketchpad; Baddeley & Hitch, 1968) and preventing the elaboration of intrusive thoughts. This hypothesis was based on the notion that visual imagery is at the core of the craving experience, and craving-related imagery can be interrupted, or reduced, by completing an alternative task which occupies the same limited working memory resources. If the mindbus task works by reducing craving-related imagery, it was predicted that the number of cravings experienced by the defusion group would be significantly less than those reported by participants in two control groups[33]. This, in turn, would lead to a significant reduction in chocolate consumption. The results of the current research aimed at broadening our understanding of how cognitive defusion brings about its effects. A literature review on food cravings and how they can be reduced using competing imagery tasks is provided.

4.1.2 What are food cravings?

Craving for food is a cognitive-emotional appetitive state distinct from physiological states such as hunger (Lafay et al., 2001; Pelchat, 2002) or nutritional status (Pelchat & Schaeffer, 2000). Weingarten & Elston (1991) defined food cravings as intense

[33] The control groups (relaxation and no-task) completed tasks which were not considered to be predominately imagery-based.

desires or urges to eat specific foods. Cravings have also been described as intrusive thoughts about food (May et al., 2010). These intrusive thoughts have an important role in maintaining dysfunctional eating behaviours (McManus & Waller, 1995; Mitchell, Hatsukami, Eckert & Pyle, 1985). Several studies have demonstrated that cravings can lead to increased intake of high calorie foods, snacking and binge eating (Basdevant, Craplet & Guy-Grand, 1993; Gendall, Joyce, Sullivan & Bulik, 1998; Schlundt, Virts, Sbrocco & Pope-Cordle, 1993; Waters, Hill & Waller, 2001). Cravings for chocolate have been found to be especially problematic in that, attempts to resist chocolate often causes a greater desire for it, subsequently leading to unwanted (over) consumption (Rogers & Smit, 2000).

4.1.3 How do food cravings lead to consumption?

When experienced, cravings form a mental cycle of elaboration of an initial intrusive thought, in which relevant information about the desired food is brought from long-term memory into the person's working memory in image form (Kavanagh, May & Andrade, 2009; May, Andrade, Kavanagh & Penfound, 2008; May, Panabokke, Andrade & Kavanagh, 2004). The elaboration process most commonly involves the formation and focus on sensory images of the desired target (e.g. mental stimulation of the sight, sound, smell, taste, and feel of an experience) though the expectancy about satisfying the desire (e.g. I'd be able to concentrate better once I've had chocolate) and planning ways of achieving the desire (e.g. I could buy a chocolate bar) also play a role. The intrusive images are initially pleasurable, but can become distressing when the individual realises that the food item may not always be immediately available. The feelings aroused by the image cause the craving to intensify, resulting in the individual actively striving to satisfy it. The only way this is achieved is by consuming the craved item. Some have argued that cravings, and subsequently consumption, can be reduced by controlling the elaboration of these sensory images (Kavanagh et al., 2009). One means of doing so is via the technique of limiting working memory (i.e. loading the visuo-spatial sketchpad).

4.1.4 Reducing cravings by limiting working memory

There is evidence to suggest that mental imagery is a key component of food cravings and that craving-related imagery is predominately visual in nature (May, Andrade, Panabokke & Kavanagh, 2004). It has therefore been suggested that cravings can be reduced by introducing information in the same sensory modality as the imagery associated with the craving (Elaborated Intrusion Theory; Kavanagh, Andrade & May, 2005). The visuo-spatial sketchpad (VSSP) in working memory is essential for vivid imagery (Baddeley & Andrade, 2000), thus concurrent tasks that rely on the same system will compete for priority and the limited cognitive resources. Hence, when one of these components is loaded with a task corresponding to the VSSP's abilities, it prevents it from being simultaneously used to construct the vivid sensory images which increase cravings. Once it has reached its maximum capacity, any other task which requires a demand on its cognitive resources cannot be performed (Green et al, 2000; Tiggemann, Kemps & Parnell, 2010).

4.1.5 Evidence that food cravings can be reduced by loading the visuo-spatial sketchpad

Several studies have found that performing a visual imagery task which loads the VSSP reduces food cravings (Harvey, Kemps & Tiggemann, 2005; Kemps et al., 2004). Kemps and Tiggemann (2007), for instance, found that participants who completed concurrent imagery tasks experienced significant reductions in vividness of chocolate craving imagery compared to those who completed an auditory task (loading the phonological loop [another component of working memory] rather than the VSSP). This study demonstrates how imagery may be disrupted with the use of a competing task in the same modality. This effect has been replicated by May, Andrade, Panabokke & Kavanagh (2010) who showed that a concurrent imagery task reduced craving but an auditory task had no effect. In another study, when pre-schoolers were asked to create 'vivid fantasies' of a different food product (e.g. the crunchiness and saltiness of pretzels), they were able to resist temptation (i.e. delay gratification) of a marshmallow sweet for an extra 17 minutes compared with thinking about marshmallows or thinking about less obviously pleasurable aspects of pretzels (e.g. their size) (Mischel & Baker, 1975). Loading the VSSP using dynamic visual noise (Quinn & McConnell, 1996), side-to-side eye movements (Kemps et al.,

2004) and forehead tracking (i.e. watching one's forefinger moving in 1cm jumps across one's forehead) (McClelland, Kemps & Tiggemann, 2006) have also been found to reduce food cravings. These studies demonstrate that the VSSP can be loaded by a diverse range of visual imagery tasks.

From the aforementioned literature it appears that visual imagery is a key component of cravings. Visuo-spatial tasks may therefore be useful to help people resist every day cravings and support abstinence attempts. Recent research has also shown that even very simple visual tasks, such as watching a flickering pattern of random black and white dots (i.e. dynamic visual noise) have been shown to reduce food cravings (for a review, see Kemps & Tiggemann, 2010). A limitation of visual imagery however is that the effects of visuo-spatial tasks on cravings are often not tested outside the laboratory. Thus, the technique of limiting working memory has limited suitability for take-home use. Some are simply too embarrassing to perform in public (e.g. forehead tracking; McClelland, Kemps & Tiggemann, 2006) or require specialised software (e.g. visual noise; Quinn & McConnell, 1996).

Some researchers are however beginning to use novel tasks which avoid these problems. In a study by Andrade, Pears, May & Kavanagh (2012), for example, plasticine modelling was utilised as a task to reduce chocolate craving. The effects of the task were compared to a simple verbal task loading the phonological loop (e.g. counting). Craving was induced by presenting participants with chocolate and asking questions relating to it. Participants were then asked to mould shapes out of plasticine, namely cubes and pyramids in an alternate fashion, or to count aloud in ones. The plasticine task was conducted out of sight of the participant (i.e. under the table at which they sat). The task was carried out in this manner so that the participants could engage working memory by visualising an image of the shape, moment by moment, in visuo-spatial memory as they were moulding it. Craving was measured using three versions of a craving experience questionnaire (CEQ) and frequency of chocolate related thoughts was measured using thought probes throughout the ten minute intervention. The authors found a significant reduction in craving strength, imagery, and frequency in the plasticine modelling condition compared to the control group. Furthermore, participants in the experimental condition experienced less intrusive thoughts about chocolate. The results clearly show that cravings were reduced by loading the VSSP, though given how recently this study was conducted further research is needed to verify these findings.

4.1.6 An alternative imagery task: mindfulness-based cognitive defusion

The current study proposed that an alternative imagery task, namely cognitive defusion may change unhealthy eating behaviours by reducing chocolate cravings in the same way as the imagery tasks previously discussed (e.g. clay modelling, Andrade et al., 2012; imagining common sights; Kemps & Tiggemann, 2007); by loading the VSSP. Cognitive defusion is taught to participants using image-based metaphors such as, the 'mindbus' (see Tapper et al., 2009; Jenkins & Tapper, 2013). The mindbus metaphor asks individuals each time they experience a craving to picture themselves as the driver of the bus (i.e. being in control of their planned route, for example to not eat chocolate) and their thoughts as merely passengers. The metaphor is used to first, encourage participants to notice unwanted chocolate-related thoughts and second, discourage them from entering into cycles of rumination and thought elaboration (Alberts et al., 2010). The current study predicted that the mindfulness-based defusion task reduces chocolate cravings by the participants constructing the mental image of the 'mindbus'. Like cravings, the mindbus task requires visual working memory resources in order to construct mental images. Thus, it was believed that the cognitive defusion strategy may act as a concurrent visual task. Consequently, the visuo-spatial sketchpad becomes loaded, and due to its limited capacity, prevents the elaboration of any chocolate cravings experienced, or at least, decreases the number of cravings elaborated on.

4.1.7 Evidence that the 'mindbus' task works by reducing food cravings

To date no research has attempted to understand whether the defusion strategy brings about its effects by reducing cravings. The present study therefore aimed to breech this research gap.

4.1.8 Current study

Self-reported chocolate cravers were assigned to one of three conditions; cognitive defusion, relaxation control, or no-task control. The procedure was a partial replication of that used by Andrade et al. (2012) in that all participants underwent a craving induction before completing a ten-minute intervention phase. During the intervention, the participants were asked to sit in front of five chocolate products and to let their mind wander, but to resist eating the chocolate. To help participants to cope with their cravings, those in the defusion group were also asked to use a defusion strategy (mindbus) whenever they experienced a thought that they wanted to eat chocolate, whereas those in the relaxation group were asked to use a relaxation strategy (tense and relax hand muscles). The no-task group were given no additional instructions. Every 60 seconds an alarm sounded and participants told the experimenter what they were thinking at that moment. At the end of the intervention phase participants completed two measures assessing chocolate cravings.

It was hypothesised that if the cognitive defusion strategy brings about its effects by reducing chocolate cravings then;

- A significant reduction in self-reported chocolate cravings would be evident amongst those in the defusion group relative to the control groups at follow-up compared to baseline
- The defusion group would experience less chocolate-related thoughts over the ten-minute intervention phase compared to the control groups.

4.2 Method

4.2.1 Participants

Participants were 60 people (18 male, 42 female; mean age = 22.45 years, SD = 6.51) who had responded to an email sent to students of Swansea University calling for 'chocolate lovers'. All participants met the inclusion criteria which comprised: not being pregnant, having no current or past history of an eating disorder or medical condition which affects normal eating behaviour, ability to read English fluently, and no previous participation in any other study conducted by the experimenter. Participants were asked to refrain from consuming any chocolate or chocolate-related products (e.g. drinks or other chocolate flavoured items) from midnight the night before the day of testing, and to refrain from ingesting any food or drink except water for two hours before the experiment. A 'chocolate goody bag' was given to participants as a token of appreciation for taking part. Swansea University's Department of Psychology research ethics committee approved the study.

4.2.2 Design and randomisation

The study employed a mixed-subjects design with three conditions (cognitive defusion, relaxation, and no-task). Participants were alternately assigned to one of these conditions using a single blind randomisation protocol.

4.2.3 Materials and apparatus

4.2.3.1 Demographics questionnaire

The current study used the same brief demographics questionnaire as that used in Study 3 (see section 3.8.3.1.1).

4.2.3.2 Measures of chocolate cravings

Chocolate cravings were measured using three versions of the Craving Experience Questionnaire (CEQ_Snow, CEQ_S10m, CEQ_F10m) (Andrade, Pears, May & Kavanagh, 2012). The CEQ_Snow asked about current chocolate cravings experienced (i.e. 'right now'). It consisted of eleven items in total, four relating to craving strength (e.g. 'how strongly do you want some chocolate?'), five relating to craving imagery (e.g. 'how vividly are you picturing chocolate?'), and two related to craving intrusiveness (e.g. 'when you're thinking about chocolate how intrusive are the thoughts?'). The CEQ_S10m items were the same as the CEQ_Snow except that the questions referred to the time they 'most wanted chocolate' over the previous ten minute period, rather than the present moment, and was completed after the experimental phase. As a result, the tense of the items was changed. The CEQ_F10m also measured cravings during the ten minutes of the experimental phase. It measured the frequency of craving during this period (e.g. four items in total relating to 'how often' chocolate cravings were experienced) in addition to craving imagery and craving intrusiveness. Craving strength was not measured using this questionnaire.

All three questionnaires were scored using a visual analogue scale with the anchor points 'not at all' and 'extremely'. Overall, the scales had high Cronbach's alpha ratings of .91 for the CEQ_Snow baseline, .91 for the CEQ_Snow at follow-up, .89 for the CEQ_S10m, and .91 for the CEQ_F10m. The strength, imagery and intrusiveness subscales of the four measures were also highly reliable, with Cronbach's alpha ratings between .81 and .90, with the exception of the intrusiveness subscale for CEQ_Snow_a for which Cronbach's alpha was .74, CEQ_Snow_b for which Cronbach's alpha was .56, and CEQ_S10m for which Cronbach's alpha was .79.

4.2.3.3 Chocolate stimuli and craving induction measure

To stimulate chocolate cravings, participants were shown two different bars of their most preferred type of chocolate (Dark: Green & Black's Organic Dark Chocolate 70% cocoa 100g and Cadbury Bourneville 200g; Milk: Galaxy, 125g and Nestle Aero 110g; White: Nestle Milkybar, 100g and Lindt Lindor White Chocolate 100g) and two different boxes of chocolates (Cadbury Milktray 400g and Ferrero Rocher 300g). The craving induction measure consisted of 12 questions corresponding to the chocolate stimuli (see appendix MM). Each question was verbally asked by the experiment, allowing sufficient time for participants to give a thoughtful answer. The bars of chocolate were on display for the entire craving induction procedure (i.e. when all 12 questions were asked). The boxed chocolates were only on display when questions 7-12 of the craving induction were asked given that the first six questions were unrelated to these products. The boxed chocolates were also added half way through the induction in order to further help increase the rate of cravings as the process progressed.

4.2.3.4 Strategy and task information sheets

The information sheets given to the intervention group (cognitive defusion) stated that reducing chocolate cravings can be difficult. It therefore may be helpful for participants to think of themselves as different from their chocolate cravings by imaging that they were the driver of a bus and their chocolate cravings like passengers (see appendix NN). The information sheets given to the relaxation-control group also stated that chocolate cravings can be difficult, but that it may be helpful for participants to try to physically relax in order to counteract the negative effects of feeling stressed (see appendix OO). The cognitive defusion and relaxation conditions were taught their allocated strategy using a briefer version of the written booklets used in Studies Two and Three (see section 3.2.3.6). The control no-task group was not taught a specific strategy but were instead only told to simply let their mind wander (see appendix PP). This information was included within the task instructions.

The task instructions stated that the experimental phase would last ten minutes, and during that time participants should sit in front of the chocolates whilst letting their mind wander (i.e. free to think about whatever they wanted). The task instructions also informed participants that they would be asked to briefly describe what they were thinking about when prompted by the experimenter at various time points during the experimental phase. Participants were advised to keep their eyes open at all times and to avoid engaging in any activity which was unrelated to the task. The instructions ended by providing participants with the opportunity to ask the experimenter questions if they did not fully understand what was required of them. Participants in all three conditions were given the same written task instructions. The defusion and relaxation groups were however also given additional instructions. These additional instructions stated that the defusion and relaxation groups should use their taught strategy whenever they found themselves thinking about chocolate (whilst letting their mind wander) during the experimental phase.

4.2.3.5 Thought-probe measure

The thought-probe measure recorded the thoughts experienced by participants when each beep sounded during the ten minute experimental phase. It consisted of ten individual sections (see appendix QQ). Each section consisted of a single line, allowing the experimenter to record the response given in the form of a short written phrase. The three options, chocolate-related, task-related, and other were also listed in each section. A tick was placed next to the option which was most related to the contents of the thought-probe response.

4.2.3.6 Pleasantness questionnaire

Participants rated the pleasantness of the task they had performed during the study's experimental phase using a scale of 1 - not at all pleasant, to 5 - neither pleasant nor unpleasant, to 10 - extremely pleasant (see appendix RR).

4.2.3.7 Strategy adherence measure

Participants in each condition were asked how often they used their strategy (cognitive defusion, relaxation or no-task) during the ten minute experimental phase using a four-point scale (1 = not at all, 2 = sometimes, 3 = nearly always, 4 = always) (see appendix SS).

4.2.4 Procedure

Participants were tested individually. The study commenced with participants completing a written consent form (see appendix TT), followed by a short demographics questionnaire. Participants also rated how much they craved chocolate using the CEQ_Snow. The study continued with participants undertaking the craving induction. The procedure of the craving induction did not explicitly ask participants to imagine chocolate. Instead, participants were asked to state their preferred choice of chocolate of out the options, white, milk or dark. Once a choice had been made, participants were next shown two bars of chocolate from their chosen type. These chocolate bars were of different brands and were also partially unwrapped, but with the wrappers still visible. Whilst these chocolate bars where on display, the participant was asked questions 1-6 of the craving induction measure. The second part of the craving induction procedure involved a line of squares from the chocolate bar chosen in question six being placed on the table in front of the participant. Lastly, the participants were shown two closed boxes of chocolates and asked questions 7-12 of the induction measure. All chocolate (bars, squares and boxes) was left on the table in front of the participant for the remainder of the study. Next, participants completed the CEQ_Snow for a second time, followed by the experimental phase.

At the start of the experimental phase participants were alternately allocated to one of three conditions (cognitive defusion n = 30, relaxation n = 15, no-task n = 15). The conditions differed in terms of what the participant was required to do during the experimental phase to help them reduce their chocolate cravings, and as a result, resist eating chocolate. Participants who were allocated to the cognitive defusion and relaxation groups were taught their strategy using a written information sheet. This consisted of a brief description of the strategy and how the strategy may help reduce chocolate cravings. These groups were also given instructions regarding what they should do during the experimental phase. In the cognitive defusion group, participants were informed that for the next ten minutes they would be left alone in the experimental cubicle and during this time they should sit still and let their mind wander. Whenever they found themselves experiencing a thought that they wanted to eat chocolate, they were instructed to use the defusion strategy. Participants in the relaxation control condition were informed of the same instruction. However, they were instead told that whenever they found themselves experiencing a thought that they wanted to eat chocolate, they should use the relaxation strategy. The no-task group only received the task instructions (i.e. no specific strategy was taught) and told to simply let their mind wander.

Participants in all three conditions were told that from time to time during the ten minute period, a beep would sound as a cue to tell the experimenter 'what you are thinking about right at that moment'. Participants were informed that only a short phrase was required and that they would not have to remember these thoughts or describe any thought which they considered to be private. Instead, participants were given the option to describe such thoughts using the phrase, 'something personal'. After each thought had been recorded, the participants were prompted to return immediately to their task. A total of ten beeps sounded using an electronic beeping device (Invisible Clock-II) at intervals of every 60 seconds. When the experimental phase had ended, participants completed the cravings questionnaires, CEQ_S10m and CEQ_F10m. The experimenter then went through the thought-probe responses with the participant to categorise them as chocolate-related, task-related or other (i.e. unrelated to chocolate or the task). Lastly, participants were asked to rate the pleasantness of the task they had performed during the study and to answer a question measuring how often they used their strategy (i.e. strategy adherence) during the experimental phase before being debriefed (see appendix UU). The study duration averaged 30 minutes.

4.3 Results

4.3.1 Descriptive statistics

4.3.1.1 Data screening

Outliers in the questionnaire measures (CEQ_Snow_a, CEQ_Snow_b, CEQ_S10m, CEQ_F10m) were identified by using z-scores. Scores above or below 3.5 standard deviations (SD) from the mean were removed. One participant scored less than 3.5 SD on the CEQ_Snow_b. This questionnaire was used to identify if the chocolate induction procedure was effective at inducing chocolate cravings. Given that the data was in the predicted direction (i.e. the induction procedure increased the number of chocolate cravings experienced compared to the number of chocolate cravings before the induction) and also that it was possible that this outlier may have been the result of the induction procedure being *more* effective across the whole sample than demonstrated for this particular individual, it was deemed justified to include this participant in the dataset. This was providing that non-parametric tests were used when analysing data which incorporated the outlier. All subsequent analyses whereby the outlier was not present were carried out using parametric statistical tests. Normal distribution of the questionnaire data was checked by looking at the skewness of the data via histograms. Although the CEQ_F10m scores showed a platykurtic distribution and slight positive skew for some of the other measures (e.g. CEQ_Snow_b), it was concluded that none was to a degree which would impact negatively on the data analysis. Outliers were also checked, using the procedure described above, in relation to the frequency of chocolate thoughts experienced during the 10 minute task, and also, participants' adherence to using the taught strategy over the 10 minute period. No further outliers were detected.

4.3.1.2 Group demographics

The whole sample consisted of 60 participants (defusion n = 30, relaxation n = 15, no-task n = 15).

	Mean Age (SD)	Gender (% female)	Dieting (% no)
Whole Sample (n = 60)	22.45 (6.51)	70.0	91.7
Defusion (n = 30)	21.80 (5.71)	76.7	96.7
Relaxation (n = 15)	22.67 (6.20)	66.7	80.0
No-task (n = 15)	23.53 (8.40)	60.0	93.3

Table 4.1 Demographic information for both the whole sample and the individual mindfulness and control groups.

Table 4.1 shows that for each of the three groups, participants' age, gender and current diet status were very similar. Three independent t-tests showed no significant difference in age between any of the groups (defusion – relaxation, t (43) = 0.467, p = 0.643; defusion – no-task, t (43) = 0.818, p = 0.418; relaxation – no-task, t (28) = 0.322, p = 0.750). Chi-square analysis also showed no significant group differences in gender or diet status (χ^2 (2, N = 60) = 1.429, p = 0.490 and χ^2 (2, N = 60) = 3709, p = 0.157 respectively). The majority of participants were in their early to mid-twenties, female and not on a diet (i.e. actively trying to lose weight by changing their eating habits).

4.3.2 Effectiveness of the craving induction

To evaluate the effectiveness of the craving induction, pre-induction and post-induction chocolate craving scores were calculated for each participant by averaging their responses to the 11 questions on the craving questionnaire (CEQ_Snow).

	Pre-Induction	Post-Induction
	Mean (SD)	Mean (SD)
Defusion (n = 30)	4.60 (1.71)	7.37 (1.46)
Relaxation (n = 15)	4.59 (2.32)	6.73 (2.31)
No-task (n = 15)	4.24 (1.82)	7.01 (1.69)

Table 4.2 Average response scores on the chocolate craving questionnaire (CEQ_Snow) pre- and post-induction for the three individual groups.

Table 4.2 shows that craving levels increased across all three groups after the induction procedure was completed. Compared to baseline, chocolate craved by the defusion and no-task groups increased by an average score of 2.77 whereas the relaxation group increased by an average score of 2.14. These findings suggest that the chocolate craving induction was effective at inducing chocolate cravings.

The effectiveness of the craving induction was supported by a 3 (group) x 2 (time) ANOVA showing a main effect for time, $F(1, 57) = 231.58$, $p = 0.001$. No significant main effect for group, $F(2, 57) = 0.302$, $p = 0.741$, or an interaction between time and group, $F(2, 57) = 1.479$, $p = 0.236$ were found.

4.3.3 Effects of a mindfulness cognitive defusion technique on craving

To analyse the effects of the 'mindbus' defusion technique on craving, mean craving scores before and after the intervention period, and the scores on the strength, imagery and intrusiveness subscales were calculated. It was hypothesised that a significant reduction in self-reported chocolate cravings would be evident amongst those in the defusion group relative to the control groups at follow-up compared to baseline.

	Average	Strength	Imagery	Intrusiveness
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Pre-Intervention (CEQ_Snow_b)				
Defusion (n = 30)	7.37	7.34	8.02	5.82
	(1.46)	(1.88)	(1.58)	(2.47)
Relaxation (n = 15)	6.73	6.68	7.23	5.57
	(2.31)	(2.55)	(2.40)	(3.16)
No-task (n = 15)	7.01	6.98	7.41	6.03
	(1.69)	(1.89)	(1.78)	(2.06)
Post-Intervention (CEQ_S10m)				
Defusion (n = 30)	6.87	6.98	6.65	7.18
	(1.62)	(1.99)	(2.25)	(1.88)
Relaxation (n = 15)	6.39	6.52	6.25	6.47
	(1.91)	(2.26)	(2.56)	(2.17)
No-task (n = 15)	6.73	7.08	6.92	5.57
	(2.15)	(2.33)	(2.27)	(2.82)
Post-Intervention (CEQ_F10m)				
Defusion (n = 30)	6.26	6.18	6.04	6.95
	(1.69)	(1.75)	(2.24)	(1.72)
Relaxation (n = 15)	5.85	5.90	5.67	6.23
	(1.88)	(2.14)	(2.51)	(2.40)
No-task (n = 15)	5.81	5.98	5.72	5.67
	(2.24)	(1.87)	(2.52)	(2.93)

Table 4.3 CEQ total average scores before (CEQ_Snow_b) and after (CEQ_S10m and CEQ_F10m) the experimental tasks, and scores on the craving strength, imagery and intrusiveness subscales. Scores are shown as mean ratings for each of the three groups.

A Mann-Whitney U-test carried out on mean craving scores pre-intervention (CEQ_Snow_b) showed no differences between the defusion group and the two control groups (relaxation; $z = -0.650$, $p = 0.515$, no-task; $z = -0.578$, $p = 0.563$). These findings suggest that all three groups reported a similar number of cravings prior to the intervention being completed.

Independent samples t-test on mean craving scores post intervention showed no differences between the defusion and relaxation groups, CEQ_S10m; $t(43) = 0.880$, $p = 0.384$, cohen's $d = 0.27$, CEQ_F10m; $t(43) = 0.727$, $p = 0.471$, cohen's $d = 0.23$ or between the defusion and no-task groups, CEQ_S10m; $t(43) = 0.233$, $p = 0.817$, cohen's $d = 0.07$, CEQ_F10m; $t(43) = 0.756$, $p = 0.454$, cohen's $d = 0.23$.[34] These findings were inconsistent with the pre-stated hypothesis.

Despite the previously reported non-significant findings and small effect sizes, further tests on the effects of the intervention were conducted for exploratory purposes. This involved calculating craving change scores by subtracting post-intervention craving scores from pre-intervention craving scores. Mann-Whitney U tests showed no significant differences between the defusion and relaxation groups for either post-intervention craving measure; CEQ_S10m; $M = 0.41$, $SD = 1.63$, $Z = -0.048$, $p = 0.962$, CEQ_F10m; $M = 1.08$, $SD = 1.94$, $Z = 0.000$, $p = 1.000$, or between the defusion and no-task groups, CEQ_S10m; $M = 0.41$, $SD = 1.63$, $Z = -0.349$, $p = 0.727$, CEQ_F10m; $M = 1.08$, $SD = 1.94$, $Z = -0.157$, $p = 0.876$. Again, these findings demonstrated no significant differences between the groups, thus failing to support the study's hypothesis.

The first item on the CEQ_S10m measure (completed post-intervention) asked participants to think about the time they *most* wanted chocolate during the ten minute intervention period and to report how long it lasted. The average score for each group was calculated and comparative analysis was conducted.

[34] Combining the two control groups (relaxation and no-task) and comparing this single control group with the defusion group showed no difference in the outcome of the analysis.

	Mean	SD
Defusion (n = 30)	133.00	131.84
Relaxation (n = 15)	107.67	149.35
No-task (n = 15)	180.00	129.78

Table 4.4 Mean and standard deviations for the average time duration (seconds) each group most wanted chocolate during the intervention period.

Statistically, no significant difference were found between the defusion and relaxation groups, t (43) = 0.581, p = 0.564, cohen's d = 0.18 or between the defusion and no-task groups, t (43) = 1.133, p = 0.263, cohen's d = -0.36 in terms of how long they most wanted chocolate during the ten minute intervention period. This finding shows that, contrary to prediction, the defusion group did not crave chocolate significantly less than the control groups.

4.3.4 Responses to thought probes

Responses to the ten thought probes during the intervention period were analysed. It was hypothesised that the defusion group would experience less chocolate-related thoughts over the ten-minute intervention phase compared to the control groups.

	Defusion (n=30)	**Relaxation (n=15)**	**No-task (n=15)**
Thought type	Mean (SD)	Mean (SD)	Mean (SD)
Chocolate-related	5.30 (2.23)	4.33 (2.55)	6.47 (2.39)
Task-related	0.67 (1.15)	0.73 (1.49)	0.13 (0.35)
Neutral	4.03 (1.94)	4.93 (2.28)	3.40 (2.20)

Table 4.5 Mean and standard deviation scores for the number of chocolate-related, task-related and neutral thoughts experienced by the three groups over the 10 minute intervention period.

Independent t-tests showed no significant difference between the defusion and control groups in terms of the number of chocolate-related thoughts experienced (defusion vs. relaxation; chocolate-related t (43) = 1.306, p = 0.199, cohen's d = 0.40; defusion vs. no-task; chocolate-related t (43) = 1.616, p = 0.133, cohen's d = -

0.51).[35] Although statistically the findings do not support the pre-stated hypothesis, a medium effect size was found between the defusion and control groups.

4.3.5 Secondary investigations of the data

4.3.5.1 Task pleasantness

Retrospective ratings of pleasantness when performing the defusion, relaxation and no-task tasks for ten minutes during the intervention period were calculated.

	Mean	**SD**	**Mode**
Defusion (n = 30)	6.37	1.97	5
Relaxation (n = 15)	6.67	1.68	8
No-task (n = 15)	7.13	2.20	6

Table 4.6 Pleasantness ratings of the task performed by each of the three groups.

Mann-Whitney U-tests showed no statistical difference in rated task pleasantness for the defusion task compared to the relaxation (control) task, $z = -0.513$, $p = 0.608$, or for the defusion task compared to the no-task (control) task, $z = -1.365$, $p = 0.172$.

4.3.5.2 Strategy adherence

The number of times participants used their taught strategy (cognitive defusion, relaxation control or no-task control) over the ten minute intervention period in relation to the number of chocolate cravings experienced was calculated for each group.

	Defusion (n = 30)	**Relaxation (n = 15)**	**No-task (n = 15)**
Not at all	0 (0%)	0 (0%)	0 (0%)
Sometimes	16 (53%)	9 (60%)	5 (33%)
Nearly always	11 (37%)	6 (40%)	7 (47%)
Always	3 (10%)	0 (0%)	3 (20%)

Table 4.7 Frequency of strategy used in the mindfulness and control groups.

[35] Combining the two control groups (relaxation and no-task) and comparing this single control group with the defusion group showed no difference in the outcome of the analysis; defusion vs. control; chocolate-related $t(58) = 0.158$, $p = 0.875$.

No significant difference were found between the defusion and control groups (relaxation, $t(43) = 0.839$, $p = 0.406$, no-task, $t(43) = 1.354$, $p = 0.183$) in relation to how often they used the taught strategy during the ten minute intervention period.

4.3.6 Summary

The findings showed that the craving induction procedure used in the current study was successful at inducing chocolate cravings in the sample. The mindfulness cognitive defusion technique however showed no significant effect on the number of chocolate cravings experienced compared to two non-mindfulness control techniques. No significant differences in the number of chocolate-related thoughts experienced by the defusion group were also found. The effect sizes of this particular analysis were however evident to be of medium strength.

4.4 Discussion

4.4.1 Summary

The study in the current chapter aimed to further explore how the mindfulness-based strategy *cognitive defusion* changes unhealthy eating behaviours. It was proposed that the effects of cognitive defusion on chocolate consumption were mediated by the total number of cravings experienced. More specifically it was theorised that, as an imagery task, the mindbus strategy would reduce cravings by limiting working memory (i.e. loading the visuo-spatial sketchpad), thus preventing the elaboration of intrusive thoughts. Contrary to prediction, the results showed no significant differences in the number of chocolate cravings experienced between the three groups (defusion, relaxation and no-task). Additionally, there were no significant differences in the number of chocolate-related thoughts experienced by the defusion group relative to the control groups. In conclusion, the current study found no statistically significant evidence for an effect of cognitive defusion on cravings. It was therefore presumed that the defusion task does not reduce chocolate consumption by influencing cravings, but instead by an alternative means.

4.4.2 Discussion of the findings

4.4.2.1 Effects of a mindfulness cognitive defusion technique on craving

It was hypothesised that the effects of the defusion strategy on chocolate consumption were meditated by the number of cravings experienced. This prediction was based on the notion that craving-related imagery can be interrupted by the completion of an alternative task which occupied the same working memory resources. The results of the present study however showed that the imagery-based cognitive defusion task did not reduce cravings either during (as measured by the CEQ_S10m) or immediately after (as measured by the CEQ_F10m) the ten-minute intervention relative to two control tasks (i.e. body relaxation and mind wandering). Thus the theory that visualisation of the 'mindbus' would reduce cravings by interfering with craving imagery was not supported. These findings therefore suggest that the effects of the defusion strategy on reducing chocolate consumption cannot be accounted for by the Elaboration Intrusion Theory (Kavanagh et al., 2005) which states that loading working memory required for visual imagery (i.e. visuo-spatial sketchpad, VSSP) reduces cravings. The results of the current study also suggest that a reduction of cravings in the defusion group was not evident because the mindbus task did not load the VSSP in the same way as other visuo-spatial tasks (Andrade et al., 2012; Kemps et al., 2004, 2005; Kemps & Tiggemann, 2009; McClelland et al., 2006; Steel et al., 2006). Further discussion of these findings is relation to similar studies, is at present, impossible. This is because, to my knowledge, the current study is the first to explore whether the defusion strategy brings about its effects by reducing cravings as a result of loading the VSSP.

Unlike the current study which used a mental imagery task (i.e. the participant imagining themselves as the 'driver' and their thoughts as 'passengers'), much of the aforementioned literature explored the effects of physical imagery tasks (e.g. clay modelling; Andrade et al., 2012) on cravings. The different visual modalities used may therefore account for the inconsistency between the findings. Shaping plasticine, for instance, might be rendered more vivid in imagery than the mindbus task, consequently loading the VSSP more effectively and therefore demonstrating the effects of the task more clearly. Furthermore, compared to the clay modelling task, the mindbus strategy allowed participants to look at the chocolates on the table in front of them without getting distracted (e.g. when clay modelling, participants need to look at the clay from time to time). Research has shown that participants are more likely to avert their gaze from distracting stimuli when attempting more complex tasks (Doherty-Sneddon, Bruce, Bonner, Longbotham & Doyle 2002; Glenberg, Shroeder & Robertson, 1998; Meskin & Singer, 1974). As a result, it is believed that the simplicity of the mindbus task relative to the clay modelling task increased the chance of the sight of the chocolates provoking cravings. In support of this, using the CEQ_S10m measure as an example, the findings of the current study showed that the defusion group reported an average number of cravings between 6.87 and 7.18, whereas Andrade et al. (2012) reported that those in the clay modelling group experienced a mean number of cravings between 2.64 and 3.29.

4.4.2.2 Possible explanations for non-significant group differences

One possible explanation for the non-significant differences between the groups is that, the current study considered the defusion strategy to be an imagery task and the relaxation and no-task (i.e. mind wandering) strategies as non-imagery tasks. It could however be argued that both control tasks also involved some degree of imagery. When trying to 'take the stress out of the craving' for instance, the relaxation group may have visualised their muscles tensing and relaxing. Moreover, the no-task group were allowed to let their mind wander (i.e. daydream). The participants in this group may therefore have used imagery when freely elaborating on their thoughts (Teasdale et al., 1995). If all three tasks were imagery-based then it is unsurprising that no group differences were found. This is because the mindbus and control tasks had the capability of loading the visuo-spatial sketchpad in the same way, thus acting as 'control processes' to disrupt the cognitive elaboration of intrusive thoughts. Future replications of the present study could usefully explore the effects of the mindbus task on cravings when compared to sufficiently matched control tasks on their ability to load the visual-spatial sketchpad (i.e. general resource load).

Due to all the participants being self-reported 'chocolate lovers', it may also be suggested that non-significant differences between the groups were caused by the chocolate being perceived as 'positive temptation' (i.e. something that still gives pleasure during abstinent attempts). Like the control groups, the defusion group may therefore have only casually abided by their task instructions to help them to avoid eating the chocolate. In support of this, the majority of participants across all three groups reported using their strategy, 'sometimes'. It would be interesting to see if significant group differences in the number of cravings experienced was found when the same participants are faced with the challenge of resisting a 'negative temptation' (i.e. something that is unpleasant during abstinent attempts). This, for example, could be something deemed more of an immediate threat to their health. Changing the sample in this way may help to identify whether the defusion group had received sufficient training in order to be appropriately skilled in the mindbus technique.

Another explanation for the null findings may be that the current study was significantly underpowered in order for an effect of the defusion strategy to be evident. The sample comprised of a total of 60 participants with small group sizes (defusion, $n = 30$; relaxation, $n = 15$; no-task, $n = 15$). Whilst significant effects of imagery-based tasks on cravings have been previously reported using similar sample sizes (Andrade et al., 2012), more recently it has been suggested that studies exploring the effects of cognitive defusion on chocolate consumption require larger samples in order for significant group differences to be demonstrated. In a sample of 56 participants (defusion group, n = 16, control groups, each n = 14), Hooper et al. (2012) reported that when the amount of chocolate participants ate in a normal week was accounted for, the three groups did not differ significantly in the amount of chocolate eaten or the amount of cravings experienced. The effects sizes reported in Hooper's study were however very small.[36] Similar strength effect sizes were also reported in the current study when exploring the effects of the defusion strategy on cravings. Increasing the sample size in future research may therefore be unhelpful. Of interest however, the findings for the number of chocolate-related thoughts experienced by the defusion group in the current study compared to the control groups showed medium to large effect sizes.

It may also be argued that the null effects were due to the mindbus strategy being a task of general distraction rather than selective interference with imagery. If this was however correct, a significant difference between the defusion and no-task group would have been expected as the latter group were permitted to think about chocolate and not asked to suppress their thoughts in any way. Previous research has also demonstrated the significant effects of the defusion strategy on chocolate cravings relative to distraction tasks (Hooper et al., 2012) therefore rendering this explanation unlikely. Alternatively, the null findings may be due to all three groups being aware that the study aimed to explore chocolate cravings. Whilst this could not be avoided, it is recognised that it is difficult to measure cravings without asking participants to introspect about it, which may act as a spur for elaboration across all groups. This suggestion would though imply that the participants did not use their taught strategies when in fact the findings showed that all participants used their strategy at least *sometimes* during the ten-minute intervention period.

4.4.2.3 Responses to thought probes

In addition to showing no significant differences in self-reported chocolate cravings between the defusion and control groups, the mindbus task was found to be ineffective at reducing the frequency of intrusive craving-related thoughts. This was

[36] In Hooper's study the means were in the predicted direction for the amount of chocolate eaten but not for the number of cravings experienced.

demonstrated by all three groups showing no significant differences in the mean number of chocolate-related thoughts reported in response to the thought-probes during the ten-minute intervention phase. With no other research in which to compare, it is impossible to state whether these findings are supportive or contradictory in nature.

An explanation for the defusion group not experiencing significantly less chocolate-related thoughts compared to the control groups is that, the intervention phase was too short to demonstrate the effects of the defusion task on cravings. Participants were required to use their taught strategy each time they experienced a chocolate craving over a brief ten-minute period. The current study therefore does not allow for the exploration of whether the defusion tasks effectively reduce chocolate-related thoughts, or whether one or more of the control strategies has reduced impact on chocolate-related thoughts when applied over a longer time period. It would therefore be useful for future research to extend the intervention time phase beyond ten-minutes. Another option would be to provide an extended amount of training time which would end once participants had reported competence in the strategy.

4.4.3 Limitations and future research

There were several weaknesses in the present study that point to potential directions for future research. First, cravings were measured by self-report, leaving room for inaccuracies given that the craving questionnaires relied on participant's accounts of their craving experiences during the study. This however may not necessarily be a limitation of the study because identifying an alternative measure of cravings would be very difficult. Rather, this point highlights the lack of available methodologies for use in craving studies. Additionally, although there is no direct evidence to lead to such as conclusion, it is possible that some of the participants misinterpreted the questions on the post-intervention craving measures (CEQ_S10m and CEQ_F10m) and based their responses on how they were feeling about chocolate at that particular moment in time instead of how they felt during the intervention phase. If misinterpretation of questions occurred, this may have had an effect on the overall total of cravings reported post-intervention by the different groups. Second, the present study was conducted in a comparatively homogeneous sample of undergraduate students who were, for the majority, not currently dieting and only reported chocolate cravings slightly above moderate intensity. The findings may therefore have been different if individuals with potentially more severe craving control problems were tested. Future research should aim to extend the present findings to individuals who experience frequent and/or intense food cravings, such as ''chocoholics'', as well as binge eaters, overweight or obese individuals who are trying to lose weight, or those suffering from an eating disorder such as bulimia nervosa (Schlundt et al., 1993; Sitton, 1991; Waters et al., 2001).

Third, although the different groups were found to be demographically similar (e.g. age and diet status) the majority of participants were female. Several studies have found increased food craving (Dye et al., 1995) and consumption (Barr, Janelle & Prio, 1995; Johnson, Corrigan, Lemmon, Bergeron & Crusco, 1994) during the luteal phase of the menstrual cycle. It is therefore possible that this had an effect on the data as a measure of menstruation was not taken. Future replications of the study should ensure that participants are matched across condition according to phase of their menstrual cycle.

A fourth weakness of the present study is that the training of the defusion and control strategies was very brief. Delivering the instructions of how to use the strategies over a slightly longer experiential training period (to allow the practice to form some level of mindfulness skill) may have demonstrated the effects of the defusion strategy on cravings more clearly. Furthermore, it could be argued that the current study was too artificial in nature. Sitting in front of a selection of chocolate products in silence for ten-minutes is not an activity which many people would carry out in their daily routine. It would therefore be useful to explore the effects of the mindbus task on chocolate cravings outside of a laboratory setting by conducting the study over an extended period of time. This would allow participants to use their taught strategy each time they experienced a chocolate craving in a number of different natural settings (e.g. at work or at home).

A final limitation of the current study is that during the ten-minute intervention phase, the number of chocolate-related thoughts was measured as opposed to cravings. Cravings were only measured after the intervention phase had been completed. To obtain a more accurate measure of the effects of the defusion strategy on chocolate cravings, future studies could ask participants to self-record each time they experienced a craving. Participants could also rate their strength of each craving using a Likert or visual analogue scale. It is however important to bear in mind that similarly to measuring thoughts, such a process, while of some value, may also interfere with the effectiveness of the intervention.

4.4.4 Conclusion

In conclusion, the present study failed to demonstrate that the defusion strategy brings about its effects (i.e. changes unhealthy eating behaviour) by limiting craving-related intrusive thoughts. More specifically, the mindbus task did not appear to reduce cravings by loading working memory and thus, prevent thought elaboration. The findings instead suggest that participants practicing the defusion strategy experience a similar number of cravings to those practicing non-mindfulness based control strategies. Further investigations are therefore needed in order to understand how the cognitive defusion works to reduce chocolate consumption.

Chapter Five

General Discussion

5.1 Research aims

There is a large body of literature demonstrating the effects of mindfulness-based therapies across a range of different health and non-health related areas (e.g. Hayes, Masuda et al., 2004; Hayes, Wilson et al., 2004; Teasdale et al., 2000), but less understanding of how these therapies work (Baer, 2009). The aim of the current thesis was therefore to identify how mindfulness brings about its' effects. Three mindfulness-based mechanisms were explored over four studies; resulting in two different but complementary lines of enquiry. The first study examined whether practicing mindfulness positively effects behaviour change by increasing attentional control. Studies 2-4 used a dismantling design to separate and explore individual mindfulness strategies widely used within mindfulness-based interventions. These studies examined how mindfulness exerts its effects on self-control related health behaviours, using unhealthy eating behaviour as an example. More specifically, Study One aimed to examine differences between experienced, novice and non-meditators in their ability to regulate attention to emotionally motivating stimuli (chocolate) using dot-probe and emotional Stroop tasks. Study Two aimed to investigate the effects of brief versions of the mindfulness-based cognitive defusion and acceptance strategies on chocolate consumption over a five-day period. Study Three sought to replicate the findings from Study Two, whilst additionally exploring whether the defusion strategy was effective at reducing chocolate consumption by either reducing automaticity and/or increasing goal accessibility. Study Four explored the alternate possibility that the effects of the defusion technique previously demonstrated in Study Two were mediated by a reduction in the number of chocolate cravings experienced. A full discussion of these studies can be found in earlier chapters.

The purpose of this final chapter is to focus on the implications of the findings and the ways in which they can help to fully exploit mindfulness as an intervention for changing unhealthy behaviours. A discussion of the implications of each individual study, in addition to a more general discussion of the research implications is provided.

5.2 Is mindfulness experience associated with reduced attentional bias to chocolate-related stimuli. What are the implications of this?

Most mindfulness-based interventions highlight attention as a core component (Bishop et al., 2004, Brown & Ryan, 2003; Walach et al., 2006). As a result, there has been much research conducted on whether greater mindfulness training enhances an individual's ability to control their attention to emotionally distracting stimuli (e.g. Brefczynski-Lewis et al., 2007; Jha et al., 2007; Moore et al., 2012, Wenk-Sormaz, 2005). The findings however are mixed, with some suggesting that more experienced meditators perform more effectively on attentional control tasks compared to novice meditators (Brefczynski-Lewis et al., 2007) and others the opposite (Dickenson et al., 2013). As previously discussed in Chapter Two, one explanation for these conflicting results is that some studies use methods (e.g. randomised control trials) which do not allow the experimental groups sufficient training to become 'experienced' meditators (e.g. Semple et al., 2010). The findings therefore fail to demonstrate the effects of long-term meditation on attentional control. To avoid this limitation, Study One extended the current literature by using a between-subject design which consisted of three groups; meditative naive participants, novice meditators and experienced meditators. It was believed that having a clearer understanding of the effects of different mindfulness experience would have important implications from an applied point of view. For instance, if the non-meditators were found to have better attentional control compared to meditators, but no differences were evident between the novice and experienced meditators, then small amounts of mindfulness meditation maybe just as beneficial for attentional control as more extensive training. This is important from an applied perspective given the presumed relationship between attentional control and behaviour (Cox, Pothos & Hosier, 2007; Waters & Feyerabend, 2000; Waters et al., 2003; Field & Eastwood, 2005).

The results of this study provided no evidence that meditation experience, irrespective of whether it was determined by participant self-assessment, frequency or length of practice, or the type of attentional controls used (focused attention and/or open monitoring) was statistically associated with attentional bias to chocolate-related stimuli, as measured by the dot-probe and emotional Stroop tasks. In addition, no statistically significant associations were found between the predicted mediators (self-reported mindfulness, attentional control and self-control scores) and the attentional bias measures. The effect sizes for both sets of analyses also failed to reach even moderate strength, thus suggesting that no effect of meditation experience on attentional control was evident, or likely to be evident, even with the recruitment of a larger sample. It was therefore concluded that those trained in mindfulness meditation do not attend to emotionally attractive stimuli any less than those who have not received mindfulness training. This however maybe somewhat understandable given that mindfulness meditation teaches practitioners to 'experience' all stimuli in the present moment, irrespective of whether it is deemed good or bad (Kabat-Zinn, 1990). In view of these findings, it was instead suggested that another process of the mindfulness training was responsible for bringing about behavioural change. Emotionally motivating stimuli elicit internal cues such as thoughts and feelings (Adriannse et al., 2009), thus one possibility was that mindfulness training works by teaching practitioners to perceive and experience internal cues differently. Study Two investigated this alternative possibility.

5.3 Are two brief mindfulness strategies derived from Acceptance and Commitment Therapy effective at reducing chocolate consumption, and how?

To my knowledge there have been only two previous attempts to improve diet using mindfulness-based interventions; Alberts et al. (2010) and Tapper et al. (2009). Both these interventions however employed a broad range of mindfulness-based strategies that are likely to have influenced a wide range of different psychological processes. Such an approach makes it more difficult to identify the precise mechanisms at work. The aim of Study Two was therefore to extract just two mindfulness-based strategies commonly used in mindfulness interventions to be able to test the effects of these strategies in isolation. The main interest of Study Two was also to look at 'brief' versions of these strategies rather than labour intensive ones. Thus, both the cognitive defusion and acceptance strategies were taught over a short 30-minute period. This was considered sufficient to ensure that participants gained understanding of, and competency at, using such techniques, yet was not overly demanding on the participants in terms of time and effort. Using brief versions of the strategies was also believed to limit the difficulties generated by attrition and adherence to applied research studies (Dumville, Torgerson & Hewitt, 2006) and formal mindfulness-interventions more generally (e.g. Shennan, Payne & Fenlon, 2010).

The results of this study showed participants in the cognitive defusion group ate significantly less chocolate than the control group. There were no significant differences in chocolate consumption between the acceptance and control groups. These findings highlight the importance of disentangling the effects of different mindfulness-based techniques. By doing so, the findings provide new evidence that different mindfulness strategies are more or less effective for changing different types of health behaviours. This has important implications for the development of new and existing mindfulness-based interventions in that they can be tailored more specifically in order to bring about the quickest and most successful behavioural change. In Study Two, the defusion strategy was shown to be effective at reducing chocolate consumption, whereas the acceptance strategy failed to demonstrate similar effects. It would therefore be advised to incorporate the defusion strategy into mindfulness-based interventions aimed at changing unhealthy eating behaviour, but not the acceptance strategy.

It may however be possible that the acceptance strategy is more effective for other health-related behaviours such as those which require create new habits, rather than breaking existing habits. Another possibility is that only certain mindfulness strategies remain effective when taught and implemented in 'brief' form. Thus, acceptance may not necessarily be ineffective at reducing chocolate consumption, but the brief, simplified version used in Study Two was insufficient at demonstrating behavioural change in the same way at the defusion strategy. It would therefore be interesting for future research to explore whether the brief acceptance strategy is made more effective by improving the training provided. Future research also needs to understand further exactly 'how' the different strategies work. Study Two showed some, but not wholly sufficient, evidence that the defusion strategy brought about its effects by reducing automaticity between chocolate-related thoughts and chocolate consumption. Study Three aimed to extend these findings in addition to exploring another potential mediator; increasing goal accessibility.

5.4 Does a brief mindfulness-based cognitive defusion intervention really reduce chocolate consumption, and if so, does it work by either reducing automaticity and/or increasing goal accessibility?

There is some evidence to suggest that mindfulness training, when taught in its more complex, formal form effectively changes unfavourable eating behaviours for more favourable ones (Alberts et al., 2010; Kristeller & Hallett, 1999; Tapper et al., 2009). None of these studies, however, have attempted to replicate their findings in order to test both the reliability and validity of the data. This has important implications for the long-term success and usefulness of mindfulness-based interventions. Study Two showed that those practicing a brief defusion strategy ate significantly less chocolate and chocolate-related products than those practicing a relaxation-control strategy over a five-day period. Given the novelty of such research, the study was repeated, making only small adjustments to the design, in order to confidently conclude that a brief defusion strategy successfully reduced chocolate consumption. As a result, Study Three was conducted. Contrary to Study Two, Study Three did not find evidence to suggest that the defusion strategy was more effective than two control strategies (relaxation and no-task) at helping participants to resist chocolate. This highlights the importance of replicating findings within mindfulness research, especially when such research is conducted with the potential of informing government and health officials. It was assumed that one possibility for the inconsistency between these studies was caused by the changes to the design. Whereas this was intended to improve the credibility of the research, these amendments may have been somewhat detrimental to the overall outcome. Future research would thereby benefit from conducting an exact replication of Study Two to truly establish if a brief cognitive defusion intervention can bring about positive behavioural change. Failing to do so may result in a substantial amount of time and money being wasted on the development and delivery of a new mindfulness-based healthy eating intervention.

Despite non-significant group differences found in Study Three, for exploratory purposes, further investigations to understand how the defusion strategy may have brought about its effects were conducted. There exists a large body of literature which has explored the association between behaviour and automaticity (Bargh et al., 1996; Dijksterhuis & Bargh, 2001; Greenwald et al., 1996) and behaviour and goals (Chartrand & Bargh, 1996; Fitzsimons & Bargh, 2003; Shah & Kruglanski, 2002). However, there is no research combining both automaticity and goals with mindfulness in order to explore how behavioural change is brought about. Study Three therefore specifically looked to examine whether cognitive defusion either works by weakening links between chocolate-related primes and chocolate consumption, and/or strengthening links between chocolate-related primes and competing goals. Contrary to prediction, there was no evidence that the strategy worked by reducing levels of automaticity between chocolate-related thoughts and chocolate consumption, as measured by a lexical decision task and self-report habit index measures. Study Two did however show a reduction in automaticity using the SRHI. It would therefore be worthwhile to explore this prediction further. There was also no evidence to suggest that the defusion strategy worked by increasing goal accessibility; this was again measured using a lexical decision task. Irrespective of this, it would be interesting for future research to adjust the goal accessibility lexical decision task to see whether this alters the sensitivity of the measure. These may, for instance, include using primes that are not implicit, and also increasing the number of critical trials (Hassin, Aarts & Ferguson, 2005). Another option would be to provide participants with feedback on their performance of the LDTs. Having a better understanding of the complex interaction between eating behaviour and automaticity, and eating behaviour and health goals will again help to inform the development of effective mindfulness interventions by understanding how the different mechanisms work.

5.5 Does the brief cognitive defusion intervention work by reducing the number of chocolate cravings experienced?

Food cravings are often described as 'intrusive thoughts' which become intensified with thought elaboration (May et al., 2010). The brief defusion task used in the current research aimed to distance thoughts from the person experiencing them, thus breaking the elaboration cycle. In view of this, Study Four explored the possibility that cognitive defusion reduces chocolate consumption by decreasing chocolate cravings. More specifically it was hypothesised that this would be achieved by the 'mindbus' defusion task loading visuo-spatial memory given that this task requires the individual to form a mental picture of themselves as the 'driver' and their thought as 'passengers'. This study was believed to be the first to investigate this explanation of how cognitive defusion strategies bring about their effects.

The findings failed to support the pre-stated hypothesis, as no significant differences in chocolate cravings between the mindfulness and non-mindfulness groups were found. There were also no significant differences in the number of chocolate-related thoughts experienced in the defusion group compared to the control groups. Thus Study Four demonstrated no evidence for an effect of cognitive defusion on cravings. In other words, defusion strategies neither prevent cravings from occurring nor do they provide a 'cure' for chocolate cravings. Instead cognitive defusion encourages individuals to change their perspective of their cravings rather than the cravings themselves. Cravings can be distressing and also very distracting, thus it is acknowledged that interventions that reduce cravings are viewed as beneficial (Andrade et al., 2012). Whilst such interventions (e.g. thought suppression) are successful at bringing about behavioural change in the short-term, there is evidence to suggest that their benefits are not sustained long-term (Wegner, 1989). The findings for Study Four therefore have important implications in that they can advise existing interventions of an alternative way of dealing with cravings, not just in terms of changing unhealthy eating behaviours, but also other addictive type behaviours. To extend this research it may first however be worthwhile investigating the general effects of the mindbus strategy on working memory.

5.6 Do the findings support the hypothesis that mindfulness changes unhealthy eating behaviours using top-down regulatory processes?

Some existing literature has supported the opinion that the beneficial effects of mindfulness on health-related behaviours are caused by top-down, as opposed to bottom-up regulatory processes (Fresco et al., 2007; Garland et al., 2010; however see Grabovac et al., 2011). The current thesis aimed, in part, to strengthen previous research by investigating whether mindfulness changes unhealthy eating behaviours by influencing how individuals manage their responses to tempting external and/or internal cues. More specifically, it was predicted that mindfulness may lead to positive health-behavioural changes by increasing self-control as a result of increased awareness of, and attention to such cues. Study One explored the effects of mindfulness training on attention to chocolate cues in the environment, thus focusing on the top-down influence of the physical properties (e.g. taste and smell palatability) of food on the 'cognitive and emotional brain' (see Figure 1.1). The remaining studies explored the effects of mindfulness training on the individual's ability to notice internal cues (i.e. thoughts and feeling), subsequently allowing temptation to be resisted. These studies predominately focused on the top-down processes involved in mental imagery, impulsivity and the hedonic values of food.

Contrary to expectation, in the current research there was no evidence to suggest that mindfulness worked by either improving attentional control (Study One), or by reducing the emotional salience of chocolate-related cues via acceptance-based techniques (Study Two). These findings may however be explained by both processes being more strongly attributed to bottom-up regulatory strategies (Brown & Ryan, 2003; Slagter et al., 2007; van Leeuwen et al., 2009). Study Two did however show that the mindfulness-based strategy, cognitive defusion, successfully changed unhealthy eating behaviours using a top-down process. This process involved strengthening executive control, causing a reduction of behavioural automaticity to chocolate and chocolate-related food items. It was therefore concluded that the mindfulness-based defusion strategy works by overriding impulsive, automatic responses and instead enabling goal-oriented actions. Caution should though be taken given that these early findings were not replicated in a later study. The precise mechanisms of how the defusion strategy heightened goal success and accessibility (Study Three) and reduced imagery-based thought elaboration (Study Four) also presently remain unclear. In view of this, additional exploration of the top-down processes involved in mindfulness and its effects of eating behaviour is advised.

5.7 Summary of the main research implications

5.7.1 Contribution to wider mindfulness research

Differentiating between distinct mindfulness components and testing the individual effects of each one will help facilitate a more detailed understanding of the different components. Exploring the effects of individual mindfulness components will also benefit future mindfulness research because those which currently investigate mindfulness more generally make it difficult to identify the precise mechanisms at work, and consequently, dilute the effects of any one component (Tapper et al., 2009; Hölzel et al., 2011). Furthermore, discussing the potential mechanisms underlying mindfulness allows future investigations into whether mindfulness as a clinical intervention adds something unique to existing clinical interventions (e.g. Cognitive Behavioural Therapy) and if so, what that unique factor is.

5.7.2 Helping to identify how mindfulness changes self-control related behaviours

Understanding how mindfulness works and its relevance to help change self-control related behaviours will be conducive for the flexible and more targeted application of mindfulness training both within clinical and community settings. Furthermore, if some aspects of mindfulness training were empirically found to be 'inert', this also highlights the possibility that certain 'unhelpful' components could be eliminated from mindfulness-based training programs. Consequently, such research will facilitate the establishment of targeted and cost-effective programs which specifically utilise mindfulness mechanisms that are most relevant for a particular behaviour type.

5.7.3 Improving health and health research

The findings will contribute towards ensuring that the population maintains a healthy diet. This in turn will lead to improved general well-being and decreased risk of developing chronic conditions linked with unhealthy eating behaviours (Kopelman, 2007). Moreover, health psychologists are frequently asked to offer their expertise in the development of new government health initiatives (Johnston, Weinman, & Chater, 2011). Thus, the findings of this research can make a significant contribution to public health policy and services which aim to reduce active engagement in unhealthy behaviours (Welsh Assembly Government, 2010). Furthermore, if the mindfulness strategies explored in the interventions are effective at reducing unhealthy eating, they could be incorporated into commercial and community healthy eating programs. Also, with such a large percentage of people eating unhealthy diets, offering a quick, simple and effective intervention may encourage its use by a diverse population and not limit its use to 'meditative types'. Consequently, this may help reduce the onset of major health problems associated with unhealthy eating and have a positive effect on society more widely. Lastly, given the theoretical overlap between overeating and other health-damaging behaviours (e.g. smoking, alcohol/drug abuse) the results from the current studies are believed to have relevance beyond diet, thus should generalise to a range of different health-related behaviours.

5.8 Limitations and future research

Study One aimed to determine whether mindfulness brings about behavioural change by reducing attentional bias. The implication of this study is that the results could be generalised to a range of health-related behaviours whereby attention is considered a key component, such as addiction (Field & Cox, 2008). The findings however showed no significant differences in attentional control between meditators and non-meditators. Whilst this finding suggests that mindfulness does not bring about its effects by reducing attentional bias to emotionally motivating stimuli, the data were only correlational in nature. This design cannot account for cause and effect and therefore may explain the non-significant findings identified. In view of this it would be worthwhile to attempt to manipulate mindfulness in order to directly assess its impact on attentional bias in future research. This could be achieved by allocating meditation naïve participants to experimental and control groups. Each would be asked to complete similar measures to those employed in Study One, though the participants allocated to the experimental group would also undergo mindfulness training over a two week period (Tang et al., 2007). Similarly to Study One, it would be expected that if mindfulness training enhances attentional control and reduces attentional bias then performance amongst the experimental participants on all measures would be enhanced at follow-up. An alternative follow-on study to Study One could use an intervention approach whereby a mobile phone application is used to assist in the practice of mindfulness or relaxation-control (i.e. 10 minutes of practice each day) over a longer-period of time (e.g. two weeks). Making these changes to the study's design is believed to reveal a more clear and robust understanding of the effects of mindfulness training on attentional control. This approach does however exclude the investigation of experienced meditators; a limitation which has been earlier discussed.

As earlier stated, previous attempts to improve diet, using mindfulness-based interventions, employ a broad range of mindfulness-based strategies (Alberts et al., 2010; Tapper et al., 2009). Given the limited time available for the delivery of current interventions, the individual effects of the different strategies are likely to become weakened and sometimes even go undetected. Consequently this can result in the publication of findings stating that mindfulness-based interventions are ineffective for bringing about a particular behavioural change whilst also offering little understanding of how such an effect, or lack of, is brought about. The findings from Study Two is therefore relatively novel in that it is able to inform health policies and interventions that, for reducing chocolate consumption, practice of a brief mindfulness-based cognitive defusion strategy is sufficient to bring about change, and change quickly (over a five-day period). However, a limitation of Study Two was that measures of the actual impact of mindfulness on health (e.g. weight loss, improvements in blood pressure) were not recorded. Instead the findings tell us simply that a brief defusion strategy reduces chocolate consumption. It is possible that the participants' substituted one type of unhealthy snack food for another (e.g. crisps), therefore their chocolate consumption was reduced, but there were no positive implications for their overall health. Future studies are advised to investigate this. It would also be interesting to expand on this research by employing a sample of participants that have already successfully reduced their chocolate intake, and thus, potentially, seen improvements in their overall health. These participants may be more highly motivated to maintain this behavioural change in order to keep hold of the positive health outcomes. It is thus worthwhile to ask the question; does the defusion strategy work any better or worse for these individuals? In other words, does this mindfulness-based strategy only work during the initial stages of behavioural change or does it extend to maintaining it also?

Future research would also benefit from identifying any difficulties people have when trying to learn brief mindfulness-based strategies. This again has implications for the development of interventions that are tailored specifically to each individual. Due to its novelty, at this stage in the current research the mindfulness strategies were taught with the general assumption that all people will learn, understand and use the concept in a similar manner; in the way they were asked to. However, this may not have been the case for all. Some people, for example, may have been kinetic learners, therefore have found the practice exercise of the teaching process very beneficial. Others however may have benefited from the literature provided (i.e. the written booklet) as they learn by acquiring 'information'. It would therefore by useful to identify which form of teaching the mindfulness strategies would be most effective for each individual and adjust the learning process accordingly. This could be achieved by simply asking participants 'In which way do you learn the best?'. It is possible that subtle differences between how those in Study 2 and those in Study 3 learned the strategy may account for the inconsistency between the research findings. Despite the current research not controlling for differences in learning ability of an unfamiliar strategy, Study 2 and 3 did take into consideration difficulties when implementing the taught strategies. This was evident by using only 'brief' versions of the strategies, enabling them to be taught over a short period of time. The implication of this was that, if effective in reducing chocolate consumption (as shown in Study Two), then these strategies may attract a wider range of the population to use them, including those who are non-meditative types (i.e. do not believe in the effects of meditation), impulsive individuals (i.e. want to reap the rewards of practicing a strategy very quickly) or those people with very little time to dedicate to such practice (i.e. a person with both a family and a demanding job). Future research would benefit from the recruitment of such individuals to test not only the effects of the strategies and identifying how it is bringing about its effects, but to explore whether the aim of scaling down mindfulness interventions to that of individual, brief strategies truly does increase its use by a greater number of people.

A frequently reported limitation of mindfulness research is whether participants using a general mindfulness based questionnaire can reliably report on the quality and/or magnitude of their mindfulness for a particular behaviour. This limitation is particularly relevant for Studies One and Two whereby participants are asked to rate their level of mindfulness. The data were used to identify if mindfulness acted as a potential mediator. There exist many 'general' measures of mindfulness (Baer et al., 2006; Brown & Ryan, 2003; Cardaciotto et al., 2008), however less are specific to certain behaviours. A new Mindful Eating Scale has however recently been devised (Hulbert-Williams et al, 2013). It may therefore be argued that future investigations of the effects of brief mindfulness strategies on healthy eating behaviour should be accessed using more specific types of measures. The posing of this question however leads to the further questions; how would one go about validating such a self-report instrument and what are objective measures of mindfulness? These questions also need to be addressed in future research.

The three mindfulness-based mechanisms chosen for investigation in the present research (attention, cognitive defusion and acceptance) were based on their ease of separation from formal interventions, and their testability using available behavioural and self-report measures. There are however many different mindfulness components that make up mindfulness-based interventions, thus exploring the effects of each one of these components and identifying how they work to bring about their effects is important. Future studies need to look at each component individually across a range of different self-control related health behaviours. It would also be worthwhile to explore different combinations of the mechanisms in order to understanding whether this strengthens or weakens its effects. It is however suggested that piloting these combinations should be carried out prior to any main analysis. It is also critical that the investigations go beyond merely answering the questions; do these strategies or combinations work? Answering the additional question of 'how' is also extremely important otherwise the development of mindfulness research will remain somewhat stunted. To mature the field of mindfulness training even further, it is also important to go beyond the questions 'does mindfulness work?' and 'how does mindfulness work?' and ask more about how best to teach it. In studies 2-4, the different groups were taught by the same researcher who had received professional mindfulness training. This was deemed necessary in order to correctly attribute the observed changes in mindfulness-based intervention studies to the active ingredient of mindfulness per se rather than many nonspecific factors (e.g. positive expectations, confidence of the teacher in the effectiveness of the intervention). Recent research however has shown that on-line teaching of mindfulness via a virtual coach can be effective at increasing the number of times participants meditated and the length of practice (Hudlicka, 2011, 2013). As 'real' mindfulness teachers are not always available or affordable to delivery mindfulness-based interventions, this training method offers the next best alternative. Testing this method of training alongside the current research which aims to identify which mindfulness strategies work and how, may have even greater implications of improving the overall effectiveness of mindfulness-based interventions.

5.9 Conclusion

With poor diet now overtaking smoking as the one of the main causes of ill health (Scarborough et al., 2011), it is unsurprising that government officials and health professional are searching for alternate ways of tackling this problem. One suggestion is to incorporate mindfulness into the National Health Service (NHS) and beyond (e.g. in schools) (National Institute for Health and Clinical Excellence [NICE], 2009; Kuyken et al., 2013). For decades research has demonstrated the positive effects of mindfulness on changing unhealthy behaviours for more favourable ones (Baer, 2003; Bishop, 2002; Grossman et al., 2004). But is knowing it works enough to justify such changes within our health-care and education systems? The simply answer to this question is, no. The current thesis was able to demonstrate this, highlighting the potential problems of current mindfulness-based interventions due to their complexity, and the importance of understanding that one mindfulness-based intervention does not 'fit' all health-related behaviours to bring about change. From the findings, it was recommended that further dismantling designs are needed in order to gain a better understanding of *which* mindfulness mechanisms work and, more importantly, *how they work.* The aim of the current research was not to dispute the effects of mindfulness previously reported. Instead, it aimed to highlight the need to take stock of what the existing literature tells us, and more importantly, what is does not. Identifying the gaps in the literature is believed to unlock important information of how best to develop mindfulness research and mindfulness-based interventions in future years.

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Appendices

The following documents are included in the appendices.

Document	Title/Description of Document
A	Study One screening questionnaire
B	Study One meditation practice questionnaire
C	Study One demographics questionnaire
D	Study One participant information sheet
E	Study One consent form
F	Study One debrief form
G	Study Two poster
H	Study Two screening questionnaire
I	Study Two demographics questionnaire
J	Study Two chocolate questionnaire
K	Study Two strategy adherence and acceptability questionnaire
L	Study Two cravings questionnaire
M	Study Two suspicion probe
N	Chocolate diary
O	'Seeing your thoughts differently' cognitive defusion strategy booklet
P	'Accepting our feelings' acceptance strategy booklet
Q	'Relaxation' control strategy booklet
R	Study Two consent form
S	Study Two debrief form
T	Pilot Study One chapter three, chocolate diaries, non-resist group
U	Pilot Study One chapter three, chocolate diaries, resist group
V	Pilot Study Two chapter three, example of the word association task
W	Pilot Study Three chapter three, written recall tasks
X	Preliminary Study chapter three, demographic questionnaire
Y	Preliminary Study chapter three, participant information sheet
Z	Preliminary Study chapter three, consent form
AA	Preliminary Study chapter three, debrief form
BB	Study Three demographic questionnaire
CC	Study Three behavioural goals measure

DD	Study Three suspicion probe
EE	Study Three strategy adherence measure
FF	Study Three self-reported strategy evaluation
GG	Study Three task adherence questionnaire
HH	Study Three description of the different trials included in the chocolate prime and goal lexical decision tasks
II	'Monitoring your chocolate eating' control strategy booklet
JJ	Study Three consent form
KK	Study Three debrief form
LL	List of differences between studies 2 and 3
MM	Study Four craving induction questions
NN	'Seeing your thoughts differently' brief version of the cognitive defusion strategy booklet for study four
OO	'Relaxation' brief version of the control strategy booklet for study four
PP	'Mind wandering task' study four
QQ	Study Four thought-probe measure
RR	Study Four pleasantness questionnaire
SS	Study Four strategy adherence measure
TT	Study Four consent form
UU	Study Four debrief form
VV	Department of Psychology, Ethics Committee Memo – Study One
WW	Department of Psychology, Ethics Committee Memo – Study Two
XX	Department of Psychology, Ethics Committee Memo – Pilot Study One, chapter three
YY	Department of Psychology, Ethics Committee Memo – Pilot Study Two, chapter three
ZZ	Department of Psychology, Ethics Committee Memo – Pilot Study Three, chapter three
A1	Department of Psychology, Ethics Committee Memo – Preliminary Study, chapter three
B1	Department of Psychology, Ethics Committee Memo – Study Three
C1	Department of Psychology, Ethics Committee Memo – Study Four

Appendix A

Participant Number:

Screening Questionnaire

Are you over 18 years old? ☐ Yes ☐ No

Do you have normal or corrected vision (not colour-blind)? If the latter, please make sure you bring your glasses with you to the study.
☐ Yes ☐ No

Do you suffer from epilepsy? ☐ Yes ☐ No

Are you currently on a diet to lose weight? ☐ Yes ☐ No

How many times (if any) have you dieted to lose weight in the past year?
(By dieting we mean attempting to lose weight by trying to alter your normal eating habits).

☐	☐	☐	☐
I haven't dieted before	About 1-5 times	About 6-24 times	25 times or more

What is your first language? ....

Are you a British native? If not, how long have you lived in the UK?
☐ Yes ☐ No

................years

You will be asked to fast for three hours before you take part in the study. Will this be something you will be able to do? ☐ Yes ☐ No

Appendix B

Participant Number:

Meditation Practice Questionnaire

We would be grateful if you could provide us with the following information

1. Do you have any experience of meditation? (*If no, please go to question 12*)
☐ Yes ☐ No

2. Are you currently practicing meditation? ☐ Yes ☐ No

3. How often do you meditate?

....

4. How long do you meditate for during each session?

....

5. What type of meditation do you practice? Please describe. (Techniques may include: walking, sitting, breathing, reflexology, sound therapy, body scanning, silence, tai-chi, stone therapy, etc)

....
....
....
....
....

6. How long have you practiced meditation?

....

7. Why do you meditate?

....
....

8. Describe your pattern of meditation use (e.g. continuous since you began practicing, started practicing then stopped for a few years, etc)

....
....
....

9. How would you class yourself in terms of your experience of meditation?

☐ Novice ☐ Experienced

10. Have you attended any meditation retreats in the past? If so, please describe (e.g. for how long, type of meditation, year completed)

☐ Yes ☐ No

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

11. Have you received any formal or informal training, teachings or other meditation instruction? (If yes, please describe)
☐ Yes ☐ No

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………

12. Do you have any experience of yoga? *(If no, please go to question 16)*

☐ Yes ☐ No

13. How often do you practice yoga?

…………………………………………………………………………………………

14. What particular type of yoga do you practice? (E.g. do you practice any breathing or relaxation techniques?)

…………………………………………………………………………………………
…………………………………………………………………………………………

15. How long have you practiced yoga?

…………………………………………………………………………………………

16. Do you have other activities/hobbies that involve meditative practices? *(If yes, please describe, if no please go to question 17)*

☐ Yes ☐ No

…………………………………………………………………………………………
…………………………………………………………………………………………

17. Do you now use or have you ever used any breathing exercises? *(If yes, please describe. If no, you have now completed this questionnaire)*

☐ Yes ☐ No

....

18. Are there any additional comments or other information about your meditation practices that you think may be useful?

....
....
....

Appendix C

Participant Number:

Demographic Questionnaire

We would be grateful if you could provide us with the following information

What is your sex? ☐ Male ☐ Female

What is your age? ………… years

Are you currently studying? ☐ Yes ☐ No

What is the highest level of qualification you have achieved UNTIL NOW at school, college or since leaving education? *(Please tick 1 box.)*

☐ Higher degree (e.g. MA, MSc, PhD, PGCE)

☐ First degree (e.g. BA, BSc)

☐ A-Levels / Highers

☐ GCSE or equivalent – *please specify the* ***level:*** ________________

☐ Trade or technical certificate – *please specify the* ***level:*** _________________

☐ NVQ / BTEC / HND – *please specify the* ***level:*** _____________________

☐ Left school without formal qualifications

☐ Other (please specify): ______________________

What is your current occupation?______________________________

What is your ethnic origin?

White	☐ White-British ☐ White-Irish ☐ Other White background (please specify)………………………………
Black or Black British	☐ Caribbean ☐ African ☐ Other Black background (please specify)………………………………
Asian or Asian British	☐ Indian ☐ Pakistani ☐ Bangladeshi ☐ Chinese ☐ Other Asian background (please specify)………………………………
Mixed	☐ White & Black Caribbean ☐ White & Black African

☐ White & Asian
☐ Other Mixed background (please specify)................................
☐ Other Ethnic background (please specify)..
☐ I decline to say

Have you ever been diagnosed with any psychological disorder? (e.g. stress, depression) If so, please provide details. ☐ Yes ☐ No

____

____

Do you have any physical conditions that affect what you eat? If so, please provide details. ☐ Yes ☐ No

____

____

Are you pregnant? ☐ Yes ☐ No

How much do you like chocolate?

I hate it ... I love it

1 2 3 4 5 6 7

How often do you eat chocolate?

Never ... Every Day

1 2 3 4 5 6 7

Thank You!

Appendix D

Meditation and Attentional Control

Participant Information Sheet

Welcome to this study on meditation and attentional control!

Before you decide whether or not to participate, it is important for you to understand why the research is being conducted and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?
We are looking at the relationship between meditation and attention towards a range of different words and pictures. We will provide further details at the end of the study.

Who is carrying out the research?
The research is led by Mrs Kim Jenkins and Dr Katy Tapper at Swansea University's Psychology Department. The research is funded by the National Institute for Social Care and Health Research (NISCHR) and has been approved by the Swansea Psychology Research Ethics Committee.

Can anyone take part?
We are looking for males and female who can speak fluent English. It is also important that you are NOT currently dieting to lose weight. In addition, the study is not suitable for individuals who suffer from epilepsy or who are colour-blind.

What happens if I agree to take part?
You will be asked to complete two computer-based tasks designed to assess responses towards different items. These should take no longer than 30 minutes. You will also be asked to complete a series of questionnaires about a variety of topics, including questions relating to your eating habits, daily thoughts, personality, and intelligence. Finally you will be asked to provide some background information about yourself such as your level of education, gender, age, ethnic origin. You will also be asked to provide information on any meditation training/practice you may or may not have undertaken both past and present. The whole session should last no longer than 1 hour. As a token of our appreciation, you will receive £8 at the end of the session. Please note, you will be asked to fast for at least three hours prior to completing the study.

Where will the study take place?
The study will take place in the Psychology Department at Swansea University. This is located on the 9th floor of the Vivian Tower (cognitive science lab, room 932-5). Alternatively, the study can be carried out at a location more convenient for you.

What if I wish to withdraw?
Your participation is entirely voluntary. You will be free to withdraw at any time you wish, without giving a reason.

What will happen to the information you collect?
All information collected will be anonymous. An analysis of the information will form part of our report at the end of the study and may be presented to interested parties and published in scientific journals and related media. Unfortunately we are unable to give you any personal feedback about your individual scores.

What if I have other questions?
If you have any questions about the study then please ask them now. Alternatively if you have any further questions after the study has been completed, please do not hesitate to contact us at the following:

Mrs Kim Jenkins
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 513373/[redacted]
Email: 290921@swansea.ac.uk

Dr Katy Tapper
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 602567
Email: k.tapper@swansea.ac.uk

I'd like to take part! What do I do now?
Please contact Kim to arrange an appointment.

Appendix E

Consent Form

Title of the project: Meditation and Attentional Control

Researchers: Mrs Kim Jenkins, Dr Katy Tapper

I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to ask questions and have had these answered satisfactorily.

I understand that my participation is voluntary and that I am free to withdraw from the study at any time, without having to give a reason.

I have been informed that the confidentiality of the data I provide will be safeguarded.

I am 18 years of age or older.

Data Protection: I agree to the University processing personal data that I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.

I agree to take part in the study.

______________	__________	______________
Your name	Date	Signature
______________	__________	______________
Researchers name	Date	Signature

Mrs Kim Jenkins
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 513373
Email: 290921@swansea.ac.uk

Appendix F

Meditation and Attentional Control

Debriefing Form

Thank you for participating in this study! The research aims to explore the relationship between meditation and an individual's ability to control their attention towards unhealthy foods (in this instance chocolate). Previous studies have found that individuals with poor attentional control for unhealthy foods show an increase in their weight one year later. This may be because the more you attend to these food items the more likely you are to eat them. We are interested in whether meditators are better able to control their attention in the presence of unhealthy foods. This is important since it may mean that meditators are more able to resist eating unhealthy foods.

The two computer-based tasks you were asked to complete were designed to see how easily you were distracted by the tempting foods. Comparing results on these computer-based tasks between those who meditate and those who do not meditate should help us determine whether meditation is associated with better attentional control in the presence of unhealthy food cues. You were also asked to fast for at least three hours prior to taking park in the study. We are more likely to notice food cues when we are hungry so the purpose of this was to make the food cues in the computer-based tasks as distracting as possible.

Additionally, you were asked to fill in a series of questionnaires. These were used to assess other factors (such as eating habits, sensitivity to reward, and ability to self-regulate behaviour) that we think may impact upon the relationship between meditation and attention.

Ultimately we hope our findings will help inform interventions designed to help people maintain a healthy diet by reducing consumption of unhealthy snacks.

If you know anyone else who may participate in this study, please do not reveal this information to them since it could influence their responses.
If you are concerned by any of the health issues raised in the questionnaires please contact your GP. Further information on healthy eating can also be found at the following websites:
http://www.nhs.uk/LiveWell/Goodfood/Pages/Goodfoodhome.aspx
http://www.bbc.co.uk/health/treatments/healthy_living/nutrition/index.shtml

If you have any other questions about the research, please do not hesitate to contact us at the following:

Mrs Kim Jenkins
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 513373
Email: 290921@swansea.ac.uk

Dr Katy Tapper
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 602567
Email: k.tapper@swansea.ac.uk

Like chocolate, but eat too much?

Take part in our study and earn yourself £10!

We are looking for males and females who want to reduce their level of chocolate consumption.

If you decide to take part you will be given a small bag of chocolates and asked to keep them in your possession at all times over a period of 5 consecutive days. You will be required to try your best to not eat the chocolates in the bag or any other chocolates or chocolate-related products until the end of the study. Please note that certain inclusion criteria apply to this study.

If you are interested in taking part, or would like to know more, please contact the researcher using the details below.

The study will be carried out at Swansea University, Singleton Park, Swansea, SA2 8PP.

Kim Jenkins 290921@swan.ac.uk
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Appendix H

Screening Questionnaire

Are you over 18 years old? ☐ Yes ☐ No

Do you want to reduce the amount of chocolate you consume? ☐ Yes ☐ No

Are you pregnant? ☐ Yes ☐ No

Are you currently suffering from, or have suffered in the past from an eating disorder?
☐ Yes ☐ No

Can you speak/read English fluently? ☐ Yes ☐ No

Do you have a medical condition that affects what you can and can't eat (e.g. high cholesterol, diabetes, hypoglycaemia, or food intolerances) specifically in relation to chocolate? ☐ Yes ☐ No

Appendix I

Participant Number:

Demographics Questionnaire

We would be grateful if you could provide us with the following information

What is your sex? ☐ Male ☐ Female

What is your age? ………… years

Are you a student or a member of staff at the university?

☐ Student ☐ Staff

If you are a student, what is your current level of study?

☐ Undergraduate ☐ Postgraduate ☐ n/a

If you are a member of staff, what is your current occupation within the University?

……………………………………………………………………………………………

Are you currently dieting to lose weight?

☐ Yes ☐ No

Appendix J

Participant Number:

Chocolate Questionnaire

Using the rating scales provided, please answer the following questions.

1. How much do you like chocolate?

I hate it I love it
1 2 3 4 5 6 7

2. How often do you eat chocolate?

Never Every day
1 2 3 4 5 6 7

3. How much do you want to reduce the amount of chocolate you consume?

Not very much Very much
1 2 3 4 5

Appendix K

Participant Number:

Strategy Adherence and Acceptability Questionnaire

How many times did you use the strategy?

Not at all

Sometimes

Nearly always

Always

How helpful did you find the strategy?

Not at all helpful

A little helpful

Moderately helpful

Very helpful

Extremely helpful

Please rate how effective you thought the taught technique would be to help you to resist eating chocolate.

On Monday

Not very effective – 1 2 3 4 5 – Very effective

On Friday

Not very effective – 1 2 3 4 5 – Very effective

Did you apply the technique you used to help you deal with other situations (e.g. everyday life situations such as, work or family) as opposed to just 'trying to resist eating chocolate'? If so, what situations? Describe.

Appendix L

Participant Number:

Cravings Questionnaire

If you had cravings for chocolates, overall how distressing did you find them?

Not at all distressing

A little distressing

Moderately distressing

Very distressing

Extremely distressing

Appendix M

Suspicion Probe

1. Do you know/have you guessed what group you were in, the control or experimental?

Guessed –

Actual Group –

2. Did you notice anything unusual about the chocolates given to you by the researcher?

Yes/No

If yes, what did you notice?

3. How many chocolates were in the bag given to you by the researcher?

4. Other than the amount of chocolate consumed during the week, do you have any other ideas about what is being investigated in this study?

Yes/No

If yes, what do you think was being investigated?

Appendix N

Chocolate Diary

Resisting the temptation to eat chocolate can be difficult. Therefore, even though we want you to try to not eat any chocolate or chocolate-related products over the next 5 days, don't worry if you do. We simply ask that you keep a record of the chocolate you do eat in this diary. There is a separate diary sheet for each of the 5 days. If you need more space, please write on the back. It is important that you record details as honestly and accurately as you can. An example page has been provided to help you to fill in the diary correctly.

Any product consumed which contains chocolate must be recorded in the diary. These may include:

Chocolate bars (e.g. galaxy, milkybar, twix)

Ice-creams (e.g. chocolate flavoured, mars ice-cream bar, magnum)

Chocolate coated fruit and nuts (e.g. raisins, brazils)

Chocolate milk products (e.g. milkshakes, yoghurts)

Cakes and desserts (e.g. trifle, fudge cake, jaffa cakes, muffins)

Biscuits (e.g. chocolate chip cookies, kitkat, digestives)

Pastries (e.g. pain au chocolat)

Chocolates from the bag (e.g. celebrations)

Chocolate cereals/cereal bars (e.g. coco pops, cadbury brunch bars)

Chocolate spreads (e.g. nutella)

Chocolate drinks (e.g. hot chocolate)

EXAMPLE

Type	Brand	Size (in grams if known)	Quantity	Total Amount Eaten
Chocolate chip cookie	Maryland	Standard size cookies from 230g pack	Two	All
Dairy Milk Bar	Cadbury	Standard size bar, 49g	One	Half a bar
Hot chocolate	Green and Blacks	One tablespoon	One mug	All
Souffle	Gu after dark hot chocolate	65g pot	One	All
Celebrations (from the bag)	Mars	3g each	Three	All
Pains au chocolat	Tesco's Finest all butter	78g	One	3/4

MONDAY

Type	Brand	Size (in grams if known)	Quantity	Total Amount Eaten

TUESDAY

Type	Brand	Size (in grams if known)	Quantity	Total Amount Eaten

WEDNESDAY

Type	Brand	Size (in grams if known)	Quantity	Total Amount Eaten

THURSDAY

Type	Brand	Size (in grams if known)	Quantity	Total Amount Eaten

FRIDAY

Type	Brand	Size (in grams if known)	Quantity	Total Amount Eaten

Seeing your thoughts differently

Throughout your life you will make many plans, such as doing more exercise, changing jobs, or trying to eat more healthily. Sometimes it's difficult to stick to these plans. One reason is that our thoughts can sabotage our intentions. For example, you may find that you tell yourself that just one chocolate won't do any harm, that it's too difficult to resist chocolate when you're so tired, or that you will try harder tomorrow.

In situations like these it can be helpful to think of yourself as DIFFERENT from your thoughts.

Imagine you are the driver of a bus, driving towards healthy eating. Your thoughts are a bit like passengers on the bus. They may say 'I really need chocolate', 'I can't concentrate on work without chocolate', or 'I'll just have one chocolate and eat less at dinner time'. Your job as the driver of the bus is to stick to your planned route, regardless of what your thoughts are saying.

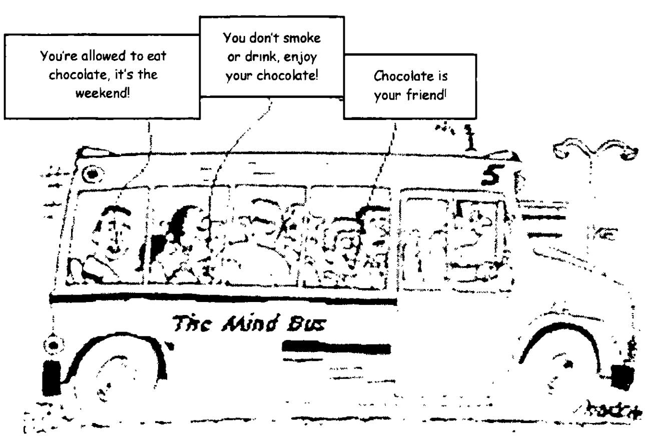
Here are a couple of strategies you might like to try:

<u>**MindBus Strategies**</u>

Describe your passengers.
For example, 'This passenger is telling me 'I'm tired and I need a sugar boost'. Then KEEP DRIVING!

Let your passengers know who's in charge.
If your passengers are telling you to buy chocolate, let them know who is in charge. Then KEEP DRIVING!

Give your passengers a voice.
For example, if you find yourself saying 'I can't resist this chocolate any longer', try saying it with a different accent, or even singing it. Then KEEP DRIVING!



Remember, you are the driver of the bus - your thoughts are simply passengers!

Practice exercise

This exercise will help you practice seeing your thoughts as separate from yourself.

First, choose ONE of the MindBus strategies listed above.

Then think of a recent plan you have made in relation to chocolate and any unhelpful thoughts you may have experienced in relation to that plan (for example, wanting to eat less chocolate but telling yourself that you don't have the willpower). If no such plans and thoughts come to mind, try to imagine the types of things you might tell yourself when you try to resist chocolate over the next few days.

For the next 5 minutes you will be asked to close your eyes and imagine this situation and these thoughts. You should then imagine yourself using your chosen MindBus strategy to help you to 'keep driving the bus' (in other words, resist eating the chocolate.) Remember, your thoughts are simply passengers - don't let them sabotage your plans.

When you are ready, close your eyes and begin the task. The researcher will inform you when the 5 minutes has ended.

Task

Over the next 5 days, we would like you to carry the bag of chocolates provided around with you (note; these must be kept in your possession as much as possible, for example, taken to work, to university, the pub etc.) We would also like you to try to resist eating any kind of chocolate, including the chocolates in the bag. Whenever you find yourself tempted to eat chocolate we would like you to try to use one of the MindBus strategies outlined above ('Describe your passengers', 'Let your passengers know who's in charge', or 'Give your passengers a voice'.) Use the strategy for the length of time which you find it helpful.

Please decide now which strategy you are going to try. (You are free to switch to one of the other strategies at a later point.)

Resisting chocolate is difficult, so you may find that you can't always manage this. If so don't worry, simply make a note of what you have eaten on the diary sheets provided.

If you have any further questions, or if there is anything you don't understand, please ask now!

Good Luck!

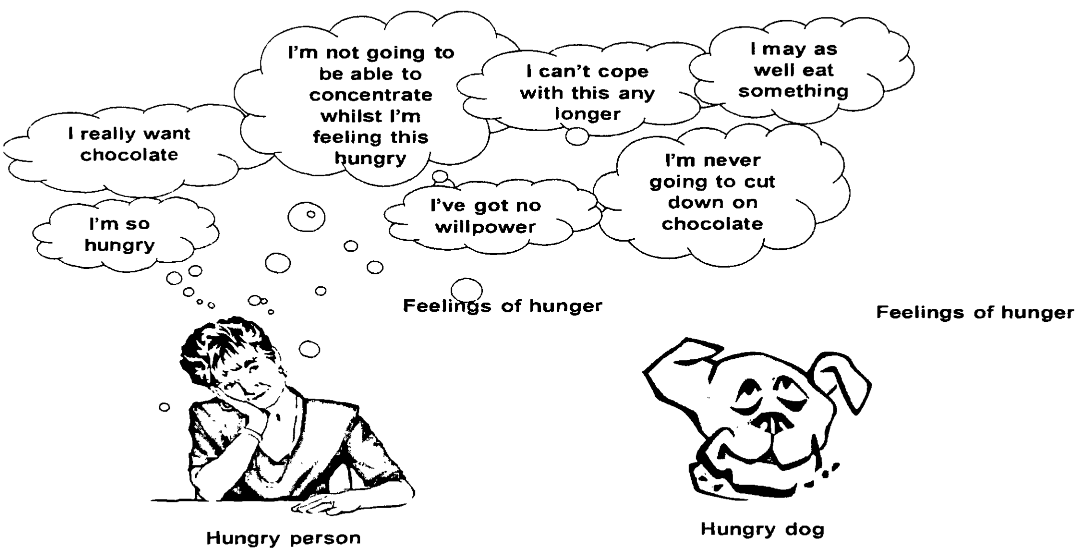
Appendix P

Accepting our feelings

In order to deal with uncomfortable feelings we often try to control them. Unfortunately, we usually fail to win the struggle with our emotions. For example, getting rid of cravings for foods such as chocolate is very difficult.

So, if control is not the most effective strategy for dealing with unpleasant feelings, what is?

Take a few minutes to look at the picture below.



What's going on? The person and the dog are both experiencing the same unpleasant feelings of hunger. However, by battling with these feelings the person is also experiencing a whole range of additional, distressing thoughts. In some ways, she's made her life even more difficult.

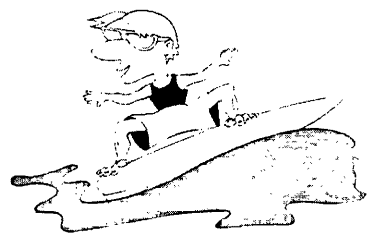
What's the alternative?

We could simply accept our difficult feelings.

Accepting feelings may not get rid of the discomfort they bring with them, but by not struggling to control the feelings we leave more energy for getting on with all the other things in life that are important to us.

'Urge Surfing'

Accepting uncomfortable feelings rather than trying to control them may help with situations in which you are trying to resist temptation. One strategy that can help you to be more willing to experience these feelings is 'urge surfing'. Urge surfing is the process by which you "ride the wave" of your urges or cravings. By being aware of your urges and cravings, you can surf them instead of 'sinking', or giving in to them.



Practice exercise

This exercise aims to help you practice accepting your thoughts.

Visualise your favourite type of chocolate in front of you and get in touch with any cravings you have to eat it. Take a few moments to do so. Deliberately become aware of any thoughts linked to the cravings (e.g. think about how it looks, how it smells, and how it may taste). For the next 5 minutes you will be asked to close your eyes and get in touch with these feelings. Just observe your feelings and see what they do. Don't struggle with them. Instead, try to use the 'urge surfing' metaphor and 'ride each urge' one at a time. The goal here is not to like or dislike the feelings or urges. We aren't evaluating them. The goal is to experience them without needless defence. Remember, you have the choice to accept your feelings and cravings; you don't have to try and control them.

When you are ready, close your eyes and begin the task. The researcher will inform you when the 5 minutes has ended.

Task

Over the next 5 days, we would like you to carry the bag of chocolates provided around with you (note; these must be kept in your possession as much as possible, for example, taken to work, to university, the pub etc.) We would also like you to try to resist eating any kind of chocolate, including the chocolates in the bag. Whenever you find yourself tempted to eat chocolate we would like you to try to use the 'urge surfing' strategy outlined above. Use the strategy for the length of time which you find it helpful.

Resisting chocolate is difficult, so you may find that you can't always manage this. If so don't worry, simply make a note of what you have eaten on the diary sheets provided.

If you have any further questions, or if there is anything you don't understand, please ask now!

Good Luck!

Relaxation

Everyone needs a certain amount of stress to live well. It's what gets you out of bed in the morning and gives us the vitality and zest to do all sorts of things. Without it, we would have no motivation for many of life's chores.

However, stress becomes a problem - 'distress' - when we experience too much of it. Too much stress can result in a range of health problems, including obesity, since being 'stressed' can sometimes cause people to overeat. This is because it is often more difficult to resist temptation (i.e. food cravings) when we're stressed. With the most popular foods craved during times of stress being high sugar foods, such as chocolate, it is maybe unsurprising that stress is often associated with weight gain.

One way to counteract stress and its negative effects is to relax!

Like exercising in order to get fit, doing relaxation exercises once won't make you 'fit'; learning to relax takes time and practice in order for you to become proficient. For relaxation techniques to be of real use, you will need to build them into your everyday life.

There are many approaches to learning to relax; none is 'right' for everyone - it is more a matter of finding an approach that makes sense and works for you. However, let's take time to consider just one simple physical method.

Muscle Relaxation

Muscle relaxation doesn't aim to achieve deep relaxation or require you to lie down for half an hour! Rather, it aims to reduce *uncomfortable* levels of stress, so that you can continue with your current activity/plans more effectively.

How does it work?

For each of the areas of the body, it is suggested that you tense up and then relax muscle groups. As you get better with time at relaxing these areas, you are advised to try using less tension before relaxing.

Practice exercise

This exercise will help you practice using the 'relaxing your muscles' technique.

First, make sure that you are sitting upright and comfortable in your chair.

Then think of a recent situation in which you have felt stressed. If no situation comes to mind, try to imagine the types of stressful events you may experience over the next 5 days.

For the next 5 minutes you will be asked to close your eyes and imagine this situation and these stressful thoughts and feelings. At the same time you will be asked to practice the muscle relaxation technique by slowly tensing the muscles as much as you can and then relaxing them fully. First start by tensing the arm muscles by clenching your fists and then unclenching your fists. Next move onto the abdominal muscles. Again, tense the stomach muscles as tight as possible, then relax. The last muscle group you will be asked to practice relaxing is the leg muscles. To do this, tense your thighs and then relax your thighs.

When you are ready, close your eyes and begin the task. The researcher will inform you when to move onto the next muscle group and also when the 5 minutes has ended.

Task

Over the next 5 days, we would like you to carry the bag of chocolates provided around with you (note; these must be kept in your possession as much as possible, for example, taken to work, to university, the pub etc.) We would also like you to try to resist eating any kind of chocolate, including the chocolates in the bag. Whenever you find yourself tempted to eat chocolate we would like you to try to use the 'relaxing your muscles' strategy outlined above. Use the strategy for the length of time which you find it helpful.

Resisting chocolate is difficult, so you may find that you can't always manage this. If so don't worry, simply make a note of what you have eaten on the diary sheets provided.

If you have any further questions, or if there is anything you don't understand, please ask now!

Good Luck!

Appendix R

Consent Form

Title of the project: Resisting Temptation

Researchers: Mrs Kim Jenkins, Dr Katy Tapper

I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to ask questions and have had these answered satisfactorily.

I understand that my participation is voluntary and that I am free to withdraw from the study at any time, without having to give a reason.

I have been informed that the confidentiality of the data I provide will be safeguarded.

I am 18 years of age or older.

I am available to attend Session 1 on Monday and Session 2 on Friday.

I agree to carry the bag of chocolates with me wherever I go over the next 5 days.

I understand that I must try my best to resist eating chocolate until the end of the study.

Data Protection: I agree to the University processing personal data that I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.

I agree to take part in the study.

____________________	____________	____________________
Your name	Date	Signature
____________________	____________	____________________
Researchers name	Date	Signature

Appendix S

Resisting Temptation

Debriefing Form

Thank you for participating in this study! We are interested in the way in which different techniques may help people resist the temptation to eat unhealthy snacks (in this instance, chocolate). It was predicted that the effectiveness of each technique would be reflected by the amount of chocolate consumed at the end of the study (i.e. the more effective the technique the less the amount of chocolate eaten).

In this study participants were randomly placed into one of three groups. Group 1 was asked to try to view their thoughts about chocolate as 'just thoughts'. Group 2 was asked to try to accept their chocolate cravings. Group 3 was asked to use relaxation to try and deal with their chocolate cravings. This latter group acted as the control group. A control group means that individuals in this group were treated exactly the same as the experimental groups, but were not exposed to the factors being tested (in this instance, mindfulness meditation techniques).

We are interested in identifying; a) whether mindfulness techniques may be an effective way of helping to cut back on unhealthy snacking, and b) whether one type of mindfulness technique is more effective than another. It was predicted that, as a result of practicing these mindfulness techniques (thought distancing and accepting feelings) individuals in Group 1 and Group 2 would consume fewer chocolates compared to the controls (Group 3).

The prediction that Group 1 would consume less chocolate was based on the theory that acknowledging your thoughts and seeing your thoughts as separate from yourself would interrupt automatic behaviour. In other words, being aware of your thoughts would break the 'habit' of eating chocolate in response to the excuses and justifications we may give to ourselves.

The prediction that Group 2 would consume less chocolate was based on the theory that accepting our feelings and not trying to control them increases our strength (i.e. willpower) to not give into craving. At both sessions 1 and 2 a hand grip task was completed. This task was a measure of self-regulation. Previous research has shown that our ability to self-regulate our behaviour (e.g. resisting eating chocolate) is similar to a muscle in the body. When we are asked to complete a task which requires us to use self-regulation (in this instance, looking at and exploring the chocolates on the table but not eating them) our ability to self-regulate depletes over time, similar to the way in which a muscle would tire if required to repeatedly lift a heavy weight. We therefore predicted that participants would hold the second hand grip for a shorter period of time at session 1. However, self-regulation has shown to improve with practice just as a muscle strengthens with exercise. Given that self-regulation (e.g. resisting eating chocolate) had been practiced by all participants it was predicted the second hand grip at session 2 (Friday) would be held for a longer period of time for each group compared to the same measure at session 1 (Monday). However, the technique used by Group 2 (accepting feelings) was predicted to increase people's self-regulation ability even more. As a result of this, it was assumed that individuals in Group 2 would hold the hand grip for the longest amount of time at session 2 (Friday).

Additionally, you were asked to fill in a series of questionnaires. These were used to assess other factors (such as, eating habits and ability to self-regulate behaviour) that we think may impact upon people's ability to resist temptation.

You may or may not have noticed that each chocolate in your bag had one corner removed. The corner was cut in order for the researcher to be able to identify the 'original' chocolates and detect if any had been substituted. Also, all participants were told that there were twelve chocolates in the bag when really there were fourteen. Participants were told this because we wanted to see if you would be tempted to eat the 'extra' chocolates which the researcher had seemingly not accounted for.

At the end of the study, participants were left alone for 3 minutes while the researcher went to get their £10 payment. Participants were told that they had successfully completed the study therefore during this time period they were allowed to eat as much chocolate as they wanted from the bowl of chocolates provided. The reason for doing this was because we wanted to see if individuals in groups 1 and 2 (i.e. those who had been practicing the mindfulness meditation techniques) continued, or did not continue, to use these techniques to help them to resist the temptation to eat chocolate in situations where the eating of chocolate was permitted.

Ultimately we hope our findings will help inform interventions designed to help people maintain a healthy diet by reducing consumption of unhealthy snacks.
If you know anyone else who may participate in this study, please do not reveal this information to them since it could influence their responses.

If you are concerned by any of the health issues raised in the questionnaires please contact your GP. Further information on healthy eating can also be found at the following websites:
http://www.nhs.uk/LiveWell/Goodfood/Pages/Goodfoodhome.aspx
http://www.bbc.co.uk/health/treatments/healthy_living/nutrition/index.shtml
If you have any other questions about the research, please do not hesitate to contact us at the following:

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Appendix T

Group 1

Chocolate Diaries

Part 1: Chocolate Consumption: 'chocolate you eat' and 'chocolate you feel like eating'

We ask that you keep a record of the chocolate and chocolate-related products you eat or feel like eating, but resist, over the next 3 days. There is a separate diary sheet for each of the 3 days. There is also a different diary for 'chocolate eaten' and 'chocolate you felt like eating'. If you need more space, please write on the back. It is important that you record all details honestly and accurately. Example pages have been provided to help you to fill in the diaries correctly.

Any product consumed, or that you would have liked to have consumed, which contains chocolate must be recorded in the diary. These may include the following: (Please note that this is not an exhaustive list.)

Chocolate bars (e.g. galaxy, milkybar, twix)

Ice-creams (e.g. chocolate flavoured, mars ice-cream bar, magnum)

Chocolate coated fruit and nuts (e.g. raisins, brazils)

Chocolate milk products (e.g. milkshakes, yoghurts)

Cakes and desserts (e.g. trifle, fudge cake, jaffa cakes, muffins)

Biscuits (e.g. chocolate chip cookies, kitkat, digestives)

Pastries (e.g. pain au chocolat)

Chocolates from the bag (e.g. celebrations)

Chocolate cereals/cereal bars (e.g. coco pops, cadbury brunch bars)

Chocolate spreads (e.g. nutella)

Chocolate drinks (e.g. hot chocolate)

Part 2: Food Thoughts

In the spaces provided, we want you to write down what thoughts you have immediately before eating, or nearly eating (i.e. temptation resisted) a chocolate or chocolate-related product.

Some of the thoughts you have may include:

I've worked extremely hard today so I am going to treat myself by eating chocolate.

I'm feeling really stressed, so I am going eat chocolate to cheer myself up.

The chocolate desserts on the menu look too good to refuse.

Eating chocolate helps to pass the time when I'm bored.

I need to eat chocolate after my dinner to satisfy my sweet craving.

Again, it is important that you record your thoughts honestly and accurately.

EXAMPLE

CHOCOLATE ATTN

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N
9.40am	Choc chip cookie	Maryland	18g	2	All	Yes

Food Thought: *I couldn't resist the offer of a biscuit because my friend would think I'm dieting.*

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N
11.10am	Chocolate Yoghurt	Muller	150g	1	Half	Yes

Food Thought: *I would take a break from my work by having a coffee and a snack.*

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N
2.30pm	Dairy Milk	Cadbury	49g	1	All	Yes

Food Thought: *How good the chocolate would taste.*

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N
6.15pm	Hot chocolate	Green & Blacks	Mug	1	All	No

Food Thought: *n/a*

EXAMPLE

[illegible]

Time felt like eating	Type	Food Thoughts Y/N
9.40am	Choc chip cookie	Yes

Food Thought: [illegible] lunch [illegible] but I had already snacked on chocolate today

Time felt like eating	Type	Food Thoughts Y/N
11.10am	Chocolate yoghurt	Yes

Food Thought: must cut down on chocolate in order to get into shape

Time felt like eating	Type	Food Thoughts Y/N
2.30pm	Diary Milk	Yes

Food Thought: I wanted chocolate but I didn't feel I deserved it because I hadn't been to the gym

Time felt like eating	Type	Food Thoughts Y/N
6.15pm	Hot chocolate	No

Food Thought: n/a

TUESDAY

CHOCOLATE EATEN

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____

WEDNESDAY

CHOCOLATE EATEN

Time Eaten	Type	Brand	Size *(grams)*	*Quantity*	*Total* Amount Eaten	Food Thoughts Y/N

Food Thought: ______________________________

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ______________________________

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ______________________________

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ______________________________

THURSDAY

CHOCOLATE EATEN

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____________________

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____________________

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____________________

Time Eaten	Type	Brand	Size (grams)	Quantity	Total Amount Eaten	Food Thoughts Y/N

Food Thought: ____________________

TUESDAY

CHOCOLATE FELT LIKE EATING

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________

WEDNESDAY

CHOCOLATE FELT LIKE EATING

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ____________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ____________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ____________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ____________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ____________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ____________________

THURSDAY

CHOCOLATE FELT LIKE EATING

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________________

Time felt like eating	Type	Food Thoughts Y/N

Food Thought: ______________________________

Appendix U

<u>Group 2</u>

Chocolate Diaries

Part 1: Chocolate Consumption: 'chocolate you eat' and 'chocolate you feel like eating'

Resisting the temptation to eat chocolate can be difficult. Therefore, even though we want you to try to not eat any chocolate or chocolate-related products over the next 3 days, don't worry if you do. Simply record what you do eat in the diary (chocolate eaten) provided. We also ask that you record any chocolate and chocolate-related products that you feel like eating, but resist. There is a separate diary sheet for each of the 3 days. There is also a different diary for 'chocolate eaten' and 'chocolate you felt like eating'. If you need more space, please write on the back. It is important that you record all details honestly and accurately. Example pages have been provided to help you to fill in the diaries correctly.

Any product consumed, or that you would have liked to have consumed, which contains chocolate must be recorded in the diary. These may include the following: (Please note that this is not an exhaustive list.)

- Chocolate bars (e.g. galaxy, milkybar, twix)
- Ice-creams (e.g. chocolate flavoured, mars ice-cream bar, magnum)
- Chocolate coated fruit and nuts (e.g. raisins, brazils)
- Chocolate milk products (e.g. milkshakes, yoghurts)
- Cakes and desserts (e.g. trifle, fudge cake, jaffa cakes, muffins)
- Biscuits (e.g. chocolate chip cookies, kitkat, digestives)
- Pastries (e.g. pain au chocolat)
- Chocolates from the bag (e.g. celebrations)
- Chocolate cereals/cereal bars (e.g. coco pops, cadbury brunch bars)
- Chocolate spreads (e.g. nutella)
- Chocolate drinks (e.g. hot chocolate)

Part 2: Food Thoughts

In the spaces provided, we want you to write down what thoughts you have immediately before eating, or nearly eating (i.e. temptation resisted) a chocolate or chocolate-related product.

Some of the thoughts you have may include:

- I've worked extremely hard today so I am going to treat myself by eating chocolate.
- I'm feeling really stressed, so I am going eat chocolate to cheer myself up.
- The chocolate desserts on the menu look too good to refuse.
- Eating chocolate helps to pass the time when I'm bored.
- I need to eat chocolate after my dinner to satisfy my sweet craving.

Again, it is important that you record your thoughts honestly and accurately.

Appendix V

Participant Number:

Word Association Task

Gender: M / F (*please circle the correct response*)

Please list in the space below all single words (e.g. craving) or short phrases (e.g. on a diet) that you associate with the word: **CHOCOLATE**. Please take as much time as you need.

Appendix W

Participant Number:

Written Recall Task

Age:

Gender: M / F (please circle the correct response)

In the space below, please list any words or short phrases you saw immediately BEFORE the rows of X's were displayed during the computer task. If you did not see any words or short phrases, please leave the space blank.

Using the list of short phrases below, please circle which one(s) you saw immediately BEFORE the rows of X's were displayed during the computer task. If you did not see any of the short phrases listed, please circle the response 'None of the above'.

- Need something light
- Need an early start
- Need a taxi
- Need something sweet
- Need an adventure
- Need a pay rise
- Need something quick
- None of the above

Appendix X

Participant Number:

Demographics Questionnaire

Age:

Gender: M / F (please circle the correct response)

Are you currently dieting? Y / N (please circle the correct response)

In the space below, please give the reason why you want to reduce the amount of chocolate you currently consume.

Participant Information Sheet

Welcome to this study on Chocolate Eating Habits and Word Recognition!

Before you decide whether or not to participate, it is important for you to understand why the research is being conducted and what it will involve. Please take time to read the following information carefully.

What is the purpose of the study?
We are interested in identifying the types of habits people have in relation to eating chocolate. We will provide you with further details at the end of the study.

Who is carrying out the research?
The research is led by Mrs Kim Jenkins and Dr Katy Tapper at Swansea University's Psychology Department. The research is funded by the National Institute for Social Care and Health Research (NISCHR) and has been approved by the Swansea Psychology Research Ethics Committee.

Can anyone take part?
We are looking for males and females who want to reduce their current level of chocolate consumption. Both dieters and non-dieters are welcome to participant. It is important that participants have normal or corrected vision and are able to read English fluently.

What happens if I agree to take part?
First you will be asked to complete a series of short questionnaires which will ask you to provide information about your age, gender, dietary status and behaviour relating to eating chocolate. Next you will be asked to complete three computer tasks. Each of these computer tasks will require you to identify if the word displayed on the computer screen is a word or a non-word (i.e. not a recognised word in the English language) by pressing one of two keys on a response box. The study will take approximately 15 minutes to complete. As a token of our appreciation, you will receive a small payment of £5 at the end of the study.

Where will the study take place?
The study will take place at Swansea University. Participants will be asked to meet the researcher for each study session outside the lifts on the 9th floor of the Vivian Tower.

What if I wish to withdraw?
Your participation is entirely voluntary. You will be free to withdraw at any time you wish, without giving a reason.

What will happen to the information you collect?
All information collected will be confidential. An analysis of the information will form part of our report at the end of the study and may be presented to interested parties and published in scientific journals and related media. Unfortunately we are unable to give you any personal feedback about your individual scores.

What if I have other questions?

If you have any questions about the study then please ask them now. Alternatively if you have any further questions after the study has been completed, please do not hesitate to contact us at the following:

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Dr Katy Tapper
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Swansea University
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Appendix Z

Consent Form

Title of the project: Chocolate Eating and Word Recognition

Researchers: Mrs Kim Jenkins, Dr Katy Tapper

1. I confirm that I have been briefed about what the study entails. I have had the opportunity to ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time, without having to give a reason.
3. I understand that the confidentiality of the data I provide will be safeguarded.
4. I am 18 years of age or older.
5. I have normal or corrected vision.
6. I am able to read English fluently.
7. I want to reduce the amount of chocolate I currently consume.
8. I have not taken part in any previous study run by Kim Jenkins
9. Data Protection: I agree to the University processing personal data that I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.
10. I agree to take part in the study.

______________________	____________	__________________
Your name	Date	Signature
______________________	____________	__________________
Researchers name	Date	Signature

Appendix AA

Chocolate Eating and Word Recognition

Debriefing Form

Thank you for participating in this study!

You may or may not have been aware but each letter string you were asked to identify as either a word or a non-word in the computer tasks were preceded by a masked (i.e. presented very quickly and then replaced with a string of X's) prime (i.e. a short word phrase). Although you might not be able to recall seeing the primes consciously, they were presented at a speed which would allow you to process them unconsciously. One of the tasks included the prime phrase 'need something sweet', another included 'need a treat' and another included 'need an energy boost'. The study aimed to identify if you responded more quickly to the target word 'chocolate' when it was preceded by one of these three chocolate-related primes compared to neutral (i.e. chocolate un-related) primes (e.g. need a lift). Responding more quickly on these trials would suggest that you are more likely to find yourself eating chocolate before you have realised you are doing so. We believe that encouraging people to become aware of their automatic behaviour may help to reduce the amount of chocolate they consume.

The study also aimed to explore if there was a relationship between people's chocolate eating habits and their performance on the computer tasks. In order to measure your chocolate eating habits we asked you to complete three questionnaires, each corresponding to a particular chocolate eating behaviour which was used as the prime phrases in the computer tasks. Then we compared the scores on these questionnaires to your task performance. The reason for this was to identify if a faster response to the target word 'chocolate' when it was preceded by a chocolate-related prime phrase was related to the strength of the person's habit. For instance, if someone reports that, without thinking, they eat chocolate when they need something sweet, it was predicted that they would respond quickly to the word chocolate when preceded with the prime phrase 'need something sweet'. However, if someone reports that they always think before they eat chocolate in response to needing something sweet, then it was predicted that they would respond more slowly given that they behave less automatically. Thus, it was expected that the stronger the habit, the more automatic the behaviour, hence faster reaction times on the critical trials of the computer tasks.

Finally the study aimed to identify if habit strength and task performance differed between males and females, and also, between those who are, and are not, dieting. The results from this study will assist in the design and recruitment of a future related study.

If you know anyone else who may participate in this study, please do not reveal this information to them since it could influence their responses.

If you have any other questions about the research, please do not hesitate to contact us at the following:

Mrs Kim Jenkins
Department of Psychology
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Dr Katy Tapper
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Email: k.tapper@swansea.ac.uk

Appendix BB

Participant Number:

Demographics Questionnaire

Age: __________

Gender: M / F (please circle the correct response)

Are you currently dieting? Y / N (please circle the correct response)

Appendix CC

In the space below, please give the main reason why you want to reduce the amount of chocolate you currently consume.

Out of the two options below, which most closely relates to the reason why you want to reduce the amount of chocolate you currently consume? PLEASE SELECT ONE OPTION ONLY.

- Health
- Weight

Appendix DD

Suspicion Probe

1. Did you notice anything unusual about the chocolates given to you by the researcher?

Yes/No

If yes, what did you notice?

2. How many chocolates were in the bag given to you by the researcher?

3. Other than the amount of chocolate consumed during the week, do you have any other ideas about what is being investigated in this study?

Yes/No

If yes, what do you think was being investigated?

Appendix EE

Participant Number:

Strategy Adherence Questionnaire

How much did you use the strategy?

1. Not at all
2. Sometimes
3. Nearly always
4. Always

Appendix FF

Participant Number:

Strategy Evaluation Questionnaire

How helpful did you find your participation in this study in terms of reducing chocolate consumption?

1. Not at all helpful
2. A little helpful
3. Moderately helpful
4. Very helpful
5. Extremely helpful

Appendix GG

Participant Number:

Task Adherence Questionnaire

1. To what extent did you keep the chocolates with you?'

    1. Not at all or hardly at all
    2. Most of the time
    3. Nearly all the time

2. How sure are you that you haven't missed anything on the diary?

Not at all sure- 1 2 3 4 5 -Very Sure

Appendix HH

Chocolate-prime task

Trial type	Number of trials	Cue[a] (total number of alternatives)	Target (total number of alternatives)
		Block 1	
Practice - word	4	do not feel well (x4)	kitchen (x4)
Practice – non-word	4	do not feel well (x4)	glib (x4)
		Block 2	
Buffer - word	2	having a party (x2)	rainbow (x2)
Buffer – non-word	2	having a party (x2)	fussled (x2)
		Blocks 3, 4 and 5[b]	
Critical	1	need something sweet (x1)	chocolate (x1)
Control 1	1	need an ambulance (x1)	chocolate (x1)
Control 2	1	need something sweet (x1)	aeroplane (x1)
Filler - word	7	need an ambulance (x4)	aeroplane (x4)
Filler non-word	10	need some money (x5)	kroutched (x5)

[a]Cues were displayed for 10ms and masked.
[b]Trials within blocks 3, 4 and 5 were identical to each other but randomised within block. Within each block, each cue and each target were presented a total of two times.

Goal-target task (health)

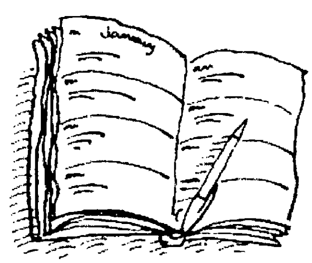
Trial type	Number of trials	Cue[a] (total number of alternatives)	Target (total number of alternatives)
		Block 1	
Practice - word	4	do not feel well (x4)	kitchen (x4)
Practice – non-word	4	do not feel well (x4)	glib (x4)
		Block 2	
Buffer - word	2	having a party (x2)	rainbow (x2)
Buffer – non-word	2	having a party (x2)	fussled (x2)
		Blocks 3, 4 and 5[b]	
Critical	1	need something sweet (x1)	health (x1)
Control 1	1	need a holiday (x1)	health (x1)
Control 2	1	need something sweet (x1)	family (x1)
Filler - word	7	need a lift (x4)	career (x4)
Filler non-word	10	need some money (x5)	wretts (x5)

[a]Cues were displayed for 10ms and masked.
[b]Trials within blocks 3, 4 and 5 were identical to each other but randomised within block. Within each block, each cue and each target were presented a total of two times.

Appendix II

Monitoring your chocolate eating

There is evidence to suggest that simply monitoring health behaviours is a useful tool for reaching health goals (in this instance, reducing the amount of chocolate you currently consume). This strategy has also been found to be effective when people are trying to change an unhealthy behaviour (e.g. eating too much chocolate) for a more favourable health behaviour (e.g. eating less chocolate). One way of monitoring how much chocolate you eat is to write down all the chocolate and chocolate-related products you consume.



Task

Over the next 5 days, we would like you to carry the bag of chocolates provided around with you (note; these must be kept in your possession as much as possible, for example, taken to work, to university, the pub etc.) We would also like you to try to resist eating any kind of chocolate, including the chocolates in the bag.

Resisting chocolate is difficult, so you may find that you can't always manage this. If so don't worry, simply make a note of what you have eaten on the diary sheets provided.

If you have any further questions, or if there is anything you don't understand, please ask now!

Good Luck!

Appendix JJ

Consent Form

Title of the project: Reducing Chocolate Consumption

Researchers: Mrs Kim Jenkins, Dr Katy Tapper

1. I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to ask questions and have had these answered satisfactorily.

2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time, without having to give a reason.

3. I have been informed that the confidentiality of the data I provide will be safeguarded.

4. I am 18 years of age or older.

5. I have normal or corrected vision.

6. I am not pregnant.

7. I have not suffered, past or present, from an eating disorder.

8. I do not have a medical condition that affects what I can and can't eat (e.g. high cholesterol, diabetes, hypoglycaemia, or food intolerances.

9. I am able to read and speak English fluently.

10. I want to reduce the amount of chocolate I currently consume.

11. I have not taken part in any previous study run by Kim Jenkins

12. I am available to attend all four sessions run over the two week study period.

13. I agree to carry the bag of chocolates with me wherever I go during week 2 of the study.

14. I understand that I must try my best to resist eating chocolate during week 2 of the study.

15. Data Protection: I agree to the University processing personal data that I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.

16. I agree to take part in the study.

Your name	Date	Signature
Researchers name	Date	Signature

Appendix KK

Reducing Chocolate Consumption

Debriefing Form

Thank you for participating in this study! We appreciate your help, and hope you found the experience both beneficial and enjoyable.

We are interested in the way in which different strategies may help people resist the temptation to eat unhealthy snacks (in this instance, chocolate). It was predicted that the effectiveness of each strategy would be reflected by the amount of chocolate consumed at the end of the study (i.e. the more effective the strategy the less the amount of chocolate eaten).

You were randomly allocated one of three groups. Group 1 was asked to use a mindfulness meditation strategy called 'cognitive defusion' to try and view their thoughts about chocolate as 'just thoughts'. Group 2 was asked to use relaxation to try and cope with their chocolate cravings. Group 3 was allocated to a 'monitoring' group. For those in this group, the same questionnaires and computer tasks were completed, but no specific strategy was taught. The reason for this was that merely monitoring health behaviours has been shown to be a useful tool for reaching health goals.

The aim of the study was to see whether the defusion group would see benefits over and above those in the other groups and if so, why? (i.e. how does this strategy work). One possibility is that acknowledging your thoughts and seeing your thoughts as separate from yourself would interrupt automatic behaviour. In other words, being aware of your thoughts would break the 'habit' of eating chocolate in response to the excuses and justifications we may give to ourselves. Whilst we expected all groups to benefit from recording their chocolate consumption in the chocolate diaries, we did not expect the relaxation strategy to provide any additional benefits.

You were asked to fill in a series of questionnaires and complete two computer-based tasks. These were used to assess levels of self-reported and behavioural automaticity, in addition to goals related to why participants wanted to reduce their intake of chocolate. We believe that these factors may impact upon people's ability to resist temptation and also may help to explain how the mindfulness strategy 'cognitive defusion' brings about behavioural change (i.e. reduction in the amount of chocolate consumed)

You may or may not have noticed that each chocolate in your bag had one corner removed. The corner was cut in order for the researcher to be able to identify the 'original' chocolates and detect if any had been substituted. Also, all participants were told that there were twelve chocolates in the bag when really there were fourteen. Participants were told this because we wanted to see if you would be tempted to eat the 'extra' chocolates which the researcher had seemingly not accounted for.
Ultimately we hope our findings will help inform interventions designed to help people maintain a healthy diet by reducing consumption of unhealthy snacks.

If you know anyone else who may participate in this study, please do not reveal this information to them since it could influence their responses.

If you are concerned by any of the health issues raised in the questionnaires please contact your GP. Further information on healthy eating can also be found at the following websites:
http://www.nhs.uk/LiveWell/Goodfood/Pages/Goodfoodhome.aspx
http://www.bbc.co.uk/health/treatments/healthy_living/nutrition/index.shtml

If you have any other questions about the research, please do not hesitate to contact us at the following:

Mrs Kim Jenkins
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 513373
Email: 290921@swansea.ac.uk

Dr Katy Tapper
Department of Psychology
Social Sciences Building
City University London
Whiskin Street, EC1R 0JD
Telephone: 02070 408500
Email: Katy.Tapper.1@city.ac.uk

Appendix LL

Differences between Study 2 & Study 3

Possibilities why non-significant findings were shown for Study 3 compared to Study 2:

- Introduction of the baseline measure of chocolate consumption. Maybe participants were fed up with recording accurately by the second week.
- Subtle differences in the population in terms of their motivations for participating. For example, there was a bigger payment (£20) for Study 3 compared to Study 2 (£10).
- Study 2 included males and females, whereas Study 3 only included females.
- Study 3 required the participants to attend more sessions (4 in total) compared to Study 2 (2 in total).
- Both studies consisted of three groups. However Study 2 had two mindfulness groups and one control group, whereas Study 3 had one mindfulness group and two control groups.
- Differences in measures used between the two studies:

Study 2	Study 3
How much chocolate is liked.	Goal measure
How often chocolate is eaten.	More detailed cravings questionnaire
Level of desire to reduce choc. Consumption.	Need for affect scale
Big 5	Need for cognition scale
DEBQ	LDTs
Mindfulness (FFMQ & PHLMS)	More specific SRHIs
Experiences questionnaire (decentering)	
Food acceptance and awareness scale	
Taste-test	
Hand grip task	

- Questionnaires in Study 2 were completed online via SurveyMonkey whereas all questionnaires in Study 3 were completed at the individual sessions with the researcher present.
- Difference between the defusion interventions – no additional check of participants' level of understanding of the taught strategy taken in Study 3 compared to Study 2.

- Unsure about Study 2, but for Study 3 a lot of 'groups' of friends participated. Despite asking them not to discuss the study between themselves, there may have been an element of 'friendly competition' going on (i.e. who would succeed at the task and not eat any chocolate). On the other hand, if a friend /housemate had seen another friend give in and eat chocolate they may have done so too. This may account for the similarities in eating behaviour between the different groups.
- Study 3 included a small number of University staff whereas Study 2 only consisted of student participants.

Appendix MM

Craving Induction – Questions

1. Which chocolate bar looks the most attractive?
2. Which chocolate bar do you think smells best?
3. Which chocolate bar do you think would taste the best?
4. Which chocolate bar do you think cost more?
5. Which chocolate bar are you most tempted to sample now?
6. Which chocolate bar would you most like to try at the end of the experiment?

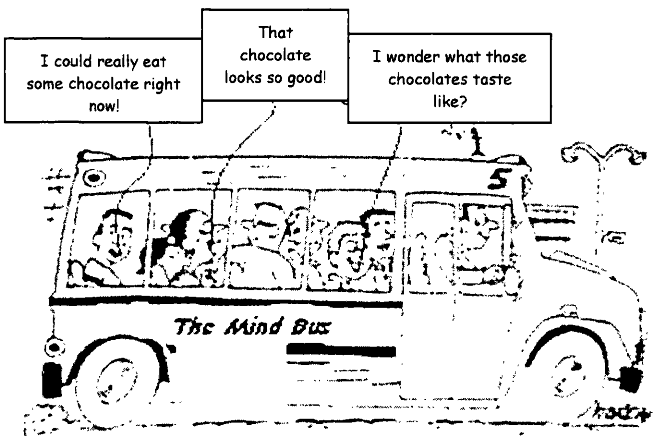
7. Which box of chocolates looks the most attractive?
8. Which box of chocolates has the best variety?
9. Which box of chocolates do you think smells best?
10. Which box of chocolate do you think would taste the best?
11. Which box of chocolates do you think cost more?
12. Which box of chocolates would you be tempted to sample now?

Seeing your thoughts and feelings differently

Chocolate cravings can be difficult. It may help to think of yourself as DIFFERENT from your chocolate cravings.

Imagine you are the driver of a bus. Your chocolate cravings are a bit like passengers on the bus. Your job as the driver of the bus is to stick to your planned route regardless of what your chocolate cravings are saying.

Sometimes it can also help to describe these passengers. For example, 'this passenger is telling me that I'm tired and I need a sugar boost'. Or 'this passenger is reminding me how hungry I am'.



Remember, you are the driver of the bus – your cravings are simply passengers!

Your task

For the next 10 minutes we would like you to simply sit in front of the chocolates and let your mind wander. You are free to think about whatever you like, though please keep your eyes open and avoid engaging in any other activities.

Additionally, whenever you find yourself thinking about the chocolates we would like you to try to use the strategy described above and imagine these thoughts and feelings as passengers on your bus.

The researcher will stop you from time to time to ask you what you are thinking about. You will only be asked to provide a brief description of your thought (e.g. a short phrase such as eating chocolate, going on holiday, something private). Once the researcher has recorded your thought, you will be asked to immediately return to the task.

If you have any questions please ask the researcher now, otherwise please let the researcher know you are ready to begin.

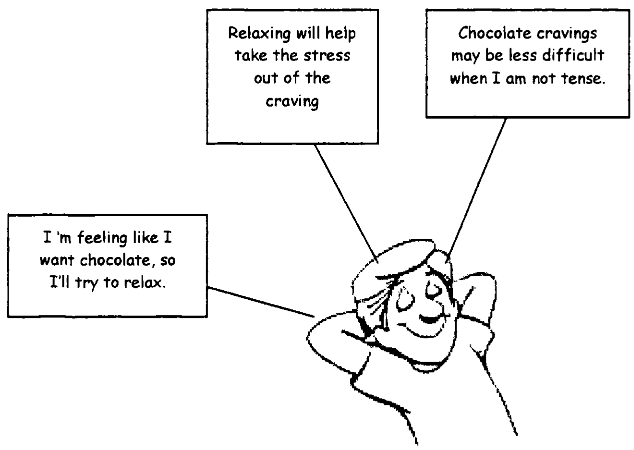
Appendix OO

Trying to relax

Chocolate cravings can be difficult. It may help to RELAX when you experience a chocolate craving.

Try to relax. Whenever you experience a chocolate craving, think about relaxing your muscles.

Sometimes it can also help if you tense up and then relax muscle groups. For example you could clench and then unclench your fists.



Your task

For the next 10 minutes we would like you to simply sit in front of the chocolates and let your mind wander. You are free to think about whatever you like, though please keep your eyes open and avoid engaging in any other activities.

Additionally, whenever you find yourself thinking about the chocolates we would like you to try to use the strategy described above to try to relax.

The researcher will stop you from time to time to ask you what you are thinking about. You will only be asked to provide a brief description of your thought (e.g. a short phrase such as eating chocolate, going on holiday, something private). Once the researcher has recorded your thought, you will be asked to immediately return to the task.
If you have any questions please ask the researcher now, otherwise please let the researcher know you are ready to begin.

Your task

For the next 10 minutes we would like you to simply sit in front of the chocolates and let your mind wander. You are free to think about whatever you like, though please keep your eyes open and avoid engaging in any other activities.

The researcher will stop you from time to time to ask you what you are thinking about. You will only be asked to provide a brief description of your thought (e.g. a short phrase such as eating chocolate, going on holiday, something private). Once the researcher has recorded your thought, you will be asked to immediately return to the task.

If you have any questions please ask the researcher now, otherwise please let the researcher know you are ready to begin

Appendix QQ

Thought-probe measure

1. ....

Chocolate related

Task related

Other (unrelated to chocolate or the task)

2. ....

Chocolate related

Task related

Other (unrelated to chocolate or the task)

3. ....

Chocolate related

Task related

Other (unrelated to chocolate or the task)

4. ....

Chocolate related

Task related

Other (unrelated to chocolate or the task)

5. ....

Chocolate related

Task related

Other (unrelated to chocolate or the task)

6. ....

Chocolate related

Task related

Other (unrelated to chocolate or the task)

7...

Chocolate related

Task related

Other (unrelated to chocolate or the task)

8...

Chocolate related

Task related

Other (unrelated to chocolate or the task)

9..

.

Chocolate related

Task related

Other (unrelated to chocolate or the task)

10...

Chocolate related

Task related

Other (unrelated to chocolate or the task)

Appendix RR

Task Pleasantness Rating

Using the scale below, please rate the pleasantness of the task?

Not at all pleasant				Neither pleasant nor unpleasant					Extremely pleasant
1	2	3	4	5	6	7	8	9	10

Appendix SS

Group 1 – cognitive defusion

How much did you 'try to see your thoughts and feelings as different from yourself' during the 10 minutes?

1. Not at all
2. Sometimes
3. Nearly always
4. Always

Group 2 - relaxation

How much did you 'try to relax' during the 10 minutes?

1. Not at all
2. Sometimes
3. Nearly always
4. Always

Group 3 - control

How much did you 'let your mind wander' during the 10 minutes?

1. Not at all
2. Sometimes
3. Nearly always
4. Always

Appendix TT

Consent Form

Title of the project: Chocolate Cravings

Researchers: Mrs Kim Jenkins, Prof Paul Bennett, Dr Katy Tapper

1. I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to ask questions and have had these answered satisfactorily.
2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time, without having to give a reason.
3. I have been informed that the confidentiality of the data I provide will be safeguarded.
4. I am 18 years of age or older.
5. I am not pregnant.
6. I have not suffered, past or present, from an eating disorder.
7. I do not have a medical condition that affects what I can and can't eat (e.g. high cholesterol, diabetes, hypoglycaemia, or food intolerances.
8. I am able to read English fluently.
9. I have not taken part in any previous study run by Kim Jenkins
10. Data Protection: I agree to the University processing personal data that I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.
11. I agree to take part in the study.

____________________	____________	________________
Your name	Date	Signature
____________________	____________	________________
Researchers name	Date	Signature

Appendix UU

Chocolate Cravings

Debriefing Form

Thank you for participating in this study! We appreciate your help, and hope you found the experience both beneficial and enjoyable.

We are interested in the way in which different strategies may help people reduce their chocolate cravings. It was predicted that the effectiveness of each strategy would be reflected by the number of chocolate cravings reported at the end of the study compared to at the start of the study.

At the beginning of the study you were shown a range of chocolate products and asked a series of questions. The purpose of this was to make you crave chocolate. This was important for the second part of the study whereby you were randomly allocated to one of three groups. Group 1 was asked to use a mindfulness meditation strategy called 'cognitive defusion' to try and view themselves as different from their chocolate cravings. Group 2 was asked to use relaxation to try and reduce their chocolate cravings. Group 3 was allocated to a 'mind wandering' group. For those in this group, the same initial instructions as the defusion and relaxation groups ('to let your mind wander') were given, but no specific strategy was taught.

The aim of the study was to see whether the defusion group would report fewer cravings at the end of the study compared to the two other groups which acted as control groups (i.e. we didn't expect these strategies to reduce chocolate cravings). Chocolate cravings were measured by the questionnaires you completed. Additionally, at certain times during the 10 minute task you were asked by the experimenter 'what you were thinking about right at that moment'. The reason for this was to identify how often you used your allocated strategy during this time period.

Ultimately we hope our findings will help inform interventions designed to help people maintain a healthy diet by reducing their chocolate cravings and consequently, their consumption of unhealthy snacks.
If you know anyone else who may participate in this study, please do not reveal this information to them since it could influence their responses.

If you have any other questions about the research, please do not hesitate to contact us at the following:

Mrs Kim Jenkins
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 513373
Email: 290921@swansea.ac.uk

Prof Paul Bennett
Department of Psychology
Swansea University
Swansea
SA2 8PP
Telephone: 01792 295840
Email: p.d.bennett@swansea.ac.uk

Appendix VV

Department of Psychology

ETHICS COMMITTEE

Memo

To:	Kimberley Jenkins Student No. 290921
From:	Dr. Steve Stewart-Williams for Departmental Ethics Committee
Copy:	Dr. Katy Tapper
Date:	21st February, 2011
Re:	Meditation and Attentional Control

Your proposed study, "Meditation and Attentional Control", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

1

Appendix WW

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Kimberley Jenkins**
	Student Number(s): 290921
From:	**Dr. Rob Lowe**
	for Departmental Ethics Committee
Copy:	**Dr. Katy Tapper**
Date:	**14th October, 2011**
Re:	**Resisting Temptation**

Your proposed study, "Resisting Temptation", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Participant Pool):**

1. Forward this approval via email to Dr. Irene Reppa (i.reppa@swansea.ac.uk)
   <u>**AND**</u>
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Kimberley Jenkins**
	Student Number(s): 290921
From:	**Dr. Jeremy Tree**
	for Departmental Ethics Committee
Copy:	**Dr. Katy Tapper**
Date:	**7th March, 2012**
Re:	**Association between thought cues and chocolate consumption – pilot study**

Your proposed study, "Association between thought cues and chocolate consumption – pilot study", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Participant Pool):**

1. Forward this approval via email to Dr. Irene Reppa (i.reppa@swansea.ac.uk)
   <u>AND</u>
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Appendix YY

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Kimberley Jenkins**
	Student Number(s): 290921
From:	**Dr. Jo Saunders**
	for Departmental Ethics Committee
Copy:	**Dr. Katy Tapper**
Date:	**26th April, 2012**
Re:	**Word Association – Pilot Study**

Your proposed study:"Word Association – Pilot Study" , has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Participant Pool):**

1. Forward this approval via email to Dr. Irene Reppa (i.reppa@swansea.ac.uk)

   AND

2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Kimberley Jenkins**
	Student Number(s): 290921
From:	**Professor Toby Lloyd-Jones**
	for Departmental Ethics Committee
Copy:	**Dr. Katy Tapper**
Date:	**22nd May, 2012**
Re:	**Subliminal Priming Check – Pilot Study**

Your proposed study, "Subliminal Priming Check - Pilot Study", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Participant Pool):**

1. Forward this approval via email to Dr. Irene Reppa (i.reppa@swansea.ac.uk)

   AND
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

• Page 1

Appendix A1

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Kimberley Jenkins**
	Student Number(s): 290921
From:	**Dr. Jo Saunders**
	for Departmental Ethics Committee
Copy:	**Dr. Katy Tapper**
Date:	**12th June, 2012**
Re:	**Chocolate Eating and Word Recognition – Pilot Study**

Your proposed study, "Chocolate Eating and Word Recognition – Pilot Study", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Participant Pool):**

1. Forward this approval via email to Dr. Irene Reppa (i.reppa@swansea.ac.uk)
   <u>**AND**</u>
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

• Page 1

Appendix B1

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Kimberley Jenkins**
	Student Number(s): 290921
From:	**Dr. Steve Stewart-Williams**
	for Departmental Ethics Committee
Copy:	**Dr. Katy Tapper/Professor Paul Bennett**
Date:	**16th July, 2012**
Re:	**Reducing Chocolate Consumption**

Your proposed study, "Reducing Chocolate Consumption", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Participant Pool):**

1. Forward this approval via email to Dr. Irene Reppa (i.reppa@swansea.ac.uk)
   AND
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).

Appendix C1

Department of Psychology

ETHICS COMMITTEE

Memo

To:	**Kimberley Jenkins**
	Student Number(s): 290921
From:	**Dr. Jeremy Tree**
	for Departmental Ethics Committee
Copy:	**Professor Paul Bennett**
Date:	**7th August, 2012**
Re:	**Effect of mindfulness meditation on chocolate cravings**

Your proposed study, "Effect of mindfulness meditation on chocolate cravings", has been reviewed and is approved. Provided that the information obtained is kept absolutely confidential and that no personally identifiable information is entered on computer, you may proceed with your study.

Please ensure that the signed copy of this Ethical Approval, together with any other paperwork associated with your research, is included in your final write up.

In order for your study to be displayed on the **Experiment Management System (Participant Pool):**

1. Forward this approval via email to Dr. Irene Reppa (i.reppa@swansea.ac.uk)

   AND
2. Send a request for your study to be made visible, via the link on the EMS website (see Researcher Documentation for details).