The Effect of Priming and Mindfulness on Food Choice and Decision Making

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Declaration

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Abstract

Overweight and obesity are argued to be one of the greatest public health challenges of the 21st century, partly explained by the excessive consumption of foods and beverages that have a high energy density and are also highly palatable. Consequently, it is important to understand the factors that contribute to these choices in order to find ways of promoting healthier decisions. Priming involves the activation of a mental concept in memory which increases the accessibility of this concept and the likelihood it will be assimilated into subsequent information processing. Priming is an important phenomenon for the simple reason that priming occurs automatically outside of awareness, meaning there is no way for an individual to counter the prime stimuli perceived. Therefore, the main aim of this thesis was to gain a deeper understanding of how prime stimuli specifically influence eating and drinking behaviour. Chapter Two is a systematic review that explicated the present state of the field by identifying all the research to date that has examined the effects of priming on the choice and intake of foods and beverages. One of the main findings of the review was that the majority of research has been laboratory-based with few studies conducted in the field. Therefore, Chapter Three is a field study that aimed to examine the effect of priming on snack choice in a real-world setting; this study also employed food-related logos as prime stimuli to more closely reflect the stimuli encountered in daily life. As the study found no effect of the prime stimuli on snack choice, Chapter Four examined whether unhealthy food-related logos could increase the selection of unhealthy foods in a laboratory setting. The results showed that participants in the prime condition were no more likely to select unhealthy foods than participants in the control condition, although this may have been due to the priming task employed. As priming effects are automatic, Chapter Five examined whether a brief mindfulness exercise could reduce the influence of automatic processes and increase the influence of conscious processes as measured by two cognitive tests. Although the results showed no difference between the conditions on either of the cognitive tests, trait measures of mindfulness and rational thinking style showed a strong positive correlation that was highly significant. Overall, the potential for brand logos to act as prime stimuli and the potential for mindfulness to reduce the influence of automatic processes both require further research. Although these are fairly new areas of research, the findings could have significant implications for future policies that are introduced to tackle the present obesity epidemic.

Chapter One:
General Introduction

The main aim of this thesis was to examine how eating and drinking behaviours are influenced by an automatic process referred to as priming, as well as the potential for mindfulness to reduce the effect of automatic processes on behaviour. Priming occurs when the perception of a prime stimulus leads to the activation of a corresponding mental concept in memory, increasing the accessibility of this concept and the likelihood that it will be incorporated into subsequent judgements, decisions, and behaviours. As this thesis is particularly concerned with the effect of priming on eating and drinking behaviour, this chapter begins with a brief overview of the present obesity epidemic including a discussion of several factors that contribute to the overconsumption of foods and beverages. This is followed by a discussion of the negative health implications of overweight and obesity in order to emphasise the importance of addressing the present epidemic. The second section goes on to distinguish between the two main types of cognitive processes that have been classified by researchers, namely controlled processing and automatic processing; as this thesis is primarily concerned with the latter, this section concludes by describing the conditions and defining qualities that are specifically associated with automatic processing. The third section introduces a particular type of automatic process referred to as priming and includes a description of the two levels at which prime stimuli can be presented: subliminal and supraliminal. This is followed by a discussion of behavioural and goal priming, including the mechanisms through which prime stimuli influence subsequent behaviour. This sections finishes by presenting recent research evidence for the effects of prime stimuli on eating and drinking behaviour, as well as discussing the importance of these findings. The final section introduces mindfulness as one way of reducing the influence of automatic processes on judgements, decisions, and behaviour. This section argues that mindfulness has the potential to reduce the influence of automatic processes on behaviour, with initial research providing support for this assertion.

1.1 Overweight and Obesity

Overweight and Obesity Definition and Prevalence

Overweight and obesity are argued to be one of the greatest public health challenges of the 21st century, presenting an increased risk to health through the abnormal and excessive accumulation of body fat (World Health Organization, n.d. -a; World Health Organization, n.d. -b). Overweight and obesity are classified through measuring Body Mass Index (BMI), which is defined as weight in kilograms divided by height in metres squared (kg/m^2). The most prevalent classification system defines overweight as having a BMI equal to or greater than 25, whereas obesity is defined as having a BMI equal to or greater than 30; obesity is further classified into Class I, Class II, and Class III depending of the level of severity (see Table 1.1 below) (World Health Organisation, n.d. -c). The most recent figures from England show that the mean BMI for males and females in 2017 was $27.6kg/m^2$ and $27.8kg/m^2$, respectively (Health Survey for England, 2018). A total of 40% of men and 32% of women were classified as overweight, while 27% of men and 30% of women were classified as obese (Health Survey for England, 2018). Although the rates of overweight and obesity in England have been fairly stable since 2003, the figures from 2017 show a slight increase compared to previous years (Health Survey for England, 2018). A simulation model study has also projected that obesity levels in England will continue to rise, potentially affecting 48% of men and 43% of women by 2030 (Wang et al., 2011).

Table 1.1

The World Health Organisation Classification System for BMI

Body mass index	Classification
< 18.5	Underweight
18.5 – 24.9	Normal weight
25.0 – 29.9	Overweight (pre-obesity)
30.0 – 34.9	Obesity Class I
35.0 – 39.9	Obesity Class II
> 40.0	Obesity Class III

The Physiology of Overweight and Obesity

From a physiological perspective, overweight and obesity are the result of an imbalance between energy intake and energy expenditure, whereby energy intake exceeds energy expenditure over a prolonged period of time (McArdle et al., 2007). As energy intake surpasses the requirements of the body, any excess calories consumed are converted into fat and stored in the adipocyte cells, which collectively form the adipose tissue (McArdle et al., 2007). These cells gradually increase in size until a hypertrophic limit is reached, at which point the body starts to generate new adipocytes to continue storing fat reserves (McArdle et al., 2007). This process continues until energy intake starts to equal energy expenditure and a state of energy balance is achieved. Although there are stores of adipose tissue all over the body, researchers have dichotomised these stores into subcutaneous fat and visceral fat based on their location. Subcutaneous fat is deposited under the skin and leads to a visible increase in body size as fat stores continue to accumulate. In comparison, visceral fat is stored around the abdominal organs and has no effect on outward appearance. There is evidence that the distribution of body fat is largely determined by genetic factors, with heritability accounting for up to 60% of body fat distribution (Schleinitz et al., 2014). Despite the greater visibility of subcutaneous fat, research has shown that high levels of visceral fat are associated with a higher risk of mortality over time (Finelli et al., 2013).

Eating Behaviour and Obesity

There are various factors that contribute to the excessive intake of energy relative to the requirements of the body. One of these is the energy density of food which is determined by the calorie content of the food relative to its weight; foods that are low in calories relative to their weight have a low energy density whereas foods that are high in calories relative to their weight have a high energy density (Nestle & Nesheim, 2012). Research has shown that tuber vegetables and fruits have an energy density of approximately 0.15 to 1.0 kcal/g whereas fries from fast-food outlets have an energy density of approximately 3.2 kcal/g (Brunstrom et al., 2018). The low energy density of tuber vegetables and fruits is due to their high water content which adds weight to the food without adding extra calories. As the water content of highly processed and refined foods is low, these foods have a much higher energy density and must be consumed in smaller portions to prevent excess energy intake. However, there is evidence that the standard portion size of various processed food products in England has dramatically increased since 1993. Research by the British Heart Foundation (2013) found that some ready meals have increased in size by as much as 100% and some snacks by as

much as 80%. This increase in portion size is concerning as research has repeatedly shown that larger portion sizes significantly increase the volume of food consumed, independent of BMI (Rolls et al., 2002; Rolls et al., 2004a; Rolls et al., 2004b). Furthermore, a recent survey by Public Health England (2018) found that energy dense foods are becoming increasingly accessible with an average of 96.1 fast-food outlets per 100,000 people in England in 2017. Remarkably, some areas had as many as 232 fast-food outlets per 100,000 people which equates to one fast-food outlet for every 431 people. In addition to the increasing number of fast-food outlets, there has also been a recent surge in the number of takeout delivery services available including Deliveroo, Just Eat, and Uber Eats. These services give people swift access to a variety of energy dense foods from the comfort of their own home.

Another important factor that contributes to the excessive intake of energy dense foods is the supra-physiological activation of the brain-reward system in response to the consumption of foods high in fat and sugar (highly palatable foods) (Fletcher & Kenny, 2018). A region of the brain called the nucleus accumbens receives information relating to taste and gastro-intestinal sensations which subsequently leads to the release of several neurotransmitters including opioids, dopamine, and serotonin; these neurotransmitters subsequently lead to the experience of pleasure and further reinforce the consumption of highly palatable foods (Erlanson-Albertsson, 2005). Research has found that the opioid system specifically stimulates food intake by making the sensation of hunger for foods high in fat and sugar more intense, indicating it is the palatability of food that activates the brain reward system rather than the energy content (Erlanson-Albertsson, 2005; Nogueiras et al., 2012). It has also been proposed that the consumption of highly palatable foods may undermine signals of satiety by disrupting homeostatic regulators of food consumption (Kenny, 2011). This effectively means that the consumption of highly palatable foods is largely regulated by the brain-reward system rather than the in-built appetite regulatory mechanism of the body. Consequently, highly palatable foods will continue to be consumed even when daily energy requirements have been fulfilled. These findings specifically highlight the importance of food choice, which appears to have a significant downstream effect on the amount of food consumed.

Drinking Behaviour and Obesity

Like many food products available, many beverages are also energy dense, available in large sizes, and easily accessible. Beverages that contain added caloric sweeteners are often referred to as sugar sweetened beverages (SSBs) and include carbonated soft drinks, fruit

drinks, sports drinks, and energy drinks (Hu & Malik, 2010). Research has found that the average can (330ml) of carbonated SSB in the UK contains 126 calories and exceeds the entire daily recommendation for sugar intake (30g) as advised by the World Health Organisation (Hashem et al., 2016). Many beverages are also available in exceptionally large sizes – the largest Coca-Cola presently available at McDonalds (500ml) contains approximately 212 calories and 53 grams of sugar (McDonalds, n.d.) – which can significantly increase daily calorie intake. Records show that a total of 5,314 million litres of carbonated beverages were consumed in the UK in 2018, with the average person consuming 79.9 litres throughout the year (British Soft Drinks Association, 2019). Furthermore, beverages that can supposedly facilitate sports performance have been found to be heavily consumed, despite the fact that many of these beverages are also high in calories (British Soft Drinks Association, 2019); a 500ml bottle of Lucozade Sport Orange contains approximately 140 calories and 18g of sugar (Lucozade Sport, n.d.). Research showing that the obesity epidemic has risen in parallel with the increase in consumption of SSBs accentuates the importance of moderating the consumption of beverages that contain added sugars (Hu & Malik, 2010). The contribution of SSBs to the increasing levels of obesity is supposedly due to the low satiation associated with SSBs and the lack of compensation afforded by individuals during subsequent eating episodes (Pan & Hu, 2011).

Physical Conditions Associated with Overweight and Obesity

Cardiovascular Disease

Cardiovascular disease (CVD) refers to an array of disorders involving the cardiovascular system and is presently the main cause of death globally (World Health Organization, 2017). CVD is characterised by a disruption in the blood supply to either the heart (coronary disease), the brain (cerebrovascular disease), or the peripheral regions of the body (peripheral vascular disease) (Frayn & Stanner, 2019). All types of CVD involve the process of atherosclerosis and thrombosis within the artery, where atherosclerosis is the formation and build-up of plaque and thrombosis is the coagulation of blood cells following a rupture in the artery wall (Frayn & Stanner, 2019). Atherosclerosis develops over a long period of time as immune cells inside the artery wall remove low-density lipoproteins (LDLs) from the blood vessels: LDLs are protein molecules that specifically contain ‘bad’ cholesterol mainly derived from saturated and trans-fats (McArdle et al., 2007). During this process, the LDLs are oxidized which makes them harden on the inside of the artery wall where they gradually accumulate (McArdle et al., 2007). The higher the concentration of LDLs in the blood, the

greater the build-up of plaque, resulting in a gradual narrowing of the artery which may eventually close up completely (McArdle et al., 2007). In contrast, thrombosis occurs specifically when there is damage at the site of an atherosclerotic plaque. In this case, the blood coagulates into a thrombus which may break away and obstruct the flow of blood at another site (Frayn & Stanner, 2019). As intake of saturated fats and trans-fats are the strongest dietary determinants of LDL concentration, it is likely that reducing intake of these will significantly reduce CVD risk (Lichtenstein et al., 2006).

Type II Diabetes

Type II diabetes is a chronic metabolic disease characterized by a prolonged increase in blood glucose levels, also known as hyperglycaemia (World Health Organization, n.d. -d). Hyperglycaemia occurs when the body becomes unresponsive to the hormone insulin which promotes the storage of glucose in order to regulate blood glucose levels (Sherwood, 2016). Over 3.2 million people in England have been diagnosed with Type II diabetes and it has been estimated that obesity accounts for up to 85% of Type II diabetes risk (Diabetes UK, n.d. -a; Diabetes UK, n.d. -b). Many of the complications associated with Type II diabetes result from the toxic effects of elevated blood glucose levels, known as glucose toxicity (Campos, 2012). Although the majority of cell types are able to regulate intracellular glucose levels independently, the intracellular glucose levels of several cell types is determined by the extracellular environment, making them highly susceptible to glucose toxicity (Campos, 2012). One of these cell types makes up the inner layer of the blood vessels (vascular endothelium) which is an active organ that maintains vascular homeostasis, including the degree of constriction (vascular tone) and blood fluidity (Widlansky et al., 2003). Damage to these cells through glucose toxicity leads to endothelial dysfunction – the inability of the endothelium to maintain vascular homeostasis – resulting in a narrowing of the blood vessels (Rajendran et al., 2013). This reduced blood flow often affects the blood vessels supplying the nerves, eyes, and kidneys leading to reduced sensations in the feet and legs (sensory neuropathy), an increased risk of blindness (diabetic retinopathy), and an increased risk of kidney disease (Diabetes UK, n.d. -c).

Cancer

Cancer refers to a class of diseases that involve the growth and spread of abnormal cells in the body. There are various types of cancer which are collectively the second leading cause of death globally (World Health Organization, n.d. -e). Research has found that obesity is a

risk factor for multiple types of cancer and may be attributable to as many as 20% of all cancer cases (Wolin et al., 2010). Obesity is also associated with poorer treatment outcomes and increased cancer-related mortality (Vucenik & Stains, 2012). Various biological mechanisms are thought to underlie the association between obesity and cancer risk, one of which is the disruption of hormone levels in the body. It has recently been discovered that the adipose tissue is the largest endocrine organ in the body, secreting more than 50 hormones and cytokines (proteins), often referred to as adipokines (Dalamaga et al., 2012). The most prolific of these is adiponectin which has many important functions in the body including the regulation of glucose and lipid metabolism, increasing insulin sensitivity, and reducing inflammation (Dalamaga et al., 2012). Paradoxically, as energy intake exceeds the requirements of the body and the adipose tissue increases in size, the concentration of adiponectin secreted into the blood is reduced (hypoadiponectinemia) (Turer et al., 2011); this results in reduced insulin sensitivity and therefore higher concentrations of insulin are required to regulate blood glucose levels. Increased levels of insulin stimulate the expression of insulin-like growth factors (IGFs) which play a key role in the inhibition of apoptosis – a regulated process resulting in the breakdown of cells that are damaged (Dalamaga et al., 2012; Sherwood, 2016). Consequently, the increased expression of IGFs increases the risk that these damaged cells will survive and result in the development of cancer.

Mental Conditions Associated with Overweight and Obesity

Depression

Depressive disorders are defined as 'the presence of sad, empty, or irritable mood, accompanied by somatic and cognitive changes that significantly affect the individual's capacity to function' (American Psychiatric Association, 2013, p. 155). A recent systematic review and meta-analysis found a significant positive association between the development of depression and being classified as overweight or obese (Pereira-Miranda et al., 2017). Specifically, overweight and obesity increased the probability of developing depression by 7% and 32%, respectively. One of the mechanisms through which overweight and obesity may lead to depression is the development of body image dissatisfaction (BID), which refers to 'the negative perceptions and feelings a person has about their body' (McGuinness & Taylor, 2016). Gavin et al. (2011) specifically examined whether BID mediates the association between obesity and depression, as well as the potential for educational attainment to moderate any association found. Overall, the results showed a strong association between obesity and depression which was partially mediated by BID regardless

of educational attainment. The association between obesity and depression is important as research has found that depression is present in approximately 60% of suicides and appears to be the most important risk factor across all age groups for suicidal ideation and behaviour (Haddad & Boyce, 2017). Furthermore, a cross-sectional study based on self-report found that approximately 10% of gastric surgery candidates had previously attempted suicide, implying that having excess weight can put a significant strain on mental health (Sansone et al., 2008).

Anxiety

Anxiety disorders are characterised by an excessive fear or anxiety that persists beyond what is considered an appropriate period (American Psychiatric Association, 2013). Although there are various types of anxiety disorder, research has found that being classified as overweight is specifically associated with panic disorder and social anxiety disorder (social phobia) in women (Barry et al., 2008). The essential feature of social anxiety disorder is 'a marked, or intense, fear or anxiety of social situations in which the individual may be scrutinized by others' (American Psychiatric Association, 2013, p. 203). Consequently, it has been proposed that the association between obesity and social phobia is mediated by weight stigma which is defined as 'the social devaluation and denigration of people perceived to carry excess weight and leads to prejudice, negative stereotyping and discrimination towards those people.' (Tomiyama, 2014, p. 8). This proposal is supported by evidence that weight stigma is twice as likely to afflict women compared to men, which may explain the higher prevalence of social anxiety disorder in this population (Puhl et al., 2008). Further support is provided by Wu and Berry (2017) who conducted a systematic review on the associations between weight stigma and physiological and psychological health; the results showed that the frequency of weight stigma was positively and significantly associated with the development of anxiety. As research has shown that negative emotions often stimulate further eating behaviour in overweight individuals (Geliebter & Aversa, 2003), anxiety disorders can make significant weight reduction even more of a challenge.

1.2 Cognitive Processing

As stated above, overweight and obesity result from the excessive consumption of calories over a prolonged period of time (McArdle et al., 2007). One factor that appears to be an

important contributor to the development of overweight and obesity is the consumption of high calorie foods that lead to the supra-physiological activation of the brain reward system (Fletcher & Kenny, 2018). As this can reinforce the consumption of these foods, it is important to reduce the number of unhealthy food and beverage choices made throughout the day in order to prevent significant weight gain. The first step to achieving this objective is to understand the various cognitive processes that are involved in the decision making process. Although researchers have identified a multitude of cognitive processes to date, these have been classified into two main types, both of which are distinguished and described below.

Types of Cognitive Processing

Information in the environment is perceived and interpreted through various cognitive processes and is subsequently collated to form a coherent understanding of the present situation, allowing the individual to determine the most appropriate response. It has long been recognised that cognitive processes may occur with or without conscious awareness, historically referred to as conscious and unconscious processing respectively. Since the beginning of psychology as a discipline, there has been a great deal of controversy regarding the relative importance of each of these processes (Uleman, 2005). However, recent improvements in research methods and techniques have allowed researchers to distinguish the defining features of conscious and unconscious processing, which are presently referred to as controlled and automatic processing respectively. Controlled processing is defined as 'any form of information processing requiring conscious attention or control, as in the performance of a novel or difficult task' (Colman, 2015, p. 167). The capacity of an individual to consciously process information is fairly limited, as research has shown that conscious processing is restricted to just 40-60 bits of information per second, the equivalent of a short sentence (Dijksterhuis, 2004). In contrast, automatic processing is defined as 'any information processing that occurs involuntarily and without conscious intention or control, as in the performance of well-practised activities such as seeing, reading, or driving a car' (Colman, 2015, p. 69). Research has shown that the capacity of an individual to automatically process information is as high as 11 million bits per second, the majority of which is processed by the visual system (Dijksterhuis, 2004). The limited capacity of conscious processing means it is vitally important that certain tasks can be undertaken automatically or with limited cognitive awareness. Therefore, despite having a historical association with weakness and laziness, automatic processes are more likely 'an adaptation that allows humans to be a uniquely productive species' (Cohen & Farley, 2008, p. 3).

Dual Process Theories of Cognition

Dual process theories of cognition elaborate on the defining features of automatic (Type 1) and controlled (Type 2) processing. According to Evans and Stanovich (2013), the defining characteristic of Type 1 processing is autonomy, as these processes are based on associative networks in the brain and make minimal demands on working memory resources; these processes also have a high capacity due to the fact they can occur fairly rapidly and in parallel. It is also argued that Type 1 processes are automatically triggered by stimuli in the environment and can therefore be initiated and run to completion outside of conscious awareness. In contrast, Type 2 processing requires access to working memory resources whereby awareness at any given time is represented by a sequential flow of consciousness through working memory (Evans, 2008). It has been proposed that Type 2 processing is rule-based in that simple if-then rules are followed in a serial order which severely restricts the capacity of these processes (Evans & Stanovich, 2013). Another defining feature of Type 2 processing is cognitive decoupling, described as 'the ability to distinguish supposition from belief and to aid rational choices by running thought experiments' (Evans & Stanovich, 2013, p. 236). Therefore, individuals are able to view different aspects of a situation in isolation and apply these simple if-then rules to determine the best course of action. The clarification of the features specific to Type 1 and Type 2 processing has subsequently led to a debate regarding how these processes interact. According to the default interventionist view, Type 1 processes provide a rapid and intuitive default response which may or may not be intervened by Type 2 processes (Evans & Stanovich, 2013). Based on this view, the majority of human behaviour is controlled by Type 1 processes with Type 2 processes only required for novel or difficult tasks.

Automatic Processing

Automatic processes have undergone extensive examination by researchers, leading to the proposal that there are three conditions of automaticity: pre-conscious, post-conscious, and goal-dependent (Bargh, 1994). Pre-conscious automaticity occurs following the perception of a stimulus in the environment which initiates an automatic response; this occurs prior to and outside of conscious awareness of any deliberative response and includes the interpretation, evaluation, and categorization of the stimulus. For example, the perception of a chocolate bar leads to automatic processes that instantly recognise the product as chocolate, evaluate it as tasting nice, and categorise it as food. Post-conscious automaticity is similar to pre-conscious automaticity, the only difference being that it relies on prior conscious processing of a related

stimulus; the activation of a mental representation temporarily increases the accessibility of the representation which is factored in to any subsequent processing. For example, a recent positive experience, such as eating a cookie, may temporarily increase the accessibility of positive life experiences. Finally, goal-dependent automaticity is based on the present goals of the individual which are usually available in conscious awareness; however, research has shown that goals can also be activated outside of conscious awareness (Bargh et al., 2001). For example, an individual who is on a diet may see a healthy eating magazine and subsequently refrain from buying unhealthy foods and beverages in order to achieve a specified weight loss.

Researchers have also identified four defining qualities of automatic processing; these are the extent to which thought and behaviour (1) occur outside of awareness; (2) are unintentional; (3) are uncontrollable; and (4) are efficient in their use of attentional resources (Bargh, 1994). In relation to awareness, there are three different ways in which an individual may be unaware of thoughts and behaviour. Firstly, the individual may be unaware of having perceived the stimulus itself (i.e. subliminal perception); secondly, the individual may be aware of the stimulus but unaware of how the stimulus has been evaluated or categorised; and thirdly, the individual may be unaware of how the stimulus is influencing subsequent thought and behaviour. The question of intentionality specifically refers to whether an individual has control over the instigation of a cognitive process; any processes triggered outside of awareness are initiated by either internal or external factors that are associated with a specific response. Controllability relates to awareness in that it requires the individual to be aware of how the stimulus is influencing subsequent thought and behaviour. However, it goes beyond awareness in that it refers to whether the individual is both motivated to and able to counteract the automatic process activated. Efficiency refers to the extent to which attentional resources are required for the cognitive process to occur; the requirement of attentional resources means that the process is unlikely to occur when these resources are allocated elsewhere. Although it was originally proposed that thoughts and behaviours were either purely automatic or purely controllable, it has since been found that many mental phenomena are of sufficient complexity to be composed of features related to both automatic and controlled processing (Bargh, 1994).

1.3 Priming

Priming is one effect of automatic processing that may influence behaviour on a regular basis due to the large number of prime stimuli in the social environment. The section below defines and describes the phenomenon of priming and also considers research showing the effect that primes can have on eating and drinking behaviour.

Priming Definition and Types

Researchers in psychology have long been interested in how exposure to certain stimuli in the environment can influence subsequent judgements, decisions, and behaviour. Priming is an avenue of research that is defined as 'the provision of a contextual cue, prime, or prompt that provides information about either the identity or the time of appearance of a target stimulus and that may facilitate a response or inhibit it' (Colman, 2015, p. 600). The majority of priming research concerns assimilation effects, whereby exposure to a prime stimulus leads to judgements, decisions, or behaviours that comply with the prime. For example, prior exposure to the word Cadbury may increase subjective liking of chocolate as measured by a Likert scale, or even the selection of a chocolate bar during a food choice task. Research examining assimilation effects has proliferated in recent years as psychologists have explored the types of stimuli that can prime a response, as well as the types of responses that can be primed. Consequently, researchers have identified various types of priming with the most widely researched briefly described in Table 1.2.

Table 1.2

The Main Types of Priming Studied in Psychology

Type of priming	Description
Perceptual	This is based on form and occurs when the prime has the same or a similar appearance to the target. For example, having an image of a bee as both the prime and target stimulus.
Conceptual/Semantic	This is based on meaning and occurs when the prime is conceptually related to the target. For example, bees are conceptually related to wasps as both are insects.
Associative	This is based on association and occurs when the prime is associated with the target without being conceptually related. For example, bees are often associated with honey.
Repetition	This involves repeatedly presenting the *same* stimulus which leads to faster recognition during subsequent presentations. For example, repeatedly presenting an image of a bee.
Behavioural	This is concerned with the downstream effects of the prime on behavioural outcomes. For example, an image of a bee increases the selection and intake of honey.
Goal	This is a type of behavioural priming and occurs when the prime activates a goal and leads to behaviours that promote goal attainment. For example, the goal to consume honey.

Each type of prime can be presented at either a subliminal or a supraliminal level, both of which are described in detail below.

Subliminal Priming

Subliminal perception refers to the 'preconscious processing of stimuli below the intensity or duration of the absolute threshold and therefore not eliciting conscious perception' (Colman, 2015, p. 739). Subliminal priming research is mainly conducted by cognitive psychologists as a means of examining the boundaries of human perception and the organisation of memory. It is presumed that the time taken to respond to the target stimulus reflects the proximity of the concepts in memory: the faster the response time, the closer the concepts are situated. In order to ensure the stimulus is subliminal, it is usually presented on a computer screen and

masked by a row of X's both prior to its presentation (forward masking) and after its presentation (backward masking). For example, the forward mask may be presented for 500ms, followed by the prime stimulus for 15ms, and finally the backward mask for another 500ms. Backward masking is particularly important as there is evidence that stimuli can remain in iconic memory (the memory system for briefly presented visual stimuli) for a short time after being removed from the display, therefore increasing the likelihood that the prime stimulus will enter conscious awareness (Sperling, 1960). Another consideration is whether the prime stimulus is to be presented in the foveal region or the parafoveal region of the display. The foveal region is between zero and two degrees from the centre of focus, whereas the parafoveal region is between two and six degrees from the centre of focus (Smith & McCulloch, 2012). Although stimuli presented in the parafoveal region remain outside of conscious awareness, they are still subject to a certain amount of cognitive processing (Bargh & Chartrand, 2000). Consequently, stimuli can be presented in the parafoveal region for a longer duration as stimuli that are from 0.3 up to 4 degrees from the centre of focus have a saccadic latency of approximately 175-200 milliseconds (Rayner et al., 1983). In order to ensure that stimuli are presented in the foveal or parafoveal region, a fixation point (usually a cross), is used to focus attention on a specific point immediately prior to presentation of the stimuli.

In order to confirm that an individual is unaware of a prime stimulus, researchers make use of both subjective and objective measures of awareness. Subjective awareness is based on self-report and involves asking the individual to report whether the prime stimulus was consciously perceived (Merikle, 1992). In contrast, objective awareness involves completing tasks that measure perceptual discriminative abilities (Merikle, 1992). As there is some controversy over the reliability of subjective measures (Eriksen, 1960), the majority of subliminal priming studies include an objective measure of awareness which is taken at the end of the study. Recognition tasks involve presenting the prime stimuli alongside new stimuli and asking the individual to identify which has been presented previously. If the individual performs at a better than chance level over a series of trials, it is assumed that the prime stimuli were consciously perceived. However, objective measures of awareness have shown that masked prime stimuli can be presented in the foveal region for up to 23 milliseconds without entering conscious awareness (Karremans et al., 2006). The initial claim that subliminally presented stimuli could influence judgements, decisions, and behaviour was made by market researcher James Vicary in 1957 (Karremans et al., 2006). This claim

created much debate regarding the ethical implications of subliminal priming, as it brought to light the potential for companies to use subliminal advertising to influence consumers impressions and choices outside of awareness. Consequently, subliminal advertising was banned in several countries, including the United Kingdom, where it remains a prohibited practice (Smith & McCulloch, 2012).

Supraliminal Priming

Supraliminal perception refers to the processing of stimuli above the threshold of consciousness or sensation, which subsequently leads to the stimuli entering conscious awareness (Colman, 2015). Therefore, supraliminal priming research involves the conscious perception of a prime stimulus and is mainly used by social psychologists to explore how the social environment can influence judgements, decisions, and behaviour. Perception of a prime stimulus activates a mental representation of the prime concept in memory, making it more accessible and therefore more likely to be factored into any subsequent cognitive processing (Molden, 2014). Furthermore, the strength of the priming effect depends on the strength of the concept activation, which is determined by the formula: Duration x Intensity = Activation (Bargh & Chartrand, 2000). Consequently, supraliminal priming effects are usually stronger than subliminal priming effects due to the longer duration and greater intensity during supraliminal presentation. In addition to this, there are various ways in which supraliminal prime stimuli may be presented to the individual; for example, it may be presented as a word embedded within a task, such as a memory test, or it may be a part of the surrounding environment, such as a word presented on a poster. However, it is important to bear in mind that different priming methods will vary in terms of the level of concept activation achieved; tasks that involve actively processing the prime stimuli will result in a greater level of concept activation and therefore stronger priming effects.

Behaviour and Goal Priming

The first study to show behavioural priming effects was by Bargh et al. (1996) who found that priming participants with either the concept of rudeness or politeness increased behaviour that was in line with the active concept. This was just one in a series of studies showing that incidentally presented words could have downstream effects on behaviour and proved to be an important finding in the history of psychology by providing evidence that behaviour can be influenced by unconscious processes as well as conscious ones (Payne et al., 2016). Consequently, these findings led to the introduction of the term ‘behavioural

priming', followed by multiple studies examining the various behaviours that could be influenced by prime stimuli. Although the evidence for behavioural priming effects has continued to accumulate, there have been recent concerns over several failed replications (Cesario, 2014). However, these concerns have been lessened following a meta-analysis by Weingarten et al. (2016), which examined the effect of incidentally presented words on various behavioural outcomes. Overall, the results showed a small positive effect on behaviour which was consistent across a variety of priming paradigms. Furthermore, as the stimuli presented in many behavioural studies are the same as those used previously to prime judgements, it has since been argued that a single prime influences judgements, decisions, and behaviour simultaneously; the effect found solely depends on the particular outcome that is measured by the researcher (Bargh, 2006).

It has also been proposed that prime stimuli can activate representations of desired end-states that are associated with reward and evoke action that will facilitate goal attainment; this is often referred to as goal priming and is thought to involve the activation of a goal-related construct as opposed to a knowledge-related construct (Förster et al., 2007). One of the earliest studies on goal priming found that priming words related to achievement significantly improved performance on a subsequent verbal task compared to a control condition (Bargh et al., 2001). Interestingly, research has found that goal priming can also reduce inattentional blindness as the subliminal presentation of words related to detection significantly increased the detection rates of a person in a gorilla suit (Lègal et al., 2017). In order to distinguish goal priming from other types of priming, researchers have identified seven principles that are only applicable to goal priming effects (Förster et al., 2007). One of these principles is that goals appear to remain active until they are fulfilled, rather than showing a gradual decline in activation. There is also evidence that the accessibility of the goal actually increases over time (as long as the goal remains unfulfilled) and diminishes as soon as the goal has been attained (Förster et al., 2005). Another feature of goal priming is that it involves the inhibition of conflicting goals that may interfere with the attainment of the original goal (Förster et al., 2007). This is thought to be the result of goal shielding which occurs when an active goal inhibits the activation of mental representations that correspond to any competing goals (Kruglanski et al., 2002).

Neural Correlates of Behaviour and Goal Priming

The human body consists of more than 660 skeletal muscles that have to coordinate effectively in order to produce simple and complex body movements (McArdle et al., 2007). The sheer number of individual muscle actions involved in any one movement means it is essential that these actions can occur automatically, outside of conscious awareness (Thatch, 1996). Skilled movement is thought to develop through a process of trial and error where the movement is initially controlled at a conscious level by the cerebral cortex and over time is brought under the control of the cerebellum (Thatch, 1996). As a certain movement is consistently performed in a specific context, the cerebellum links the mental representation of the context with the relevant premotor generators, therefore allowing the movement to be triggered automatically by contextual cues and resulting in behavioural priming (Bargh, 2005). However, goal priming is far more complex in that higher mental processes are required to determine the most appropriate course of action for goal attainment. The executive functions responsible for regulating goal attainment, such as strategic planning and decision making, are controlled by an area of the brain called the prefrontal cortex, with the right prefrontal cortex specifically responsible for monitoring behaviour and resisting distractions (Colman, 2015). As research has found there is also a link between the cerebellum and the prefrontal cortex, this may explain the automaticity of higher mental processes including the effects of goal primes on behaviour (Bargh, 2005). In this case, it is argued that contextual cues may trigger action plans through connections with the prefrontal cortex, leading to behaviour that promotes goal attainment.

Priming as a Conditional Phenomenon

Research has identified certain conditions that are essential in order for priming effects to occur. Firstly, it is imperative that the prime stimuli have previously been perceived by the individual, either consciously or unconsciously, in order for a mental representation to be created and stored in memory (Bargh, 2016). Stimuli that are new to the individual will fail to show priming effects as there is no mental representation stored in memory to be activated. Therefore, it is important that any laboratory-based research confirms the prime stimuli are familiar to the participants at the end of the study. Secondly, it is important that the prime stimuli are relevant to the present goals of the individual as this will generally lead to stronger priming effects (Bargh, 2016). This is supported by the recent meta-analysis by Weingarten et al. (2016) which found that prime stimuli associated with important outcomes resulted in stronger priming effects than prime stimuli associated with less important

outcomes. However, as goals can influence judgements, decisions, and behaviour outside of conscious awareness, it can be difficult to determine whether the prime stimuli are relevant or irrelevant to the goals presently being pursued (Marien et al., 2012). Thirdly, it is essential that the individual is unaware of the link between the prime stimuli and the subsequent measure of effect. The stronger the priming task, the more likely the individual will become aware of this link and determine the aim of the study. Consequently, this increases the likelihood that the results will be influenced by demand effects and reduces the internal validity of the research (Bargh & Chartrand, 2000). As the strength of the prime stimuli determines the strength of the effect, it is important to develop a priming task that allows for maximum exposure to the prime stimuli without the individual becoming aware of the aim of the study. In order to check for awareness of this link, it has become standard procedure to take the participant through a funnelled debrief where participants are asked a series of questions regarding the nature of the study, as well as the specific tasks that have been completed. Social psychologists also use subliminal priming paradigms to support any effects found following exposure to supraliminal prime stimuli; significant findings further rule out the potential for awareness of the study aims and demand effects to explain the results (Bargh & Chartrand, 2000).

Models of Priming

The Goal Conflict Model of Eating Behaviour

The goal conflict model of eating behaviour proposes that restrained eaters find it difficult to regulate eating behaviour because they have two active conflicting goals (Stroebe et al., 2013). One of these goals is to promote weight control through the consumption of healthy foods that are low in calories, while the other relates to eating enjoyment which usually involves consuming unhealthy foods that are high in calories. Although the focal goal for restrained eaters is weight control, exposure to unhealthy food products increases the accessibility of the eating enjoyment goal and activates a mental representation of the enjoyment that would be experienced if these foods were consumed. As restrained eaters are highly responsive to the eating enjoyment goal, exposure to unhealthy food products often undermines the goal to control weight and results in the consumption of unhealthy food. However, it is also argued that constant priming of the weight control goal can undermine the eating enjoyment goal, leading to the consumption of healthy foods. As many social environments contain stimuli that promote unhealthy foods, inhibiting the eating enjoyment goal in order to fulfil the weight control goal requires more cognitive resources than fulfilling

the eating enjoyment goal. The constant exposure to unhealthy foods makes fulfilling the weight control goal ever more difficult for two reasons. Firstly, increasing the accessibility of the eating enjoyment goal naturally decreases the accessibility of the weight control goal, reducing the individual's ability to focus on regulating eating behaviour. Furthermore, inhibiting the eating enjoyment goal depletes working memory resources and further reduces the individual's ability to focus on weight control.

Based on this model, exposure to a food cue elicits a craving which leads to the consumption of unhealthy foods. As detailed in Chapter Two, a food cue differs from a prime as the individual is aware of having a craving for a particular food and may take action to avoid the particular food that is desired; for example, an individual may decide to walk past the bakery aisle of a supermarket when craving something sweet. In contrast, priming effects occur outside the awareness of the individual, even when the prime stimuli has been consciously perceived; in other words, the individual is unaware that exposure to the prime stimuli is influencing subsequent cognition and behaviour. Consequently, food cues activate the eating enjoyment goal which leads to the creation of mental simulations that are experienced consciously, whereas diet cues unobtrusively activate the weight control goal outside of awareness. However, this model also proposes that restrained eaters who repeatedly and successfully regulate food intake after exposure to food cues develop associative links to the weight control goal, meaning that exposure to food cues increases the accessibility of the weight control goal while inhibiting the accessibility of the eating enjoyment goal. Therefore, exposure to the sight or smell of food has the potential to act as a food cue or a prime depending on the individual perceiving the stimulus.

Bottom-up and Top-down Processing

Research has also examined the effect of priming on bottom-up and top-down processing in order to clarify how exposure to primes influences food-related decision making (Mas et al., 2020); bottom-up processing is the integration of sensory information regarding the physical characteristics of a stimulus, whereas top-down processing is based on existing knowledge and expectations (Lieberman, 2004). One particular study by Mas et al. (2020) utilized a within-subjects design where participants were exposed to two different olfactory primes, a pear and a pound cake odour, as well as a control condition with no odour present. Bottom-up processing was examined by means of attentional bias whereby the response times to pictures of food was recorded and compared between conditions and weight status. The results

showed that overweight and obese participants were slower to react to the food pictures than normal weight participants when primed with the pear and pound cake odour; the authors argued that the odours may have slowed the bottom-up processing of the stimulus as they added another element to take into account. Furthermore, top-down processing was examined by recording the number of commission errors made during a Go/No-go task which were the number of trials in which the participant failed to engage in response inhibition when presented with distractor stimuli. The results showed that there was no effect of the prime stimuli on the number of commission errors made with all participants making more commission errors when presented with pictures of high energy dense foods. Consequently, the authors concluded that exposure to implicit olfactory stimuli may only influence the bottom-up processing of food pictures, having no effect on top-down processing.

Interestingly, the results showed that exposure to the prime stimuli only influenced the response times (bottom-up processing) of participants who were overweight or obese. This has also been found by prior research that examined attentional bias following exposure to the same two olfactory primes, a pear and a pound cake odour, which were presented at both an implicit and explicit level (Mas et al., 2019). The findings showed there was only an olfactory priming effect in the implicit priming condition, although all participants showed an attentional bias towards food pictures, particularly those of foods with a high energy density. It was also found that obese participants had a stronger attentional bias towards pictures of foods after being primed with a high energy dense odour than a low energy dense odour; the reverse was true for normal weight participants and no effect was found for overweight participants. Consequently, the authors concluded that obese individuals may be vulnerable to specific cognitive processes that influence the processing of food-related stimuli when exposed to implicit prime stimuli but not explicit prime stimuli. Overall, these findings imply that implicit prime stimuli are integrated with other sensory information in the environment, influencing how the situation is interpreted, as well as the behavioural response.

The Effects of Priming on Eating and Drinking Behaviour

Since the first demonstration of behavioural priming by Bargh et al. (1996), multiple studies have examined the effect of priming on eating and drinking behaviour. These studies have varied considerably in terms of the types of prime stimuli presented, whether the prime stimuli are subliminal or supraliminal, the interval between the priming task and the outcome measure, and the specific foods or beverages presented to participants. One study by Stämpfli

and Brunner (2016) explored whether exposure to thin human-like sculptures by the artist Alberto Giacometti could influence subsequent intake of Pringles during a taste-rating task. The findings showed that participants in the prime condition (exposure to sculptures) consumed significantly less than participants in the control condition (exposure to a neutral screensaver), implying that the sculptures activated the goal to lose weight which directly influenced food intake. A different priming procedure was used Robinson et al. (2011) who used a word search task to expose participants to either ten social acceptance words or ten neutral words. The results showed that participants exposed to the social acceptance words consumed significantly less popcorn during a subsequent task than participants exposed to the neutral words. This implies that prime stimuli that are unrelated to health can also reduce subsequent food intake. Finally, a study by Chiou et al. (2013) examined whether priming the concept of masculinity through a scrambled sentence task could influence energy drink consumption among men. On completion of the scrambled sentence task, all participants were asked to select either a can of Red Bull or a bottle of Perrier mineral water as a reward for taking part in the study. The results showed that participants in the prime condition were significantly more likely to select Red Bull than participants in the control condition, implying that priming the concept of masculinity promoted behaviour that was consistent with this concept.

The effects of priming on eating and drinking behaviour is extremely important due to the severe consequences of overweight and obesity on both physical and mental health. One of the main concerns over priming effects is that they occur outside of conscious awareness and are therefore outside the control of the individual. This point is reiterated by Bargh (1994, p. 13) who states that 'a lack of awareness of the prime on subsequent judgements, decisions, and behaviour is important as it means the individual has no control over the effect of the prime'. Therefore, priming effects reflect the extent to which the environment has control over behaviour, which is especially concerning for prime stimuli that specifically encourage behaviours that are detrimental to health. Furthermore, many types of prime stimuli are highly prevalent in the social environment, meaning that they are likely to influence behaviour on a regular basis. As stated by Tulving and Schacter (1990, pg. 302), 'Although priming is typically observed only under carefully controlled experimental conditions, similar conditions frequently occur naturally, outside the laboratory. It is reasonable to assume, therefore, that priming represents a ubiquitous occurrence in everyday life'. Finally, the fact that prime stimuli may be perceived in a different context to the effect observed means that

prime stimuli in the social environment may have a far greater influence on everyday life than present concerns would allege. Consequently, exposure to any prime stimuli could have an effect on subsequent behaviour regardless of the context in which it is perceived. As goal primes have been found to increase in strength over time, this delay is particularly concerning for prime stimuli that activate the goal to consume unhealthy foods and beverages. Based on the points discussed above, it is important to understand the boundaries of priming and the specific mechanisms through which priming exerts its effects so that appropriate policies and legislation can be implemented.

1.4 Mindfulness

As discussed above, exposure to prime stimuli can have a significant effect on both eating and drinking behaviour. However, evidence for the increased selection and consumption of unhealthy foods and beverages is particularly concerning, as this could have a detrimental effect on both physical and mental health. Consequently, it is important to consider whether it is possible to reduce or counteract the effect of prime stimuli on subsequent judgements, decisions, and behaviour. One recently proposed approach is the cultivation of mindfulness which is argued to reduce the influence of automatic processes, including priming effects, through an increase in present moment awareness. Below is a description of the origin of mindfulness, as well as a discussion of how mindfulness relates to automatic processing.

Mindfulness Definition and Origin

Mindfulness has been defined as paying attention in a particular way: on purpose, in the present moment, and non-judgementally (Kabat-Zinn, 1994). Mindfulness originates from the teachings of the Buddha who lived in North-East India over 2,500 years ago (Cantwell, 2010). The Buddha observed that suffering is a universal phenomenon that arises from the quality of impermanence, a condition that afflicts all forms of existence (Biddulph & Flynn, 2009). The term Buddha translates as ‘Awakened One’ and refers to one who has awakened fully to the true nature of things, including the quality of impermanence, and has therefore liberated himself from all forms of suffering (Williams & Tribe, 2000). The Buddha proposed a system of practices, including mindfulness meditation, in order to teach his disciples how they could also achieve liberation from suffering. The teachings of the Buddha are preserved in the Pāli Canon which is the collection of texts regarded as ‘Word of the Buddha’ by the

Theravāda School of Buddhism (Bodhi, 2005). The Pāli Canon acquired its named because scriptures of the early Buddhist teachings were written in Pāli, an ancient Indian language mainly spoken in Northern India (Cantwell, 2010). The Pāli word for mindfulness is *Sati*, which literally translates to English as 'remembrance' (Brazier, 2013). The role of mindfulness in achieving liberation from suffering is clearly explained by Thanissaro Bhikkhu (2000, p. 2) who states, 'Awakening is like a mountain on the horizon, the destination to which you are driving a car. Mindfulness is what motivates you to keep your attention on the road to the mountain, rather than letting it get focused on glimpses of the mountain or get distracted by other paths leading away from the road'.

The Practice of Mindfulness

The fullest explanation of mindfulness practice is provided in the Buddhist text known as the Satipatthana Sutta, which is translated in English as 'Scripture of the Foundations of Mindfulness'. According to this text, there are four foundations of mindfulness which are (1) the body in and of itself; (2) feelings in and of themselves; (3) the mind in and of itself; and (4) mental qualities in and of themselves (Bhikkhu, 2000). The term 'in and of itself' refers to viewing each foundation in its own terms as opposed to its function in the context of the world (Bhikkhu, 2000); for example, focusing on the direct experience of the body, such as the experience of the breath, rather than the aesthetic components. Mindfulness is usually cultivated during meditation practice, where time is set aside to intentionally develop a mindful awareness of the present moment. Mindfulness practice initially involves cultivating awareness of the body including the sensations of sight, sound, odour, taste, and touch, where each experience is recognized as being either pleasant, unpleasant, or neutral (Biddulph & Flynn, 2009). This is then extended to emotional states of mind, ultimately leading to a comprehensive understanding of the workings of the mind and the ability to distinguish between the nature of the mind and the heart (Biddulph & Flynn, 2009). The purpose of mindfulness meditation is eloquently put by Jon Kabat-Zinn (2015, p. 1482) who states 'meditation is all about … the systematic and intentional cultivation of mindful presence, and through it, of wisdom, compassion, and other qualities of mind and heart conducive to breaking free from the fetters of our own persistent blind-ness and delusions'.

Mindfulness and Automaticity

Automatic processes play an important role in everyday life by allowing individuals to complete various tasks with relatively little attention or effort. This increases the availability of cognitive resources which can then be allocated to tasks that are more effortful and require conscious processes; for example, a decision that involves identifying and weighing up the relative contribution and importance of several different factors. However, automatic processes can also lead to judgements, decisions and behaviours that are detrimental to health, such as the consumption of unhealthy foods as a way of coping with stress. Consequently, it is important to find ways of reducing or eliminating automatic processes that may have significant implications for the individual if they are not addressed. According to Kang et al. (2013), one way of reducing the influence of automatic processes is through the cultivation of mindfulness by engaging in regular meditation practice. They argue that the conscious awareness required to achieve and maintain a mindful state, conflicts with the automatic processes that unconsciously influence judgements, decisions, and behaviours.

This is supported by a study which examined the effect of eight weekly mindfulness sessions to reduce negative automatic thinking (Frewen et al., 2008). Each session lasted 120-150 minutes and included instruction and in-session practice of mindfulness meditation, yoga, and psychoeducation; the psychoeducation component involved discussing one of the seven principles of mindfulness: acceptance, non-judging, non-striving, beginner's mind, letting go, patience, and trust. Participants were also given exercises to do in-between the sessions which involved sitting meditation and/or yoga, as well as exercises based on cognitive therapy that promoted an understanding of the practicality of mindfulness as a means of coping with daily life stress. Prior to the intervention, the authors found that trait mindfulness was negatively correlated with frequency of negative automatic thoughts, and positively related to the ease with which individuals were able to let go of these negative thoughts. However, completion of the mindfulness intervention was found to mirror these findings, reducing the frequency of negative automatic thoughts and increasing the ability to let go of these thoughts. Consequently, this provides initial support for the theory that mindfulness may be an effective approach to reducing the negative effect of automatic processes on judgements, decision, and behaviour. However, it is important to acknowledge the lack of a control group which reduces the internal validity of the study. Therefore, further research is required to provide strong evidence for the negative association between mindfulness and automatic processing.

1.5 The Present Thesis

The Aims of the Present Thesis

Based on recent research evidence, it is likely that prime stimuli unconsciously influence the eating and drinking behaviour of individuals on a daily basis. Therefore, the first aim of this thesis is to increase the present understanding of this phenomenon by conducting a systematic review of studies that examine this effect. Specifically, this review aims to identify those conditions under which priming effects appear stronger and more persistent. Secondly, this thesis aims to examine whether food logos can also prime eating and drinking behaviour and whether any effects found are comparable to those found after exposure to other types of prime stimuli. Thirdly, the role of mindfulness will be examined by testing whether mindfulness moderates the effect of prime stimuli on snack choice by reducing the influence of automatic processes and increasing the influence of conscious processes. Furthermore, an empirical study will be conducted to determine whether a mindfulness exercise can improve cognitive reflection and reasoning by reducing the influence of automatic processes on decision making.

Chapter Two:
A Systematic Review Examining The Effect of Priming on The Choice and Intake of Foods and Beverages

Abstract

The overall aim of this systematic review was to determine the effect of priming on the choice and intake of foods and beverages in children and adults. Specifically, the review analysed experimental studies that compared a prime condition with a control or standard comparison. As previous research has found both significant and non-significant effects of priming on eating and drinking behaviour, it is important to explicate the present state of the field in terms of the variety of priming tasks utilized, the specific foods and beverages measured, and the contexts in which priming has been examined. This will give insight into the effectiveness of different priming tasks and the conditions that favour significant priming effects. Since the introduction of the term priming, much research has focused on exploring the boundaries of this phenomenon including the types of stimuli that can prime a response and the types of responses that can be primed. The diversity of primes and responses discovered means that many proposed definitions of priming are fairly general and indefinite. For example, Molden (2014, p. 5) generally describes priming as 'facilitative effects of some event or action on subsequent associated responses'. Based on this definition, it is not possible to distinguish between those stimuli that merely activate a mental concept in memory and those that recruit additional cognitive processes. This is important as stimuli that activate additional cognitive processes, such as stimuli that consciously influence decision making (i.e. incentives), influence behaviour through mechanisms that are not involved in priming. Therefore, the first stage of this review involved developing a more precise, operational definition of priming in order to identify relevant studies. The section below considers the distinguishing features of priming and integrates these features to form an operational definition for this review.

2.1 Introduction

How to Define Priming

There are many potential primes in the social environment, assuming the stimulus in question has meaning to the perceiver. Although it is important to develop a definition that captures the diversity of prime stimuli in the social environment, it is also essential to recognise those stimuli that go beyond simply activating a mental concept in memory. Different types of stimuli and situations will be discussed below with a particular emphasis on how they differ from the stimuli and effects that are involved in priming.

Familiarity

In order for a stimulus to be considered a prime, the perceiver must have a corresponding mental concept of the stimulus stored in memory. More specifically, the *content* of the stimulus must be familiar to the individual through knowledge of the concept that it represents. Therefore, even though a stimulus may not have been perceived in the same form previously, it can still influence judgements, decisions, and behaviour providing the concept it represents is familiar. For example, as long as an individual is familiar with the concept of thinness, exposure to the Giacometti sculptures will activate this concept, even if the sculptures themselves are unfamiliar. Furthermore, Bargh (2016) argues that presenting new information involves learning rather than the passive activation of stored knowledge (Bargh, 2016). Consequently, presenting a stimulus with an unfamiliar concept (new information) will not lead to priming effects as there is no corresponding mental concept in memory to be activated.

Explicit Task Instruction

Explicit task instructions openly direct the individual to think, feel, or behave in a certain way (Bargh, 2016). Consequently, the individual has an intention to think, feel, or behave in the way directed by the stimulus and is aware of how the stimulus is influencing judgements, decisions, and behaviour. For example, the sentence ‘consume five portions of fruits and vegetables per day’ explicitly encourages the consumption of fruits and vegetables, meaning that any effect of the sentence on subsequent food choice or intake is likely to be consciously recognised by the individual. As stated by Bargh (2016), having an awareness of how the stimulus is influencing judgements, decisions, and behaviour eliminates the passive effects

required for priming. However, presenting the words ‘fruits’ and ‘vegetables’ gives no direct instruction to the individual, although the processes involved in perceiving these words would automatically activate the corresponding mental concept in memory.

Explicit Promotion

Explicit promotion refers to any stimulus that promotes the positive attributes and/or benefits of a product in order to encourage selection of that product in the future; for example, stating the real and/or hypothetical benefits of the product such as the health benefits and/or feelings of happiness. Therefore, a stimulus that explicitly promotes a food or beverage product (e.g. a food or drink that is promoted as being high in protein) is not considered a prime as the individual will be aware that the stated benefit(s) has led to selection of the promoted product. However, the stimulus may be promotional in nature and still be considered a prime, as long as the stimulus does not promote a product and/or behaviour that forms part or all of the outcome measure. For example, a flyer that includes the words ‘healthy’ in reference to a sports beverage, as long as the sports beverage is not part of the outcome measure.

Incentives

It is also important that the stimulus does not encourage a specific response or make a specific response appear more favourable over alternative responses; this is considered an incentive which is described as the provision of an offer or reward in order to motivate an individual to take a specific course of action (Harré & Lamb, 1983). For example, the influence of price on food and beverage choice has led many food companies to utilize price promotions to increase the sales of certain products (Hawkes, 2009). Food companies also offer the chance to win free prizes and exclusive experiences with certain promotional packs (Cadbury FC, n.d.). The explicit nature of incentives means that the individual will be aware that they have selected a product(s) due to the reward on offer. Consequently, any stimulus that makes a specific response favourable over alternative responses is considered an incentive rather than a prime.

Packaging

The packaging of a product often influences decision making through the process of sensation transference where the sensory attributes of the packaging are transferred to the experience of the product itself (Spence, 2012). Therefore, altering the packaging may influence the expectations of a product and how it is subsequently experienced; for example,

research has found that the colour of packaging is associated with the perception of various attributes related to quality, including the flavour and nutritional value of a product (Silayoi & Speece, 2005). Furthermore, packaging may be even more important for low involvement products – products that are fairly low risk and require less cognitive effort to evaluate – as decision making is often founded on relatively unimportant attributes in the absence of more informative criteria (Kardes, 1988). As the packaging directly influences the perception and evaluation of a product, this goes beyond the passive activation of a mental concept and falls outside the confines of priming.

Food Cues

A food cue is encountered when exposure to the sight and/or smell of food has a profound effect on motivation and physiological preparedness to eat (Ferriday & Brunstrom, 2011). Even brief exposure to food cues can initiate a 'cephalic phase response', which refers to anticipatory physiological regulation in response to food and feeding where digestive and metabolic responses prepare the organism to ingest, digest, absorb, and metabolize food (Power & Schulkin, 2008). As this response is experienced consciously as a craving, individuals are often aware of the specific food cue exposure that has led to this acute desire for food (Cornell et al., 1989). Furthermore, research has shown that food cues activate areas of the brain that are associated with reward and reinforcement, including the insula and caudate nucleus (Pelchat et al., 2004). Therefore, the conscious physiological response associated with food cues, along with the rewarding value of subsequent consumption, is sufficient to distinguish the effects of food cues from the effects of priming.

Delayed Effects

One of the most distinguishing features of priming effects is the fact that there may be a substantial delay between exposure to the prime stimulus and the effect on judgements, decisions, or behaviour. In the case of semantic priming – when the prime stimuli and the target are conceptually related – research has shown that mental concepts can remain activated for up to 24 hours following the initial presentation of the prime (Was, 2010). Furthermore, there is evidence that a delay can actually increase the strength of a primed goal which continues to increase until the goal is fulfilled (Förster et al., 2007); goal priming is a type of behavioural priming and occurs when the prime stimuli activates a goal and leads to behaviours that promote goal attainment. Goal priming is also thought to be moderated by equifinality which refers to the fact there may be more than one means of achieving the same

goal; the same prime stimuli may have different effects on behaviour depending on the subsequent contexts encountered (Förster et al., 2007). Consequently, the effects of priming are likely to be quite flexible and varied making it difficult to observe these effects in a real-world setting. However, research has also shown that priming effects can occur during and immediately following exposure to the prime stimuli, meaning that delayed effects can only be used to identify priming under certain conditions.

Conceptual and Operational Definitions of Priming

Based on the discussion above, the following conceptual definition of priming has been developed: 'The presence of a stimulus which activates a stored mental concept that has an immediate or delayed effect on judgements, decisions, and/or behaviour outside of conscious awareness'. However, for the purpose of this review the following operational definition will be employed: 'The introduction of a simple stimulus that has an immediate or delayed effect on judgements, decisions, and/or behaviour outside of conscious awareness. A simple stimulus refers to any stimulus that does not include explicit instruction or promotion, provide an incentive, and/or present new information in relation to the behaviour of interest'.

Review Summary

The excessive consumption of energy-dense foods is one of the main factors contributing to the ever-rising levels of overweight and obesity. Understanding how the environment influences the choice and intake of different foods and beverages is important for developing strategies to address the present obesity epidemic. As previous research has found both significant and non-significant effects of priming on eating and drinking behaviour (Anschutz et al., 2009; Chiou et al., 2013; Guerrieri et al., 2007; Robinson et al., 2011), this review aimed to clarify how prime stimuli influence the choice and intake of foods and beverages in children and adults. Specifically, the review aimed to examine: (1) whether there was a difference in the priming effects observed by research conducted in the laboratory compared to research conducted in the field; (2) whether certain priming tasks were more likely to result in significant effects; and (3) whether certain variables, such as appetite, were consistently found to moderate priming effects.

2.2 Method

Search Strategy and Screening

The review was registered in the PROSPERO database (registration number: CRD42018073763). The search strategy involved identifying relevant published articles from Academic Search Complete, Business Source Complete, Medline, PsycINFO, SCOPUS and Web of Science. Unpublished articles were identified through studies registered with BASE, Open Grey and PsychFileDrawer. These databases were decided on through discussions with one of the university library consultants with expertise in conducting systematic reviews. Each database was searched individually for relevant articles in March 2018 by SF. Each search included the following search terms to identify studies on priming: prime, priming, concept activation, cue, prompt, advert, advertisement, and branding. To provide an example, Table 2.1 shows the full subject and key word search used in SCOPUS.

Table 2.1

SCOPUS Subject and Key Word Search

Subject	Key Words
Priming	prime OR priming OR "concept activation" OR cue OR prompt OR advert OR advertisement OR branding
Food choice & intake (AND)	(food W/3 choice) OR (food W/3 decision) OR (food W/3 prefer*) OR (food W/3 select*) OR (food W/3 purchase) OR (food W/3 intake) OR (food W/3 consum*) OR (snack W/3 choice) OR (snack W/3 prefer*) OR (snack W/3 select*) OR (snack W/3 purchase) OR (snack W/3 intake) OR (snack W/3 consum*) OR "diet* choice" OR "healthy eating" OR "unhealthy eating" OR "eating behaviour" OR "energy intake"
Beverage choice & intake (AND)	(beverage W/3 choice) OR (beverage W/3 prefer*) OR (beverage W/3 select*) OR (beverage W/3 purchase) OR (beverage W/3 intake) OR (beverage W/3 consumption) OR (drink W/3 choice) OR (drink W/3 prefer*) OR (drink W/3 select*) OR (drink W/3 purchase) OR (drink W/3 intake) OR (drink W/3 consumption)
(NOT)	geograph* OR climat* OR agricultur* OR animal OR rats

The results of this search were refined further by limiting the results to English scholarly and academic journal articles published since 1996. The following subject filters were also applied: psychology, social science, decision sciences, neuroscience, economics, econometrics, and finance.

In order to identify articles that may be relevant for the review, the titles and abstracts of all the literature identified were screened by SF and either excluded from the review or subject to full-text screening; another researcher (Katy Tapper) also screened 10% of all the literature identified, as well as 10% of the articles subject to full-text screening to ensure the eligibility criteria had been applied consistently. These articles were selected randomly through random.org and there were no disagreements regarding the final articles selected by both researchers. The reference lists of all relevant articles identified were then manually searched by SF for any further research that met the eligibility criteria. Finally, the main authors of all relevant articles were emailed to inquire about any other published or unpublished work that may be eligible for the review.

Study Selection

The eligibility criteria limited study selection to published and unpublished articles written in English and conducted during or after 1996; this date was selected as studies conducted before 1996 precede the first experimental studies to demonstrate behavioural priming effects. Studies were included if they recruited children and/or adults as subjects and compared an experimental condition with a control or standard comparison. Studies must have examined the effect of auditory, olfactory, or visual primes on the choice or intake of foods or beverages, although the outcome measure taken could be real or hypothetical. The primes could be presented at a subliminal or supraliminal level, as long as an awareness check was administered to confirm participants were unaware of the link between the prime stimuli and the outcome measure. The only exception to these criteria were subliminal primes presented for 15 milliseconds or less which were assumed to remain outside of conscious awareness when followed by a backward mask. Subliminal primes presented for longer than 15 milliseconds must have included a subliminality check, either through a free recall task or a recognition task. Studies that presented supraliminal primes must have included a funnelled debrief either after the outcome measure or at the end of the study; this was to ensure participants were unaware of the aims of the study or the potential effect of the prime stimuli on behaviour. It was assumed that no-one was suspicious of the study aims if the results of

the funnelled debrief were not reported. The exclusion criteria stated that studies measuring non-behavioural outcomes such as attitude, liking, intention, or preference would be excluded from the review, as were studies conducted on participants with eating disorders or neurodegenerative diseases. Conference abstracts and papers were also excluded.

Data Extraction

The data was extracted from each article by SF using the guiding principles shown in Table 2.2. Although the BMI and dieting status of participants was initially part of the data to be extracted, this was not recorded by the majority of studies. Another researcher (Katy Tapper) also extracted data from 10% of the articles to ensure consistency across the data extraction (the articles checked were selected randomly through random.org). There were no discrepancies regarding the data extracted by both researchers. The authors of relevant studies were contacted to resolve ambiguities in the study procedure and to obtain missing or incomplete data.

Table 2.2

The Data Extracted and the Guiding Principles Employed

Data extracted	Guiding principles employed
Study reference	Full study reference
Study aims	Whether the study aimed to increase or decrease food/beverage choice or intake
Study design	Whether the study had a between or within-subjects design
Study setting	Whether the study was field-based, laboratory-based, or conducted online
Randomization method	Whether the participants were randomly allocated to each condition (yes/no) and the randomization method used
Sample characteristics (after exclusions)	Population recruited (adults/students/children); sample size; mean age; percentage of females
Prime characteristics	The type of prime utilized (auditory/olfactory/visual); level of awareness (subliminal/supraliminal); the specific task utilized
Outcome measure	The outcome measure (food/beverage choice or intake); the specific foods or beverages measured; whether the outcome was hypothetical or real; how the outcome was assessed (milliliters/grams/pieces)
Interval[a]	The time between exposure to the prime and the outcome measure (simultaneous/immediate/brief/moderate/long)
Standardized appetite	Whether appetite/thirst was standardized across participants or a measure of hunger/thirst was taken (yes/no)
Social setting	Whether the outcome measure took place in the presence of others including the experimenter (yes/no)
Extent of debrief	The number of questions included in the debrief
Study results	The log odds ratio and 95% confidence intervals for studies measuring food/beverage choice; the mean, standard deviation and number of participants in each condition for studies measuring food/beverage intake
Source of funding	The source of funding.
Conflicts of interest	Whether there were any conflicts of interest

[a]Simultaneous: outcome measured during the prime exposure; immediate: outcome measured immediately (milliseconds) after the prime exposure; brief: outcome measured within 5 minutes of the prime exposure; moderate: outcome measured between 5 and 60 minutes after the prime exposure; long: outcome measured more than 60 minutes after the prime exposure.

Quality Assessment

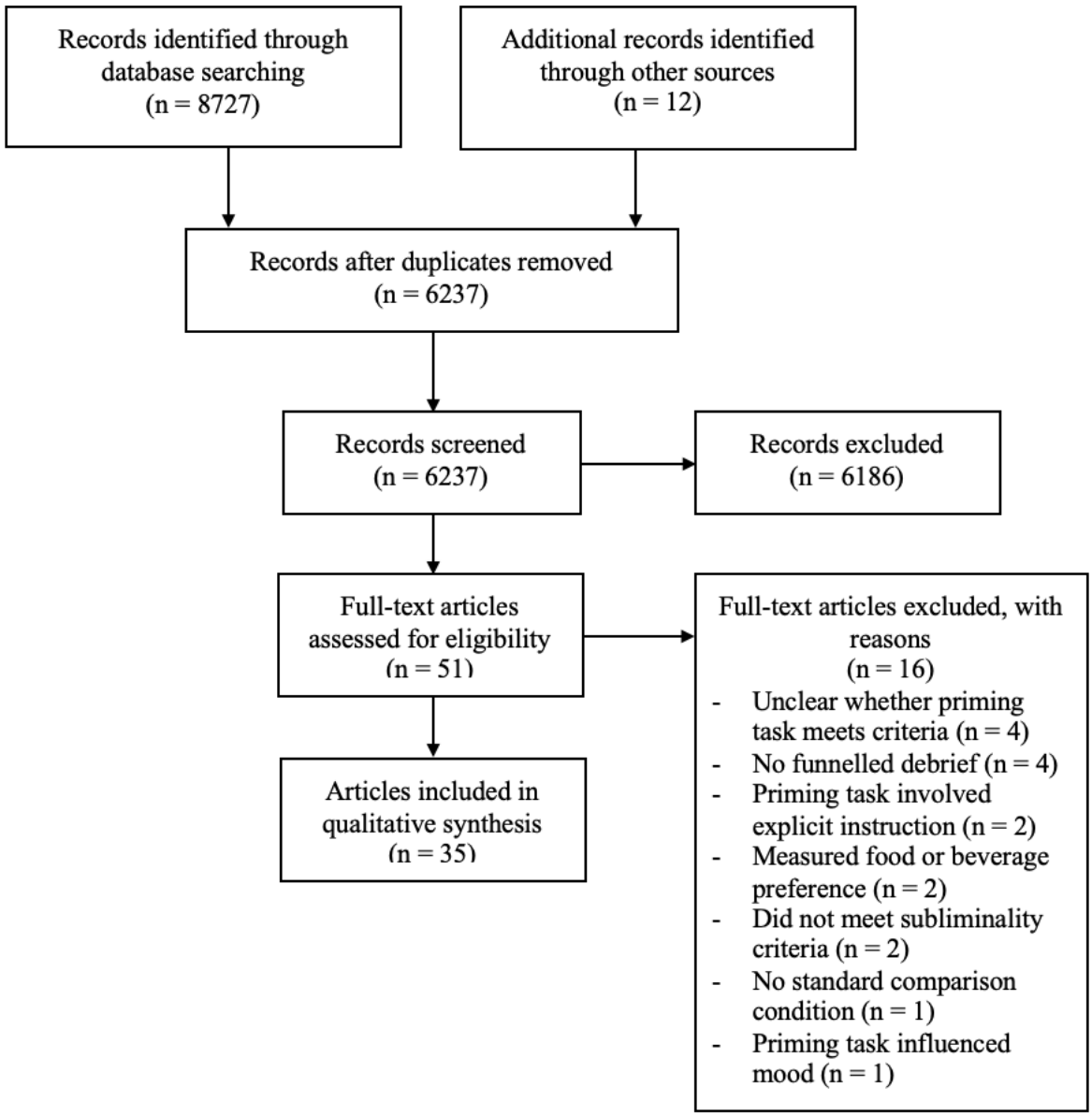
The quality of all relevant studies was determined by SF using the Cochrane Risk of Bias Tool. This assessment tool was selected as it specifically focuses on aspects of research that relate to internal validity, allowing for a comprehensive assessment of the extent to which the results are reliable. Studies were assessed on the following components: random sequence generation, allocation concealment (experimenters), selective reporting, blinding of participants, blinding of the outcome assessment, and incomplete outcome data. Selective reporting was assessed by comparing the outcomes reported in the article with the outcomes specified in the study pre-registration. Both the Centre for Open Science and the Open Science Framework were searched for the study if pre-registration was not explicitly stated in the article; selective reporting was recorded as unclear for studies that were not found on either platform. Blinding of participants was assessed based on whether the study included a cover story to conceal the aims of the study; studies that included a cover study were assessed as low risk whereas studies with no cover story were assessed as high risk. Blinding of the outcome was assessed on whether the outcome being measured was objective or subjective and the awareness of the assessor. Where the outcome was objective (i.e. intake was measured with a scale) the study was recorded as low risk; where the outcome was subjective (i.e. hypothetical) and the assessor may have been aware of the intervention, the study was recorded as high risk. Incomplete outcome data was assessed by comparing the number of participants reported in the method section (after exclusions) with the number of participants included in the relevant data analysis; this was determined using the participant degrees of freedom reported in the results section. Studies that had between one and five participants missing from the data analysis were recorded as medium risk and studies that had more than five participants missing were recorded as high risk. The risk of potential confounding bias was also assessed by recording (1) whether the studies included a procedure to standardize appetite or took a measure of appetite during the study; (2) whether the participants were alone during the choice or intake task; and (3) whether the choice or intake task was hypothetical. Any uncertainty regarding the quality of a study was addressed by discussing the study with another researcher (Katy Tapper).

2.3 Results

The stages of the systematic review are summarised in Figure 2.1. The initial database search yielded a total of 8,727 articles, with a further 12 articles found through other sources. After duplicates were removed, a total of 6,237 articles were subject to title and abstract review. The majority of these were excluded for one of two reasons: either they did not conform to the definition of priming as defined for this review or they did not measure the effect of priming on eating or drinking behaviour. The full texts of the remaining 51 articles were reviewed, with 35 articles meeting the eligibility criteria stated above. Four of the excluded articles did not describe the priming task in sufficient detail to determine whether the study conformed to the definition of priming developed for this review. Further information regarding the nature of the priming tasks was requested from the authors but could not be obtained. Another four articles were excluded as there was no funnelled debrief to ensure participants were unaware of the aims of the study or the potential effect of the prime on behaviour. The reasons for excluding the remaining eight articles are shown in Figure 2.1.

Figure 2.1

A Flow Diagram Showing the Stages of the Systematic Review



Participant Characteristics

The characteristics of the 41 studies eligible for the review are shown in Table 2.7. The participant characteristics reported are the statistics for the final samples, after exclusions were removed, as it was considered more important to report the characteristics of the participants that contributed to the effects found. The final sample size varied greatly across studies with the smallest sample being 26 (29) and the largest being 149 (3); however, this

statistic was not reported by five studies (7, 14, 15, 17, 30). The mean age of the participants also varied greatly from 19 years (9) to 54 years (21) with a mean of 25 years across the 20 studies that reported this statistic (1-4, 6, 9, 10, 19, 21-23, 25, 26, 33-35, 37, 38, 40, 41); the remaining 21 studies reported the mean age for the entire sample, before exclusions were removed. The proportion of females taking part ranged from 0% to 100% with the proportion of females not reported by nine studies (5, 11, 14, 15, 17, 18, 24, 36, 39). Three studies only recruited male participants (7, 27, 33) whereas 13 studies only recruited female participants (1, 2, 4, 8-10, 19, 29-32, 34, 38). The remaining 16 studies recruited both males and females although the majority had a higher proportion of females with an average of 63%.

Study Characteristics

The publication dates of all 41 studies had a range of 20 years, from 1998 to 2018. All studies utilised a between-subjects design except for one which utilised a within-subjects design (9). Five studies conducted field research (8, 16, 21-23) while the remaining 36 studies were conducted in a laboratory. The majority of the studies presented the primes at a supraliminal level with just nine studies presenting the primes at a subliminal level (12, 13, 19, 28, 33, 34, 37, 38, 40). A total of 22 different priming tasks were employed across the studies which were classified according to whether the participants were primed with words or with an object or image; two studies were classified as 'other' as one exposed participants to a female fertility pheromone (33) and another exposed participants to a male sex pheromone (34).

Overall, 24 studies used exposure to specific words as prime stimuli (3, 6, 7, 9, 11-19, 21-24, 27, 28, 35, 37-39, 41) and the remaining 15 studies used exposure to specific objects or images. The methods used to present the word primes included a word search (3, 18, 24), modified stroop task (6), scrambled sentence task (7, 9, 11, 14, 15), visual detection task (12, 13, 37), poster or flyer (16, 21, 39), lexical decision task (17, 28), tachistoscope (19, 38), memory test (22, 23), synonym generation task (27, 41), and a banner displayed on a computer screen (35). The methods used to present the object and image primes included a short film (1), television adverts (2, 29-32), presence of a body weight scale (4), Giacometti sculptures applied as a computer screensaver (5, 25, 26), colouring different sized scale labels (8), an overweight confederate (10), using a 'cute' (versus a standard) ice cream scoop (20), presence of a mirror (36), and a gender classification task (40). There was also variation within the different priming tasks; for example, two of the word search tasks presented seven prime words and six neutral words (3, 18), whereas another presented ten prime words and no

neutral words (24). A variety of different concepts were primed with the following concepts primed on more than one occasion: thinness (2, 5, 10, 25, 26, 29-32), health (3, 11, 17, 21, 35, 39), Lipton Ice (12, 13, 37), overweight (1, 2), positive expectancy (6, 27), happy (19, 40), angry (19, 40), and high status (22, 23). However, the concepts that were only primed on a single occasion included: weight (4), masculinity (7), goal progress (8), impulsivity (9), self-control (14), spending (15), saving (15), environmental harshness (16), achievement (18), hunger (19), loneliness (19), cuteness (20), social acceptance (24), thirst (28), the self (36), physical threat (38), ego threat (38), positive affect (41), and negative affect (41).

The Effect of Priming on Food and Beverage Choice

Overall, 5 of the 12 studies that measured food or beverage choice reported a significant main effect of priming (7, 8, 13, 17, 35), while three studies reported no main effect of priming (12, 21, 37), and four did not report whether any main effect of priming was found (14, 15, 22, 23). All five of the significant studies reported priming effects in the expected direction, although none of these studies were found to be pre-registered. The mean sample size across the three significant studies that reported this statistic was 86 (8, 13, 35), whereas the mean for the three non-significant studies was 102 (12, 21, 37). Four of the significant studies reported the proportion of females taking part which ranged from 0% to 100%; one study recruited only males (7) and another study recruited only females (8). Two of the significant studies recruited a mixed sample although both had a higher proportion of females with an average of 82% (13, 35). All three of the non-significant studies recruited a mixed sample with the average proportion of females across the three studies at 81% (12, 21, 37). All five significant studies and all three non-significant studies utilised a between-subjects design. Four studies that found a significant effect were conducted in a laboratory (7, 13, 17, 35) while just one was conducted in the field (8). Similarly, two studies that found a non-significant effect were conducted in a laboratory (12, 37) with just one conducted in the field (21). Table 2.3 compares the characteristics of the significant and non-significant studies that measured food or beverage choice.

Table 2.3

Characteristics of Significant and Non-significant Studies Measuring Choice

Characteristic	Significant studies (n = 5)	Non-significant studies (n = 3)
Presentation level		
Subliminal	20% (13)	67% (12, 37)
Supraliminal	80% (7, 8, 17, 35)	33% (21)
Priming task	Scrambled sentence task (7); colouring wide/narrow scale labels (8); visual detection task (13); lexical decision task (17); exposure to a banner (35)	Visual detection task (12, 37); exposure to a flyer (21)
Prime stimuli		
Words	80% (7, 13, 17, 35)	100% (12, 21, 37)
Images	20% (8)	0%
Primed concepts	Masculinity (7); goal progress (8); Lipton Ice (13); health (17, 35)	Lipton Ice (12, 37); health (21)
Food or beverage choice[a]	Red bull or mineral water (7); chocolate bar or apple (8); Lipton Ice or mineral water (13) granola bar, SunChips or potato chips (17)	Lipton Ice or mineral water (12, 37); various unhealthy snacks (21)
Food or beverage taste[a]		
Sweet	20% (8)	0%
Savoury	0%	0%
Both	60% (7, 13, 17)	100% (12, 21, 37)
Food or beverage healthiness[ab]		
Healthy	40% (7, 13)	67% (12, 37)
Unhealthy	20% (17)	0%
Both	20% (8)	33% (21)
Choice task		
Real	60% (7, 8, 17)	33% (21)
Hypothetical	40% (13, 35)	67% (12, 37)
Interval[cd]		
Simultaneous	20% (35)	0%
Immediate (msec)	0%	0%
Brief (< 5 minutes)	60% (7, 13, 17)	100% (12, 21, 37)

[a]Not reported by one significant study (35)
[b]Based on the National Health Service guidelines for reference intakes (NHS, n.d.)
[c]Not reported by one significant study (8)
[d]The time between exposure to the prime and the outcome measure.

Quality Assessment for Food and Beverage Choice Studies

The results of the quality assessment for the choice studies using the Cochrane Risk of Bias Tool are shown in Table 2.4. Although three significant studies (7, 13, 35) and two non-significant studies (12, 37) explicitly stated that the participants had been randomly allocated to conditions, none reported how the random sequence had been generated. Therefore, all of these studies were assessed as unclear for random sequence generation. Furthermore, one non-significant study which recorded the units of unhealthy snacks purchased at a supermarket was assessed as unclear for blinding of the outcome assessment (21); the authors did not specify what was classified as one unit or what criteria was used to categorise the foods as unhealthy.

Table 2.4

Risk of Bias for Significant and Non-significant Studies Measuring Choice

Risk of bias	Significant studies (n = 5)	Non-significant studies (n = 3)
Random sequence generation		
Low risk	0%	0%
High risk	0%	33% (21)
Unclear	100% (7, 8, 13, 17, 35)	67% (12, 37)
Allocation concealment (experimenters)		
Low risk	0%	0%
High risk	0%	0%
Unclear	100% (7, 8, 13, 17, 35)	100% (12, 21, 37)
Selective reporting[a]		
Low risk	0%	0%
High risk	0%	0%
Unclear	100% (7, 8, 13, 17, 35)	100% (12, 21, 37)
Blinding of participants (cover story)		
Low risk	80% (7, 8, 13, 17)	100% (12, 21, 37)
High risk	0%	0%
Unclear	20% (35)	0%
Blinding of the outcome assessment		
Low risk	100% (7, 8, 13, 17, 35)	67% (12, 37)
High risk	0%	0%
Unclear	0%	33% (21)
Incomplete outcome data		
Low risk	60% (13, 17, 35)	100% (12, 21, 37)
High risk	0%	0%
Unclear	40% (7, 8)	0%
Standardized appetite		
Low risk	40% (13, 35)	100% (12, 21, 37)
High risk	60% (7, 8, 17)	0%
Unclear	0%	0%
Presence of others		
Low risk	20% (13)	33% (12)
High risk	0%	33% (21)
Unclear	80% (7, 8, 17, 35)	33% (37)
Real or hypothetical choice		
Low risk	60% (7, 8, 17)	33% (21)
High risk	40% (13, 35)	67% (12, 37)
Unclear	0%	0%

[a]No pre-registrations were stated in any of the articles or found in the Centre for Open Science or Open Science Framework databases.

Moderation Effects

Four studies reported a significant interaction effect where two studies reported appetite as a significant moderating variable (12, 13), one reported BMI as a significant moderating variable (21), and one reported a significant three-way interaction between the prime condition, thirst and habit (37). Only one of the four studies reported a significant main effect of priming on choice (13), whereas the remaining three studies found no main effect of priming on choice (12, 21, 37). All the interaction effects observed were expected by the authors; none of the interactions were exploratory in nature. More specifically, the results showed that an increase in appetite increased the priming effects found as participants who had higher levels of thirst were more likely to select the primed beverage (12, 13). It was also found that having a higher BMI increased the effect of a health prime; overweight and obese participants purchased fewer unhealthy snacks than normal weight participants after being primed with phrases related to health (21). Lastly, participants who were primed with 'Lipton Ice' and who also had higher levels of thirst and a stronger habit toward mineral water were more likely to select Lipton Ice during a subsequent choice task (37).

The Effect of Priming on Food and Beverage Intake

Overall, 16 of the 29 studies measuring food or beverage intake found a significant main effect of priming (5, 6, 11, 19, 24-30, 32-34, 39, 41), eight found no main effect of priming (2, 9, 10, 18, 20, 31, 36, 40), and five did not state whether any main effect of priming was found (1, 3, 4, 16, 38). A total of 14 significant studies reported priming effects in the expected direction (5, 6, 11, 19, 24, 27-30, 32-34, 39, 41) while two studies did not state any specific directional hypothesis regarding priming effects (25, 26). None of the 16 studies that found a significant priming effect were pre-registered. The sample size was reported by all but one of the significant studies with a mean sample size of 82; the mean sample size of the eight non-significant studies was 73 (2, 9, 10, 18, 20, 31, 36, 40). The proportion of females taking part in the significant studies ranged from 0% to 100%; two studies recruited only males (27, 33) and five studies recruited only females (19, 29, 30, 32, 34). Another five significant studies recruited both males and females although most had a higher proportion of females with an average of 61% (6, 25, 26, 28, 41), while four studies failed to report the proportion of females recruited (5, 11, 24, 39). A total of four non-significant studies only recruited female participants (2, 9, 10, 31), while two recruited a mixed sample (20, 40); the average proportion of females was 50% across both studies. The remaining two non-significant studies did not report the proportion of females recruited (18, 36). Sixteen

significant studies and seven non-significant studies utilised a between-subjects design with just one non-significant study utilising a within-subjects design (9). All the significant and non-significant studies were conducted in a laboratory. Table 2.5 compares the characteristics of the significant and non-significant studies that measured food or beverage intake.

Table 2.5

Characteristics of Significant and Non-significant Studies Measuring Intake

Characteristic[a]	Significant studies (n = 16)	Non-significant studies (n = 8)
Presentation level		
Subliminal	25% (19, 28, 33, 34)	12% (40)
Supraliminal	75% (5, 6, 11, 24-27, 29, 30, 32, 39, 41)	88% (2, 9, 10, 18, 20, 31, 36)
Priming task	Giacometti sculptures screensaver (5, 25, 26); modified Stroop task (6); scrambled sentence task (11); tachistoscope (19); word search task (24); synonym generation task (27, 41); lexical decision task (28); television adverts (29, 30, 32); exposure to pheromones (33, 34); exposure to a poster (39)	Television adverts (2, 31); scrambled sentence task (9); slim confederate (10); word search task (18); using 'cute' ice cream scoop (20); exposure to a mirror (36); gender classification task (40)
Prime stimuli		
Words	44% (6, 11, 19, 24, 27, 28, 41)	37% (9, 18, 40)
Images	44% (5, 25, 26, 29, 30, 32, 39)	63% (2, 10, 20, 31, 36)
Other	12% (33, 34)	0%
Primed concepts[b]	Thinness (5, 25, 26, 29, 30, 32); positive expectancy (6, 27); health (11, 39); lonely (19); social acceptance (24); thirst (28); and negative affect (41)	Thinness (2, 10, 31); impulsivity (9); achievement (18); cuteness (20); the self (36); happy (40); angry (40)
Foods consumed	Chocolate (5, 26); mini cheddars (19); Butterkist toffee popcorn (24); Pringles (25); blueberries (26); popcorn (29, 30, 32); pretzels (29, 30, 32); whole-wheat crackers (29, 30, 32); Ritz crackers (29, 30, 32); cookies (39)	M&Ms (2, 10, 36); crisps (2); cookies (18); vanilla ice cream (20); popcorn (31); pretzels (31); whole-wheat crackers (31); Ritz crackers (31);
Beverages consumed	Non-alcoholic beer (6, 33, 34, 41); vinegar health tonic (11); beer (27); Kool-Aid (28).	Strawberry milkshake (9); Kool-Aid (40)
Food or beverage taste		
Sweet	31% (5, 24, 26, 28, 39)	76% (9, 10, 18, 20, 36, 40)
Savoury	69% (6, 11, 19, 25, 27, 29, 30, 32-34, 41)	12% (31)
Both	0%	12% (2)

Table 2.5

Characteristics of Significant and Non-significant Studies Measuring Intake (continued)

Characteristic[a]	Significant studies (n = 16)	Non-significant studies (n = 8)
Food or beverage healthiness[cd]		
Healthy	38% (6, 11, 27, 33, 34, 41)	0%
Unhealthy	31% (5, 19, 24, 25, 39)	76% (2, 9, 10, 18, 20, 36)
Both	25% (26, 29, 30, 32)	12% (31)
Choice task		
Real	100% (5, 6, 11, 19, 24-30, 32-34, 39, 41)	100% (2, 9, 10, 18, 20, 31, 36, 40)
Hypothetical	0%	0%
Interval[e]		
Simultaneous	6% (5)	25% (2, 10)
Immediate (msec)	56% (6, 11, 19, 24, 25, 26, 28-30)	0%
Brief (< 5 minutes)	0%	50% (9, 20, 31, 40)
Moderate (< 60 minutes)	38% (27, 32-34, 39, 41)	25% (18, 36)

[a]Where both percentages ended in .5 the higher percentage was round up and the lower percentage round down.
[b]Two studies presented olfactory primes (33, 34).
[c]The healthiness of one significant study (28) and one non-significant study (40) could not be determined.
[d]Based on the National Health Service guidelines for reference intakes (NHS, n.d.)
[e]The time between exposure to the prime and the outcome measure.

Quality Assessment for Food and Beverage Intake Studies

The results of the quality assessment for the intake studies using the Cochrane Risk of Bias Tool are shown in Table 2.6. Although eight significant studies (6, 11, 27, 29, 30, 32, 34, 41) and three non-significant studies (2, 10, 20) explicitly stated that the participants had been randomly allocated to conditions, none reported how the random sequence had been generated. One study was assessed as high risk for incomplete outcome data as all 32 participants who did not consume any food were excluded from the final analysis (36). Furthermore, one significant study and two non-significant studies that were assessed as low risk for standardised appetite asked participants to rate their appetite after the food or beverage intake task, which may have reduced the accuracy of these ratings (2, 10, 28).

Table 2.6

Risk of Bias for Significant and Non-significant Studies Measuring Intake

Risk of bias	Significant studies (n = 16)	Non-significant studies (n = 8)
Random sequence generation		
Low risk	0%	0%
High risk	6% (33)	0%
Unclear	94% (5, 6, 11, 19, 24-30, 32, 34, 39, 41)	100% (2, 9, 10, 18, 20, 31, 36, 40)
Allocation concealment (experimenters)		
Low risk	0%	0%
High risk	0%	0%
Unclear	100% (5, 6, 11, 19, 24-30, 32-34, 39, 41)	100% (2, 9, 10, 18, 20, 31, 36, 40)
Selective reporting[a]		
Low risk	0%	0%
High risk	0%	0%
Unclear	100% (5, 6, 11, 19, 24-30, 32-34, 39, 41)	100% (2, 9, 10, 18, 20, 31, 36, 40)
Blinding of participants (cover story)		
Low risk	100% (5, 6, 11, 19, 24-30, 32-34, 39, 41)	100% (2, 9, 10, 18, 20, 31, 36, 40)
High risk	0%	0%
Unclear	0%	0%
Blinding of the outcome assessment		
Low risk	100% (5, 6, 11, 19, 24-30, 32-34, 39, 41)	100% (2, 9, 10, 18, 20, 31, 36, 40)
High risk	0%	0%
Unclear	0%	0%
Incomplete outcome data		
Low risk	94% (5, 6, 11, 19, 24-30, 32, 34, 39, 41)	88% (2, 9, 10, 18, 20, 31, 40)
High risk	0%	12% (36)
Unclear	6% (19)	0%
Standardized appetite		
Low risk	44% (5, 19, 24, 28-30, 32)	88% (2, 9, 10, 20, 31, 36, 40)
High risk	56% (6, 11, 25-27, 33, 34, 39, 41)	6% (18)
Unclear	0%	0%
Presence of others		
Low risk	50% (24, 28-30, 32-34, 39)	50% (2, 10, 31, 40)
High risk	6% (6)	0%
Unclear	44% (5, 11, 19, 25-27, 41)	50% (9, 18, 20, 36)
Real or hypothetical choice		
Low risk	100% (5, 6, 11, 19, 24-30, 32-34, 39, 41)	100% (2, 9, 10, 18, 20, 31, 36, 40)
High risk	0%	0%
Unclear	0%	0%

[a]No pre-registrations were stated in any of the articles or found in the Centre for Open Science or Open Science Framework databases.

Moderation Effects

Ten studies reported a significant interaction effect with two studies reporting restrained eating as a significant moderating variable (1, 26) and one study reporting a significant three-way interaction between the prime condition, anagram difficulty, and restrained eating (18). The remaining seven studies reported the following significant moderating variables: muscle firming (11), message framing (16), liking (25), drinking habits (27), normative information (31), calorie content (36), and appetite (40). Only four of these studies reported a significant main effect of priming on intake (11, 25-27), while four found no main effect of priming on intake (18, 31,36, 40), and two did not state whether any main effect of priming was found (1, 16). Eight of the interaction effects observed were expected by the authors (1, 11, 16, 18, 27, 31, 36, 40) although one of these did not state the expected direction of the interaction effect (40). The remaining two studies did not state that any moderating effects were expected (25, 26). Each of the interactions found is explained in detail below.

One of the studies that reported restrained eating as a moderating variable found that highly restrained eaters consumed more M&Ms and crisps after being primed with the concept of thinness than after being primed with the concept of largeness (1). However, the other study found that highly restrained eaters consumed less blueberries and milk chocolate after being primed with the concept of thinness than after exposure to a neutral image (26). Furthermore, the three-way interaction showed that highly restrained eaters consumed more cookies than low restrained eaters when experiencing goal unfulfillment; this state was induced by priming participants with the concept of achievement and then presenting unsolvable anagrams (18). Muscle firming was found to moderate the effect of health primes on the consumption of an unpalatable health tonic as participants who performed the muscle firming action consumed more of the tonic than participants who performed a control action (11). Message framing was also found to moderate the effect of an environmental harshness prime on food intake as participants in the prime condition consumed more M&Ms when they were labelled as high calorie rather than low calorie (16). Another study showed that liking moderated the effect of a thinness prime on the consumption of Pringles as participants with a high liking of Pringles consumed less after being primed with the concept of thinness than after being exposure to a neutral image (25). Drinking habits was found to moderate the effect of positive expectancy primes on alcohol consumption as heavy drinkers were found to consume more than light drinkers after exposure to the prime stimuli (27). Normative information was also found to act as a moderating variable as intake of savoury snacks was higher for participants who

received normative information compared to those who received no normative information following exposure to primes showing thinness (31). Another study found that calorie content acted as a moderating variable as participants who were exposed to a self-prime and consumed a high calorie milkshake had a higher intake of M&Ms than participants who were exposed to a self-prime and consumed a low calorie milkshake (36). Lastly, thirst influenced the effect of a happy prime on intake of Kool-Aid as participants with higher levels of thirst consumed more than participants with lower levels of thirst (40). However, the same study also found that the moderating effect reversed when participants were presented with an angry prime as participants with low levels of thirst consumed more Kool-Aid than participants with high levels of thirst (40).

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
1	Anschutz (2008)	Between-subjects; Laboratory study; Randomized: NR N = 104; Mean age: 21; Females: 100%	Prime: supraliminal exposure to overweight actresses through showing a film on a wide screen (16:9). Control: supraliminal exposure to thin actresses through showing a film on a standard screen (4:3).	Restrained eating	M&Ms; crisps	Real intake during prime exposure (simultaneous).	Main effect of condition on food intake not reported. Significant condition x restrained eating interaction where high restrained eaters consumed more in the control (thin) condition than in the prime (large) condition.
2	Anschutz (2009)	Between-subjects; Laboratory study; Randomized: Yes N = 110; Mean age: 20; Females: 100%	Prime one: supraliminal exposure to two television adverts showing slightly overweight models and eight neutral adverts. Prime two: supraliminal exposure to two television adverts showing thin models and eight neutral adverts. Control: supraliminal exposure to ten neutral television adverts.	Restrained eating; thin ideal internalization	M&Ms; crisps	Real intake during prime exposure (simultaneous).	No main effect of condition found when comparing the prime conditions with the control condition.
3	Boland (2013); study two	Between-subjects; Laboratory study; Randomized: Yes N = 149; Mean age: 20; Females: 54%	Prime one: supraliminal exposure to seven health-related words and six neutral words through a word search task. Prime two: supraliminal exposure to seven indulgence-related words and six neutral words through a word search task. Control: supraliminal exposure to thirteen neutral words through a word search task.	Time of day	M&Ms	Real intake after a brief interval.	Main effect of condition on food intake not reported.
4	Brunner (2010); study one	Between-subjects; Laboratory study; Randomized: Yes N = 54; Mean age: 21; Females: 100%	Prime: supraliminal exposure to a body-weight scale present in the laboratory. Control: the absence of a body-weight scale in the laboratory.	Confederate intake	Chocolate	Real intake during prime exposure (simultaneous)	Main effect of condition on food intake not reported.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
5	Brunner (2012); study one	Between-subjects; Laboratory study; Randomized: NR N = 95; Mean age: NR; Females: NR	Prime: supraliminal exposure to images of Giacometti sculptures applied as a screensaver. Control: supraliminal exposure to a Rothko painting applied as a screensaver.	None	Chocolate	Real intake during prime exposure (simultaneous)	Food intake was significantly lower in the prime condition than the control condition.
6	Carter (1998)	Between-subjects; Laboratory study; Randomized: Yes N = 64; Mean age: 20; Females: 59%	Prime one: supraliminal exposure to seven positive expectancy words, each presented three times through a modified stroop task. Prime two: supraliminal exposure to seven negative expectancy words, each presented three times through a modified stroop task. Control: supraliminal exposure to seven neutral words, each presented three times through a modified stroop task.	None	Non-alcoholic beer	Real intake after a brief interval.	Beverage intake was significantly higher in the positive prime condition and significantly lower in the negative prime condition than in the control condition. The results were calculated by dividing intake by weight.
7	Chiou (2013); Study one	Between-subjects; Laboratory study; Randomized: NR N = NR; Mean age: NR Females: 0%	Prime: supraliminal exposure to six masculine-related words and six gender-neutral attributes through a scrambled sentence task. Control: supraliminal exposure to twelve gender-neutral attributes through a scrambled sentence task.	None	Red Bull; Perrier mineral water	Real choice after a brief interval.	The prime condition were significantly more likely to select Red Bull than the control condition.
8	Fishbach (2005)	Between-subjects; Field study; Randomized: NR N = 45; Mean age: NR Females: 100%	Prime: supraliminal exposure to wide scale labels (+/- 25lbs). Control: supraliminal exposure to narrow scale labels (+/- 5lbs).	None	Chocolate bar; apple	Real choice. Length of interval is unclear.	The prime condition were significantly more likely to select a chocolate bar than the control condition.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
9	Guerrieri (2007)	Within-subjects; Laboratory study; Randomized: NR N = 38; Mean age: 19; Females: 100%	Prime: supraliminal exposure to fifteen impulsivity-related words and ten neutral words through a scrambled sentence task. Control: supraliminal exposure to twenty-five neutral words through a scrambled sentence task	Trait impulsivity	Strawberry milkshake	Real intake after a brief interval.	No main effect of condition found.
10	Hermans (2008)	Between-subjects; Laboratory study; Randomized: Yes N = 102; Mean age: 21; Females: 100%	Prime: supraliminal exposure to a slim confederate. Control: supraliminal exposure to a normal-weight confederate.	Confederate intake	M&Ms	Real intake during prime exposure (simultaneous)	No main effect of condition found.
11	Hung (2011); study three	Between-subjects; Laboratory study; Randomized: Yes N = 91; Mean age: NR; Females: NR	Prime: supraliminal exposure to eight health-related sentences through a scrambled sentence task. Control: supraliminal exposure to eight neutral sentences through a scrambled sentence task.	Muscle firming	Tonic consisting of vinegar and water	Real intake after a brief interval.	Beverage intake was significantly higher in the prime condition than the control condition. Significant condition x muscle firming interaction where participants in the prime condition consumed more when performing a muscle firming action rather than a control action.
12	Karremans (2006); study one	Between-subjects; Laboratory study; Randomized: Yes N = 61; Mean age: NR Females: 67%	Prime: subliminal exposure to the words 'Lipton Ice' through a visual detection task. The prime was presented 25 times for 23 milliseconds. Control: subliminal exposure to the words 'Npeic Tol' through a visual detection task. The control words were presented 25 times for 23 milliseconds.	Thirst	Lipton Ice; Spa Rood mineral water	Hypothetical choice after a brief interval.	No main effect of condition found. Significant condition x thirst interaction where participants in the prime condition were more likely to select Lipton Ice when levels of thirst were high rather than low.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
13	Karremans (2006); study two	Between-subjects; Laboratory study; Randomized: Yes N = 105; Mean age: NR Females: 70%	Prime: subliminal exposure to the words 'Lipton Ice' through a visual detection task. This was presented 25 times for 23ms. Control: subliminal exposure to the words 'Npeic Tol' through a visual detection task. This was presented 25 times for 23ms.	Thirst	Lipton Ice; Spa Rood mineral water	Hypothetical choice after a brief interval.	The prime condition were significantly more likely to select Lipton ice than the control condition. Significant condition x thirst interaction where participants in the prime condition were more likely to select Lipton Ice when levels of thirst were high rather than low.
14	Laran (2009); study one	Between-subjects; Laboratory study; Randomized: NR N = NR; Mean age: NR Females: NR	Prime: supraliminal exposure to ten self-control words through a scrambled sentence task. Control: supraliminal exposure to ten neutral words through a scrambled sentence task.	Temporal distance	Raisins; apple; celery sticks; baby carrots; rice cake; granola bar; low fat yogurt; cheerios; fruit roll ups; chocolate; cookies; Oreos; doughnuts; ice cream; cheese curls; Doritos	Hypothetical choice after a moderate interval. Present and future food choice was recorded.	Main effect of priming on present food choice not reported.
15	Laran (2009); study four	Between-subjects; Laboratory study; Randomized: NR N = NR; Mean age: NR Females: NR	Prime one: supraliminal exposure to eight spending-related words and two neutral words through a scrambled sentence task. Prime two: supraliminal exposure to eight saving-related words and two neutral words through a scrambled sentence task. Control: supraliminal exposure to ten neutral words through a scrambled sentence task.	None	Not reported	Hypothetical choice after a brief interval (participants believed it was a real choice). Present and future food choice was recorded.	Main effect of priming on present food choice not reported.
16	Laran (2012); study one	Between-subjects; Field study; Randomized: NR N = 121; Mean age: NR; Females: 50%	Prime: supraliminal exposure to six environmental harshness words displayed on a poster. Control: supraliminal exposure to six neutral words displayed on a poster.	Calorie content frame (high or low calorie content)	Milk chocolate M&Ms	Real intake during prime exposure (simultaneous)	Main effect of condition on food intake not reported. Significant condition x frame interaction where participants in the prime condition consumed more when the M&Ms were framed as high calorie rather than low calorie.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
17	Laran (2016)	Between-subjects; Laboratory study; Randomized: NR N = NR; Mean age: NR Females: NR	Prime (unconscious condition): supraliminal exposure to ten healthy eating-related words and ten neutral words through a lexical decision task. Control: supraliminal exposure to twenty neutral words through a lexical decision task.	None	Granola bar; SunChips; potato chips	Real choice after a brief interval.	The prime condition were significantly more likely to select one of the acceptable alternatives (granola bar or SunChips) than the control condition.
18	Masicampo (2011); study two	Between-subjects; Laboratory study; Randomized: NR N = 80; Mean age: NR; Females: NR	Prime: supraliminal exposure to seven achievement-related words and six neutral words through a word search task. Control: supraliminal exposure to thirteen neutral words through a word search task.	Goal fulfilment or unfulfillment; restrained eating	Cookies	Real intake after a moderate interval.	No main effect of condition found. Significant condition x anagram difficulty x restrained eating interaction where high restrained eaters consumed more than low restrained eaters when primed with achieved and presented with difficult anagrams.
19	Meyer (1999)	Between-subjects; Laboratory study; Randomized: NR N = 100; Mean age: 20; Females: 100%	Subliminal exposure to one the following words through a tachistoscope: hungry, happy, angry, lonely, or gallery (control). Each word was presented ten times for four milliseconds.	Eating attitude (healthy or unhealthy)	Mini cheddars	Real intake after a brief interval.	Food intake was significantly higher in the lonely prime condition than the control condition.
20	Nenkov (2014); study one	Between-subjects; Laboratory study; Randomized: Yes N = 33; Mean age: NR; Females: 36%	Prime: Use of a cute ice cream scoop. Control: Use of a neutral ice cream scoop.	None	Vanilla ice cream	Real intake after a brief interval.	No main effect of condition found (p is reported as < 0.10).
21	Papies (2014)	Between-subjects; Field study; Randomized: No N = 99; Mean age: 54; Females: 95%	Prime: supraliminal exposure to phrases related to health consciousness on a recipe flyer Control: supraliminal exposure to control phrases on a recipe flyer	Body Mass Index	Cakes; cookies; chocolate; sweets; chips; savoury snacks	Real choice after a brief interval.	No main effect of condition found. Significant condition x BMI interaction where overweight or obese participants in the prime condition purchased fewer unhealthy snacks than normal weight participants.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
22	Puska (2018); study one	Between-subjects; Field study; Randomized: Yes N = 80; Mean age: 26; Females: 50%	Prime: supraliminal exposure to twelve high status words and eight neutral words through a memory test. Control: supraliminal exposure to twenty neutral words through a memory test.	None	Organic coffee; non-organic coffee; organic bacon; non-organic bacon	Hypothetical choice. Length of interval is unclear.	Data from this study pooled with data from Puska (2018) Study two.
23	Puska (2018); Study two	Between-subjects; Field study; Randomized: Yes N = 88; Mean age: 28; Females: 50%	Prime: supraliminal exposure to twelve high status words and eight neutral words through a memory test. Control: supraliminal exposure to twenty neutral words through a memory test.	Social setting	Organic coffee; non-organic coffee; organic bacon; non-organic bacon	Hypothetical choice. Length of interval is unclear.	Main effect of condition on food choice not reported.
24	Robinson (2011); study two	Between-subjects; Laboratory study; Randomized: NR N = 47; Mean age: NR; Females: NR	Prime: supraliminal exposure to ten social acceptance words through a word search task. Control: supraliminal exposure to ten neutral words through a word search task.	Appetite; BMI; restrained eating	Butterkist toffee popcorn	Real intake after a brief interval.	Food intake was significantly lower in the prime condition than the control condition.
25	Stämpfli (2016)	Between-subjects; Laboratory study; Randomized: NR N = 128; Mean age: 46; Females: 73%	Prime: supraliminal exposure to images of Giacometti sculptures applied as a screensaver. Control: supraliminal exposure to a static white image applied as a screensaver.	Cognitive load; liking of chips	Pringles	Real intake after a brief interval.	Food intake was significantly lower in the prime condition than the control condition. Significant condition x liking interaction where participants with a high liking of Pringles consumed more in the control condition than in the prime condition.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
26	Stämpfli (2017); study one	Between-subjects; Laboratory study; Randomized: NR N = 114; Mean age: 32; Females: 62%	Prime: supraliminal exposure to images of Giacometti sculptures applied as a screensaver. Control: supraliminal exposure to a blue image applied as a screensaver.	Restrained eating	Blueberries; milk chocolate	Real intake after a brief interval.	Food intake was significantly lower in the prime condition than the control condition. Significant condition x restrained eating interaction where high restrained eaters consumed more in the control condition than in the prime condition.
27	Stein (2000)	Between-subjects; Laboratory study; Randomized: Yes N = 98; Mean age: NR; Females: 0%	Prime: supraliminal exposure to fifteen positive alcohol expectancy words through a synonym generation task. Control: supraliminal exposure to fifteen neutral words through a synonym generation task.	Drinking habits	Beer	Real intake after a moderate interval.	Beverage intake was significantly higher in the prime condition than the control condition. Significant condition x drinking habits interaction where participants in the prime condition who were heavy drinkers consumed more than light drinkers.
28	Strahan (2002); Study one	Between-subjects; Laboratory study; Randomized: NR N = 81; Mean age: NR; Females: 48%	Prime: subliminal exposure to thirst-related words through a lexical decision task. The primes were presented 26 times for 16 milliseconds. Control: subliminal exposure to neutral words through a lexical decision task. The primes were presented 26 times for 16 milliseconds.	Thirst	Kool-Aid with extra sugar	Real intake after a brief interval.	Beverage intake was significantly higher in the prime condition than the control condition.
29	Strahan (2007); study one	Between-subjects; Laboratory study; Randomized: Yes N = 26; Mean age: NR; Females: 100%	Prime: supraliminal exposure to two television adverts showing thin women and four neutral television adverts. Control: supraliminal exposure to four neutral television adverts.	None	Popcorn; pretzels; whole-wheat crackers; Ritz crackers	Real intake after a brief interval.	Food intake was significantly lower in the prime condition than the control condition.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
30	Strahan (2007); study two[b]	Between-subjects; Laboratory study; Randomized: Yes N = NR; Mean age: NR; Females: 100%	Prime: supraliminal exposure to two television adverts showing thin women and four neutral television adverts. Control: supraliminal exposure to four neutral television adverts.		Popcorn; pretzels; whole-wheat crackers; Ritz crackers	Real intake after a brief interval.	Food intake was significantly lower in the prime condition than the control condition.
31	Strahan (2007); study three	Between-subjects; Laboratory study; Randomized: NR N = 109; Mean age: NR; Females: 100%	Prime: supraliminal exposure to two television adverts showing thin women and four neutral television adverts (presumed). Control: supraliminal exposure to four neutral television adverts (presumed).	Normative information	Popcorn; pretzels; whole-wheat crackers; Ritz crackers	Real intake after a brief interval.	No main effect of condition found. Significant condition x normative information interaction where participants in the prime condition who received normative information consumed more than those receiving no normative information.
32	Strahan (2007); study four	Between-subjects; Laboratory study; Randomized: Yes N = 32; Mean age: NR; Females: 100%	Prime: supraliminal exposure to two television adverts showing thin women and four neutral television adverts. Control: supraliminal exposure to four neutral television adverts.	None	Popcorn; pretzels; whole-wheat crackers; Ritz crackers	Real intake after a moderate interval.	Food intake was significantly lower in the prime condition than the control condition.
33	Tan (2015)	Between-subjects; Laboratory study; Randomized: No N = 94; Mean age: 24; Females: 0%	Prime: Exposure to female pheromones from the ovulatory phase. Control: Prime: Exposure to female pheromones from the follicular phase.	None	Non-alcoholic beer	Real intake after a moderate interval.	Beverage intake was significantly higher in the prime condition than the control condition.
34	Tan (2017)	Between-subjects; Laboratory study; Randomized: Yes N = 103; Mean age: 22; Females: 100%	Prime: Exposure to the male hormone androstenone through a cologne rating task. Control: Prime: Exposure to water through a cologne rating task.	None	Non-alcoholic beer	Real intake after a moderate interval.	Beverage intake was significantly higher in the prime condition than the control condition.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
35	Van der Laan (2017)	Between-subjects; Laboratory study; Randomized: Yes N = 107; Mean age: 23; Females: 93%	Prime: supraliminal exposure to twenty-four banners with phrases related to health consciousness. Control: supraliminal exposure to twenty-four banners with words unrelated to health consciousness.	None	Not reported	Hypothetical choice during prime exposure (simultaneous).	The prime condition were significantly more likely to select low energy foods than the control condition.
36	Van de Veer (2015); study one	Between-subjects; Laboratory study; Randomized: NR N = 75; Mean age: NR; Females: NR	Prime one: supraliminal exposure to the self through a mirror. Control: no exposure to the self through a mirror.	Calorie content	M&Ms	Real intake after a moderate interval.	No main effect of condition found. Significant condition x calorie content interaction where intake was higher for participants in the prime condition who consumed a high calorie milkshake rather than a low calorie milkshake.
37	Verwijmeren (2010)	Between-subjects; Laboratory study; Randomized: Yes N = 146; Mean age: 21; Females: 82%	Prime: subliminal exposure to the words 'Lipton Ice' through a visual detection task. The prime was presented 20 times for 17ms. Control: subliminal exposure to the words 'Npeic Tol' through a visual detection task. The control words were presented 20 times for 17ms	Thirst; habit	Lipton Ice; Spa Rood mineral water	Hypothetical choice after a brief interval.	No main effect of condition found. Significant condition x thirst x habit interaction where participants with high levels of thirst were more likely to select Lipton Ice than participants with low levels of thirst when primed with Lipton Ice and having a high preference for mineral water or no preference.
38	Waller (1998)	Between-subjects; Laboratory study; Randomized: NR N = 60; Mean age: 23; Females: 100%	Prime one: subliminal exposure to a physical threat presented 10 times for 4ms through a tachistoscope. Prime two: subliminal exposure to an ego threat presented 10 times for 4ms through a tachistoscope. Control: subliminal exposure to a neutral message presented 10 times for 4ms through a tachistoscope.	Eating attitude (healthy or unhealthy)	Salted peanuts	Real intake after a brief interval.	Main effect of condition on food intake not reported.

Table 2.7

Characteristics of Articles in the Review Examining the Effect of Priming on Food or Beverage Choice and Intake (continued)

Study number	First author (year)	Design and participants (after exclusions)[a]	Priming task	Moderating variables	Foods or beverages	Real or hypothetical choice and interval	Main result
39	Walsh (2012); study two	Between-subjects; Laboratory study; Randomized: NR N = 85; Mean age: NR; Females: NR	Prime: supraliminal exposure to the word healthy presented twice on an advertisement which was used for an evaluation task. Control: supraliminal exposure to the word helpful presented twice on an advertisement which was used for an evaluation task.	Ego depletion	Mini chocolate chips	Real intake after a moderate interval.	Food intake was significantly lower in the prime condition than the control condition.
40	Winkielman (2005); study one	Between-subjects; Laboratory study; Randomized: NR N = 39; Mean age: 22; Females: 64%	Prime one: subliminal exposure to happy faces presented 8 times for 16 milliseconds. Prime two: subliminal exposure to angry faces presented 8 times for 16 milliseconds. Control: subliminal exposure to neutral faces presented 8 times for 16 milliseconds.	Thirst	Lemon-lime Kool Aid	Real intake after a brief interval.	No main effect of condition found. Significant condition x thirst interaction where participants in the happy (angry) prime condition consumed more when level of thirst was high (low) rather than low (high).
41	Zack (2006)	Between-subjects; Laboratory study; Randomized: Yes N = 69; Mean age: 20; Females: 61%	Prime one: supraliminal exposure to fifteen negative affect words through a synonym generation task. Prime two: supraliminal exposure to fifteen positive affect words through a synonym generation task. Control: supraliminal exposure to fifteen neutral words through a synonym generation task.	Gender	Non-alcoholic beer	Real intake after a moderate interval.	Beverage intake was significantly higher in the negative affect prime condition than the control condition.

[a]NR: Not reported
[b]Two prime conditions were excluded as it was not clear whether the advertisements contained food product.

2.4 Discussion

Review Summary

The search yielded a total of 41 studies that met the eligibility criteria for the review; 12 studies examined the effect of priming on choice while 29 studies examined the effect of priming on intake. Overall, 5 studies (42%) reported a significant effect of priming on choice and 16 studies (55%) reported a main effect of priming on intake. None of the studies examined the effect of priming on the eating or drinking behaviour of children. The majority of the studies that found a significant main effect of priming on either choice or intake were conducted in a laboratory; only one significant study which examined the effect of priming on food choice was conducted in the field. Six studies recruited only females while the majority of mixed samples recruited a higher proportion of females than males. Although numerous moderating variables were identified, restrained eating and appetite were the only two variables found to act as moderating variables on more than one occasion. Overall, the quality assessment identified three main areas of improvement including random sequence generation, allocation concealment, and selective reporting. Although the three databases searched for unpublished articles failed to return any results, it is still important to acknowledge that the number of significant versus non-significant studies identified may have been influenced by publication bias.

The first aim of the review was to determine whether there was a difference in the priming effects observed by research conducted in the laboratory compared to research conducted in the field. Overall, the results showed that the majority of priming research has taken place in the laboratory with only one significant and one non-significant study conducted in the field. Therefore, no definitive conclusions can be drawn based on the laboratory and field research that has been conducted to date. The large number of studies that have examined priming effects in the laboratory are important for several reasons: (1) confirming and replicating priming effects in a controlled setting; (2) examining the mechanisms that underlie any priming effects observed; and (3) confirming that priming effects occur outside of awareness through replicating findings using subliminal stimuli. Evidence for the effect of subliminal primes is particularly important as it implies there is no way to counter the effect of prime stimuli, even when they encourage behaviours that oppose the goals of the individual (e.g. weight loss). However, as the majority of stimuli in the social environment are presented at a

supraliminal level, the evidence that supraliminal primes can also influence choice and intake implies that many of the stimuli encountered on a daily basis have the potential to prime behaviour. This is also an important finding due to the large number of decisions that are made over the course of each day regarding eating and drinking behaviour. However, laboratory-based research may be more conducive if it made use of prime stimuli that are already found in the social environment in order to increase the external validity of the results. Research that specifically examines priming in the field is also required in order to determine whether the priming effects found in the laboratory transfer to real-world settings. This research will be particularly important for the development of future policies and legislation to reduce overweight and obesity.

The second aim of the review was to examine whether certain priming tasks were more likely to result in significant priming effects. The results showed that various priming tasks led to significant priming effects; all five significant choice studies employed different priming tasks, whereas ten different priming tasks were utilised across the 16 significant intake studies. Consequently, there is no evidence that one particular priming task is more effective than any other at producing significant priming effects. Furthermore, the priming tasks were classified according to whether the participants were primed with words or with an object or image. The results showed that the majority of the choice studies primed the participants with specific word stimuli, which resulted in both significant and non-significant effects. In contrast, almost half of the intake studies primed the participants with specific word stimuli and half primed the participants with either objects or images; as with the choice studies, both types of stimuli resulted in significant and non-significant effects. Additionally, two of the intake studies primed the participants with olfactory stimuli, both of which resulted in significant priming effects. Overall, there is no evidence that priming participants with either words or with objects or images is more effective at producing priming effects.

The third aim was to examine whether certain variables, such as appetite, were consistently found to moderate the priming effects found. Overall, the studies measured a variety of moderating variables and there was a lack of consistency regarding the moderating variables measured across the studies. Only appetite and restrained eating were found to act as moderating variables on more than one occasion. Two choice studies and one intake study reported appetite as a moderating variable where both choice studies found that increased thirst resulted in stronger priming effects; however, this finding was expected as both studies

were attempting to prime the selection of a thirst quenching beverage. The intake study that found appetite to be a moderating variable reported that thirst increased intake when participants were primed with the concept 'happy' and decreased intake when participants were primed with the concept 'angry'. This implies that the specific effect of each moderating variable depends on the concept being primed. Furthermore, two of the intake studies reported restrained eating as a moderating variable although one reported that highly restrained eaters consumed more when primed with the concept of 'thinness', whereas the other reported that highly restrained eaters consumed less when primed with the concept of 'thinness'. One potential explanation for this difference is the percentage of males and females taking part in each study; the study that reported an increase in intake recruited only female participants, whereas the study that reported a decrease in intake recruited a mixed sample (see discussion below on gender differences). However, further research is required to explicate the moderating variables that consistently influence priming effects, as well as the direction in which these effects are likely to be observed.

Based on the results of the review, it is also important to consider the possibility that exposure to prime stimuli has no effect on either eating or drinking behaviour. This is based on the mixed evidence obtained for the effect of priming on both choice and intake; approximately 50% of studies reported a significant main effect of priming while 50% reported no main effect of priming. Furthermore, the majority of studies were assessed as unclear for random sequence generation, allocation concealment (experimenters), and selective reporting; therefore, it is unclear to what extent the significant studies were influenced by selection bias and/or selective reporting. Selection bias occurs when the sample selected does not represent the target population leading to a systematic (type 1) error and reducing the internal validity of the study. In contrast, selective reporting refers to instances where the author(s) only report a subset of findings based on the direction and significance of the results obtained; however, this can be addressed by pre-registering the study and stating all the aims and outcome measures prior to conducting the research. Although study pre-registration is relatively new in the field of psychology, there is no reason why more recent priming research should not be pre-registered; the Centre for Open Science which maintains the Open Science Framework was founded in 2013 and 11 studies in the review were published in 2014 or later. Consequently, this calls into question the reliability of the results reported and could reduce the validity of the research.

Considerations for Future Research

Laboratory-Based Research

Although field research would give more insight into how primes influence eating and drinking behaviour in the social environment, there are also several ways in which laboratory-based research could advance the present understanding of priming effects in daily life. Firstly, understanding the effect of primes on the choice and intake of unhealthy beverages is important as research has shown that subsequent food intake is not always reduced to compensate for the extra calories consumed through beverages (Van Wymelbeke et al., 2003). This is becoming ever more important due to the increasing availability of beverages that are extremely high in calories; for example, a large Starbucks Signature Caramel Hot Chocolate made with whole milk contains 729 calories (Starbucks, n.d.). Therefore, future research could examine whether primes have the potential to increase the likelihood that individuals will select either healthier beverages or smaller sizes of unhealthy beverages. Furthermore, presenting a selection of beverages that may be encountered in daily life, such as a selection of beverages presently available at Starbucks, would increase the external validity of future research. Secondly, the majority of laboratory-based research utilises priming tasks that present the prime stimuli in the absence of any other concepts in order to maximise the activation of the concept of interest. Over the last 20 years, this approach has allowed researchers to provide evidence for the effect of primes on behaviour, as well as to examine the underlying mechanisms of behavioural priming. However, given the strong evidence that presenting primes in isolation can influence subsequent behaviour (Weingarten et al., 2016), future research would benefit from examining how exposure to multiple concepts simultaneously influences priming effects, with a particular focus on which prime has the greatest effect. Eye-tracking could also be used to determine whether the effects are simply determined by the prime that receives the most attention.

There are also two main methodological improvements for laboratory-based research that have been identified through the review. Firstly, even though priming research aims to examine whether the activation of a mental concept in one context, influences thoughts, feelings, goals, and behaviour in a subsequent unrelated context (Bargh & Chartrand, 2000), several studies in the review presented the prime and measured the behavioural outcome at the same time. Although it has been argued that this may lead to the activation of a mental procedure or schema (Bargh & Chartrand, 2000), the possibility that it may have activated a

mental concept cannot be discounted. However, it is important to be aware that different mechanisms may be involved when presenting the prime and outcome task simultaneously and that presently it is not possible to determine which mechanism is responsible for any effects on behaviour. Therefore, in order to confirm that a mental concept has been activated, future research would benefit by having the prime exposure and the outcome measure take place in different contexts. Secondly, most studies examining intake simply calculated the overall intake of each participant at the end of the study, whereas a more accurate measure would be to divide the intake of each participant by their weight. This would account for differences in food intake based on the daily energy requirements of each participant, such as those with a higher metabolic rate requiring more calories than those with a lower metabolic rate. Consequently, this would reduce the effect of individual differences for studies using a between-subjects design and would also make the results of different studies more comparable, particularly studies that have different eligibility criteria, such as those specifically recruiting males or females.

Gender Differences

The review also found that primes can influence the eating and drinking behaviour of both male and female participants. However, as many studies recruited a mixed sample, it is important to consider how recruiting both males and females may influence the priming effects found. In the present day West, the male body ideal has been described as a mesomorphic body build that is muscular, lean, and fit (Gattario et al., 2015); the desire to meet this ideal is supported by research showing that as many as 70-90% of men living in the West would like to be more muscular (Frederick et al., 2007). In contrast, the female body ideal is described as an ultra-lean figure with a flat stomach, thin waist, and well-defined muscles (Calogero et al., 2007); the desire to meet this ideal is supported by a recent survey which found that 45% of women in the UK reported trying to lose weight most of the time (Powell, 2019). As gaining muscle requires an increase in calorie intake and losing weight requires a reduction in calorie intake, this could have a significant impact on how primes influence the food and beverage choice of males and females. For example, priming the concept of attractiveness may increase the selection of unhealthy foods among males (as these are generally higher in calories) while decreasing the selection of unhealthy foods among females. Therefore, it is important to consider whether certain primes may have the reverse effect on males and females based on the particular ideals that are emphasised in the West. It may also be beneficial for future priming research to conduct exploratory analyses to

ensure that the size and direction of any effect found can be generalised to both males and females.

Cultural Differences

There are also several ways in which cultural differences may have contributed to any priming effect or lack of effect found. Firstly, as priming effects depend on the individual having a representation of the primed concept in memory, it is important to ensure that the prime stimuli are familiar to the sample of participants recruited for the study. As the majority of the studies in the review recruited undergraduate university students, this is a particularly important point as students often come from diverse cultural backgrounds. This could be done through a simple question at the end of the study that asks the participants to confirm that they have seen the prime stimuli previously. Furthermore, confirming the stimuli are familiar to participants would increase the internal validity of the study. Secondly, it is important to ensure that the prime stimuli have the same meaning to participants from different cultures. For example, in the United States, McDonald's is often associated with the availability of cheap, fast food that is relatively unhealthy, whereas countries such as China view McDonald's as a special treat (Oswald, 2007). Therefore, where participants from the U.S. may have more negative associations with McDonald's, participants from China may have more positive associations with McDonalds. This could result in significantly different priming effects if the sample recruited includes both American and Chinese participants. Thirdly, it is important to consider whether the foods or beverages included in the outcome measure are more or less popular across different cultures. For example, KitKats are the most popular chocolate product in Japan because the name sounds similar to 'kitto katsu' which translates as 'good luck' in Japanese (Timeout, 2018). In fact, KitKats are so popular that Nestle estimates that it sells around 4 million per day in Japan which are often given as gifts before important events or to anyone needing a bit of luck (Rao, n.d.; Timeout, 2018). Consequently, future research should consider whether the popularity of certain products in different cultures may increase the selection of these products during a food or beverage choice task.

Quality Assessment Results

The quality assessment found that many of the studies failed to report the information required to accurately determine the risk of bias. Despite almost half the articles stating that the participants were randomly allocated to conditions, none described in detail how the

random allocation sequence had been generated. Similarly, none of the articles stated whether the allocation of participants to conditions was concealed from the experimenters or whether the study was pre-registered; however, as many of the studies were conducted before the development of pre-registration databases, this finding was not unexpected. Most studies reported the inclusion of a cover story to conceal the aim of the study; this is an important aspect of priming research as awareness of the link between the prime and the outcome measure often results in contrast effects (Lombardi et al., 1987). Furthermore, the majority of the studies involved blinding of the outcome assessment as choice and intake were measured objectively by the experimenters; this increases the internal validity of the research by reducing the risk of experimenter bias. The outcome data was also considered complete for most of the studies as the participant degrees of freedom reported in the results section matched the sample size reported in the method (accounting for exclusions).

The studies were also assessed based on whether controls were in place for several factors that have previously been found to influence the effect of primes on behaviour. Only half the studies either standardised appetite or measured appetite using a Likert scale, meaning that appetite may have acted as a confounding factor for half of the studies reviewed. Overall, eleven studies that found a significant effect of priming on eating or drinking behaviour were assessed as high risk for standardised appetite. In relation to social setting, less than half the studies stated that the participant was alone during the choice or intake task, meaning that social factors may have influenced the results of a large proportion of the studies reviewed. Overall, eleven studies that found a significant effect of priming on eating or drinking behaviour were assessed as unclear for social setting with one study assessed as high risk. The majority of the studies reviewed involved completing a real choice or intake task, reducing the likelihood of the results being influenced by social desirability bias. Only two studies that found a significant effect of priming on eating or drinking behaviour were assessed as high risk for hypothetical choice or intake.

Based on the results of the quality assessment, future research could be improved by ensuring that the allocation sequence is randomly generated and the method for generating the allocation sequence is explicitly reported in the research article. In relation to this, it is also important to state the approach taken to conceal the allocation sequence from the experimenters to ensure that the results are not influenced by experimenter bias. As none of the studies were pre-registered, future research should also make sure that the research is

registered on one of the open science databases to prevent the reporting of significant results that are not part of the main hypotheses. The finding that appetite moderates the effect of priming on both choice and intake means that future research should either standardised appetite across participants or ask participants to rate their appetite on a Likert scale. This will give more insight in to the role of appetite as a moderator as it was found to both increase and decrease the priming effects reported. Furthermore, as research has found that the presence of others may also influence eating and drinking behaviour, future research should report whether the participants are alone during the choice or intake task, including whether the experimenter is present or not. This will confirm that any effects found are not due to mimicking the behaviour of others or conforming to social norms. Finally, as research that involves making a real choice has higher ecological validity than research that involves making a hypothetical choice, future research should aim to involve making a real food or beverage choice where possible.

In conclusion, priming appears to have a significant effect on both the choice and intake of various foods and beverages, although the number of significant versus non-significant studies identified may have been influenced by publication bias. As most of the priming research conducted to date has been laboratory-based, more field research is required in order to determine whether prime stimuli influence eating and drinking behaviour in daily life. There are also various ways in which laboratory-based research could be improved to advance the present understanding of behavioural priming effects. Overall, the results of the review show that priming has the potential to be implemented as a behavioural change technique and may be utilised to develop future policies and legislation to reduce overweight and obesity.

Chapter Three:
A Field Study Examining The Effect of Priming on Snack Choice

Abstract

As Chapter Two found that the majority of priming research has been conducted in a laboratory, the main aim of this study was to analyse the effect of priming on snack choice in a real-world setting. The study specifically examined whether food-related logos could influence snack choice where the logos presented during the priming task corresponded to the logos on the snacks offered. The main reason for using logos as prime stimuli was to examine whether stimuli that are often present in the social environment could significantly influence snack choice. Therefore, the prime conditions involved presenting the participants with either the M&S logo or the Mars logo in the background of a larger image. The study also advanced previous research by presenting an image that contained multiple concepts in order to reflect how primes would be perceived in a real-world setting. According to the Situated Inference Model (Loersch & Payne, 2011), exposure to a prime activates a mental concept which immediately becomes more accessible in memory. This increased accessibility is then misattributed to the individual's natural response toward the prime when it is subsequently encountered. How the prime influences behaviour ultimately depends on the questions afforded by the situation; questions that relate to behavioural responses will result in behavioural priming effects. Therefore, it was expected that brief exposure to the food-related logos would: (1) activate the corresponding mental concept of the logo; (2) temporarily increase the accessibility of the mental concept which would be attributed to the individual's own thoughts and feelings; and (3) lead to selection of the corresponding snack (i.e. either an M&S snack or a Mars bar).

3.1 Introduction

Obesity Levels and Snacking

As discussed in Chapter One, levels of obesity in England have risen to the extent that obesity is now considered an epidemic, affecting both adults and children (NHS, 2013). The excessive consumption of foods that are energy dense, along with reductions in physical activity, mean that energy intake often exceeds energy expenditure for a large proportion of the population. One factor that is argued to contribute to the excessive intake of energy, relative to daily requirements, is the frequent consumption of energy dense snack foods that have little nutritional value (Mattes, 2018). A recent review of meal patterns across ten European countries found that the UK consumed more snacks than any other country, with an average of 4 snacks per day for men and 4.1 snacks per day for women (Huseinovic et al., 2016). The contribution of snacks to overweight and obesity has recently been shown by O'Connor et al. (2015), who examined the association between snacking frequency and adiposity in a large cohort of volunteers from Cambridgeshire. The results showed that there was a positive association between snacking frequency and waist circumference in individuals with a BMI of 25 or higher. More specifically, the results showed that individuals classed as overweight or obese consumed a greater amount of crisps, sweets, chocolates and ice cream compared to individuals classed as having a normal weight. Furthermore, overweight and obese individuals consumed a smaller amount of yogurt and nuts than normal weight individuals.

Priming Food and Beverage Choice

Since the first studies on behavioural priming, the variety of behaviours that can be primed has been closely examined by researchers, with several studies reported in Chapter Two that specifically examined the influence of prime stimuli on food and beverage choice. One study by Fishbach and Dhar (2005) primed either high progress towards ideal weight or low progress towards ideal weight in order to examine the effect of each prime on subsequent snack choice. The participants were initially asked to colour either a wide scale or a narrow scale as a means of priming high progress and low progress respectively. The participants were subsequently asked to select either an apple or a chocolate bar as a parting gift, which was the main outcome measure taken by the researchers. Overall, the results showed there was a significant difference in the snacks chosen by both conditions; where 85% of the

participants primed with high progress selected a chocolate bar, only 58% of the participants primed with low progress selected a chocolate bar. Another study by Chiou et al. (2013) examined whether priming the concept of masculinity through a scrambled sentence task could influence drink choice among men. On completion of the scrambled sentence task, all participants were asked to select either a can of Red Bull or a bottle of Perrier mineral water as a reward for taking part in the study. The results showed that participants in the prime condition were significantly more likely to select Red Bull than participants in the control condition, implying that priming the concept of masculinity promoted behaviour that was consistent with the prime. The unconscious effect of prime stimuli on behaviour has also been confirmed by several studies that have employed subliminal priming techniques. For example, Karremans et al. (2006) compared the hypothetical choice of a prime condition and a control condition following subliminal exposure to the words 'Lipton Ice' (prime condition) or 'Npeic Tol' (control condition). The result showed that participants exposed to the Lipton Ice primes were significantly more likely to select Lipton Ice than mineral water; however, further analyses showed that this effect was moderated by degree of thirst where participants with higher levels of thirst were more likely to be influenced by the primes.

Brand Logos as Prime Stimuli

The use of logos to mark ownership of products is a well-established practice, thought to date back as far as 2,000 years (Mollerup, 1997). In the second half of the nineteenth century, logos were often used to distinguish between different packaged products and also became a mark of quality assurance (Lury, 2004). However, by the second half of the twentieth century, brands started designing logos to reflect their social identity, making the logo an active contributor to the value of the brand (Lury, 2004). Over the last few decades, the prevalence of logos in the social environment has continually increased as brands have started to use logos as a means of increasing brand awareness. According to Schecter (1993, p. 33) logos are 'the single most pervasive element in corporate and brand communications, repeated in every conceivable medium from trucks and signage to packaging and advertising'. The high prevalence of logos has also been acknowledged by Lury (2004), who states that 'logos are ubiquitous, constantly presented to us on products, on packaging and promotion, on hoardings, on the sides of buses, taxis and buildings, on bag's and people's clothing, on screens in the cinema, television and computers, and as signage and orientation devices'. More recently, brands have started to sponsor or form partnerships with governing bodies and organisations, many of which receive a considerable amount of media attention

and therefore have access to a large audience. Through this partnership, many brands are given the right to display the brand logo at various national and international events and tournaments, further increasing awareness of the brand. Overall, this continual exposure to brand logos means that there are numerous opportunities for logos to activate certain concepts in memory and influence behaviour. Due to the evidence that exposure to prime stimuli can significantly influence food and beverage choice (Chiou et al., 2013; Karremans et al., 2006), it is important to understand whether food-related logos also have a similar effect.

Food Brands and English Football

Mars Wrigley Confectionary (Mars) is a leading global food company that produces approximately three million Mars bars per day in the UK alone (Mars, n.d.). In 2009, Mars became an 'Official Supporter' of the England Football Team and 'Official Partner' to the English Football Association Mars Just Play programme – an initiative that encourages adults to play football regardless of skill level (Activity Alliance, 2018). As an 'Official Supporter' of the England Football Team, Mars has the right to display the Mars logo on the Football Association (FA) website (The FA, n.d), as well as on advertising boards during pre- and post-match interviews with the England players and manager (BeanymanSports, 2017). As an 'Official Partner' of the Just Play programme, Mars is further promoted through having the Mars colours and logo advertised on the Just Play football shirts and footballs (The FA, 2017). According to The FA (2017), this initiative has recently surpassed one million attendees, undeniably increasing exposure to the Mars brand. A more recent example of food company affiliation in football is the introduction of Cadbury as the 'Official Snack' of the Premier League (Premier League, n.d.). This affiliation began at the start of the 2017/18 season and allows Cadbury to display the Cadbury logo on the Premier League website, as well as on display boards during the Golden Boot and Golden Glove awards at the end of the season (Premier League, n.d.; Liverpool Football Club, 2019a; Liverpool Football Club, 2019b). The main benefit of this affiliation for Cadbury is that it gives the food company access to a global audience as the Premier League is presently followed by more than 1.35 billion people worldwide (Premier League, 2019).

The Situated Inference Model

Based on the discussion above, it seems reasonable to assume that brand logs have the potential to activate a mental concept in memory and influence subsequent behaviour. In this

case, the potential for logos to influence behaviour on a daily basis is fairly high given the high prevalence of logos in the social environment. However, the specific mechanisms that translate this increased accessibility into behaviour are less well understood. One model that attempts to explain this mechanism is the Situated Inference Model by Loersch and Payne (2011), which proposes that the effect of prime stimuli on judgments, decisions, or behaviour can be accounted for by a single process that has three discrete stages. The first stage involves exposure to the prime stimuli which increases the accessibility of any mental content that is experientially, semantically, or evaluatively related to the prime. Importantly, this stage only reflects an increase in the readiness to use the activated content during information processing, as opposed to having a direct effect on judgments, decisions, or behaviour. During the second stage, the individual misattributes the increased accessibility of the mental concept to their own natural response toward a specific element of the environment. More precisely, the accessibility of the primed concept is misattributed to the natural thoughts and feelings experienced by the individual and is therefore more likely to be taken into account during subsequent judgements, decisions, and behaviour. The third stage relates to the specific questions afforded by the present situation; in other words, the situation determines the different ways in which an individual may respond. As the priming effect obtained depends on the specific questions asked, it is argued that questions relating to behavioural responses will subsequently result in behavioural priming effects.

Study Summary

As stated above, snacking has become a part of daily life in the UK and research has shown that the consumption of unhealthy snacks contributes to weight gain and the development of overweight and obesity. Therefore, this study aimed to determine whether unobtrusive exposure to specific food logos (primes) could influence snack choice in a subsequent decision making task. The present study aimed to build on the previous research identified by the systematic review in two ways. Firstly, no previous studies to date have used food logos as a means of priming eating behaviour. One of the reasons for using logos is that they represent stimuli that are often found in the social environment and are therefore likely to be highly familiar and easily recognizable; this is partly due to recent advances in information technology which has increased the number of ways in which companies can advertise specific brands. Furthermore, the high prevalence of logos in the social environment means that any effects found are likely to reflect how food logos influence eating behaviour in real world settings. Secondly, the logos were presented in the background of an image rather than

in isolation; the main reason for taking this approach was to emulate the presentation of prime stimuli in the social environment as experienced during daily life. The importance of brand awareness on product choice has led to the proliferation of stimuli in the social environment as companies compete for consumer attention; consequently, brand logos are usually perceived in the presence of multiple stimuli.

In order to examine the effect of specific food logos on subsequent snack choice, participants were primed through the completion of a World Cup Quiz that contained an image with either the M&S logo, the Mars logo, or no food logos visible in the background. The M&S and Mars logos were employed as both were sponsors of the English FA at the time of the study; the use of different food-related logos was prohibited due to laws regarding false advertising in the UK. Following the World Cup Quiz, participants were asked to select either an M&S fruit and nut assortment (M&S snack) or a Mars bar as a thank you for taking part. The first confirmatory hypothesis stated that participants who were exposed to the M&S logo would be more likely to select the M&S snack compared to participants exposed to the Mars logo or no food-related logos. The second confirmatory hypothesis stated that participants who were exposed to the Mars logo would be more likely to select the Mars bar compared to participants exposed to the M&S logo or no food-related logos. The data analysis also explored whether any effect of the primes on snack choice was moderated by conscious effort to eat healthily, hunger, tiredness, and/or self-reported BMI. This study was pre-registered on the Open Science Framework prior to the start of the data collection period (osf.io/vyter).

3.2 Method

Participants

An a priori calculation using G*Power indicated that 156 participants would be required to detect a small effect size (0.25) and achieve a 0.8 level of power with alpha at 0.05. Therefore, a total of 205 participants (before exclusions) were recruited by the main researcher and a City, University of London psychology graduate who was briefed on the study procedure. Any participants who reported they had an allergy or specific dietary need that prevented them from taking one of the snacks, or failed to recognise either the M&S and/or the Mars logo were excluded from the data analysis. In keeping with the pre-

registration form, extra participants were recruited to make up for these exclusions. Ethical approval was granted by the City, University of London Psychology Department Research Ethics Committee.

Measures

Demographic Information

The demographic information questionnaire included measures of age, gender and education. The participants were specifically asked to state the highest level of education attained at the time of the study.

Funnelled Debrief

Awareness of the link between the priming task and the snacks offered was checked by asking the participants two questions: (1) whether they had any ideas about the aim of the present study; and (2) whether they thought anything they had completed during the study may have influenced their snack choice.

Eating Behaviour Questionnaire

The motivation to consume a healthy diet was measured by means of a single question; participants were asked to rate the statement 'I make a conscious effort to eat healthy foods' on a 7-point Likert scale from 'Strongly disagree' to 'Strongly agree'. Participants were also asked to specify whether they were currently dieting and whether they had any allergies and/or specific dietary needs that prevented them from taking one of the snacks offered. Hunger was measured by asking participants to rate how hungry they felt at the time of the study on a 7-point Likert scale from "Extremely hungry' to 'Extremely full'. Similarly, tiredness was measured by asking participants to rate how tired they felt at the time of the study using a 7-point Likert scale from 'Extremely tired' to 'Extremely alert'. Recognition of both the M&S logo and the Mars logo was checked by asking participants to indicate whether they recognised each logo by ticking one of two boxes (corresponding to yes or no). Finally, each participant was asked to self-report their height and weight before indicating whether they chose the M&S fruit and nut assortment, the Mars bar, or declined to take a snack; the actual snack chosen was observed by the researcher in order to confirm that the response to this question was correct.

Priming Task

The participants were primed through the completion of a quiz on the 2018 World Cup which was developed by the main researcher. The quiz was presented on an A4 sheet of paper and included an image of Gareth Southgate, the England manager, located at the top of the quiz sheet; the image was approximately 16cm x 8.6 cm in all three conditions. In the background of the image was an advertising board displaying the logos of various sponsors of the English Football Association. The logos shown on the advertising board were modified so that the M&S logo was present in the first experimental condition, the Mars logo was present in the second experimental condition, and no food-related logos were present in the control condition. The last quiz question concerned the identity of the individual in the image (Gareth Southgate) to ensure all participants would be exposed to the logos.

Procedure

The study took place in one of the indoor walkways at City, University of London. A stand was set-up between 11am and 3pm on five weekdays over a two-week period and consisted of two display boards, two tables and two chairs. The display boards were arranged in a T shape with one table and one chair on either side of the vertical display board; this set-up allowed the researchers to recruit two participants at a time and prevented the participants from seeing each other's snack choice. The snacks were offered to participants in a small wicker basket which was hidden behind the horizontal display board so participants were not aware that the study involved food. Posters were also attached to the display boards which advertised the study as a brief quiz on the 2018 World Cup, with two notifications informing the participants they could enter a prize draw for a £50 Amazon voucher on completion of the study. The participants included students, staff, and visitors to the university who were recruited as they walked past the stand. All participants were provided with basic information about the study and were required to give verbal consent prior to taking part.

The quiz sheets were randomly ordered by another researcher (Katy Tapper) who was not involved with the data collection. Randomisation was done using a restricted randomisation procedure to ensure each condition was approximately the same size throughout the data collection period (Schulz & Grimes, 2002). The quiz sheets were randomised in blocks of nine using the website graphpad.com; three quiz sheets from each of the three conditions were randomly ordered in each block. The quiz sheets were subsequently given to the participants in the order they were received from Katy Tapper, with the researchers collecting

the data unaware of how the participants were allocated to conditions. The demographic questionnaire was also attached to the quiz sheet and was intentionally placed over the prime image to ensure each trial was double blind. Once each participant had agreed to take part they were seated at one of the tables and completed the demographic questionnaire followed by the 2018 World Cup Quiz. The quiz was comprised of five questions and took approximately 1-2 minutes to complete; however, the participants were only required to look at the image to answer the fifth question. The amount of time spent looking at the image varied across participants, with those immediately recognising the individual as Gareth Southgate having less exposure to the image. Once the quiz had been completed and returned to the researcher, each participant was asked if they would like to select either an M&S fruit and nut assortment or a Mars bar as a thank you for taking part; participants were also free to decline if they did not want to take either snack. Once a snack had been selected (or declined) each participant was taken through the funnelled debrief in order to check for awareness of the true aim of the study; this was done verbally by the researchers who wrote the responses on an A4 sheet of paper. Participants were then asked to fill in the eating behaviour questionnaire before being debriefed about the aims of the study. All participants who wished to enter the prize draw were asked to write down their email address before leaving.

3.3 Results

Data Screening and Participant Characteristics

A total of 35 participants did not meet the inclusion criteria and were therefore excluded from the analysis. The first five participants were excluded as the participants may have guessed the aim of the study due to procedural errors by the researcher; seventeen participants reported having an allergy or specific dietary need that influenced their snack choice; five participants failed to recognise at least one of the logos during the eating behaviour questionnaire; and five participants guessed the aim of the study during the funnelled debrief. A further three participants were excluded as two participants reported having a dislike for one of the snacks and one participant gave the snack back at the end of the study. This resulted in a final sample size of 170 participants. Table 3.1 shows the demographic and personal characteristics as a function of condition.

Table 3.1

Characteristics of Participants as a Function of Condition

Characteristic[a]	Control (n = 60)	M&S Prime (n = 56)	Mars Prime (n = 54)	F-tests
Females (%)[b]	32	45	47	$\chi^2 = 3.18$, $p = 0.20$
Age (Mean, SD)[cd]	25.08 (9.81)	24.04 (7.27)	27.81 (11.17)	$F = 2.16$, $p = 0.12$
Completed education level (%)[e]				
GCSE's	2	2	4	
A-Levels	60	48	46	$\chi^2 = 3.11$, $p = 0.80$
Bachelor's degree	22	27	26	
Postgraduate degree	17	23	24	
Conscious effort to eat healthily (Mean, SD)	5.02 (1.43)	5.43 (1.23)	5.33 (1.30)	$F = 1.54$, $p = 0.22$
Dieting (%)[f]	15	22	32	$\chi^2 = 4.45$, $p = 0.11$.
Hunger (Mean, SD)	3.77 (1.49)	3.93 (1.41)	3.78 (1.40)	$F = 0.23$, $p = 0.80$
Tiredness (Mean, SD)	4.18 (1.66)	3.79 (1.60)	3.69 (1.81)	$F = 1.40$, $p = 0.25$
BMI (Mean, SD)[g]	23.89 (3.37)	23.05 (3.53)	25.20 (4.65)	$F = 3.92$, $p = 0.02$

[a]Conscious effort to eat healthily, hunger, and tiredness were all measured on 7-point Likert scales where higher scores reflected a higher agreement with each measure.
[b]Three missing values in the control condition and the Mars prime condition.
[c]One missing value in the control condition and the M&S prime condition.
[d]Significance based on Welch's F-test due to unequal homogeneity of variance.
[e]Percentages may not total 100 due to rounding.
[f]One missing value in the M&S prime condition.
[g]Number who declined to say: Control = 7, M&S prime = 3, Mars prime = 7.

A series of chi-square and F-tests were run to confirm that all three conditions were comparable in terms of the characteristics of the participants. The results showed that the characteristics of the participants was comparable across all three conditions, with the exception of self-reported BMI which was significantly higher in the Mars prime condition

compared to the control and M&S prime condition. Therefore, it is important to take this into account when interpreting the results.

Confirmatory Analysis: The Effect of Condition on Snack Choice

The data analysis was run with and without the participants who declined to take a snack; when these participants were included, the no snack choice and M&S snack choice were collapsed into one category as both choices can be interpreted as healthier than the Mars bar. Although the results were the same, the participants who took no snack (n = 11) were excluded from the analysis. This decision was made as collapsing these categories is based on the assumption that the participants who took no snack had the same underlying motivation as the participants who chose the M&S snack. However, it may be the case that the participants who declined a snack did so as they disliked both of the snacks offered. The main analysis examined the effect of condition on snack choice using logistic regression. Table 3.2 shows the effect of condition (control, M&S prime, or Mars prime) on snack choice (M&S snack or Mars bar), with the control condition entered as the reference category. The results showed that the participants assigned to either the M&S prime or the Mars prime condition were no more likely than those assigned to the control condition to select the M&S snack or the Mars bar.

Table 3.2

A Logistic Regression Model Showing the Effect of Condition on Snack Choice

		b (S.E)	Sig.	Odds Ratio	95% CI for Odds Ratio	
					Lower	Upper
Included						
Constant		0.07 (0.27)	0.79	1.07		
Condition	M&S prime	-0.07 (0.39)	0.85	0.93	0.44	1.98
	Mars prime	-0.03 (0.39)	0.93	0.97	0.45	2.07

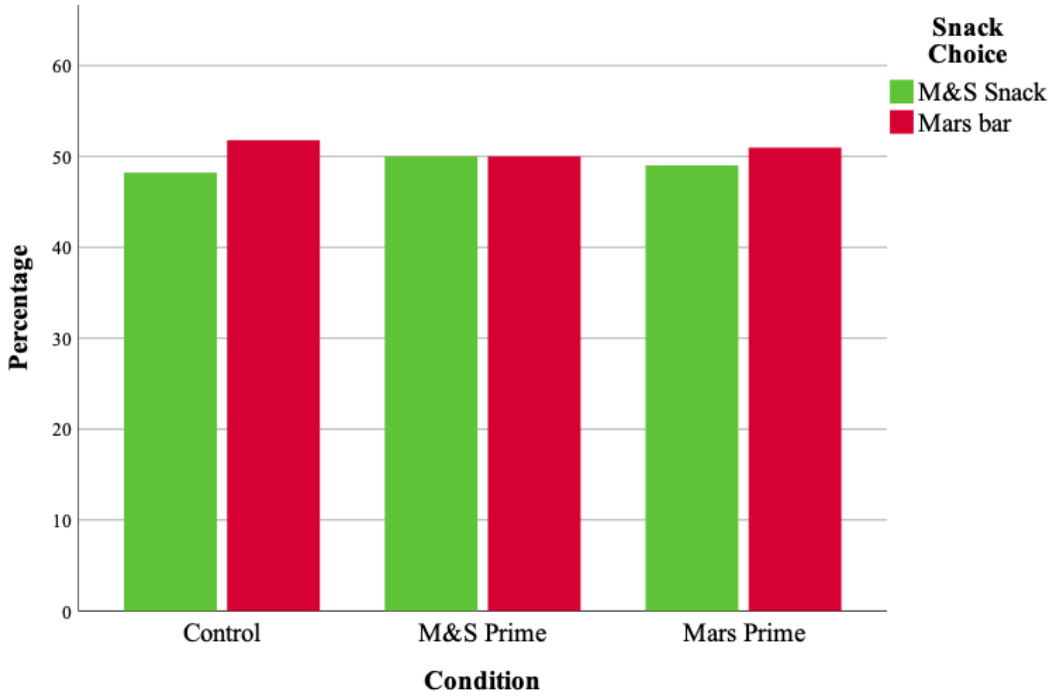
Note. The control condition served as the reference category.
R^2 = 0.00 (Hosmer-Lemeshow), 0.00 (Cox-Snell), 0.00 (Nagelkerke).
Model $\chi^2(2) = 0.03$, $p = .98$.

The M&S prime condition and the Mars prime condition were also compared by altering the reference group used in the logistic regression model above. The analysis showed that there was no difference in the snack choices made by either the M&S prime condition or the Mars

prime condition (p = 0.92). The main findings are visually represented in Figure 3.1 which shows the percentage of M&S snacks and Mars bars selected in each condition.

Figure 3.1

The Percentage of M&S Snacks and Mars Bars Selected in Each Condition



Exploratory Analysis: The Moderating Effect of Traits

A series of logistic regressions were run to determine whether age (mean centred), gender, and education level moderated the association between prime condition and snack choice. For each moderator variable, three separate regressions were run to compare the three conditions. Each analysis involved entering the moderating variable at step 1, condition at step 2, and the interaction term at step 3. The M&S snack choice was coded as 0 and the Mars bar was coded as 1 for each analysis. A significance cut-off point of $p < 0.05$ was used despite the large number of tests being performed. A stringent Bonferroni correction for seven moderators in total – the three traits explored here (age, gender, and education level) and four states considered below (effort to eat healthily, hunger, tiredness, and BMI) – and three regressions per moderator (hence 21 tests) would imply a significance cut-off at $p < 0.0024$ (0.05/21). However, conscious of the limited sample size and therefore power of the current study, the findings are reported at the conventional 0.05 threshold.

The Moderating Effect of Age

The results showed a significant main effect of age on snack choice whereby older participants were more likely to select the M&S snack than younger participants, b = -0.06, OR = 0.95, p = 0.01, R^2 (Cox & Snell) = 0.05, R^2 (Nagelkerke) = 0.07. A significant interaction was found when the control condition (coded as 0) was compared with the M&S prime condition (coded as 1), b = -0.19, OR = 0.82, p = 0.04. The coefficient of the interaction term was not significant when the control condition (coded as 0) was compared with the Mars prime condition (coded as 1) (b = -0.07, OR = 0.93, p = 0.13) or when the M&S prime condition (coded as 0) was compared with the Mars prime condition (coded as 1) (b = 0.12, OR = 1.13, p = 0.19). The R^2 values for the overall model are as follows: Cox & Snell = 0.09, Nagelkerke = 0.12. A simple slopes analysis was run to explore the interaction between age and condition when comparing the control condition (coded as 0) with the M&S prime condition (coded as 1). For younger participants (1 SD below the mean), although exposure to the M&S prime reduced selection of the M&S snack, this reduction was non-significant, b = 1.33, OR = 3.79, p = 0.66. For average aged participants, exposure to the M&S prime had no effect on snack choice, b = -0.13, OR = 0.88, p = 0.76. For older participants (1 SD above the mean), exposure to the M&S prime increased selection of the M&S snack, although this increase was non-significant, b = -1.59, OR = 0.20, p = 0.07. The Johnson-Neyman technique showed that for adults aged 37 years and older, condition had a significant effect on snack choice with those in the M&S condition more likely to select the M&S snack, b = -2.56, OR = 0.08, p = 0.05. Overall, 92% of the sample were below 37 years of age and only 8% were 37 years or older.

The Moderating Effect of Gender

The results showed there was no main effect of gender on snack choice, b = 0.18, OR = 1.19, p = 0.60, R^2 (Cox & Snell) = 0.00, R^2 (Nagelkerke) = 0.00. No significant coefficient for the interaction was found when the control condition (coded as 0) was compared with the M&S prime condition (coded as 1) (b = -0.37, OR = 0.69, p = 0.66) or the Mars prime condition (coded as 1) (b = -0.69, OR = 0.50, p = 0.41). There was also no significant coefficient for the interaction term when the M&S prime condition (coded as 0) was compared with the Mars prime condition (coded as 1) (b = 0.32, OR = 1.38, p = 0.69). The R^2 values for the overall model are as follows: Cox & Snell = 0.01, Nagelkerke = 0.01.

The Moderating Effect of Education Level

The results showed there was no main effect of education level on snack choice, b = -0.18, OR = 0.83, p = 0.34, R^2 (Cox & Snell) = 0.01, R^2 (Nagelkerke) = 0.01. No significant interaction coefficient was found when the control condition (coded as 0) was compared with the M&S prime condition (coded as 1) (b = -0.19, OR = 0.83, p = 0.70) or the Mars prime condition (coded as 1) (b = 0.37, OR = 1.45, p = 0.45). There was also no interaction when the M&S prime condition (coded as 0) was compared with the Mars prime condition (coded as 1) (b = 0.56, OR = 1.75, p = 0.24). The R^2 values for the overall model are as follows: Cox & Snell = 0.02, Nagelkerke = 0.02.

Exploratory Analysis: The Moderating Effect of States

A series of logistic regressions were run to determine whether conscious effort to eat healthily, dieting status, hunger, tiredness, and/or self-reported BMI moderated the associated between prime condition and snack choice; these were all mean centred before being entered into the regression models. For each moderator variable, three separate regressions were run to compare the three conditions. Each analysis involved entering the moderating variable at step 1, condition at step 2, and the interaction term at step 3. The M&S snack was coded as 0 and the Mars bar was coded as 1 for each analysis.

The Moderating Effect of Conscious Effort to Eat Healthily

The results showed a significant main effect of conscious effort to eat healthily on snack choice whereby participants showing a greater effort to eat healthily were more likely to select the M&S snack, b = -0.54, OR = 0.59, p < 0.001, R^2 (Cox and Snell) = 0.09, R^2 (Nagelkerke) = 0.13. No significant interaction coefficient was found when the control condition (coded as 0) was compared with the M&S prime condition (coded as 1) (b = 0.09, OR = 1.10, p = 0.80) or the Mars prime condition (coded as 1) (b = 0.05, OR = 1.05, p = 0.89). There was also no significant interaction coefficient when the M&S prime condition (coded as 0) was compared to the Mars prime condition (coded as 1) (b = -0.05, OR = 0.96, p = 0.91). The R^2 values for the overall model are as follows: Cox & Snell = 0.10, Nagelkerke = 0.13.

The Moderating Effect of Dieting Status

The results showed no main effect of dieting status on snack choice, b = -0.33, OR = 0.72, p = 0.39, R^2 (Cox and Snell) = 0.01, R^2 (Nagelkerke) = 0.01. No significant interaction coefficient was found when the control condition (coded as 0) was compared with the M&S prime condition (coded as 1) (b = -1.13, OR = 0.32, p = 0.33) or the Mars prime condition (coded as 1) (b = 1.59, OR = 4.92, p = 0.12). However, there was a significant interaction coefficient when the M&S prime condition (coded as 0) was compared to the Mars prime condition (coded as 1) (b = -2.72, OR = 0.07, p = 0.01). The R^2 values for the overall model are as follows: Cox & Snell = 0.05, Nagelkerke = 0.07. A simple slopes analysis was run to explore the interaction between condition and dieting status when comparing the M&S prime condition (coded as 0) with the Mars prime condition (coded as 1). For participants who were not dieting, the effect of condition on snack choice did not reach significance, b = -0.53, OR = 0.59, p = 0.26. However, for participants who were dieting, there was a significant effect of condition on snack choice, whereby participants were far more likely to select the snack that corresponded with the prime stimuli, b = 2.20, OR = 9.03, p = 0.02. As the moderating variable was dichotomous, the Johnson-Neyman technique could not be used to determine the significant transition point.

The Moderating Effect of Hunger

The results showed a main effect of hunger on snack choice whereby participants with higher levels of hunger were more likely to select the M&S snack than participants with lower levels of hunger, b = -0.29, OR = 0.75, p = 0.02, R^2 (Cox and Snell) = 0.04, R^2 (Nagelkerke) = 0.05. No significant interaction coefficient was found when the control condition (coded as 0) was compared with the M&S prime condition (coded as 1) (b = 0.21, OR = 1.24, p = 0.44) or the Mars prime condition (coded as 1) (b = -0.50, OR = 0.61, p = 0.13). However, there was a significant interaction when the M&S prime condition (coded as 0) was compared to the Mars prime condition (coded as 1), b = -0.71, OR = 0.49, p = 0.03. The R^2 values for the overall model are as follows: Cox & Snell = 0.07, Nagelkerke = 0.09. The interaction between condition and hunger when comparing the M&S prime condition (coded as 0) with the Mars prime condition (coded as 1) was explored through a simple slopes analysis. For participants with lower levels of hunger (1 SD below the mean), there was no difference between the conditions regarding snack choice, b = 0.99, OR = 2.68, p = 0.11. For participants with average hunger levels, exposure to the prime stimuli had no effect on snack choice, b = 0.01, OR = 1.01, p = 0.98. For participants with higher levels of hunger (1 SD

above the mean), there was no difference in the snack choice of participants in the M&S prime condition compared to the Mars prime condition, b = -0.96, OR = 2.61, p = 0.12. The Johnson-Neyman technique showed there was no statistically significant transition point for this interaction.

The Moderating Effect of Tiredness

As the tiredness data had a bimodal distribution, it was dichotomised in order to compare participants who scored low and high on tiredness. The results showed that there was no main effect of tiredness on snack choice, b = 0.22, OR = 1.25, p = 0.50, R^2 (Cox and Snell) = 0.00, R^2 (Nagelkerke) = 0.00. However, there was a significant interaction when the control condition (coded as 0) was compared to the M&S prime condition (coded as 1), b = 1.92, OR = 6.85, p = 0.02. There was no interaction when the control condition (coded as 0) was compared to the Mars prime condition (coded as 1) (b = 0.38, OR = 1.46, p = 0.64) or when the M&S prime condition (coded as 0) was compared to the Mars prime condition (coded as 1) (b = -1.54, OR = 0.21, p = 0.07). The R^2 values for the overall model are as follows: Cox & Snell = 0.04, Nagelkerke = 0.05. A simple slopes analysis was run to explore the interaction between condition and tiredness when comparing the control condition (coded as 0) with the M&S prime condition (coded as 1). For participants who were less tired, the effect of condition on snack choice just reached significance, b = -1.32, OR = 0.27, p = 0.05, with those in the M&S condition more likely to select the M&S snack. However, for participants who were more tired, there was no effect of condition on snack choice, b = 0.60, OR = 1.78, p = 0.23. As the moderating variable had been dichotomised, the Johnson-Neyman technique could not be used to determine the significant transition point.

The Moderating Effect of Self-reported BMI

Even though self-reported BMI was significantly higher in the Mars prime condition than the control or M&S prime condition, the results showed there was no main effect of BMI on snack choice, b = 0.01, OR = 1.01, p = 0.88, R^2 (Cox and Snell) = 0.00, R^2 (Nagelkerke) = 0.00. There was no interaction when the control condition (coded as 0) was compared with the M&S prime condition (coded as 1) (b = -0.11, OR = 0.90, p = 0.38). However, there was a significant interaction when the control condition (coded as 0) was compared with the Mars prime condition (coded as 1), b = -0.27, OR = 0.76, p = 0.03. There was no interaction when the M&S prime condition (coded as 0) was compared with the Mars prime condition (coded as 1) (b = -0.16, OR = 0.85, p = 0.20). The R^2 values for the overall model are as follows:

Cox & Snell = 0.04, Nagelkerke = 0.05. The interaction between condition and self-reported BMI when comparing the control condition (coded as 0) with the Mars prime condition (coded as 1) was explored through a simple slopes analysis. For participants with a lower BMI (1 SD below the mean), the effect of condition on snack choice approached significance, $b = 1.12$, $OR = 3.05$ $p = 0.08$, whereby participants in the Mars prime condition were more likely to select the Mars bar. For participants with an average BMI, there was no difference in the snack choice of participants in the control condition compared to the Mars prime condition, $b = 0.14$, $OR = 1.14$, $p = 0.75$. For participants with a high BMI (1 SD above the mean), there was no difference between the conditions regarding snack choice, $b = -0.85$, $OR = 2.33$, $p = 0.18$. The Johnson-Neyman technique showed that participants in the Mars prime condition with a BMI of 19 or less were significantly more likely to select the Mars bar than the M&S snack, $b = 1.53$, $OR = 4.60$, $p = 0.05$. Furthermore, participants in the Mars condition with a BMI of 35.7 or more were significantly more likely to select the M&S snack than the Mars bar, $b = -3.02$, $OR = 0.05$, $p = 0.05$.

Deviations from Pre-registration

The pre-registration form stated that the main data analysis would be conducted using a multinomial regression model and a series of logistic regression analyses whereby the M&S snack choice and no snack choice would be collapsed into one category. However, as the no snack category was very small and collapsing the categories involved making assumptions about these participants, it was decided that excluding the no snack category was the most appropriate way of analysing the data.

3.4 Discussion

The main aim of this study was to analyse the effect of priming on snack choice, where the food logos presented during the priming task corresponded to the logos on the snacks offered. The participants were primed through the completion of a 2018 World Cup Quiz that contained an image of Gareth Southgate, the England football team manager, with either the M&S logo, the Mars logo, or no food-related logos in the background. The effect of the primes was measured by offering participants the choice of either an M&S fruit and nut assortment or a Mars bar as a thank you for taking part. A verbal funnelled debrief was also completed to ensure participants were unaware of the true aim of the study. Contrary to

expectations, the results showed that there was no effect of the logos on snack choice; the percentage of participants selecting the M&S snack and the Mars bar were similar across all three conditions. Although this does not support the initial prediction, several potential explanations that may account for this finding are discussed below.

Firstly, the priming task may have been too weak to have an effect on snack choice due to a fairly short exposure to the prime stimuli. The participants who immediately recognised the individual in the image as Gareth Southgate will have had far less exposure to the prime stimuli than the participants who took longer to answer this question. As a result, it is likely there was considerable variation in the length of time each individual was exposed to the prime stimuli across the sample. According to Bargh and Chartrand (2000), the level of concept activation is determined by the formula Duration x Intensity = Activation, whereby a longer duration and higher intensity lead to a greater level of concept activation. Consequently, participants exposed to the image for a longer duration will have achieved a greater level of concept activation and may have been more likely to select the corresponding snack. However, due to the design of the study, it was not possible to measure the length of time each participant was exposed to the image and so the effect of exposure duration on snack choice cannot be determined. In reality, exposure to logos will vary considerably depending on the context; logos visible on websites may only be viewed briefly whereas logos visible on advertising boards during interviews may be in view for several minutes or more. Future research could address this issue by ensuring greater control over the exposure duration to the prime stimuli; for example, a video of an interview with a football manager or player would ensure that each participant is exposed to the prime stimuli for the same duration. Furthermore, it would also be interesting for future research to vary the exposure time across conditions to determine whether longer exposure time results in stronger priming effects in this particular context.

Secondly, the strength of the prime stimuli may have been weakened due to the complexity of the image shown to participants. Despite research evidence showing that even subliminal primes can increase the accessibility of a mental concept and influence subsequent judgements, decisions, and behaviour (Van den Bussche et al., 2009; Karremans, et al., 2006), these studies usually involve presenting the prime stimuli in isolation; for example, presenting a word or image by itself rather than as part of a more complex sentence or image. As stated above, the level of concept activation is determined by the duration and intensity of

the prime stimuli presented to the participants (Bargh & Chartrand, 2000). Therefore, as the primes in the present study were shown in the background of a larger and more detailed image, the intensity and subsequent activation of the corresponding mental concepts is likely to have been reduced. Although research using fMRI methods has found that a stimulus may still be processed even when it is not consciously attended to (Vuilleumire et al., 2005), the participants were not specifically instructed to look at the food-related logos, which may have further reduced the level of concept activation achieved. This is supported by research showing that consciously processing the prime stimuli usually results in stronger priming effects than presenting the prime stimuli subliminally (Bargh & Chartrand, 2000). Therefore, future research could examine the extent to which primes are processed by using both a free recall (explicit memory) task and a recognition (implicit memory) task. However, in order to check the effectiveness of the priming task in the present study, a confirmation task could be conducted where the accessibility of the relevant food-related concepts is assessed through a response latency task following completion of the World Cup Quiz.

Thirdly, the effectiveness of the priming task may have been compromised by the inclusion of several different concepts in the prime image. Negative priming effects occur when the inhibition of a prime stimulus reduces the accessibility of the corresponding mental concept during a subsequent task (Tipper, 1985). According to Frings et al. (2015), if an initial distractor stimulus subsequently becomes the target stimulus in a cognitive or behavioural task, response to this target is reduced in terms of latency and/or accuracy. For example, perception of the image may have activated irrelevant mental concepts through the identification of Gareth Southgate, as well as recognition of the logos that were not food-related. As the specific food-related logos in the image were irrelevant to the initial priming task – recognition of the individual in the image – they may have acted as distractor stimuli and therefore become less accessible as a result. As the percentage of M&S snacks and Mars bars was approximately equal across conditions, it appears that the accessibility of the prime concepts was not significantly increased or decreased by the priming task. However, it is important to acknowledge the potential for negative priming effects to occur depending on the priming task employed. This could be examined through laboratory-based research examining how prolonged exposure to the image affects subsequent responses on a lexical decision task; a reduction in response latency would imply the primes had a facilitative priming effect whereas an increase in response latency would imply a negative priming effect.

Finally, even though the explanations above may account for the lack of effect found, it is also important to acknowledge the possibility that exposure to food-related brand logos has no effect on food choice. Although any prime stimulus that has a corresponding mental concept in memory has the potential to prime behaviour, this effect may be eliminated if the individual has developed strong habitual eating and drinking behaviours. Habits have been described as learned behaviours that are performed automatically following exposure to specific environmental cues (van't Riet et al., 2011), with evidence that habits account for 18% of daily eating and drinking behaviours (Gardner et al., 2011). Consequently, habits may override the effect of prime stimuli if a particular stimulus or context is associated with a specific behavioural response.

The Main Effects of Age, Conscious Effort to Eat Healthily and Hunger

The exploratory analyses found several significant main effects on snack choice including age, conscious effort to eat healthily, and hunger. The main effect of age showed that older participants were more likely to select the M&S snack than younger participants; this is in line with research showing that older individuals are more likely to eat healthy foods in order to prevent future health issues (Chambers et al., 2008). In this case, the M&S fruit and nut assortment may have been perceived as healthier than the Mars bar due to the high nutrition and fibre content of fruits and nuts (Murray et al., 2012). There was also a significant main effect of conscious effort to eat healthily on snack choice whereby participants who reported a greater conscious effort to eat healthily were more likely to select the M&S snack than participants reporting a lower conscious effort to eat healthily. As this was expected, based on the assumption that the M&S snack is perceived as a healthier choice than the Mars bar, this provides support for the validity of this measure. Lastly, there was a significant main effect of hunger on snack choice whereby participants indicating a higher level of hunger were more likely to select the M&S fruit and nut assortment. Although care was taken to ensure both snacks were of a comparable size, the M&S snack was approximately 70 grams while the Mars bar was slightly smaller at 51 grams; consequently, the M&S snack may have been perceived as more filling than the Mars bar due to its larger size.

The Moderating Effects of Age, Dieting Status, Hunger, Tiredness and BMI

The exploratory analyses also showed several significant interaction effects that influenced the snack choice of the participants. Firstly, age was found to be a significant moderator

when comparing the control condition with the M&S prime condition; the simple slopes and Johnson-Neyman technique showed that exposure to the M&S prime only increased the selection of the M&S snack for participants who were 37 years or older. This may be due to the core target for M&S being women who are aged 50 or over with only 22% of M&S customers aged under 35 (BBC News, 2016). Although the same interaction would be expected when comparing the M&S prime condition with the Mars prime condition, the lack of effect may be due to the greater variance in age in the Mars prime condition. Specifically, there were an extra seven participants aged 37 or older in the Mars prime condition compared to the M&S prime condition. Consequently, this may have offset any effect of the M&S prime on snack choice, reducing the difference between these conditions.

Secondly, a significant moderating effect of dieting status was found when the M&S prime condition was compared to the Mars prime condition. Further analysis of this interaction showed there was no effect of condition on snack choice for participants who reported they were not dieting; however, there was a significant effect of condition on snack choice for participants who reported they were dieting, where these participants were far more likely to select the snack that corresponded with the prime stimuli presented. This implies that exposure to the M&S prime and the Mars prime activated the corresponding mental concepts in memory and led to the selection of the conforming snack. This finding may be due to restrained eaters having an enhanced orientation of detection toward food stimuli in comparison to unrestrained eaters; research has shown that restrained eaters are faster to detect food stimuli than unrestrained eaters, implying that food-related stimuli in the environment are more salient to these individuals (Hollitt et al., 2010). Consequently, these individuals may have been quicker to detect the prime stimuli, as well as processing the prime stimuli more deeply, resulting in behavioural priming effects.

Thirdly, hunger was found to be a significant moderator when the M&S prime condition was compared to the Mars prime condition. The simple slopes analysis showed that participants in the Mars prime condition were more likely to select the M&S snack as hunger increased, although there was no statistically significant transition point for this interaction. Interestingly, level of hunger had no effect on the snack choice of participants in the M&S prime condition, although one reason for this could be that M&S sells a variety of consumer goods and may not automatically activate the concept of food. However, in the Mars prime condition, it may be the case that hungry participants were more likely to perceive the Mars

logo than less hungry participants, based on research showing that hunger heightens the perception of food cues (Piech et al., 2010); therefore, perception of the Mars logo may have unconsciously activated the goal to consume food in order to reduce feelings of hunger. Nonetheless, it is unclear why participants exposed to the Mars logo and reporting high levels of hunger were more likely to select the M&S snack as opposed to the Mars bar. One potential explanation is that the M&S snack was perceived as more filling than the Mars bar as it was slightly larger in size and has a lower glycaemic index; this is based on research showing that foods with a high glycaemic index can actually increase hunger relative to foods with a low glycaemic index (Roberts, 2000). Alternatively, it may be the case that this is a spurious finding due to the large number of significance tests conducted; as the number of tests conducted increases, the chances of finding a significant effect also increases. Consequently, further research is required to examine the moderating effect of hunger and whether high levels of hunger are associated with stronger priming effects.

Fourthly, a significant moderating effect of tiredness was found when the control condition was compared to the M&S prime condition; the simple slopes analysis showed that participants in the M&S prime condition with lower levels of tiredness were more likely to select the M&S snack. However, as tiredness was dichotomised into high and low levels of tiredness, the Johnson-Neyman technique could not be used to determine whether there was a significant transition point for this effect. As priming is the result of automatic processes, participants reporting higher levels of tiredness would be expected to show a stronger priming effect than participants reporting low levels of tiredness, assuming that tiredness increases reliance on automatic processes. This seems a reasonable assumption given that sleep deprivation has previously been found to impair performance on cognitive based tasks (Alhola & Polo-Kantola, 2007). However, it may be the case that the participants reporting lower levels of tiredness may have processed the prime stimuli more deeply, leading to greater activation of the corresponding mental concept in memory and stronger priming effects. This is supported by research showing that sleep deprivation significantly reduces the ability to effectively extract information from visual stimuli, implying that tiredness may actually reduce the amount of cognitive processing taking place, rather than just increasing reliance on automatic processes (Ratcliff & Van Dongen, 2009). Alternatively, this may be another spurious finding due to the large number of statistical tests conducted.

Lastly, self-reported BMI was also a significant moderator when the control condition was compared with the Mars prime condition. The simple slopes and Johnson-Neyman technique showed that participants in the Mars prime condition with a BMI of 19 or less were more likely to select the Mars bar, whereas those with a BMI of 35.7 or more were more likely to select the M&S snack. This may be due to those with a lower BMI feeling less self-conscious and therefore more open to the influence of the primes. In contrast, those with a higher BMI may have felt extremely self-conscious about their weight and therefore less open to the influence of the primes. This may relate to the dominant view in society that each individual is responsible for their own physical health and the belief that obese individuals are unable to lose weight due to a failure of personal willpower (Pearl & Lebowitz, 2014). Therefore, the participants with a higher BMI may have thought that selecting the Mars bar may reinforce this societal belief and lead to them being judged negatively by the researcher.

Theory and Previous Research

The study was based on the Situated Inference Model which proposes that exposure to a stimulus increases the accessibility of a synonymous mental concept in memory (Loersch & Payne, 2011). The individual misattributes this increased accessibility for their own thoughts and feelings which subsequently influences judgements, decisions, and behaviour. As it is likely that the priming task was not strong enough to activate the corresponding mental concepts in memory, it is not possible to evaluate the Situated Inference Model based on this study. In order to test this model effectively, future research should employ a stronger priming task where the prime stimuli are presented for a longer duration and/or at a greater intensity. It may also be beneficial to include a measure of how each participant thinks and feels about each snack to determine whether this mediates any effect of the primes on snack choice.

However, the findings of the study provide strong support for the goal conflict model of eating behaviour as participants who were dieting were significantly more likely to select the snack that corresponded with the prime stimuli presented; the results also showed there was no main effect of dieting on snack choice which further supports this model. Assuming that the M&S snack was perceived as a healthy food choice and the Mars bar was viewed as an unhealthy food choice, this finding implies that exposure to the M&S prime activated the weight control goal and exposure to the Mars prime activated the eating enjoyment goal. As stated above, this may be due to restrained eaters having an attentional bias toward food

stimuli in the environment, leading to greater activation of the corresponding mental concepts in memory. Furthermore, the findings also imply that exposure to the Mars logo did not activate the weight control goal which would be expected for participants classed as successful dieters; however, as the success rate of the dieters was not measured it is not possible to evaluate this aspect of the model. Therefore, future research would benefit from measuring (1) the success rate of those participants who are dieting; (2) the capacity for each prime stimulus to activate the weight control goal and the eating enjoyment goal; and (3) the extent to which each snack is considered healthy or unhealthy.

The findings also support research examining the bottom-up processing of sensory stimuli in the environment, which are integrated to form a coherent understanding of the situation; this is supported by the significant moderating effect of self-reported BMI when the control condition was compared with the Mars prime condition. The finding that exposure to the Mars prime influenced the snack choice of both underweight and obese participants implies that these participants did integrate the prime stimuli through bottom-up processing to form an understanding of the situation. However, the contrasting effects observed suggest that the prime stimuli may have activated different mental concepts depending on the BMI of the participant. As the underweight participants were more likely to select the Mars bar, it may be the case that the Mars prime was associated with mainly positive concepts for these individuals, encouraging the selection of the corresponding snack. On the other hand, it may be the case that the Mars prime was associated with mainly negative concepts for the obese participants, leading to the selection of the M&S snack; more specifically, exposure to the Mars prime may have activated negative concepts associated with the self, increasing feelings of self-consciousness and the threat of being judged. Overall, the findings of the present study advance those of previous research by implying that both underweight and obese individuals are vulnerable to specific cognitive processes that influence the processing of food-related stimuli. Consequently, further research is required to examine the effect of prime stimuli on underweight individuals as well as those who are classed as obese.

In relation to previous research, the present findings are in contrast with the results of previous studies (Chiou et al., 2013; Fishbach & Dhar, 2005; Karremans et al., 2006), although this is likely a result of the specific priming task used. Previous research has often used the scrambled sentence task or a memory task that ensures each participant will consciously process the prime stimuli. However, as the purpose of the present study was to

replicate a natural setting where various stimuli are visible simultaneously, the priming task employed did not require conscious processing of the prime. Consequently, the present study has a higher level of ecological validity compared to lab-based studies and there is also a reduced likelihood of demand characteristics affecting the results.

In conclusion, the results of this study did not support the hypothesis that exposure to a food-related prime would increase the selection of the corresponding snack in a subsequent choice task. However, the results may have been influenced by the specific priming task employed; the task did not require conscious processing of the prime and it was presented as part of a more detailed image that included various logos unrelated to food. Alternatively, it may be the case that exposure to brand logos has no effect on food choice, particularly if the individual has developed strong eating habits over time. As this task reflects exposure to primes in a more natural setting, the overall effectiveness of priming through football sponsorship requires more research before any definitive conclusions can be drawn.

Chapter Four:
A Laboratory-Based Study Examining The Effect of Priming on Snack Choice

Abstract

As Chapter Three found no effect of the food-related logos on snack choice in a real-world setting, the present study examined whether food-related logos could influence snack choice in a laboratory setting. Although significant moderating effects of both hunger and tiredness were reported, these are not examined further as the main aim of this thesis is to determine whether food-related logos have a direct effect on food choice. One reason for conducting laboratory-based research was to allow for the completion of a stronger priming task in order to increase the level of concept activation achieved; a novel priming task was developed that involved presenting six unhealthy food-related logos at a higher intensity and for a much longer duration than the logos presented during the field study. A variety of unhealthy food-related logos were presented as most social environments contain numerous brand logos rather than just the same logo presented repeatedly. Furthermore, the frequency and duration of exposure to the prime stimuli was increased in order to more closely reflect how individuals are exposed to primes in the social environment. Another reason for conducting laboratory-based research was to allow for the completion of a more sensitive measure of snack choice. Specifically, the participants completed a food selection task that involved selecting five foods from a variety of healthy and unhealthy snack items so that even a small effect of the primes on snack choice could be detected. As it has been proposed that mindfulness may reduce the influence of automatic processes on behaviour, it was also examined whether any priming effect was moderated by trait mindfulness. As with the field study, the Situated Inference Model (Loersch & Payne, 2011) provided the theoretical basis for the expected effect of the unhealthy food-related primes on snack choice. Based on this model it was expected that exposure to the food-related logos would: (1) activate the corresponding mental concept of the logos in memory; (2) temporarily increase the accessibility of the corresponding mental concepts which would be attributed to the individual's own thoughts and feelings; and (3) result in a greater selection of unhealthy snacks during the food selection task.

4.1 Introduction

Brand Logos as Prime Stimuli

Although the field study failed to find an effect of the food-related logos on snack choice, there is recent evidence that exposure to brand logos can increase the accessibility of the brand concept in memory (Muscarella et al., 2013). Specifically, Muscarella et al. (2013) compared an unconscious prime condition with a conscious prime condition where both involved exposing the participants to five brand logos that had previously been confirmed as highly familiar and recognizable during a pilot study; the logos selected had also elicited the strongest unconscious and conscious priming effects in a previous study that exposed the participants to ten different brand logos. The participants in the unconscious prime condition were exposed to each prime for 17 milliseconds whereas those in the conscious condition were exposed to each prime for 34 milliseconds. Following exposure to each prime, the participants completed a lexical decision task where the target words were from one of four target word categories: (1) a related brand condition (e.g. the McDonald's logo followed by the word "MCDONALDS"); (2) a related non-brand condition (e.g. the McDonald's logo followed by the word "HAMBURGER"); (3) an unrelated brand condition (e.g. the McDonald's logo followed by the word "LACOSTE"); (3) and a unrelated non-brand condition (e.g. the McDonald's logo followed by the word "TIRES"). The results showed that participants responded significantly faster on both brand and non-brand trials where the prime and target were related as opposed to unrelated. Furthermore, a significant interaction was observed where participants responded faster in the related brand condition than the related non-brand condition. Based on these findings, exposure to brand logos can activate a corresponding mental concept in memory, which has the potential to have downstream effects on behaviour.

The research described above provides evidence for the capacity of individual brand logos to activate a mental concept in memory when presented at both a subliminal and supraliminal level. However, Bargh and Chartrand (2000) state that supraliminal primes usually produce stronger effects than subliminal primes, as the strength of the priming effect is determined by the strength of the concept activation; this can be calculated using the formula: Duration x Intensity = Activation (Bargh & Chartrand, 2000). As supraliminal primes are presented for a longer duration than subliminal primes, this will result in a greater level of concept activation

even when the intensity of the primes remains the same. However, the likelihood of finding a significant priming effect is increased when the prime stimuli are presented at both a high intensity and for a prolonged period of time. Nevertheless, it is important to be aware that the stronger the priming task, the more likely the participants will become aware of the aim of the study (Bargh & Chartrand, 2000). As this can lead to a contrast effect, it is important to develop a priming task that results in a high level of concept activation without directing the participant to the aim of the study. One way of achieving this is to include a delay between the priming task and the outcome measure, as this reduces the likelihood that the participant will recognise the link between the two tasks. Although priming effects decrease in strength over time, this approach will allow for the completion of a much stronger priming task which may offset the effect of the delay.

Snack Variety

As snacking has become a normal part of daily life, the diversity and number of snacks available has increased dramatically. At present, Cadbury produces 35 different types of single chocolate bar with many of these also available as bite-sized versions sold in bags or boxes (Cadbury, n.d. -a); for example, a Boost bar is presently available as a single chocolate bar or as a bag of bite-sized snacks called 'Boost bites'. Although the 'Boost bites' have fewer calories per individual chocolate, the whole bag contains more than twice the number of calories in a single bar; each bag contains almost 560 calories whereas a single bar contains 250 calories (Cadbury, n.d. -b; Cadbury, n.d. -c). For individuals attempting to reduce daily energy intake, treat and snack size versions of chocolate bars and confectionaries are now widely available in many UK supermarkets. However, the fact that many of these are only available in multipacks defeats the objective of buying smaller sizes, as the total volume of unhealthy snacks purchased and consumed may actually increase. This is supported by research which found that smaller versions of hedonic food products led to an increase in consumption as individuals discarded the calories in each item causing them to 'fly under the radar' (Coelho do Vale et al., 2008).

The large variety of snacks available in the UK is highlighted by Thornton et al. (2013), who compared the display of snack foods and soft drinks in various supermarkets across the following eight countries: Australia, Canada, Denmark, the Netherlands, New Zealand, Sweden, the United Kingdom (UK), and the United States of America (USA). The authors measured the total aisle length in each supermarket that was dedicated to the following four

snack food and beverage groups: crisps, chocolate, confectionary, and soft drinks. The results showed that the UK had the greatest total aisle length dedicated to snack food of all eight countries with an average of 56.4 metres per store, adjusted for total store size. Sub-analyses also showed that the UK ranked first for the greatest aisle length dedicated to crisps (15.2m), chocolate (15.6m), and confectionary (11.6m); Australia ranked first for the greatest aisle length dedicated to soft drinks (18.4m), followed by the USA (14m) and the UK (13.9m). The authors also calculated the ratio of the aisle length for snack foods compared to the aisle length for fruits and vegetables; overall, the UK ranked second with a ratio of 1.31, meaning that for every 2 metres of fruits and vegetables there are approximately 3 metres of snack foods.

Mindfulness and Automatic Processing

As discussed in Chapter One, mindfulness is an ancient Buddhist practice that involves paying attention in a particular way: on purpose, in the present moment, and non-judgementally (Kabat-Zinn, 1994). As the ability to stay present improves, the true nature of thoughts and concepts becomes more apparent; thoughts are recognized as transient mental events that rise and fall (Bishop et al., 2004), whereas concepts are seen as a projection of thoughts and beliefs onto a mental image or physical object (Nisker, 1998). Therefore, cultivating a mindful disposition allows for each moment to be observed more fully, the present moment to be experienced more deeply, and situations to be perceived with greater clarity (Titmuss, 2014). This runs counter to the automatic and habitual mind states that are so pervasive in everyday life, many of which lead to unhealthy behaviours and untimely consequences (Titmuss, 2014).

The potential for mindfulness to reduce the influence of automatic processes and increase the influence of conscious processes on behaviour has recently been proposed by Kang et al. (2013). Specifically, they argue that mindfulness increases the activation of conscious processes through four specific mechanisms: awareness, attention, focus on the present, and non-judgemental acceptance. Awareness refers to the conscious awareness of one's present moment experience including both internal events (e.g. bodily sensations, thoughts and emotions) and external events (e.g. sights and sounds); for example, a mindful individual will have greater awareness of when judgements and decisions are being influenced by cognitive biases. Attention refers to the focus of attention being directed specifically at these internal and external events; the mind is gently guided back to these events whenever it drifts away or

becomes distracted. Focus on the present moment involves the focus of attention being directed at the events occurring in each moment; this is the opposite of being caught up in thoughts about the past or the future including memories, plans, or fantasies. Non-judgemental acceptance involves allowing each event to enter conscious awareness, without being judged as good or bad, desirable or undesirable, important or trivial (Germer et al., 2005); acceptance allows individuals to appreciate both concrete experiences, such as sensory pain, and abstract experiences, such as feelings of rejection. As mindfulness is cultivated, individuals start to realize that thoughts are simply transient mental events that continually rise and fall from conscious awareness (Kang et al., 2013). This realization leads to the creation of mental distance from present thoughts, often referred to as cognitive decoupling, allowing individuals to become more aware of how they intuitively react to various internal and external events. As a result, individuals are able to respond to the event from a conscious level rather than an unconscious level.

Mindfulness and Reward Reactivity

The behavioural activation system is a motivational system that strives to attain rewards through organizing and regulating behaviour (Gray, 1989). As this system relies on high-order executive control processes, it was initially assumed that this system operates within conscious awareness (Capa & Bouquet, 2018). However, a recent study by Pessiglione et al. (2007) has found that under certain conditions, individuals are unable to report the goals or rewards that drive particular behaviours. This study specifically examined whether presenting motivational stimuli at a subliminal level could activate reward circuits in the brain and subsequently improve motor performance. Motivation was manipulated by presenting an image of a penny (low motivation) or a pound coin (high motivation) at either a subliminal or supraliminal level. The results showed that the activation of reward circuits in the brain was similar for all the participants who were shown the pound coin, regardless of the level of presentation. Furthermore, these participants also showed improved motor performance on a hand grip task, implying that the activation of unconscious motivational processes can have a downstream effect on behaviour. The authors concluded that ‘these results indicate that the motivational processes involved in boosting behaviour are qualitatively similar, despite whether subjects are conscious or not of the reward at stake’ (Pessiglione et al., 2007, p. 906). Therefore, these findings show that prime stimuli have the capacity to elicit reward reactivity outside of awareness.

The potential for mindfulness to reduce reward reactivity has recently been proposed by Keesman et al. (2017) who argue that cognitive decoupling is the mechanism responsible for this effect. Keesman et al. (2017) conducted a review that specifically focussed on the potential for mindfulness to reduce reward reactivity to food cues - stimuli that include the sight and/or smell of food (Ferriday & Brunstrom, 2011). Exposure to food cues automatically elicits a simulation of consumption, resulting in a physiological response as the body prepares to eat (Nederkoorn et al., 2000). The automaticity of this process is supported by fMRI studies showing that simply being exposed to food cues activates areas of the brain that process information related to taste and reward (Chen et al., 2016). However, Keesman et al. (2017) contend that cognitive decoupling can reduce reactivity to food cues by targeting the simulations that motivate the subsequent consumption of food. Specifically, they argue that cognitive decoupling allows the individual to perceive the simulation as an impermanent mental state that will eventually dissipate, reducing the elaboration of these simulations and the motivation to consume the food presented. This is also supported by Tapper (2018) who examined the effect of different types of mindfulness practices on cravings for food, cigarettes, and alcohol. Although the results were mixed, it was concluded that there was some evidence for the effectiveness of cognitive decoupling as a means of reducing craving. In relation to the present study, it is expected that individuals who are higher in trait mindfulness will naturally engage in cognitive decoupling, resulting in lower levels of trait reward reactivity following exposure to the prime stimuli. Although personality traits are often viewed as stable characteristics, research has found that they can and do change over time, with evidence showing that the greatest change occurs during young adulthood (Roberts & Mroczek, 2009).

Study Summary

As stated above, research has shown that subliminal and supraliminal exposure to brand logos can activate a corresponding mental concept in memory (Muscarella et al., 2013). Therefore, this study aimed to examine whether the presentation of unhealthy food-related logos (primes) would result in a greater number of unhealthy snack choices in a subsequent food selection task. This study aimed to build on the previous study in three ways. Firstly, each logo was presented in isolation to prevent the effect of the prime stimuli from being compromised due to exposure to several different concepts at the same time. This also allowed for a larger image of each logo to be presented, increasing the intensity of the prime stimuli and the resulting concept activation. Secondly, the nature of the priming task meant

that all the participants were exposed to the prime stimuli for a fairly long duration. As the logos formed an integral part of the priming task, this maximised the conscious processing of the primes and further increased the resulting concept activation. Specifically, the priming task involved distinguishing between an original and a modified version of various brand logos and was designed to be fairly difficult for two reasons: (1) to increase the amount of time the participants were exposed to the logos; and (2) to reduce the likelihood that the participants would become aware of the true aim of the study. Thirdly, the food selection task included a large variety of healthy and unhealthy food items in order to increase the sensitivity of the outcome measure. Consequently, this increased the likelihood of detecting a significant priming effect and also reflected the large variety of foods presently available in the UK.

In order to examine the effect of unhealthy food-related logos on snack choice, the participants were primed through the completion of a novel priming task which involved distinguishing between an original and a modified version of various brand logos. Approximately five minutes after completing the priming task, the participants were presented with a food selection task which involved selecting five foods from a list of 12 healthy and 12 unhealthy food items. The first confirmatory hypothesis stated that participants who were exposed to the unhealthy food-related logos would select a greater number of unhealthy food items during the food selection task. The second confirmatory hypothesis stated that participants exposed to the unhealthy food-related logos who were also high in trait mindfulness would be less influenced by the prime stimuli (moderation). The third confirmatory hypothesis stated that trait mindfulness would reduce the effect of the unhealthy food-related logos through a reduction in reward reactivity (mediation). The data analysis also explored whether any effect of the unhealthy food-related logos on snack choice was moderated by alertness, last food consumption, conscious effort to eat healthily, and/or BMI. This study was pre-registered on the Open Science Framework prior to the start of the data collection period (osf.io/cdb5p).

4.2 Method

Pilot Study One

The first pilot study was completed by a total of 50 female students who had resided in the United Kingdom for more than three years at the time of recruitment. All participants were required to give informed consent before starting the study which was set up using Qualtrics; the study was administered through the online recruitment platform Prolific Academic and took approximately 15 minutes to complete. The main aims were to determine the extent to which 16 food-related logos were perceived to be associated with unhealthy foods and the extent to which 36 food items were perceived to be healthy or unhealthy. For each food-related logo presented, the participants were asked (1) whether they recognised the logo; (2) what came to mind when they saw the logo; and (3) to rate their perception of the logo on a 7-point Likert scale from 'Extremely unhealthy' to 'Extremely healthy'. The Likert scale ratings were analysed by calculating the mean health rating for each logo presented; however, if a participant did not recognise a particular logo then their rating for that logo was excluded from the analysis. The eight logos with the lowest ratings and therefore considered the least healthy were then used to construct the priming task for the main study. The participants were also asked to rate 36 different food items on a 7-point Likert scale from 'Extremely unhealthy' to 'Extremely healthy'. After calculating the mean rating for each item, the 12 foods with the highest health rating and the 12 foods with the lowest health rating were included in the food selection task. On completion of both tasks, all the participants were debriefed and received £1.25 for taking part.

Pilot Study Two

The second pilot study recruited a total of 32 female students who had resided in the United Kingdom for more than three years at the time of recruitment. All participants were required to give informed consent before starting the study which took approximately 15 minutes to complete; the study was set up on Qualtrics and administered through the online recruitment platform Prolific Academic. The aim of the pilot study was to ensure that the prime and control tasks developed for the main study were comparable in terms of timing and difficulty. The participants completed a total of 32 trials where each trial involved distinguishing between an original and a modified version of a well-known brand logo. For each trial, participants were asked (1) whether they recognised the logo; (2) to identify the original

version of the logo; and (3) to rate the difficulty of each trial on a 7-point Likert scale from 'Extremely easy' to 'Extremely difficult'. Overall, the participants were presented with eight unhealthy food-related logos, eight clothing shop logos, eight social media logos, and eight car logos; each trial was also timed in order to compare the amount of time each logo was in view. The responses were analysed by calculating the mean difficulty rating and the mean time taken to complete each trial. Following this analysis, two logos were removed from each of the four logo categories to ensure that the difficulty rating and the time taken to complete each category was comparable. All the participants were debriefed and received £1.25 for taking part on completion of the study.

Participants

An a priori calculation using G*Power showed that 156 participants would be required to detect a small to medium effect size (0.4) and achieve a 0.8 level of power with alpha set at 0.05. Therefore, the main study recruited a total of 170 female participants (before exclusions) through leaflets administered in the Department of Psychology as well as an advertisement on the online experiment management system SONA. Females were recruited as it was important for the participants to be motivated to eat healthily in order to find a priming effect; the assumption that females are more motivated than males to eat healthy foods in order to regulate body weight was recently confirmed by Renner et al. (2012). The inclusion criteria also stated that participants must be at least 18 years old, have resided in the UK for a minimum of three years (to ensure familiarity with the logos), and have normal or corrected-to-normal vision (to ensure each logo could be perceived clearly). Any individuals with a food allergy or who identified as vegan were excluded due to the influence this may have while completing the food selection task. Ethical approval was granted by the City, University of London Psychology Department Research Ethics Committee.

Measures

Demographic Information The demographic information questionnaire included measures of age and education; The participants were specifically asked to state the highest level of education attained at the time of the study.

Alertness Level of alertness was measured by asking participants to rate how alert they felt in the present moment on a 7-point Likert scale ranging from 'Extremely alert' to 'Extremely unalert'.

Food Selection Task

The food selection task presented the participants with a total of 24 food items; these were the 12 foods considered the most healthy and the 12 foods considered the most unhealthy in the first pilot study. Each participant was asked to select five foods to evaluate in a 'taste test' at the end of the study, with both the healthy and unhealthy categories comprised of six savoury and six sweet food items.

Food Desire

Food desire was measured by asking the participants to rate how much they wanted to consume the food items presented during the food selection task in the present moment and without concern for calories or a healthy diet. The participants rated each of the 24 food items on a 7-point Likert scale from 'No desire' to 'Extreme desire'.

Five-Facet Mindfulness Questionnaire Short-Form (FFMQ-SF)

The FFMQ-SF is a 24-item questionnaire that measures trait mindfulness through five components: observing, describing, acting with awareness, non-judgement, and non-reactivity (Bohlmeijer et al., 2011). The observing subscale consists of four items (α for the present study = 0.52), whereas the describing subscale (α = 0.85), acting with awareness subscale (α = 0.81), non-judgement subscale (α = 0.80), and non-reactivity subscale (α = 0.74) all consist of five items. The authors have confirmed the replicability and validity of the questionnaire by cross-validating with an independent sample of participants (Bohlmeijer et al., 2011).

The Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ)

The behavioural approach systems subscale of the RST-PQ was administered as a means of measuring trait reward reactivity. This subscale measures four different components including reward interest (α for the present study = 0.77), goal-drive persistence (α = 0.85), reward reactivity (α = 0.80), and impulsivity (α = 0.77) (Corr & Cooper, 2016). The authors obtained evidence of validation in the form of convergent and discriminant correlations with existing personality scales (Corr & Cooper, 2016).

Funnelled Debrief

Awareness of the link between the priming task and the food selection task was assessed by asking participants a series of questions based on the awareness check guidelines provided by Bargh and Chartrand (2000). For example, participants were asked whether they had any ideas about the aim of the present study and whether any of the tasks completed during the 'first study' could have influenced their responses during the 'second study' (see Appendix A for a complete list of questions).

Eating Behaviour

The motivation to consume a healthy diet was measured by means of a single question; participants were asked to rate the statement 'I make a conscious effort to eat healthy foods' on a 7-point Likert scale from 'Strongly disagree' to 'Strongly agree'. Participants were also asked to specify (1) whether they were following a particular diet at the time of the study; (2) the last time they consumed food to the nearest 15 minutes; and (3) when they next planned to consume food to the nearest 15 minutes.

Body Mass Index (BMI)

After giving consent, the height and weight of each participant was taken so that BMI could be calculated.

Priming Task

Both the priming and control tasks consisted of 18 trials whereby each trial involved distinguishing between an original and a modified version of a well-known brand logo. Participants in the prime condition were presented with six trials of unhealthy food-related logos, six trials of social media logos, and six trials of car logos. Participants in the control condition were presented with the same logos as the prime condition, apart from the presentation of six trials of clothing shop logos in place of the six trials of unhealthy food-related logos for all unhealthy food-related logos presented). Each logo was approximately 15cm by 10cm on the computer screen, although this varied slightly depending on the shape of the logo. For each trial, the participants were asked to indicate whether they recognised the logo and to identify the original version. The duration of the exposure to each prime stimuli could not be measured due to the logos being presented in a random order by Qualtrics. Furthermore, even though the responses to each trial were recorded, the participants were not given any feedback regarding their performance on the priming task.

Procedure

Advertisements instructed participants to contact the researcher by email if they were interested in taking part in the study. Alternatively, participants could sign-up automatically though the experiment management system SONA used by the Department of Psychology at City, University of London. All participants were emailed and asked to confirm they adhered to the eligibility criteria before taking part. The study was completed through the computer software Qualtrics in one of the behavioural research laboratories located in the Department of Psychology. On arrival, participants were welcomed by the researcher and informed that they would be completing two separate studies to disguise the true aim of the research. All participants were given a study information sheet and asked if they had any questions before giving informed consent. Explicit instructions were provided on the computer screen to guide participants through the study.

The 'first study' was titled 'Recognition memory and thinking style' and took approximately 10 minutes to complete. The researcher waited outside the laboratory while the study was being completed to avoid unconsciously influencing the responses made. Participants were initially asked to state their age, educational attainment and present level of alertness before being automatically randomised to either the prime or control condition by Qualtrics. The participants then completed either the priming task or control task where the prime condition were exposed to the unhealthy food-related logos and the control condition were exposed to logos that were unrelated to food (see priming task above). Subsequently, the participants were asked to complete the 10-item rational-experiential inventory (REI-10) which was used as a decoy to prevent participants from becoming aware of the true aim of the research. On completion of the REI-10, a message on the computer screen asked the participant to inform the researcher they had now completed the 'first study' and were ready to start the 'second study'. On entering the laboratory, the researcher closed the window of the 'first study' and clicked on a desktop shortcut to open a new window for the 'second study'. The studies were purposely set-up as separate projects in Qualtrics to further conceal the true aim of the research.

The 'second study' was titled 'Food evaluation and personality' and also took approximately 10 minutes to complete. Prior to starting the 'second study', the participants were reminded that the first task was to select five foods to consume and evaluate as part of a 'taste test' at

the end of the study; this reminder ensured that participants were under the impression they would have to consume the five foods selected later on. The researcher then left the laboratory to avoid unconsciously influencing the subsequent responses made. Once five foods had been selected from the 12 healthy and 12 unhealthy foods items, the participants were asked to rate their desire for each of the 24 foods on a 7-point Likert scale from 'No desire' to 'Extreme desire'; the order in which the foods were presented during this task was automatically randomised by Qualtrics. This task was followed by completion of the FFMQ-SF and the behavioural approach systems subscale of the RST-PQ. After filling out both questionnaires, the participants were given the verbal funnelled debrief to ensure they were unaware of the link between the prime condition and the food selection task. The final part of the study involved completing the eating behaviour questionnaire and recording the height and weight of participants who consented to having these measures taken. After taking these measures, the participants were told that they would not be required to complete the taste test and were informed of the true nature of the study; all participants received a debrief sheet and were asked if they had any questions or comments regarding the study. As a result of not completing the taste test and as a thank you for taking part, all the participants were offered a snack to take away with them. Lastly, the assigned number of course credits or payment due was given to each participant.

4.3 Results

Data Screening and Participant Characteristics

Four participants showed awareness of the true aim of the study during the funnelled debrief and were therefore excluded from the main analysis. A further eight participants were excluded for the following reasons: the first six participants may have been unaware the five foods selected were to be consumed as part of a 'taste test', as all six participants started to leave the laboratory after completing the 'second study'; one participant was aiming to gain weight which may have increased the number of unhealthy foods selected by this participant; and one participant was found to be chewing gum throughout both studies. This resulted in a final sample size of 158 participants. Table 4.1 shows the demographic and personal characteristics of the participants as a function of condition.

Table 4.1

Characteristics of Participants as a Function of Condition

Characteristic[a]	Control (n = 82)	Prime (n = 76)	T-tests
Age (Mean, SD)	21.77 (6.28)	20.79 (6.84)	t = 0.94, p = 0.35
Completed education level (%)			
GCSE's	1	0	
A-Levels	70	78	
Bachelor's degree	11	12	χ^2 = 3.49, p = 0.48
Postgraduate degree	12	5	
Other	6	5	
Alertness (Mean, SD)	5.57 (0.97)	5.66 (1.05)	t = -0.52, p = 0.60
Conscious effort to eat healthily (Mean, SD)	4.83 (1.28)	4.84 (1.24)	t = -0.06, p = 0.95
Dieting (%)	9	9	χ^2 = 0.02, p = 0.88
Last food consumption in hours (Mean, SD)[b]	2.84 (3.84)	3.14 (3.67)	t = -0.51, p = 0.61
BMI[c] (Mean, SD)	23.25 (5.43)	24.49 (6.36)	t = -1.23, p = 0.22

[a]Alertness and conscious effort to eat healthily were both measured on 7-point Likert scales where higher scores reflected a higher agreement with each measure.
[b]One missing value in the control condition.
[c]Number who declined to have measures taken: Control = 9, prime = 12.

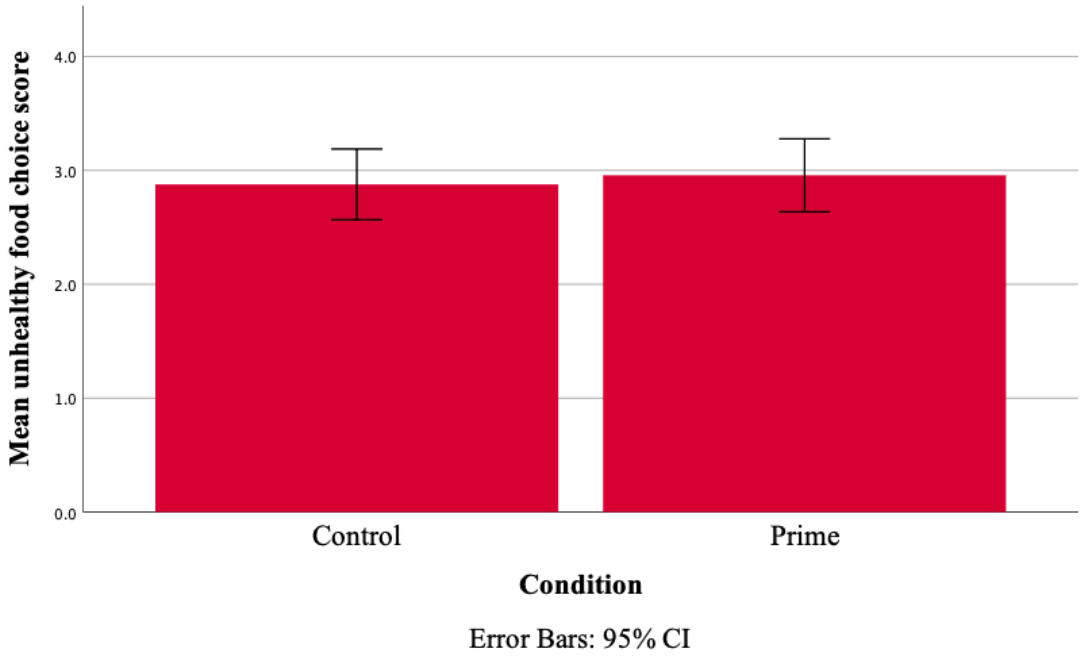
Confirmatory Analysis: The Effect of Condition on Food Choice Score

The number of unhealthy food choices made by each participant were summed to give a total unhealthy food choice score out of 5; participants selecting 5 healthy foods scored 0 and participants selecting 5 unhealthy foods scored 5. As four of the participants selected six foods to consume rather than five, these scores were adjusted to reflect the proportion of unhealthy food choices made by each participant based on the selection of five foods; this was calculated by dividing the original unhealthy food choice score by six and then multiplying by five. The descriptive statistics showed that the mean unhealthy food choice

score was slightly lower in the control condition (mean = 2.88, SD = 1.41) than the prime condition (mean = 2.96, SD = 1.40), supporting the initial research hypothesis. However, an independent t-test showed that this difference was not statistically significant, $t(156) = -0.36$, $p = 0.72$. The mean unhealthy food choice scores for the control condition and prime condition are visually represented in Figure 4.1.

Figure 4.1

The Mean Unhealthy Food Choice Scores for the Control and Prime Conditions



Confirmatory Analysis: The Moderating Effect of Mindfulness on Food Choice Score

A hierarchical linear regression was run to determine whether trait mindfulness (centred) moderated the association between condition and unhealthy food choice score. The analysis involved entering trait mindfulness at step 1, condition at step 2, and the interaction term at step 3. Table 4.2 shows a main effect of trait mindfulness on unhealthy food choice score whereby participants higher in trait mindfulness were less likely to select unhealthy foods, *ß* = -0.17, $t = -2.19$, $p = 0.03$. However, there was no significant interaction between condition and trait mindfulness on unhealthy food choice score, *ß* = 0.09, $t = 0.88$, $p = 0.38$.

Table 4.2

A Linear Regression Model Examining the Main and Moderating Effect of Trait Mindfulness on Unhealthy Food Choice Score.

	Food choice score		
	B	SE	Beta
Step 1			
Constant	2.92	0.11	
Trait mindfulness	-0.50	0.23	-0.17**
R^2	0.03		
Step 2			
Constant	2.88		
Condition[a]	0.07	0.22	0.02
R^2	0.03		
ΔR^2	0.00		
Step 3			
Constant	2.89		
Interaction	0.40	0.46	0.09
R^2	0.04		
ΔR^2	0.01		

[a]The control condition was coded as 0 and the prime condition was coded as 1.

**$p < 0.05$.

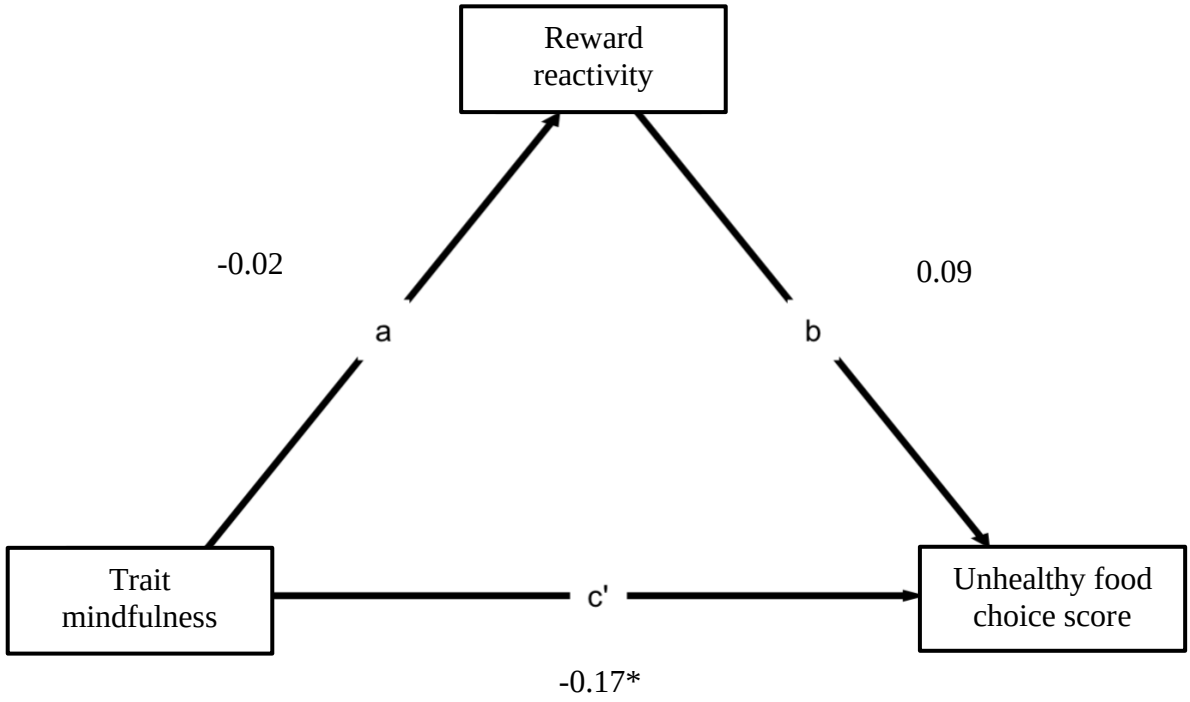
Confirmatory Analysis: The Mediating Effect of Reduced Reward Reactivity

Visual inspection of the data showed that reward reactivity had a non-normal distribution, although this was corrected following a square root transformation. Two simple linear regression analyses were performed to determine whether the effect of trait mindfulness on unhealthy food choice score was mediated by a reduction in reward reactivity. As the previous analysis had already established a main effect of trait mindfulness on unhealthy food choice score, the first regression tested for a direct effect of trait mindfulness on reward reactivity (path a) and the second for a direct effect of reward reactivity on unhealthy food choice score (path b). The results showed there was no main effect of trait mindfulness on reward reactivity or of reward reactivity on unhealthy food choice score. As the results precluded the potential for reward reactivity to act as a mediating variable, no further

analyses were performed. The standardised coefficients for each of the regression analyses are shown in Figure 4.2.

Figure 4.2

A Mediation Model Examining Whether Reward Reactivity Mediates the Effect of Trait Mindfulness on Unhealthy Food Choice Score.



Note. Standardised coefficients reported. *p < 0.05.

Exploratory Analysis: Mediating Effect of Impulsivity

As an alternative mediator, two simple linear regression analyses were performed to determine whether the effect of trait mindfulness on unhealthy food choice score was mediated by a reduction in impulsivity. As the previous analysis had already established a main effect of trait mindfulness on unhealthy food choice score, one regression tested for a direct effect of trait mindfulness on impulsivity and the other for a direct effect of impulsivity on unhealthy food choice score. The first regression showed there was a significant effect of trait mindfulness on impulsivity, whereby higher levels of mindfulness were associated with lower levels of impulsivity, (ß = -0.24, t = -3.02, p = 0.003); however, the second showed there was no significant effect of impulsivity on unhealthy food choice score (ß = 0.12, t =

1.49, $p = 0.14$). As the results precluded the potential for impulsivity to act as a mediating variable, no further analyses were performed.

Exploratory Analysis: Association Between Trait Mindfulness and Food Choice Score

A forced entry multiple regression showed the association between the five subscales of the FFMQ-SF and unhealthy food choice score was low to moderate (Multiple $R = 0.27$, $p = 0.04$) with the subscales accounting for 4% of the variance in unhealthy food choice score (Adjusted R^2). The data analysis showed that none of the subscales were intercorrelated (observing, VIF = 1.08; describing, VIF = 1.21; non-reactivity, VIF = 1.21; acting with awareness, VIF = 1.27; non-judgement, VIF = 1.44). Overall, non-judgement was the only significant predictor of unhealthy food choice score whereby participants reporting higher levels of non-judgement selected fewer unhealthy foods, $\beta = -0.27$, $p = 0.004$ (95% CI = -0.79 – -0.15). The unstandardized and standardised coefficients for each of the five subscales are shown in Table 4.3.

Table 4.3

A Linear Regression Model Examining the Effect of the Five Subscales of the FFMQ-SF on Unhealthy Food Choice Score.

	Food choice score		
	B	SE	Beta
Step 1			
Constant	4.77	0.82	
Observing	-0.27	0.17	-0.13
Describing	0.09	0.14	0.06
Non-reactivity	-0.09	0.16	-0.05
Acting with awareness	0.10	0.15	0.06
Non-judgement	-0.47	0.16	-0.27*

*$p < 0.05$.

Exploratory Analysis: The Moderating Effect of States

A series of hierarchical linear regressions were run to determine whether alertness, last food consumption, conscious effort to eat healthily and BMI moderated the association between condition and unhealthy food choice score. All moderator variables were mean centred before

being entered into each regression model. Each analysis involved entering the moderating variable at step 1, condition at step 2, and the interaction term at step 3.

The Moderating Effect of Alertness

The results showed there was no main effect of alertness on unhealthy food choice score, *ß* = 0.05, *t* = 0.63, *p* = 0.53. The coefficient of the interaction term was also not significant, *ß* = -0.03, *t* = -0.28, *p* = 0.78. The R^2 value for the overall model was 0.00.

The Moderating Effect of Last Food Consumption

Visual inspection of the data showed that last food consumption had a non-normal distribution, although this was corrected following a log10 transformation. There was no main effect of last food consumption on unhealthy food choice score, *ß* = 0.03, *t* = 0.32, *p* = 0.75. The coefficient of the interaction term was also not significant, *ß* = -0.17, *t* = -1.55, *p* = 0.12. The R^2 value for the overall model was 0.02.

The Moderating Effect of Conscious Effort to Eat Healthily

A main effect of conscious effort to eat healthily on unhealthy food choice score was found, whereby higher levels of conscious effort to eat healthily were associated with fewer unhealthy food choices, *ß* = -0.21, *t* = -2.64, *p* = 0.009. However, the coefficient of the interaction term was not significant, *ß* = -0.10, *t* = -0.93, *p* = 0.36. The R^2 value for the overall model was 0.05.

The Moderating Effect of BMI

As five BMI scores were identified as outliers through tests of normality, the values of these scores were replaced with the largest BMI score that was not identified as an outlier (Kwak & Kim, 2017). The results showed there was no main effect of BMI on unhealthy food choice score, *ß* = -0.11, *t* = -1.33, *p* = 0.19. The coefficient of the interaction term was also not significant, *ß* = -0.13, *t* = -1.14, *p* = 0.26. The R^2 value for the overall model was 0.02.

Exploratory Analysis: The Effect of Condition on Desire

As desire was measured on a 7-point Likert scale, a mean desire rating for the 12 unhealthy food products was calculated and compared between conditions. The descriptive statistics showed that the prime condition had a slightly higher desire for unhealthy foods (mean = 2.58, SD = 0.69) than the control condition (mean = 2.38, SD = 0.62). However, an

independent t-test showed that this difference was not statistically significant, $t(156) = 1.90$, $p = 0.06$.

4.4 Discussion

The main aim of this study was to analyse the effect of unhealthy food-related logos on subsequent food choice for a supposed 'taste test' at the end of the study. The participants were primed through a novel priming task that involved distinguishing between an original and a modified version of various brand logos; the prime condition were exposed to six unhealthy food logos while the control condition were not exposed to any food-related logos. The effect of the primes was measured by asking participants to select five foods from a list of 12 healthy and 12 unhealthy food items to consume as part of a subsequent 'taste test'. The participants also completed a verbal funnelled debrief to ensure they were unaware of the true aim of the study. The results showed there was no effect of the unhealthy food primes on the number of unhealthy food items selected; the mean number of unhealthy food items selected was similar for both the prime and control conditions. Although this result was unexpected, several potential explanations to account for these findings are discussed below.

Firstly, the priming task exposed the participants to six unhealthy food-related logos which only accounted for 33% of the stimuli in the priming task. As the task was developed to increase the strength of the concept activation by presenting the primes at a high intensity for a fairly long duration, it was determined that a higher frequency of prime stimuli may increase the proportion of participants becoming aware of the aim of the study. However, the importance of frequent exposure to prime stimuli has been demonstrated by Srull and Wyer (1979) who varied both the proportion of prime stimuli presented (20% or 80%) and the length of the priming task (30 items or 60 items). The results showed that participants exposed to a higher proportion of prime stimuli showed a stronger priming effect during a subsequent evaluation task than those exposed to a lower proportion of prime stimuli. Furthermore, participants who completed the 60-item priming task showed a stronger priming effect than participants who completed the 30-item priming task, even when both tasks had a high proportion of prime stimuli. Another study by Higgins et al. (1985) examined the importance of frequency and recency on the priming effects obtained following either a brief or moderate delay. The results showed that the priming effects were in line with

the more recently primed concept after a brief delay and the more frequently primed concept after a moderate delay. Based on these findings, the lack of effect found in the present study may be due to both the low proportion of prime stimuli in the priming task and the delay between the priming task and the food selection task. Therefore, future research could examine the importance of frequency in more detail by comparing two conditions that present the prime stimuli for the same overall duration but differ in terms of frequency.

Secondly, although the priming task was intentionally designed to be quite difficult in order to increase the exposure time to the logos, it may have been the case that the task was too difficult, leading the participants to randomly guess which logo was the original and reducing the overall exposure time to the prime stimuli. However, it was not possible to record the exact exposure time of each logo and present the logos in a random order, meaning that the average exposure time is unknown. Despite this, a fairly high percentage of participants indicated that they were unsure which of the logos presented was the original; the percentage of participants responding that they were unsure ranged from 9.2% to 48.7% across all six food-related logos. This implies that the participants found the priming task fairly hard, a comment that was often made during the verbal funnelled debrief after completing the 'first study'. The percentage of correct answers given was also fairly low with the percentage of correct answers given ranging from 25% to 53.9% across the six food-related logos, reaffirming the difficulty of the task. Furthermore, as the prime stimuli formed an integral part of the priming task, it is likely that top-down processes will have been engaged in order to distinguish between the original and modified logos, reducing the level of affect experienced in response to the prime stimuli. More specifically, the engagement of top-down processes may have reduced the level of positive affect experienced and the likelihood that exposure to the logos would influence subsequent food choice. However, as the evidence to support this argument is fairly limited at present, further research is required to examine this in more detail.

Thirdly, although there was no statistically significant difference between the conditions, the mean unhealthy food choice score was closer to the high end of the scale than the low end (approximately 3 out of 5). One reason for this may be because the majority of participants were first year undergraduate students, a population who have previously been found to be particularly vulnerable to weight gain. A prospective study examining weight change in first-year university students found that 77% of students gained weight during their first year, with

the majority of weight gain occurring during the first semester (Lloyd-Richardson et al., 2009). Both males and females gained an average of 3.5 kilograms over their first year of university with rates of overweight and obesity increasing from 21.6% at baseline to 36% by the end of the year. Furthermore, a meta-analysis of 24 studies has also been conducted to estimate the amount of weight gained during the first year of college or university (Vella-Zarb & Elgar, 2009); the results showed that the average first year gains almost two kilograms during their first year with one study reporting an average increase of almost 4 kilograms (Hovell et al., 1985). Interestingly, further analyses found a small significant association between gender composition and weight gain where studies with a higher proportion of females generally reported greater weight gain. Consequently, future research may benefit from specifically examining the effect of priming on female dieters who aim to consume healthy foods as a means of losing weight.

Lastly, the participants may have justified the selection of unhealthy foods by viewing the taste test as a 'one off' situation that is not frequently encountered. This is synonymous to the phenomenon of self-licensing whereby individuals are more likely to select hedonic food items when the decision context allows for consumption to be justified. It has been argued that 'sometimes indulgence is not determined by one's capacity to control oneself but rather by the availability of reasons to justify the prospective indulgence' (De Witt Huberts et al., 2012, p. 491). Therefore, the participants may have thought that consuming unhealthy foods on this occasion would have little impact on overall weight compared to more habitual eating behaviours. It may also be the case that the selection of one healthy food item provided justification for the selection of one unhealthy food item. This is supported by research examining the effect of health claims on the choice of side orders where participants who thought they were ordering a healthy main meal, ordered higher calorie side orders than participants who thought they were ordering an unhealthy main meal (Chandon & Wansink, 2007). Research has also shown that the mere presence of a healthy food option can lead to the selection of an indulgent food choice (Wilcox et al., 2010); ironically, it was found that the presence of a healthy food option led participants to select the most indulgent food item available with the effects most pronounced for participants high in self-control. Although there is no way for future research to account for this, it is important to at least acknowledge the potential effect of self-licensing on the results.

Exploratory Analysis: Main Effects

The results of the exploratory analysis showed a main effect of mindfulness on unhealthy food choice score whereby participants with higher levels of mindfulness were less likely to select unhealthy foods; this supports previous research which has also found a positive association between trait mindfulness and healthy eating behaviour (Jordan et al., 2014). In the present study it was specifically found that non-judgement of inner experience – allowing thoughts and feelings to be experienced without evaluating them as good or bad (Baer et al., 2008) – was negatively related to food choice score. However, future research should attempt to replicate this association, as well as establish whether non-judgement of inner experience has a causal effect on food choice. As the results showed that this association was not mediated by a reduction in reward reactivity, the mechanism through which non-judgement may influence food choice also requires further investigation.

There was also a main effect of conscious effort to eat healthily on unhealthy food choice score where participants reporting a greater effort to eat healthily made fewer unhealthy food choices; this confirms that the healthy food items perceived as healthy in the pilot study were also perceived as healthy in the main study.

Theory and Previous Research

As with the previous study, this study was based on the Situated Inference Model which proposes that the accessibility of a mental representation in memory increases following exposure to a stimulus (Loersch & Payne, 2011). As this increased accessibility is misattributed to the individual's own thoughts and feelings, it is then able to influence subsequent judgements, decisions, and behaviour. Overall, this study did not support the Situated Inference Model as there was no effect of the unhealthy food-related logos on food choice. As discussed above this may be because the priming task did not successfully activate the corresponding mental concepts in memory; although the priming task in this study was stronger than the previous study, the effectiveness of the priming task was not confirmed. Therefore, future research would benefit from confirming the accessibility of the primed concepts through the completion of a lexical decision task; specifically, the response times to both target and neutral words could be recorded and compared between conditions. As this model explicitly states that the increase in the accessibility of a mental concept is only temporary, it may also be the case that the delay between the priming task and the outcome measure was too long for the level of activation achieved. This could be examined by

reducing the delay between the priming task and the outcome measure, although it is important to be aware that this may increase the proportion of participants becoming aware of the link between the two tasks. Lastly, the participants in the prime condition may not have attributed the increased accessibility of the primed concepts to their own thoughts and feelings. If this is the case, then the increased accessibility of the primed concepts will have been dismissed by the participants during the food selection task, having no effect on the foods selected by the participants. However, as individuals often lack conscious awareness of the origin of thoughts and feelings, it would be difficult to confirm whether this accounts for the findings of this study (Bargh, 2014).

Although the field study provided support for the goal conflict model of eating behaviour, the low number of dieters recruited for this study precludes the potential to test for the moderating effect of dieting status on food choice; the inclusion criteria did not state that the participants had to be dieting in order to take part in the study. Even though a measure of conscious effort to eat healthy was taken, this is not the same as aiming to control weight through restricting overall food intake. As no comments can be made regarding this model based on the present study, future research would benefit from specifically recruiting individuals who are classified as restrained eaters in order to test this model effectively. Similarly, the results do not support previous research examining bottom-up processing which found that obese individuals in particular may be vulnerable to specific cognitive processes that influence the processing of food-related stimuli. However, this may be accounted for by the low percentage of obese individuals recruited for the study; only 8.2% of the sample recruited were classified as obese. Therefore, future research could examine this model in more detail by recruiting a more diverse sample of participants, including individuals who are classified as underweight, normal weight, overweight, and obese.

The findings of this study also contrast with the results of the previous research described in the preceding chapter (Chiou et al., 2013; Fishbach & Dhar, 2005; Karremans et al., 2006). Interestingly, all three previous studies presented the participants with a higher proportion of prime stimuli with the primes accounting for 50% of the stimuli in one study (Chiou et al., 2013) and 100% of the stimuli in the two remaining studies (Fishbach & Dhar, 2005; Karremans et al., 2006). In comparison, the primes only accounted for 33% of the stimuli in the present study which further supports the proposition that future research should increase the frequency that the prime stimuli is presented. Furthermore, the choice task in all three

previous studies involved selecting between just two foods or beverages as opposed to selecting several foods from a large variety of items. Although a large variety of food was presented in this study to increase the sensitivity of the outcome measure, the results may have been different had the participants been presented with just one healthy and one unhealthy item. However, as the diversity and number of snacks available has increased dramatically in recent years, the present study more closely reflects a real-world setting and therefore has a higher level of ecological validity.

In conclusion, the results of this study did not support the hypothesis that exposure to unhealthy food-related logos would increase the number of unhealthy food items selected. Although the study was designed to increase the level of concept activation achieved, as well as the sensitivity of the outcome measure, there are several potential explanations for the lack of effect found. One of these relates to the frequency with which the prime stimuli were presented, as the present study had a lower frequency of prime stimuli than previous priming research. Consequently, further research is required to determine whether exposure to unhealthy food-related logos can lead to unhealthy food choices.

Chapter Five:
The Effect of Mindfulness on Cognitive Reflection and Reasoning

Abstract

One of the most interesting findings from the previous study was the significant effect of mindfulness on food choice whereby participants who reported higher levels of trait mindfulness selected a higher proportion of healthy foods. It has been proposed that many unhealthy behaviours, including unhealthy eating and drinking behaviours, are the result of automatic processes that are initiated and executed outside of awareness. This is supported by the results of the systematic review which found that exposure to prime stimuli can increase the choice and intake of various unhealthy foods (Fishbach & Dhar, 2005; Meyer & Waller, 1999). However, as mentioned in Chapter Four, it has recently been put forward that mindfulness can reduce the influence of automatic processes and increase the influence of conscious processes through four specific mechanisms: awareness, attention, focus on the present, and non-judgemental acceptance (Kang et al., 2013). Therefore, the aim of this study was to examine whether a brief mindfulness exercise would decrease the activation of automatic processes and increase the activation of conscious processes. This was measured through the completion of the Expanded Cognitive Reflection Test (ECRT) and a syllogistic reasoning test which specifically distinguish between automatic and conscious processing. Measures of trait mindfulness and trait thinking style (rational or intuitive) were also taken by means of the Five-Facet Mindfulness Questionnaire Short-Form (FFMQ-SF) and the Rational-Experiential Inventory – Revised (REI-R), respectively.

5.1 Introduction

Mindfulness and Consciousness

From the Buddhist perspective, our lives are lived through a limited state of consciousness, simulating an extended dream as opposed to full conscious awareness or wakefulness (Kabat-Zinn, 1994). Accordingly, mindfulness involves learning to wake up from this extended dream by cultivating an ever-deepening conscious awareness of moment-to-moment experience. Mindfulness can be cultivated through regular meditation practice whereby attention is focused on the present moment and is gently but firmly guided back whenever the mind drifts off. Neurological studies have shown that there are at least four brain regions correlated with both meditation and consciousness: the insula, the anterior cingulate cortex, the posterior cingulate cortex, and the prefrontal cortex (Manuello et al., 2015). Furthermore, the practice of meditation has been found to result in both structural and functional alterations within neural networks that promote and maintain consciousness, although these alterations are more likely to be observed in long-term meditators than beginners (Manuello et al., 2015). As conscious awareness of moment-to-moment experience deepens, this lays the foundation for the development of metacognition – a conscious awareness of the constant changing of perceptions, sensations, emotions, and thoughts as represented in consciousness (Jankowski & Holas, 2014). This allows the individual to reflect and comment on the various mental states that are presently being experienced (Fleming et al., 2012). Consequently, mindful awareness is regarded as the highest level of metacognition as it incorporates all consciously accessible phenomena and cognitive processes in the present moment (Jankowski & Holas, 2014).

Cognitive De-coupling and Reasoning

As mentioned in Chapter Four, it has been proposed that mindfulness can reduce the influence of automatic processes and increase the influence of conscious processes through four specific mechanisms: awareness, attention, focus on the present, and non-judgemental acceptance (Kang et al., 2013). As mindfulness is cultivated, thoughts are perceived as mental events that rise and fall, allowing thoughts to be observed rather than experienced. This is often referred to as cognitive decoupling and is one of the mechanisms through which mindfulness may specifically influence cognitive reflection and reasoning. According to Evans and Stanovich (2013) cognitive decoupling aids rational choices by allowing

individuals to distinguish supposition from belief and run thought experiments. According to the default-interventionist view of dual process theory, a rapid and intuitive default response is provided by automatic processes, which may or may not be intervened by conscious processes. However, it has been proposed that the capacity of conscious processes to monitor and override automatic processes is achieved through the process of cognitive decoupling (Mega & Voltz, 2014). Specifically, a mental representation of the automatic process is formed and manipulated through metacognition, allowing the individual to consciously determine the best course of action. Consequently, cultivating mindfulness will make the individual more aware of how they intuitively respond to internal and external events, as well as allowing them to consider a greater number of potential responses. The effect of mindfulness on reasoning ability has also been acknowledged by Mellinger (2010) who has previously stated 'In Buddhist psychology, mindfulness is considered the method for cultivating the ability to perceive reality accurately, so the cognitions and feelings of a person who attains mindfulness would represent a very sound basis for arriving at truth through rational thinking' (p. 220).

Previous Research

One of the advantages of using mindfulness as a means of increasing cognitive reflection and reasoning is that mindfulness has also been associated with reduced anxiety and depression (Schreiner & Malcolm, 2008), an increased ability to deal with stressful events (Donald et al., 2016), and increased self-esteem (Pepping et al., 2013). In relation to reasoning and rationality, a recent study found a positive association between facets of mindfulness and critical thinking – a higher order cognitive process that involves analysing and evaluating evidence in the absence of bias and prior knowledge – which was fully mediated by the inhibition element of executive function (Noone et al., 2016). This study was followed-up with a randomized controlled trial which found that a 6-week mindfulness intervention and a 6-week sham meditation intervention both significantly increased mindfulness and critical thinking; however, there was no significant difference between the interventions on either of these measures (Noone & Hogan, 2018). Although the randomized controlled trial employed a fairly intensive mindfulness intervention, the potential for brief mindfulness interventions to influence cognition has also been confirmed by previous research (Hopthrow et al., 2017; Weger et al., 2012). Furthermore, a recent study has shown that even a brief five-minute computer-mediated mindfulness practice can significantly increase state mindfulness compared to a control condition (Mahmood et al., 2016).

Study Summary

Research has confirmed that automatic processes can lead to the choice and intake of unhealthy foods, as supported by the findings of the systematic review (Fishbach & Dhar, 2005; Meyer & Waller, 1999). However, it has been proposed that mindfulness can reduce the activation of automatic processes on behaviour by increasing the activation of conscious processes through four mechanisms: awareness, attention, focus on the present, and non-judgemental acceptance (Kang et al., 2013). It is argued that conscious processes override automatic processes through cognitive decoupling – a mental simulation of the automatic process is created and various actions are applied in order to determine which action will result in the most favourable outcome (Mega & Voltz, 2014). As a mindful state can be cultivated through practice, this study explored whether a brief mindfulness exercise would increase conscious processing which was measured directly through the ECRT and a syllogistic reasoning test. The mindfulness condition involved listening to the 'leaves on a stream' exercise which specifically encourages cognitive decoupling by teaching participants how to dissociate from thoughts in the present moment.

In order to examine whether a brief mindfulness exercise could increase the influence of conscious processes, the participants listened to a 15-minute audio of the 'leaves on a stream' exercise as a means of increasing state mindfulness and cognitive decoupling. After listening to the audio, the participants completed a manipulation check followed by the ECRT and the syllogistic reasoning test. The relationship between trait mindfulness and trait rationality was also examined through completion of the FFMQ-SF and the REI– R, respectively. The first confirmatory hypothesis stated that the brief mindfulness exercise would lead to improved performance on the ECRT and the syllogistic reasoning test. The second confirmatory hypothesis stated that the brief mindfulness exercise would have a greater effect on individuals who were predominantly intuitive thinkers due to a greater increase in cognitive decoupling. The third confirmatory hypothesis stated that trait mindfulness would be positively associated with trait rationality. Finally, the fourth confirmatory hypothesis stated that trait mindfulness would be positively associated with both the ECRT and the syllogistic reasoning test.

5.2 Method

Pilot Study

A total of 16 undergraduate students were recruited for the pilot study which took approximately 10 minutes to complete. The eligibility criteria stated that all participants must be at least 18 years old, first-time university students, and have English as their first language. The study was set up using Qualtrics and administered through the online recruitment platform Prolific Academic. The main aim of the study was to identify six believable and six unbelievable statements for use in the syllogistic reasoning test. Participants were asked to rate the believability of 18 statements on a 7-point Likert scale from 'Extremely believable' to 'Extremely unbelievable'; the 18 statements included nine statements that the researcher considered believable and nine statements that the researcher considered unbelievable. The study also included the ECRT in order to determine the difficulty of the test and to calculate the average response time for each question. The believability of the 18 statements was analysed by calculating the mean score for each statement where 'Extremely believable' was rated as seven and 'Extremely unbelievable' was rated as one. Subsequently, the three statements considered the least believable of the nine believable statements and the three statements considered the most believable of the nine unbelievable statements were excluded from the final version of the syllogistic reasoning test. The means of the statements included in the final version of the test ranged from 6.94 to 6.38 for the believable statements and from 1.38 to 2.44 for the unbelievable statements. The answers to the ECRT were analysed by calculating the average response time for each question; this was based on correct answers only so that an appropriate incentive system could be developed for the main study. All the participants received £1.25 for taking part.

Participants

The eligibility criteria stated that all participants must be at least 18 years old, first- or second-year undergraduate students, and fluent in English. An a priori calculation using G*Power indicated that 156 participants would be required to achieve a 0.8 level of power and detect an effect size (Cohen's d) of 0.4 with alpha set at 0.05. A small to medium effect size was selected as successful brief mindfulness interventions have shown a range of effect sizes, from 0.28 to 0.89 (Mahmood et al., 2016). Participants received either the assigned number of course credits or a £5 payment for taking part, as well as the extra financial reward

earned during the study. Ethical approval for the study was granted by the City, University of London Psychology Department Research Ethics Committee.

Measures

Demographic Information

Demographic information and personal characteristics were measured through a brief questionnaire which consisted of four questions concerning age, gender, sleep, and present-moment awareness. Sleep was measured by asking participants to state the total number of hours they had slept the night before the study; this was measured as acute sleep deprivation has been found to have a negative impact on cognitive performance (Alhola & Polo-Kantola, 2007). Level of alertness in the present moment was measured using a 7-point Likert scale ranging from 'Extremely alert' to 'Extremely unalert'; this was measured as substances such as caffeine have been found to improve cognitive performance by increasing alertness and vigilance (Smith, 2002).

Expanded Cognitive Reflection Test

Cognitive reflection was measured using the Expanded Cognitive Reflection Test (ECRT) which is a brief 7-item test by Toplak et al. (2014). This measure is based on dual process theory and has been developed specifically to distinguish between automatic (Type 1) and conscious (Type 2) processes. Each question has a mathematical basis and has been designed to elicit an automatic response that is incorrect; for example, one of the questions is 'A bat and a ball cost £1.10 in total. The bat costs a pound more than the ball. How much does the ball cost?'. The intuitive response to this question is 10p whereas the correct response is actually 5p. As each question can be answered incorrectly (scoring 0) or correctly (scoring 1), this test yields a score ranging from 0-7 depending on the number of correct answers given. The validity of the ECRT is supported by previous research which has shown that this test is a substantial unique predictor of rationality (Toplak et al., 2014). This finding has also been confirmed by Šrol (2018) who recently examined the psychometric properties of the ECRT.

Syllogistic Reasoning Test

Syllogistic reasoning is a measure of deductive reasoning ability and involves deciding whether a conclusion is true or false based on two premises. The automatic response is to focus on the believability of the conclusion rather than whether it follows logically from the premises, often referred to as belief bias. Syllogisms may be presented in four different

formats based on the validity and believability of the conclusion: (1) valid and believable; (2) valid and unbelievable; (3) invalid and believable; or (4) invalid and unbelievable. The syllogistic reasoning test involved completing a total of 12 syllogisms developed by the researcher with three in each of the four formats described above. As the syllogism must present a conflict between the validity and believability of the conclusion in order to distinguish between automatic and conscious processing, only the six syllogisms that presented this conflict were included in the data analysis. For example, one of the syllogisms presented was 'No bears are arctic dwellers, some polar bears are arctic dwellers, therefore, some polar bears are not bears'. Although this syllogism is valid, it presents a conflict to the reader because the conclusion is unbelievable. Each syllogism presented can be answered incorrectly (scoring 0) or correctly (scoring 1), yielding a score from 0-6 depending on the number of correct answers given. The effect of belief bias on syllogistic reasoning performance has previously been confirmed by Evans et al. (1983).

Five-Facet Mindfulness Questionnaire Short-Form (FFMQ-SF)

The FFMQ-SF is a 24-item questionnaire that measures trait mindfulness through five components: observing, describing, acting with awareness, non-judgement, and non-reactivity (Bohlmeijer et al., 2011). The observing subscale consists of four items (α for the present study = 0.62), whereas the describing subscale (α = 0.79) acting with awareness subscale (α = 0.75) non-judgement subscale (α = 0.74) and the non-reactivity subscale (α = 0.75) all consist of five items. The authors have confirmed the replicability and validity of the questionnaire by cross-validating with an independent sample of participants (Bohlmeijer et al., 2011).

Rational Experiential Inventory – Revised

The REI-R is a 40-item questionnaire that is composed of two parts; the 20-item Need for Cognition Scale (NCS) and the 20-item Faith in Intuition Scale (FI) (Pacini & Epstein, 1999). This questionnaire measures the extent to which trait thinking style is rational (NCS) or intuitive (FI). The NCS is comprised of the 10-item rational engagement subscale (α for the present study = 0.79) and the 10-item rational ability subscale (α = 0.80). The FI is comprised of the 10-item experiential engagement subscale (α = 0.79) and the 10-item experiential ability subscale (α = 0.81). The validity and reliability of the REI-R has been confirmed in two separate studies by Pacini & Epstein (1999).

Manipulation Check

Participants in the mindfulness condition were also required to complete a manipulation check to determine adherence to the mindfulness exercise. This involved giving a brief description of the exercise, rating the extent to which the exercise had been followed, and rating the extent to which they had noticed their thoughts; both ratings were completed on a 5-point Likert scale from 'Not at all' to 'All of the time'.

Audio Recordings

The mindfulness condition involved listening to a 15-minute audio recording of the 'leaves on a stream' exercise which was recorded by the researcher (Hayes & Smith, 2005). This exercise encourages the listener to imagine leaves floating down a slow-moving stream and to place each thought that arises onto one of the leaves before letting it drift off. This exercise shows participants how to dissociate from thoughts in the present moment, allowing these thoughts to be observed rather than experienced. Consequently, participants cultivate a greater awareness of thoughts in the present moment and start to perceive them as transient mental events that come and go. In comparison, the control condition listened to a 15-minute audio recording of the prologue from The Lord of the Rings which concerned the life and times of Hobbits (Tolkien, 2005). A book-listening control was chosen as research has found this to be a reliable control condition (Johnson et al., 2013).

Procedure

The participants were recruited through advertisements displayed in the Department of Psychology as well as through the experiment management system SONA. The study was completed through the computer software Qualtrics in one of the sound-proof cubicles located in the Department of Psychology. On arrival, all participants were given a study information sheet and asked if they had any questions before giving informed consent. Each participant was alone for the duration of the study and was guided through the study by explicit instructions provided on the computer screen. The participants initially completed four questions relating to demographics and personal characteristics, before they were randomly assigned to either the mindfulness or control condition by Qualtrics. The corresponding audio recordings were then played through the computer speakers and participants could only start the next section once the recording had played through to the end. After the recording had finished, the participants in the mindfulness condition were also asked to complete a brief manipulation check.

The second part of the study involved completing the ECRT followed by the syllogistic reasoning test; prior to completing the tests, all the participants were informed they would receive a financial reward based on their performance. Specifically, they were told they would earn points for each question they answered correctly within a specified time frame and the points earned would be totalled at the end of the study to determine the overall financial reward, up to a maximum of £4. This ensured that the participants were motivated to give the correct answers as quickly as possible, balancing the motivation for automatic versus conscious processing. On completion of the cognitive tests, participants were asked to complete both the FFMQ-SF and the REI-R before they were debriefed. Lastly, the assigned number of course credits and payment due was given to each participant. The study took approximately 40 minutes to complete.

Data Analysis

It was initially planned to examine the first and second hypotheses using ANOVA and the third and fourth hypotheses using multiple regression. It was decided to run multiple regression as this would allow for the contribution of each of the five mindfulness subscales to be determined. However, as the ECRT and syllogistic reasoning test scores were both found to have a severe positive skew that was unresponsive to data transformation, it was determined that a series of generalised linear mixed models would be the most appropriate way to examine hypothesis 1, 2 and 4.

5.3 Results

Data Screening and Participant Characteristics

In order to account for exclusions, a total of 168 first- and second-year undergraduate students from City, University of London were recruited for the main study. Nine participants had previously completed one or both of the cognitive tests; one had previously read an article on the ECRT; one had a technical issue with the audio recording; and one completed the study without consulting the researcher. This left a final sample size of 156 participants. Table 5.1 shows the demographic and personal characteristics of the participants as a function of condition.

Table 5.1

Characteristics of Participants as a Function of Condition

Characteristic	Mindfulness (n = 81)	Control (n = 75)	T-tests
Age (Mean, SD)	19.42 (3.60)	19.23 (1.98)	t = -0.41, p = 0.68
Females (%)	86	73	χ^2 = 4.19, p = 0.04
Sleep – Hours (Mean, SD)	7.06 (1.35)	7.00 (1.34)	t = -0.29, p = 0.77
Alertness – 1-7 (Mean, SD)	5.30 (1.10)	5.31 (1.21)	t = 0.06, p = 0.96
FFMQ score – 1-5 (Mean, SD)	3.02 (0.43)	3.12 (0.44)	t = 1.44, p = 0.15
REI - Rational – 1-5 (Mean, SD)	3.25 (0.52)	3.38 (0.57)	t = 1.54, p = 0.13
REI - Intuitive – 1-5 (Mean, SD)	3.45 (0.52)	3.41 (0.50)	t = -0.50, p = 0.62

The manipulation check showed that participants in the mindfulness condition reported following the instructions most of the time (3.88 out of 5, SD = 0.62) and also noticed their thoughts most of the time (3.95 out of 5, SD = 0.76). Both the ECRT and syllogistic reasoning test were scored so that higher scores reflected a greater degree of cognitive reflection and reasoning. As initial tests of normality showed both of these measures to have a severe positive skew, a theoretically appropriate Generalized Linear Mixed Model (GLMM) and non-parametric tests were used to analyse the data.

A series of Spearman's Rho correlations showed no significant association between ECRT score and sleep, r (155) = 0.00, p = 0.98; no significant association between ECRT score and alertness, r (155) = -0.04, p = 0.64; and a significant association between ECRT score and time spent on the test, r (155) = 0.35, $p < 0.001$. There was also no significant association between syllogistic reasoning score and sleep, r (155) = -0.14, p = 0.08; no significant association between syllogistic reasoning score and alertness, r (155) = 0.01, p = 0.91; and a significant association between syllogistic reasoning score and time spent on the test, r (155)

= 0.32, $p < 0.001$. Therefore, the more time participants spent on the ECRT and the syllogistic reasoning test, the more questions they answered correctly.

Confirmatory Analysis: The Effect of Condition on Cognitive Test Score

The descriptive statistics showed that participants in the mindfulness condition scored lower on the ECRT (mean = 1.19 out of seven, SD = 1.31) than participants in the control condition (mean = 1.33, SD = 1.50), a finding that was in contrast with the initial research hypothesis (see Figure 5.1). The descriptive statistics also showed that participants in the mindfulness condition answered slightly more syllogisms correctly (mean = 1.85 out of six, SD = 1.76) than participants in the control condition (mean = 1.76, SD = 1.58), a finding that supported the initial research hypothesis (see Figure 5.2). However, it is important to note that the mode was 0 for both conditions on both tests.

Figure 5.1

The Distribution of ECRT Scores in the Mindfulness and Control Conditions

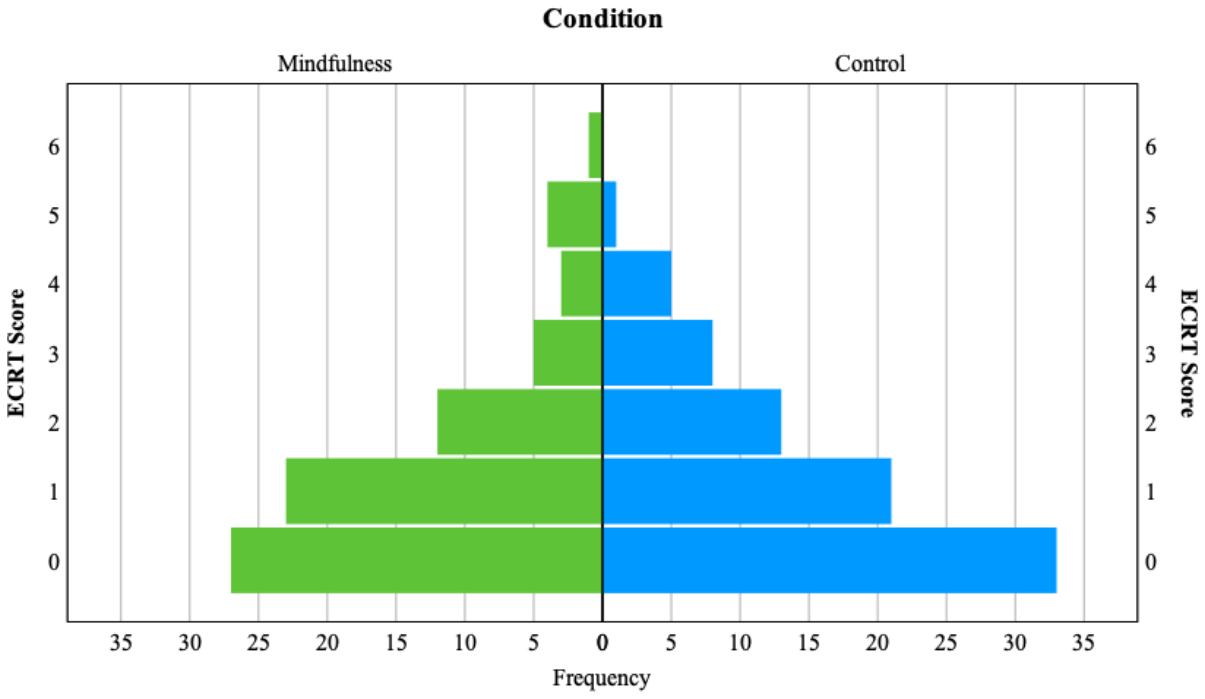
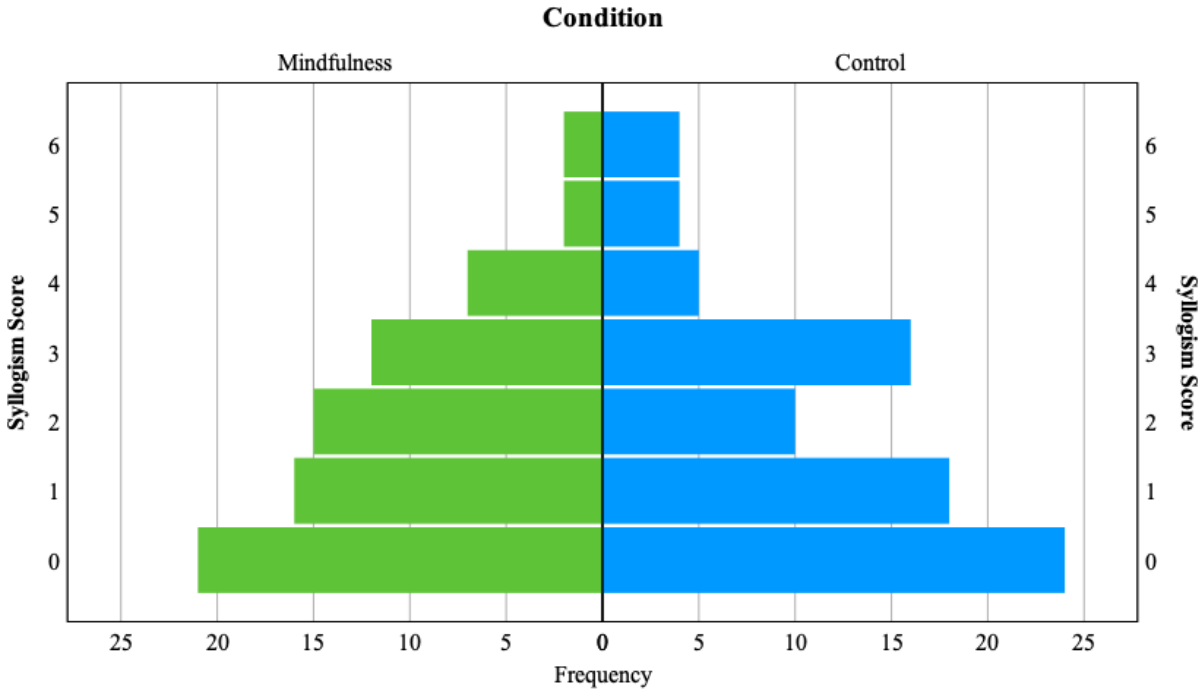


Figure 5.2

The Distribution of Syllogism Scores in the Mindfulness and Control Conditions



As the data violated the assumptions required for ANOVA, a Generalized Linear Mixed Model (GLMM) analysis was run to determine whether the mindfulness exercise would: (1) lead to an improved performance on the ECRT and syllogistic reasoning test; and (2) have a greater effect on individuals in the mindfulness group who scored higher on trait intuitive thinking. Two models were tested, one with the ECRT scores as the dependent variable and one with the syllogism scores as the dependent variable. Both models were run with a logistic link function and binomial noise as these are specifically applicable in studies where the dependent variable represents the sum of binary outcomes (Jaeger, 2008). The models included three fixed effects: mindfulness condition, intuition (i.e. score on the REI-R experiential scale) and the interaction of these variables. The model also included a random intercept in order to properly model the clustering of answers within participants. The analysis was run using the MATLAB fitglme command and was based on maximum likelihood estimation using the Laplace approximation. The conditions were entered into the model using effects coding and the REI-R was mean centred. The first model showed no significant fixed effect of condition on ECRT score, F (1, 152) = 0.30, p = 0.58, as well as no significant interaction between condition and intuition, F (1, 152) = 0.29, p = 0.59. The unadjusted beta values for the first model are provided in Table 5.2.

Table 5.2

Generalized Linear Mixed Model for ECRT Score Based on Seven Responses Clustered Within each of 156 Participants.

Parameter	Coefficient (β)	Standard Error	P value	95% CI	
				Lower	Upper
Intercept	-1.85	0.12	< 0.001	-2.09	-1.61
Condition	-0.07	0.12	0.58	-0.31	0.17
REI-R Intuition	-0.33	0.25	0.18	-0.82	0.16
Condition*REI-R Intuition	0.13	0.25	0.59	-0.35	0.62

The second model also showed no significant fixed effect of condition on syllogism score, F (1, 152) = 0.06, p = 0.80, as well as no significant interaction between condition and intuition, F (1, 152) = 0.32, p = 0.57. The unadjusted beta values for the second model are provided in Table 5.3.

Table 5.3

Generalized Linear Mixed Model for Syllogistic Reasoning Score Based on Six Responses Clustered Within each of 156 Participants.

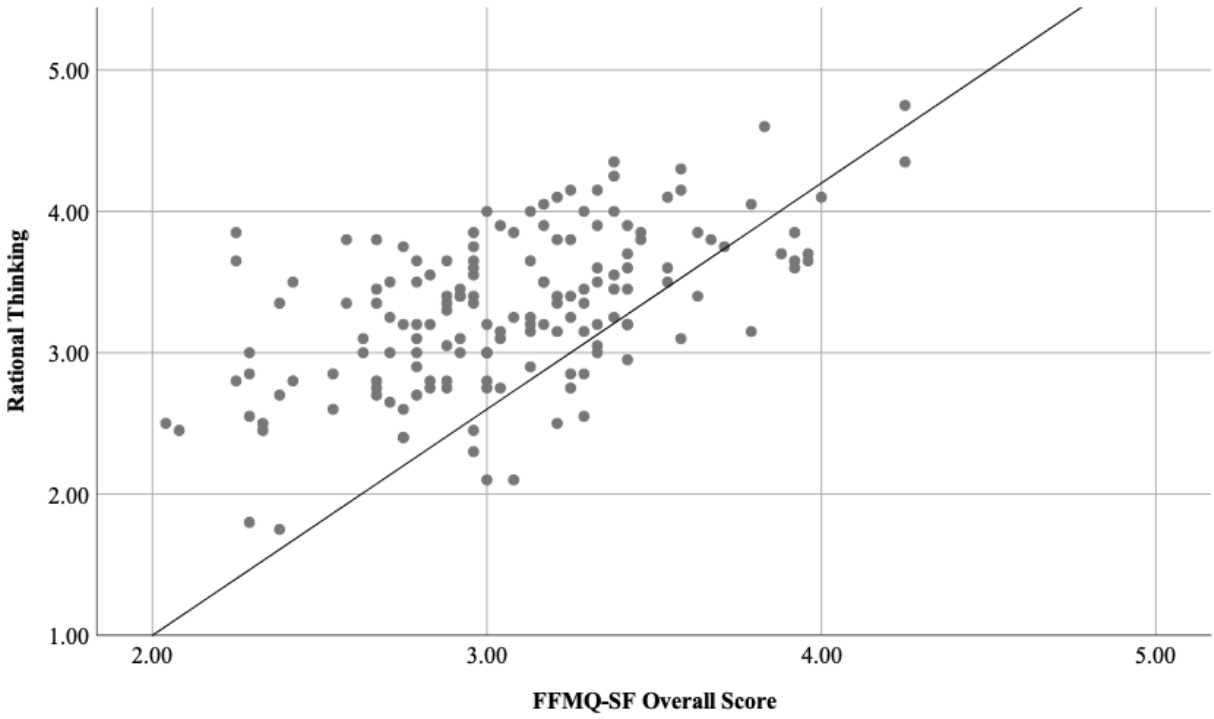
Parameter	Coefficient (β)	Standard Error	P value	95% CI	
				Lower	Upper
Intercept	-1.12	0.13	< 0.001	-1.39	-0.86
Condition	0.03	0.13	0.80	-0.23	0.30
REI-R Intuition	0.18	0.26	0.48	-0.33	0.70
Condition*REI-R Intuition	-0.15	0.26	0.57	-0.66	0.37

The Association Between Trait Mindfulness and Trait Rationality

A forced entry multiple regression showed the association between the five subscales of the FFMQ-SF and trait rationality was moderate to strong (Multiple $R = 0.58$, $p < 0.001$) with the subscales accounting for 31% of the variance in trait rationality (Adjusted R^2) (see Figure 5.3). The data analyses showed that none of the subscales were intercorrelated (observing, VIF = 1.02; describing, VIF = 1.24; acting with awareness, VIF = 1.29; non-reactivity, VIF = 1.10; non-judgement, VIF = 1.28). The standardised coefficients for each of the five subscales were as follows: observing = 0.24, $p = 0.00$ (95% CI = 0.08 – 0.29); describing = 0.20, $p = 0.01$ (95% CI = 0.04 – 0.25); acting with awareness = 0.26, $p = 0.00$ (95% CI = 0.08 – 0.30); non-reactivity = 0.22, $p = 0.00$ (95% CI = 0.06 – 0.25); and non-judgement = 0.08, $p = 0.26$ (95% CI = -0.05 – 0.18). Therefore, it can be concluded that all subscales, except for the subscale of non-judgement, were positive predictors of trait rationality. A second forced entry multiple regression showed there was no association between the five subscales of the FFMQ-SF and trait intuition, (Multiple $R = 0.14$, $p = 0.71$).

Figure 5.3

The Association Between Trait Mindfulness and Trait Rationality



Trait Mindfulness as a Predictor of Cognitive Reflection and Reasoning

A GLMM analysis showed that the five subscales of the FFMQ-SF significantly predicted ECRT score, ΔD (5) = 15.55, p = 0.01. The untransformed β values of each of the five subscales (without mean centring) are shown in Table 5.4. In the main text that follows, the effects are described in terms of odds. Applying the model equation for the mean-average participant the odds of success on the ECRT was 0.16, or a 14% chance of success on each question. The results showed that the subscale of non-judgement was the only significant predictor of ECRT score, exp (β) = 1.75, t (150) = 3.04, p = 0.00. This suggests that a one-point increase in this component of trait mindfulness is associated with a 75% increase in the odds of correctly answering questions on the ECRT, which supports the research hypothesis. The results for the remaining four subscales were as follows: observing, exp (β) = 1.40, t (150) = 1.88, p = 0.06; describing, exp (β) = 0.92, t (150) = -0.45, p = 0.65; acting with awareness, exp (β) = 1.12, t (150) = 0.65, p = 0.52; and non-reactivity, exp (β) = 0.94, t (150) = -0.37, p = 0.71.

Table 5.4

Generalized Linear Mixed Model for Trait Mindfulness as a Predictor of ECRT Score Clustered Within each of 156 Participants.

Parameter	Coefficient (β)	Standard Error	P value	95% CI	
				Lower	Upper
Intercept	-4.44	0.97	< 0.001	-6.35	-2.53
Observing	0.34	0.18	0.06	-0.02	0.69
Describing	-0.08	0.17	0.65	-0.42	0.27
Acting with Awareness	0.12	0.18	0.52	-0.24	0.47
Non-Reactivity	-0.06	0.16	0.71	-0.38	0.26
Non-Judgement	0.56	0.18	0.00	0.20	0.93

A further GLMM analysis (Table 5.5) showed that the five subscales of the FFMQ-SF were not significant predictors of syllogistic reasoning score, ΔD (5) = 4.77, p = 0.45. The results for each of the five subscales were as follows: observing, exp (β) = 0.85, t (150) = -0.89, p = 0.38; describing, exp (β) = 0.82, t (150) = -1.06, p = 0.29; acting with awareness, exp (β) = 0.84, t (150) = -0.84, p = 0.40; non-reactivity, exp (β) = 0.87, t (150) = -0.79, p = 0.43; and non-judgement, exp (β) = 1.01, t (150) = 0.03, p = 0.97.

Table 5.5

Generalized Linear Mixed Model for Trait Mindfulness as a Predictor of Syllogistic Reasoning Score Clustered Within each of 156 Participants.

Parameter	Coefficient (β)	Standard Error	P value	95% CI	
				Lower	Upper
Intercept	1.07	1.07	0.32	-1.03	3.18
Observing	-0.17	0.19	0.38	-0.54	0.21
Describing	-0.20	0.19	0.29	-0.58	0.17
Acting with Awareness	-0.17	0.20	0.40	-0.57	0.23
Non-Reactivity	-0.14	0.18	0.43	-0.49	0.21
Non-Judgement	0.01	0.21	0.97	-0.41	0.42

The Association Between Trait Rationality and Cognitive Reflection and Reasoning

A series of Spearman's Rho correlations indicated a small positive association between the ECRT and trait rationality, r = 0.22, p = 0.01, as well as a small negative association between syllogistic reasoning score and trait rationality, (r = -0.24, p = 0.00). There was no association between ECRT score and syllogistic reasoning score (r = 0.00, p = 0.97).

5.4 Discussion

The main aim of this study was to determine the effect of a brief mindfulness exercise on measures of cognitive reflection and reasoning. The participants completed a brief mindfulness exercise as a means of increasing state mindfulness and cognitive decoupling – the mechanism proposed to reduce automatic processing and increase conscious processing.

The effect of this exercise on cognitive reflection and reasoning was measured through the ECRT and a syllogistic reasoning test. Trait measures of mindfulness and thinking style (rational or intuitive) were also taken through the FFMQ-SF and the REI-R. Overall, the results showed that the mindfulness exercise had no effect on cognitive reflection or reasoning; there was no difference between the mindfulness and control conditions on either the ECRT or the syllogistic reasoning test. The second aim was to determine whether the brief mindfulness exercise would have a greater effect on individuals who are predominantly intuitive thinkers due to a greater increase in cognitive decoupling. As the results showed no interaction between condition and trait intuition, this implies there was no greater benefit for the predominantly intuitive thinkers compared to the more rational thinkers.

One of the most surprising findings was the low scores on the ECRT and the syllogistic reasoning test for both conditions. As a recent meta-analysis found that males generally performed better than females on the Cognitive Reflection Test (CRT - the first three questions of the ECRT), the high percentage of females in this study may have contributed to the low scores obtained (Brañas-Garza et al., 2019). Specifically, the meta-analysis found that (1) males outperformed females on all three questions; (2) females were more likely to fail to answer any of the questions correctly (45% compared to 27%); and (3) males were more likely to answer all three questions correctly (25% compared to 12%). Furthermore, the differences between males and females persisted even after controlling for test characteristics, such as monetary incentives and student samples. This gender difference has also been found for the ECRT, an effect that was attributed to differences in mathematical ability rather than differences in reasoning ability (Juanchich et al., 2019). Specifically, the authors found that both males and females were equally likely to engage in cognitive reflection, however, females were more likely to make mathematical errors due to higher levels of mathematics-related anxiety. Another recent study found that males also performed better than females on 22 syllogistic reasoning items; the average number of correct responses for male and female students was 15.04 and 13.93, respectively (Preiss et al., 2013). However, there is evidence that this may have been due to a slightly higher preference for rational processing among younger males compared to younger females (Sladek et al., 2010).

As well as contributing to the low scores overall, the higher percentage of females in the mindfulness condition may have confounded any effect of the mindfulness exercise on the

ECRT and syllogistic reasoning scores. As a result, future research would benefit from employing different measures of cognitive reflection and reasoning. A more appropriate measure of cognitive reflection may be the 10-item verbal cognitive reflection test (CRT-V) which was recently developed by Sirota et al. (2018). The CRT-V has been found to be a valid and reliable measure of cognitive reflection with the mean around the centre point of the summation index; consequently, this test is less prone to floor effects than both the CRT and the ECRT. Furthermore, as this test is less associated with numeracy, men and women have been found to perform equally well on this measure (Sirota et al., 2018). In order to assess reasoning ability, future studies may be improved by administering the Halpern Critical Thinking Assessment (HCTA) which scores participants on five dimensions of critical thinking, including verbal reasoning (Schuhfried, n.d.). As well as being a more sensitive measure, this test would also (1) show whether improvements are specific to one or more dimensions of critical thinking, and (2) allow for critical thinking to be measured both before and after the mindfulness exercise.

The lack of effect found may also be accounted for by several alternative explanations. Firstly, the mindfulness exercise may have been too brief to have had any effect on cognitive reflection and reasoning. A systematic review of studies examining the effect of mindfulness on cognition showed that most involved attending a series of mindfulness sessions over several weeks or months (Chiesa et al., 2011). Furthermore, studies that have supported the effect of mindfulness over a shorter period of time have often utilised more intense mindfulness practices, such as retreats which involved meditating for up to 11 hours per day (Khoury et al., 2017). Despite this, research has also shown that shorter periods of mindfulness practice can lead to significant increases in state mindfulness (Mahmood et al., 2016). However, as the present study did not employ a measure of state mindfulness before and after the mindfulness condition, it cannot be stated whether the mindfulness exercise was successful in this respect. Furthermore, the present study employed a different mindfulness exercise which may have been less effective in the short-term; it could be argued that decentring from thoughts is a difficult skill to learn and therefore may take more time to develop. As previous research has shown that level of mindfulness is positively associated with mindfulness practice, future research would benefit from employing a more intense mindfulness practice over a longer period of time to ensure an increase in level of mindfulness (Carmody & Baer, 2008).

In relation to this, cognitive measures based on dual process theories comprise questions that are naturally dichotomous (the answers are either correct or incorrect) in order to distinguish between automatic and conscious processes. As this is also the case with the ECRT and syllogistic reasoning test, it could be argued that these tests are fairly insensitive to slight changes in cognitive reflection and reasoning. Therefore, it may be the case that a greater increase in mindfulness is required in order for any effects to be detected by these measures. This further supports the argument for future research to employ a more intense mindfulness practice as a means of increasing the level of mindfulness achieved (Carmody & Baer, 2008). Furthermore, future research would benefit from measuring cognitive reflection and reasoning both before and after the mindfulness intervention to accurately assess any effect on cognitive reflection and reasoning. As the ECRT only comprises seven questions, dividing this test into two shorter tests would further reduce the sensitivity of this measure. However, as the number of syllogistic reasoning items that could be developed is relatively unlimited, future research could employ a greater number of syllogisms in order to measure reasoning ability both before and after the mindfulness intervention.

Another factor that may have contributed to the lack of effect is the added time pressure to complete the ECRT and the syllogistic reasoning test in the least amount of time. Before starting the tests, each participant was informed they would receive a financial reward based on their performance; specifically, the participants were told that faster correct responses would result in a greater financial reward than slower responses. The purpose of this reward was to balance the motivation to answer the questions automatically versus consciously, although the participants were not informed of the amount of time they had to answer each question. Therefore, it may be that the added time pressure inadvertently made the participants more reliant on automatic processes to complete both the ECRT and the syllogistic reasoning test, leading to an increase in the number of incorrect responses. This explanation is supported by research which examined the effect of experiential cues (cues related to automatic processes) on decision making under four levels of time pressure (Fraser-Mackenzie & Dror, 2011). The results showed that as the time pressure increased, participants became increasingly reliant on automatic processes to make decisions. The nature of both cognitive tests may have further increased the reliance on automatic processes as the default-interventionist model proposes that conscious processes only override automatic processes when the present task is perceived as being difficult or novel (Evans & Stanovich, 2013). Consequently, if the participants perceived both cognitive tests to be fairly

easy then conscious processes will not have been activated. As a result, future research may be improved by testing participants without the added pressure of a time restriction.

Finally, the poor performance of the participants may be accounted for by a lack of engagement while completing both cognitive tests. Even though participants were informed they would receive a financial reward based on their performance, they were unaware of how well they were performing while completing the tests. Consequently, the participants may have been less motivated to focus on answering the questions correctly and more concerned with completing the study in the least amount of time possible, resulting in a poorer performance on both tests. A lack of engagement in laboratory-based research has been found by research examining the use of attention checks to detect inattentive respondents and improve the quality of the data obtained (Abbey & Meloy, 2017). The results showed that up to 20% of data could be lost when including a single attention check and as much as 69% could be lost when including up to three attention checks. Although it is important to detect and eliminate those participants who are inattentive during a study, it is also imperative to be aware that eliminating a large percentage of the sample can reduce the level of power achieved, as well as increasing the likelihood of making a Type II error (Abbey & Meloy, 2017). However, as the present study did not include an attention check, the level of engagement with the mindfulness exercise and both cognitive tests is unknown. Consequently, future research should consider using an attention check to ensure the participants are engage in the study, which is particularly important for studies that include measures that are sensitive to level of engagement, such as measures of cognition.

The third aim of the study was to establish whether trait mindfulness was positively associated with trait rationality, as measured by the FFMQ-SF and the REI-R, respectively. The results showed a moderate to strong positive relationship between these measures which was found to be significant. Further analyses showed that this association was partly accounted for by four of the five FFMQ-SF subscales, namely observing, describing, acting mindfully, and non-reactivity; only the subscale of non-judgement showed no association with a rational thinking style. This is in line with a recent study which concluded that trait mindfulness appears to facilitate critical thinking performance; this study specifically found that the mindfulness subscale of observing was positively related to critical thinking, an effect which was fully mediated by the inhibition element of executive function (Noone et al., 2016). Furthermore, the subscale of non-reactivity was negatively associated with critical

thinking which implies there may be mechanisms of mindfulness that have a detrimental effect on the ability to think critically. This finding suggests that rationality and critical thinking require different cognitive processes, although further research is required to determine the specific mechanisms through which these processes work. This will allow researchers to gain a deeper understanding of how mindfulness influences cognition and determine when mindfulness will have a positive or negative effect. However, it is also important to acknowledge the challenges in measuring mindfulness and thinking style through self-report measures; one of the main issues with self-report measures of mindfulness is that individuals who are unfamiliar with the concept of mindfulness can easily misinterpret the items, leading to inconsistencies within studies (Bergomi et al., 2013).

The final aim of the study was to establish whether the FFMQ-SF was positively associated with both the ECRT and the syllogistic reasoning test. The results showed a small positive association between the FFMQ-SF and ECRT score, implying that higher trait mindfulness was associated with greater cognitive reflection; this association was found to be significant and therefore supports the initial research hypothesis. Further analyses showed that this association was accounted for by the subscale of non-judgement which was the only positive predictor of ECRT score; this implies that having a non-judgmental attitude is positively associated with cognitive reflection. One explanation for this finding is that an incorrect intuitive response is partially due to an automatic judgement that is not questioned by the participant. The results also showed a trend toward a negative association between the FFMQ-SF and syllogistic reasoning score, which implies that lower trait mindfulness is associated with an increase in reasoning ability and therefore opposes the initial research hypothesis. Further analyses showed that none of the FFMQ-SF subscales were significantly associated with syllogistic reasoning score. Overall, this finding suggests that the ECRT and the syllogistic reasoning test rely on different cognitive processes to answer the questions correctly. This is also supported by the positive (ECRT) and negative (syllogistic reasoning) associations with trait rationality, as well as the lack of association between both cognitive tests. Overall, these findings support the argument that mindfulness may have a positive or negative effect on cognition depending on the nature of the task at hand (Noone et al., 2016).

In conclusion, the results of this study did not support the hypothesis that a brief mindfulness exercise would increase cognitive reflection and reasoning. There are several potential explanations for the lack of effect found including the high percentage of females recruited

and the briefness of the mindfulness exercise completed. However, the results did show a moderate positive association between trait mindfulness and trait rational thinking style. Consequently, further research is required to determine whether increasing state mindfulness can increase cognitive reflection and reasoning.

Chapter Six:
General Discussion

Overall, the systematic review provided evidence that exposure to prime stimuli can influence both eating and drinking behaviour; however, both priming studies that followed provided no support for the effectiveness of food-related logos as prime stimuli. As the lack of priming effect found may have been due to the priming tasks utilized, further research is required in order to determine whether food-related logos can prime unhealthy eating and drinking behaviour. As priming is the result of automatic processes that occur outside of awareness, the final study examined whether mindfulness has the potential to reduce the influence of these processes on cognition. Although this study established a significant positive association between trait mindfulness and trait rational thinking (conscious processing), there was no support for the proposal that a brief mindfulness exercise could lead to an increase in cognitive reflection and reasoning. Similarly, the short duration of the mindfulness exercise may have contributed to the lack of effect found, meaning that further research in this area is also required.

As mentioned above, the lack of priming effect reported by both the field study and the laboratory study may be due to the ineffectiveness of the priming tasks completed. However, as the capacity of each task to activate the corresponding mental concepts in memory was not assessed, the extent to which this contributed to the null findings is unknown. Therefore, it is important that future research assesses the effectiveness of the specific priming task employed in order to confirm that the task was successful in activating the target concept. This could be done through an implicit association test whereby the prime stimuli is presented at a subliminal level prior to the completion of a lexical decision task – a string of letters is presented immediately following the prime stimuli and the participant is asked to indicate whether it is a word or a non-word. The words presented are either target words or neutral words where the target words are either the same as or related to the prime stimuli. A decreased response time to the target words, compared to the neutral words, is taken as evidence that the priming task has been successful. Confirmation that the priming tasks in the field and laboratory study were successful could be seen as evidence against the existence of behavioural priming effects, although it could be also argued that behavioural priming effects involve different or additional mechanisms compared to semantic priming effects.

Alternatively, it may be the case that the dependent variables employed were not sensitive enough to show any effects of the prime stimuli on food choice. Even though a more sensitive measure of food choice was developed specifically for the laboratory study, the sensitivity of this task was still fairly limited (the equivalent of a 6-point Likert scale). However, significant advances in technology mean that novel approaches to examining food choice have recently been developed, including the intelligent buffet which records the amount of food taken from different food options by individual participants (Mikkelsen et al., 2016). At present, the intelligent buffet has eight different food options for participants, although the number of options available is likely to increase as technology continues to advance. Furthermore, a mobile version of the intelligent buffet has been developed allowing researchers to monitor food choices in natural as well as in laboratory settings. Future research may also be improved by employing visual analogue scales, which consist of a straight line and two contrasting statements at either end of the scale, such as 'Strongly agree' and 'Strongly disagree', in place of Likert scales. It has been argued that visual analogue scales may be more accurate at measuring outcomes like desire, as Likert scales can be systematically biased either upwards or downwards if the true value of the participant is between two response options (Kuhlmann et al., 2017).

However, it is also important to consider the possibility that exposure to prime stimuli has no effect on eating or drinking behaviour, based on the lack of effect found by both priming studies, as well as the results of the systematic review. Even though the systematic review search failed to identify any unpublished studies, this does not preclude the possibility that the effect of primes on eating and drinking behaviour is being overestimated due to publication bias. This argument is supported by the results of a similar systematic review and meta-analysis which examined the effect of weight control cues on food intake (Buckland et al., 2018); a funnel plot of the effect sizes obtained showed a slight shift to the left which indicates the presence of publication bias. Secondly, although approximately half the studies in the review reported a main effect of priming, the potential for bias to have influenced the results of these studies is fairly high; almost all the studies that reported a significant main effect were assessed as unclear for random sequence generation, allocation concealment (experimenters) and selective reporting. This is also similar to the findings of Buckland et al. (2018) who reported that the majority of studies had a high risk of bias and that the findings should be interpreted with caution. Thirdly, the potential for the findings to be the result of

Type I error is further implicated by the lack of direct replications reported. According to Cesario (2014), being able to confirm that the original finding was not the result of Type I error depends on replications where the methodology is exactly the same for both studies. Furthermore, the lack of direct replications reported means that researchers may explain failed conceptual replications as a result of differences in methodology and/or unknown moderating variables, rather than as evidence against priming effects (Cesario, 2014).

Even though conceptual replication failures are often attributed to differences in methodology and/or unknown moderating variables, the results of the systematic review by Buckland et al. (2018), as well as the large number of moderating variables identified, does give some weight to this argument. The review by Buckland et al. (2018) reported that priming effects were only significant in studies that validated the cues before or during the study. As the majority of the studies included in the present review did not validate the priming task, it is unknown to what extent the prime stimuli activated the corresponding mental concepts in memory, which may account for those studies finding no effect on eating or drinking behaviour. Furthermore, the present review identified numerous moderating variables with two of these acting as moderating variables on more than one occasion (restrained eating and appetite); this finding is also supported by Buckland et al. (2018) who reported that studies controlling for appetite found larger effect sizes than those that did not. Overall, Buckland et al. (2018) concluded that exposure to weight cues had a trivial effect on food intake and that the magnitude of the effect was greater for individuals with strong weight control goals. However, many of the studies in the present review did not recruit a large enough sample to detect a small effect size which may have influenced the results of these studies. Furthermore, it is unlikely that all the significant effects reported are Type I error as this would imply that there are a large number of unpublished studies that failed to find an effect.

One of the most interesting findings reported was the significant negative association between the mindfulness subscale of non-judgement and unhealthy food choice score (Chapter Four), where participants who scored higher on the subscale of non-judgement selected fewer unhealthy foods. A similar finding was reported by Jordan et al. (2014) who found a positive association between trait mindfulness and heathy eating behaviour, as well as a negative association between trait mindfulness and calorie intake; participants who were higher in trait mindfulness were more likely to select a piece of fruit over sweets. The findings of the present study may be explained by the participants low in trait mindfulness

judging the unhealthy foods more positively due to the higher level of gratification experienced while consuming these foods. However, further research is required to confirm this finding and determine whether non-judgement has a causal effect on healthy food choice. This could be done by increasing non-judgement through a meditation practice that specifically cultivates this facet of mindfulness and examines the effect on subsequent food choice. It would also be beneficial to examine the judgement of healthy and unhealthy food items through an implicit association test, as this would show how participants high and low in trait mindfulness automatically evaluate various food products without the influence of social desirability bias. Interestingly, the results of the mindfulness study showed that non-judgement was the only mindfulness subscale that was not a significant predictor of trait rationality, implying that rational thinking and healthy food choices involve different aspects of mindfulness and that making healthy food choices does not depend on the ability to think rationally. However, future research should aim to replicate this finding before examining the causal effect of mindfulness on rational thinking in more detail, as well as the role of rational thinking in making healthy food choices.

6.1 Brand Logos as Goal Primes

The studies described in chapter three and chapter four build on previous research by employing well known food-related logos as prime stimuli. This was done as logos are highly prevalent in the social environment and are more likely to reflect how priming influences behaviour in everyday life. Although both priming studies failed to find an effect of the food-related logos on food choice, it is likely that this was due to the priming tasks utilized. The potential for brand logos to influence behaviour has been recognised by Park et al. (2013) who proposed that one of the mechanisms through which logos influence behaviour is by conveying the functional benefits of the brand to the consumer. According to Park et al. (2006) brands can reduce the uncertainty faced in everyday life by giving individuals a sense of control and efficacy in either attaining desirable outcomes and/or avoiding undesirable outcomes. This means that certain logos may also be associated with concepts related to desired end-states that are associated with reward and may therefore act as goal primes that evoke action to facilitate goal attainment. For example, the Red Bull logo is an image of two red bulls charging at each other in front of a yellow sun, with the slogan ‘vitalizes body and

mind' at the base of the can (Park et al., 2013); therefore, this logo would appear to be associated with an end state that comprises an increase in energy and feeling mentally alert.

One of the main concerns around goal priming is that the strength of the effect has been found to increase the longer the goal remains unfulfilled (Förster et al., 2005). This implies that the longer the delay between exposure to an unhealthy food-related prime and the opportunity to behave in accordance with the prime, the more likely an individual will choose and consume unhealthy foods. This is important as it means that prime stimuli can be presented in various settings and still influence behaviour; in other words, exposure to the prime stimuli does not have to occur in the same setting as the eating or drinking behaviour. In fact, presenting the prime stimuli in a different setting reduces the likelihood that the individual will become aware of how the prime is affecting behaviour, ultimately increasing the probability of assimilation. Another concern is that evidence implies that goal priming leads to the inhibition of competing goals that may prevent fulfilment of the original goal (Förster et al., 2007). According to Kruglanski et al. (2002), this is due to the phenomenon of goal shielding where the activation of a specific goal inhibits competing goals in order to facilitate goal attainment. Therefore, activation of the goal to consume unhealthy foods may inhibit the goal to consume healthy foods, even when the individual is actively trying to lose weight. However, as stated by Förster et al. (2007), exposure to a goal prime must increase the value of the end state, as well as the value of objects and actions that will facilitate goal attainment, in order for goal priming effects to occur. Consequently, it may be the case that exposure to the brand logos did not increase the value of the end state in both the priming studies conducted.

Overall, the potential for goal primes to have a strong influence over behaviour means it is important for future research to establish whether brand logos function as goal primes, particularly those that are associated with unhealthy behaviour. There are several ways in which future research could provide valuable information to this field of research. Firstly, future research could examine brand concept maps – graphical representations of the brand associations that are activated following activation of a brand name (John et al., 2006) – to determine the specific concepts associated with different food-related brand logos, including the end-states associated with these brands. The brand associations that are activated by the concept of McDonalds was recently examined by French and Smith (2013) who compared the responses of participants with either a positive or negative attitude towards McDonald's.

Although the responses of both groups were similar, those with a positive attitude reported 'tasty' as a first-order (direct) association whereas those with a negative attitude did not report 'tasty' as an associated concept. Therefore, future research could examine whether participants who associate food with being tasty also experience stronger cravings than participants who do not report this association. Secondly, although there is evidence that brand logos activate a corresponding concept in memory (Muscarella et al., 2013), it would be beneficial for these findings to be replicated with a variety of food-related logos, particularly those that are generally associated with unhealthy foods. This would confirm that food-related brand logos have the potential to prime judgements, decisions, and behaviour. Thirdly, research should aim to provide evidence that exposure to unhealthy food-related logos leads to an increase in the selection and/or intake of unhealthy food and beverage products. In order to confidently state whether unhealthy food-related primes are effective in this respect, it would be beneficial for future research to utilise a priming technique that has already been validated. If this is confirmed, examining whether the strength of the effect increases over time would provide concrete evidence that unhealthy food-related logos function as goal primes.

Although the present research utilised brand logos as prime stimuli for the simple reason that brand logos are highly prevalent in the social environment, logos may be considered slightly different from other prime stimuli as they are developed to represent a brand in its entirety. It has recently been argued that logos have numerous associations in memory which represent the summary of the marketing efforts undertaken by the brand (Park et al., 2013). Furthermore, logos have been described as 'the tool to quickly unlock a series of associations that are fashioned over time, developing the connection to who an organization is and what they stand for' (Wheeler, 2014, p. 56). According to Park et al. (2013), some of the most important associations are the core beliefs and values of the brand, especially when they are consistent with the core beliefs and values of the consumer. These associations are important as they encourage the individual to see the brand as a part of themselves (Walsh et al., 2010), ultimately making the brand a medium through which the individual can express and define their actual or desired self (Escalas & Bettman, 2003). However, according to Park et al. (2013), logos are more than just visual representations that reflect the core values and beliefs of the brand and the consumer. Park et al. (2013, p. 182) argue that 'logos have the potential to not only express such brand-self associations, but also to reinforce and strengthen them, thus enhancing customers' willingness to exert effort and invest resources towards sustaining

their relationship with the brand'. Therefore, brand logos exert their influence on behaviour by activating the core beliefs and values of the consumer which are subsequently fulfilled when the consumer selects the products or services provided by the brand.

The discussion above shows that brand logos that activate the core beliefs and values of the consumer have the potential to have a significant effect on behaviour. However, not all brands will be successful in this regard meaning that the effects of brand logos on behaviour will differ considerably across individuals. Therefore, the lack of effect in both priming studies may be due to a discrepancy between the core beliefs and values of the brands shown and the core beliefs and values of the participants recruited. Consequently, it may be beneficial for future research to include a measure of the extent to which the participants can relate to each brand shown, including how well they identify with the brand and whether the brand reflects their own core beliefs and values. Interestingly, the study by Park et al. (2013) also found that brand logos in the form of symbols are more effective at (1) communicating the functional benefits of the brand and (2) providing self-identity and expressiveness benefits than brand logos that are in the form of names. As all the food-related logos were in the form of names, with the exception of the M&S logo and the McDonald's logo, this may partly account for the lack of effect found. However, further research is required to determine whether logos in the form of symbols are more effective at influencing behaviour than those in the form of names.

6.2 The Ethical Implications of Priming

At present, there is an ongoing debate regarding the ethical implications of influencing consumer decisions outside of awareness. The claims by James Vicary in 1957 which concerned the effects of subliminal primes on judgements, decisions, and behaviour led to this practice being banned in several countries, including the United Kingdom, just a year later in 1958 (Smith & McCulloch, 2012). However, both subliminal and supraliminal priming effects involve the activation of a mental concept in memory, increasing the accessibility of this concept and the likelihood it will be incorporated into subsequent information processing. The only difference between these types of priming is the level at which each is presented; subliminal primes are presented below the level of conscious awareness whereas supraliminal primes are presented above the level of conscious

awareness. However, even though supraliminal primes are consciously perceived, the effect of the prime stimulus on judgements, decisions, and behaviour still occurs outside of awareness. As stated by Bargh (2016, p. 50) 'the same qualities of priming effects are obtained for both supraliminal and subliminal priming methods, as long as the person is not aware of the influence of the primes'. The fact that both subliminal and supraliminal prime stimuli influence judgements, decisions, and behaviour outside of awareness is important as it means there is no way to counter the effect of the prime stimuli. Furthermore, supraliminal primes have actually been found to result in stronger priming effects than subliminal primes due to the greater activation of the mental concept in memory (Bargh & Chartrand, 2000). Overall, the evidence to date implies that the ethical concerns over subliminal primes are just as applicable to supraliminal primes and even more so given the stronger effects observed following the conscious perception of prime stimuli.

Junk food advertising in the UK has rapidly increased over the last few decades, with junk food brands spending 27.5 times more money on advertising than the government has available to promote healthy eating campaigns (O'Dowd, 2017). However, in recognition of the growing obesity epidemic in England, the government has implemented several policies that endeavour to reduce exposure to junk food advertising in the social environment. One of the first policies to be implemented was a ban on television adverts for foods high in fat, salt, and sugar (HFSS) on all dedicated children's channels in 2008 (BBC News, 2008); the government is presently considering whether to extend this ban to all junk food advertising on television and social media before 9pm (Sky News, 2019). Furthermore, on the 25th February 2019 the government implemented a ban on HFSS advertising across the entire London public transport network (BBC News, 2019). These policies reflect the governments concern for the present obesity epidemic, particularly the increasing levels of childhood obesity. However, the evidence that prime stimuli can also increase unhealthy eating and drinking behaviour (Chiou et al., 2013; Fishbach & Dhar, 2005), implies that these policies do not go far enough. Based on these findings, all junk food advertising should be banned to prevent food and beverage companies from encouraging unhealthy food choices through exposure to prime stimuli. Furthermore, future research evidence that brand logos act as goal primes would further support the argument for banning all junk food advertisements in the social environment. However, a lack of evidence for this effect means that only banning junk food advertisements in settings where foods and beverages are bought and consumed would be sufficient to reduce unhealthy eating and drinking behaviour.

6.3 Mindfulness as a Training Intervention

Although priming is the result of automatic processes that occur outside of awareness, it has recently been proposed that mindfulness has the potential to reduce the influence of these processes on subsequent judgements, decision, and behaviour (Kang et al., 2013). Even though the final study failed to find an effect of the brief mindfulness exercise on cognitive reflection and reasoning, there has been a considerable amount of research showing the potential for mindfulness-based interventions to have a positive effect on health behaviour (Papies, 2016). Several interventions have focused on cultivating mindfulness over a prolonged period of time, such as the Mindfulness Based Stress Reduction (MBSR) course which involves daily meditation practice over an eight-week period. Even though these interventions are not tailored specifically to address eating behaviour or weight loss, many studies have examined whether these more general mindfulness interventions can significantly reduce obesity-related eating behaviours. A recent review by Katterman et al. (2014) specifically examined whether these interventions can improve health by reducing binge eating and emotional eating, as well as promoting short-term weight loss. A total of 14 studies were included in the review with the shortest intervention lasting six weeks and the longest intervention lasting 16 weeks. Overall, the results showed that the mindfulness-based interventions had a positive effect on eating behaviour, with significant reductions in both binge eating and emotional eating reported. Interestingly, the evidence for the effect of the interventions on weight loss was mixed with just three studies reporting a significant reduction in weight. Furthermore, two of these studies involved weight-loss specific components in addition to the mindfulness intervention. Consequently, the authors concluded that 'there is no evidence that weight loss occurs in response to mindfulness training in the absence of a specific focus on weight' (Katterman et al., 2014, p. 203).

Based on the findings discussed above, mindfulness based interventions that encourage a mindful state during specific negative health behaviours may be more successful at promoting weight loss. For example, mindful eating interventions teach individuals how to be mindful while consuming food, such as paying attention to the sensory properties of food, paying attention to feelings of hunger and satiety, and learning to notice thoughts as 'merely thoughts' rather than as representing the truth (cognitive decoupling) (Jenkins & Tapper,

2014; Tapper & Seguias, 2020). The efficacy of these more specific mindfulness interventions was recently reviewed by Tapper (2017) who examined the independent effects of mindfulness and mindfulness-related strategies on eating behaviour and weight loss. A total of 19 studies were included in the review, although only one study examined the effect of mindfulness on food choice. This study found that participants who completed a 12-minute mindfulness exercise that taught the skill of cognitive decoupling were less likely to select unhealthy food items than participants who received no training. Five studies examined whether mindfulness-based techniques can reduce intake of high calorie foods, with four studies examining the effect of cognitive decoupling and two studies examining the effect of acceptance. The review found that decoupling from food-related thoughts significantly reduced intake of high calorie foods whereas decoupling from cravings or focusing on acceptance had no effect on intake. Overall, Tapper (2017) concluded that cognitive decoupling was a promising mindfulness-based technique, although further research on this strategy is required.

The Advantages of Mindfulness

There are several advantages of implementing mindfulness as a training intervention to address the present obesity epidemic. Firstly, mindfulness is a universal skill that can be cultivated by anyone with a willingness to commit to a regular meditation practice (Kabat-Zinn, 1994). The increased interest in mindfulness over recent years has also increased the variety of resources available, providing beginners with a complete guide to formal and informal mindfulness practices. Secondly, mindfulness has been described as a way of life rather than a technique (Kabat-Zinn, 1994), meaning that mindfulness is accessible at all times and can be applied in any situation. Therefore, mindfulness has the potential to influence all automatic processes that lead to undesirable outcomes; for example, an individual could apply mindfulness to improve their food and beverage choices, as well as to increase their participation in physical activity. Thirdly, the research on mindfulness to date implies that mindfulness may have additional benefits to the individual, above and beyond those that are the main target of the intervention. For example, mindfulness has been associated with reduced anxiety and depression (Schreiner & Malcolm, 2008), an increased ability to deal with stressful events (Donald et al., 2016), and increased self-esteem (Pepping et al., 2013). Lastly, as there is compelling evidence that mindfulness alters the neurophysiology of the brain (Hölzel et al., 2011), the effects of mindfulness have the

potential to lead to long-term changes in behaviour which is essential for long-term improvements in health.

The Disadvantages of Mindfulness

However, there are also several disadvantages of mindfulness as a training intervention to address the present obesity epidemic. Firstly, cultivating higher levels of trait mindfulness requires dedicating a certain amount of time to regular meditation practice which may be difficult given the high demands associated with modern day life. Consequently, few people may be willing to invest the time required to bring about the desired effect on behaviour. Secondly, mindfulness can be a difficult skill to develop and may be frustrating for beginners who are finding it hard to follow a given practice. The effort required to achieve a mindful state has previously been recognised by Jon Kabat-Zinn (1994, p. 8) who stated 'mindfulness requires effort and discipline for the simple reason that the forces that work against our being mindful, namely our habitual unawareness and automaticity, are exceedingly tenacious'. Therefore, regular mindfulness practice requires a strong commitment from the individual which will allow them to persevere when feeling frustrated. Lastly, there is evidence to suggest that mindfulness-based interventions can occasionally lead to negative experiences and outcomes, although this area of research has received relatively little attention. Specifically, it has been found that a small percentage of people may experience severe negative effects as a result of meditation including disorientation and depression (Shapiro, 1992). However, a recent qualitative analysis found that more severe negative events generally occurred when individuals attempted more advanced practices rather than more conventional practices (Lomas et al., 2015). Despite this, it may be advisable for individuals who are new to meditation to seek the guidance of an experienced meditator.

6.4 Conclusion

In conclusion, the thesis presented provides convincing evidence for the effect of prime stimuli on both eating and drinking behaviour; however, the potential for brand logos to act as prime stimuli requires further investigation. This area of research is important due to the ethical implications of priming behaviour outside of awareness and may also be taken into account when developing new policies and legislation regarding food and beverage advertising. At present, mindfulness appears to be a promising intervention for decreasing

unhealthy eating behaviour, particularly the strategy of cognitive decoupling. However, further research is required before any specific recommendations can be made.

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Appendices

Appendix A

The following five questions comprised the funnelled debrief at the end of the laboratory-based priming study described in Chapter Four.

1) Do you have any ideas about the aim of the present study?

2) Do you think that any of the activities and questionnaires you completed today could be related in any way? If yes, in what way could these activities and questionnaires be related?

3) Was there anything you did during the first study that may have influenced your responses during the second study? If so, how exactly did it influence it?

4) While you were completing the recognition memory task did you notice anything unusual about the logos? If so, what did you notice?

5) Some participants completed a slightly different recognition task during the first study. Have you learned anything about what other participants did?