Regulating Unhealthy Snacking Behaviour: The Interplay Between Desire and Self-control

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Summary

The dominant view of self-control is that it is the ability to override immediate impulses or desires in order to pursue a long-term goal. However, self-control research has often neglected the importance of empirically testing desire, and focused more on behavioural restraint and motivation toward long-term goals. This thesis presents the results of six empirical studies exploring the interplay between self-control both at dispositional and situational levels and desire in the regulation of unhealthy snack consumption.

While previous theorists had proposed desire to be in part predicted by positive implicit evaluations of relevant stimuli, Chapter 2 presents the first empirical test of this relationship. A negative implicit evaluation of unhealthy snack food predicted lower temptation to indulge, which mediated the relationship between negative implicit food evaluations and lower intake of unhealthy food. Following these findings, Chapters 3 and 4 report studies testing computer-based tasks aimed at retraining these implicit food evaluations. Findings suggested that such interventions may be more successful at reducing snack intake if targeted at individuals with lower trait self-control, or implemented in situations where individuals lack inhibitory control resources, as low self-control appeared to enable overcoming of trained impulses toward unhealthy food. Chapter 4 also showed that high situational self-control may enable the downregulation of an automatic positive evaluation of food stimuli before it becomes a conscious temptation.

The relationship between desire, snack intake, and experimentally-manipulated situational self-control was further explored in Chapter 5. While it appeared as though individuals with higher self-control were better able to overcome desire to indulge in unhealthy snack food, rather than experiencing weaker desire leading to lower snack intake, the effect was not statistically significant. A similar question about whether dispositional self-control enables the overcoming of desire or instead weakens desire, was tested in Chapter 6.

Results revealed that individuals with higher trait self-control ate less snack food than their low self-control counterparts, which was accounted for by the lower desire experienced.

Chapter 7 aimed to test a potential explanation derived from counteractive control theory for the relationship between trait self-control and lower desire observed in Chapter 6. However, the relationship between higher self-control and lower desire was not replicated in Chapter 7. Nevertheless, the findings did suggest that when the goal of weight management was highly cognitively accessible, individuals with high trait self-control experienced less intense temptation to indulge in unhealthy snack food and subsequently ate less.

Overall, the studies support the centrality of the experience of desire in the regulation of unhealthy snacking behaviour, and underscore the importance of this often overlooked variable as a target for interventions promoting effective regulation of unhealthy snacking, especially for individuals with low self-control. The findings also suggest that the role of self-control at both trait and state levels is more complex than simply overriding strong desires that conflict with valued goals to enact goal-consistent behaviour, but that self-control may contribute to weaker desire.

Declaration

‘I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text’.

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Ashleigh Haynes

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Statement of Co-authorship

Chapters 2 – 7 of this thesis are presented in manuscript form. All are published in peer-reviewed journals, except for Chapter 5, which is under review. I am the primary author of all these manuscripts; the co-authors include members of my supervisory committee. I took the lead in conceiving and designing each study, analysing and interpreting the results, and writing the manuscripts, with input and guidance from Eva Kemps and Robyn Moffitt. Philip Mohr also provided assistance in the conceptualisation, design, and interpretation of the work presented in Chapter 2 and Chapter 7. Following is a list of the bibliographic details of each Chapter, including a list of co-authors.

Chapter 2

Haynes, A., Kemps, E., Moffitt, R., & Mohr, P. (2014). Reduce temptation or resist it? Experienced temptation mediates the relationship between implicit evaluations of unhealthy snack foods and subsequent intake. *Psychology and Health,* 30, 534-550. DOI 10.1080/08870446.2014.984713

Chapter 3

Haynes, A., Kemps, E., & Moffitt, R. (2015). Inhibitory self-control moderates the effect of changed implicit food evaluations on snack food consumption. *Appetite,* 90, 114-122. DOI 10.1016/j.appet.2015.02.039

Chapter 4

Haynes, A., Kemps, E., & Moffitt, R. (2015). The moderating role of state inhibitory control in the effect of evaluative conditioning on temptation and unhealthy snacking. *Physiology and Behavior,* DOI 10.1016/j.physbeh.2015.09.020

Chapter 5

Haynes, A., Kemps, E., & Moffitt, R. Too depleted to try? Testing the process model of ego depletion in the context of unhealthy snack consumption. *Manuscript under review, submitted September 2015 to Motivation and Emotion.*

Chapter 6

Haynes, A., Kemps, E., & Moffitt, R. (2016). Does trait self-control predict weaker desire for unhealthy stimuli? A lab-based study of unhealthy snack intake. *Personality and Individual Differences, 89,* 69-74. DOI 10.1016/j.paid.2015.09.049.

Chapter 7

Haynes, A., Kemps, E., Moffitt, R., & Mohr, P. (2014). Resisting temptation of unhealthy food: interaction between temptation-elicited goal activation and self-control. *Motivation and Emotion,* 38, 485-495. DOI 10.1007/s11031-014-9393-6

CHAPTER 1: Regulating Unhealthy Snacking Behaviour: The Interplay Between Desire and Self-control

1.1 Introduction

Self-control refers to the ability to alter one's thoughts, feelings, and actions, so as to support the pursuit of long-term goals (Baumeister, Vohs, & Tice, 2007). At the core of self-control is a conflict between a long-term goal and a desire or impulse toward behaviour that brings immediate gratification (Kotabe & Hofmann, 2015; Muraven & Baumeister, 2000). An impulse can be broadly defined as any thought, feeling, or behaviour activated by a hedonically rewarding temptation that promotes indulgence in that temptation at the expense of a long-term goal (Fujita, 2011; Hofmann, Friese, & Wiers, 2008). By this definition, desire, which is a conscious, affectively-charged motivation toward an object to bring pleasure or relief from discomfort, is considered an example of an impulse.

The traditional conceptualisation of self-control is that it involves the effortful inhibition of impulses or desires that conflict with a long-term goal (Fujita, 2011; Muraven & Baumeister, 2000). However, some researchers argue that self-control is not always an effortful process (Fujita, 2011). Instead, individuals can enact strategies that can, for example, automatically activate goal-consistent behaviour, or change the experience of impulses, therefore eliminating the need for effortful inhibition (Fujita, 2011). Additionally, over time and with repeated practice, behaviours that required effortful self-control in the past may become automatic and habitual (Kotabe & Hofmann, 2015). As Hofmann and Van Dillen (2012), and Hofmann et al. (2008) note, much of the self-control literature has been dominated by a focus on the *restraint* of desire and the capacity for self-control, at the expense of a comprehensive understanding of the critical role of desire or impulses themselves. Indeed, researchers have often neglected to measure the strength of desire and impulses. Instead, in laboratory-based research, self-control outcomes have been measured by

assessing behaviour in response to stimuli that are assumed to elicit an impulse toward indulgence that is of equal intensity for all individuals (Friese & Hofmann, 2009; Hofmann & Van Dillen, 2012). In this way, Fujita (2011) argues that the outcome of self-control (e.g., behaving in a manner consistent with a goal, such as choosing healthy over unhealthy snack food) is often conflated with the process of self-control (e.g., goal-consistent choice is assumed to be a result of effortfully *overcoming* the desire or impulse toward consumption of the unhealthy food). Taking the strength of desire to indulge in behaviour that conflicts with the pursuit of a long-term goal into consideration may facilitate understanding of the process of self-control. For example, this may provide insight into how and when self-control might be an effortless process versus when it might involve deliberately overcoming impulses. The current thesis aimed to explore the relationships and interactions between self-control on the one hand, and experienced desire and its automatic precursors on the other, in the context of unhealthy snack food consumption.

Unhealthy snack consumption presents a typical self-control dilemma. While many individuals are motivated toward health-related goals such as attaining or maintaining a healthy body weight, unhealthy snack food is immediately hedonically rewarding for most people. In their study of weight-related concerns and practices in Australia, Timperio, Cameron-Smith, Burns, and Crawford (2000) reported that almost one half of participants were trying to lose, or avoid gaining, weight. Regulating food intake was the most common method used in these weight management attempts (Timperio et al., 2000). However, the achievement of weight management goals through healthy eating is impeded by the rewarding nature and ubiquity of unhealthy foods. Energy-dense foods high in sugar, salt, and fat, are immediately gratifying which may in part be attributable to the adaptive function that a preference for these foods served in our evolutionary history (Birch, 1999; Cohen & Farley, 2008). Hofmann, Baumeister, Förster, and Vohs (2012) found that a desire to eat is the most

commonly experienced desire. In fact, experimental evidence has shown that palatable food promotes an urge to eat that is independent of a homeostatic need for the nutrients which it contains (Yeomans, 2004). Therefore, it is often not a biological need state that drives individuals to eat highly palatable food, but the anticipation of hedonic reward (Yeomans, 2004). In addition, the current food environment in many Western societies is characterised by an abundance of readily available and affordable unhealthy foods, larger serving sizes, more convenience-oriented eating opportunities, and ready-made foods with higher proportions of fats and sugars compared to decades ago (Cutler, Glaeser, & Shapiro, 2003; Hill & Peters, 1998; Nielsen & Popkin, 2003; Swinburn, Egger, & Raza, 1999; Wansink, 1996). This 'obesogenic' food environment paired with the hedonically rewarding nature of unhealthy snack foods makes it especially difficult for many individuals to regulate their intake, despite commonly held intentions to do so (Cutler et al., 2003; Heshmat, 2006; Swinburn et al., 1999).

1.2 Theoretical Perspectives on How Self-Control Relates to, and Interacts with, Desire

The remainder of this introductory chapter outlines several theoretical perspectives related to self-control with a focus on the role of desire and its automatic precursors. This chapter is not intended to present an exhaustive review of all theories relevant to self-control, but to provide a foundation for the subsequent empirical chapters. First, Section 1.2.1 reviews dual process models of behaviour, which provide a broad framework for understanding self-control. The dual process model perspective is consistent with the conceptualisation of self-control as being responsible for overcoming impulsive tendencies to approach rewarding stimuli in order to facilitate pursuit of long-term goals. According to the theory, behaviour is driven by two interacting systems: the impulsive system (which operates automatically, and usually promotes immediately hedonically rewarding behaviours), and the reflective system (which operates with more conscious deliberation and regulates impulsive influences in order

to promote behaviour consistent with goals). Self-control is predicted to enable an individual to overcome impulsive influences on behaviour, thereby enabling the reflective system to influence behaviour. While self-control can vary both situationally (state self-control), and dispositionally (trait self-control), dual process models do not refer specifically to one or the other. Instead both situational and dispositional differences in self-control resources are proposed to enable an individual to overcome impulses.

In contrast, Section 1.2.2 reviews two competing theories specific to situational fluctuations in self-control: the strength model and the process model. These two theories make competing predictions about the relationship between situational self-control and desire. Namely, that situational self-control enables an individual to overcome desire for unhealthy stimuli that conflicts with valued goals (strength model), or that situational self-control predicts a less intense desire for stimuli that conflicts with valued goals (process model).

The focus then shifts to dispositional self-control in Section 1.2.3. Specifically, while the proposed mechanism for the relationship between dispositional self-control and desire are different, similar competing predictions are made about dispositional self-control as for situational self-control. Namely, the traditional conceptualisation of trait self-control is that it enables an individual to effortfully overcome desires that conflict with valued goals. However, a more contemporary conceptualisation proposed by Gillebaart and de Ridder (2015) predicts that dispositional self-control relates to a less intense experience of those desires. Additionally, Section 1.2.3.2 discusses counteractive control theory and relatedly, counteractive evaluation, as potential explanations for the relationship between trait self-control and desire for unhealthy stimuli. The aims of each empirical chapter will be briefly summarised in the context of the relevant theoretical discussion.

1.2.1 Dual Process Models of Behaviour

An important conceptual distinction relevant to self-control of behaviour is the one between impulsive and reflective influences. Dual process models of behaviour, such as the reflective-impulsive model (Strack & Deutsch, 2004), predict that behaviour is driven by two interacting systems. The impulsive system drives behaviour toward hedonically rewarding stimuli and operates relatively automatically with little conscious awareness or intent (Strack & Deutsch, 2004). An automatic appraisal of a stimulus in terms of its affective and motivational properties originates in an associative network of long-term memory, and is activated upon encountering that stimulus (Strack & Deutsch, 2004). This automatic appraisal can then activate a behavioural schema which drives behaviour toward that stimulus. For example, individuals' implicit evaluations of a stimulus (i.e., the extent to which a stimulus is automatically associated with positive affect) have been found to predict the tendency to approach that stimulus across time and situations (e.g., Chen & Bargh, 1999; Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Duckworth, Bargh, Garcia, & Chaiken, 2002; Ferguson & Bargh, 2008). In the domain of eating behaviour, more positive implicit evaluations of unhealthy food have been demonstrated to predict higher intake and choice of unhealthy over healthy foods (Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007; Friese, Hofmann, & Wanke, 2008; Hofmann & Friese, 2008).

In contrast to the impulsive system, the reflective system guides behaviour in a reasoned manner and through conscious deliberation based on a system of long-term goals and personal standards (Deutsch & Strack, 2006; Strack & Deutsch, 2004). The reflective system can regulate the automatic behaviours driven by the impulsive system (e.g., the drive toward consumption of unhealthy snack food), but to do so requires sufficient control resources (Deutsch & Strack, 2006; Strack & Deutsch, 2004). Thus, the relative influence of the reflective and impulsive systems on behaviour is determined by available resources

(Hofmann et al., 2008). Impulsive determinants of behaviour are more strongly predictive of behaviour when individuals lack the self-control capacity (either because of situational depletion, or because of low levels of self-control at a dispositional level) to inhibit those impulses and act in accordance with the standards of the reflective system (Hofmann et al., 2008). In contrast, when self-control capacity is high, behaviour is more strongly driven by the reflective system, and is therefore more consistent with goals and standards (Hofmann et al., 2008).

A number of studies have provided evidence for the moderated relationship between impulsive processes (e.g., an implicit positive evaluation of unhealthy stimuli) and behaviour (e.g., consumption) by various proxies for self-control resources. For example, Hofmann, Friese, and Roefs (2009) found that for individuals with lower inhibitory control measured with a computer-based cognitive task (i.e., lower situational capacity for inhibition of impulses), more positive automatic evaluations of unhealthy snack stimuli predicted higher intake; for individuals with higher inhibitory control, the relationship between implicit evaluations and intake was not statistically significant. Similarly, experimentally-manipulated depletion of self-control has been found to moderate the relationship between implicit preferences for unhealthy snacks and both consumption and choice of unhealthy over healthy snack foods, such that implicit preferences were stronger predictors of behaviour when self-control was depleted (Friese et al., 2008; Hofmann, Rauch, & Gawronski, 2007). Self-control on a dispositional level has also been shown to moderate the relationship between implicit evaluations of unhealthy snack food and alcohol, and subsequent consumption of these substances, respectively (Friese & Hofmann, 2009). Specifically, for individuals with higher trait self-control assessed using a self-report measure, a more positive implicit evaluation of food and alcohol predicted higher consumption of food and alcohol, respectively. In contrast,

individuals with higher trait self-control showed no significant relationship between implicit evaluations and consumption.

Although the conscious experience of desire consumes limited cognitive resources, it can be triggered by impulsive processes such as implicit positive evaluations of the desired stimulus (Hofmann & Van Dillen, 2012; Kavanagh, Andrade, & May, 2005). Some researchers have even gone so far as to argue that a conscious desire or temptation to indulge in unhealthy food can be considered an impulsive process as it can arise automatically, and can also drive behaviour toward hedonically rewarding stimuli in a relatively automatic manner (Milyavskaya, Inzlicht, Hope, & Koestner, 2015). While the relationship between an implicit positive evaluation of food and experienced desire to indulge in those foods had previously been theorised by Hofmann and Van Dillen (2012), the first empirical test of this relationship is presented in Chapter 2 of this thesis. The study revealed that the self-reported strength of temptation to indulge in unhealthy snack food mediated the relationship between an implicit positive evaluation of those foods and subsequent consumption. These findings provide support for the relationship between a positive implicit evaluation of unhealthy food and subsequent experienced temptation.

Based on the results of the study presented in Chapter 2, two studies were conducted to assess the effects of computer-based interventions aimed at retraining implicit food evaluations on consumption of snack food (Chapters 3 and 4), and experienced temptation to indulge in that food (Chapter 4). According to the dual process model perspective, self-control is an effortful process required to suppress or overcome impulses toward engaging in behaviour that conflict with valued long-term goals. This is supported by a body of research demonstrating that self-control resources moderate the relationship between impulsive reactions toward appetitive targets and subsequent consumption of those targets, which is detrimental to long-term goals. Therefore, the studies presented in Chapters 3 and 4 also

explored whether the effects of interventions designed to change these impulsive determinants on subsequent behaviour toward appetitive targets (i.e., snack consumption) would be moderated by dispositional (Chapter 3) and situational (Chapter 4) self-control. The two studies provide support for dual process models by demonstrating stronger behavioural effects of changing impulsive determinants among participants with lower self-control. However, the results of the study presented in Chapter 4 revealed that those with higher self-control were less susceptible to the effects of the intervention on their experienced temptation to indulge in the unhealthy snack food. These results promoted further exploration of the relationship between situational self-control and desire to indulge in unhealthy snack food. The following section outlines two competing theories about the nature of situational self-control, and consequently presents two competing hypotheses about the relationship between self-control and desire to indulge in unhealthy substances.

1.2.2 Situational Self-control

1.2.2.1 The strength model. The dominant account of how self-control operates at a situational level is the strength model (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister & Heatherton, 1996). This model conceptualises self-control as a limited resource that varies situationally (although there are individual differences in the reserve of this self-control resource, which can be strengthened through training; Baumeister et al., 1998; Baumeister et al., 2007; Muraven, Baumeister, & Tice, 1999). This limited resource is required to effortfully overcome desires for immediately hedonically rewarding stimuli in order to control behaviour in line with valued long-term goals and standards (Baumeister et al., 2007; Muraven & Baumeister, 2000). In this way, the strength model is consistent with dual-process models. Following one act of self-control, self-control resources become temporarily depleted, such that subsequent self-control attempts are impaired, even in unrelated behavioural domains (Baumeister & Heatherton, 1996; Baumeister et al., 2007;

Muraven, Tice, & Baumeister, 1998). The detrimental effect of self-control on subsequent self-control strivings is termed ‘ego depletion’ (Baumeister et al., 1998).

Explanations of self-control in the literature commonly refer to the overcoming of unhealthy desires or impulses that conflict with goals. While research has demonstrated that implicit evaluations of stimuli predict behaviour toward those stimuli to a greater extent when individuals are depleted of self-control resources (Friese et al., 2008; Hofmann et al., 2007), the evidence for the moderation of the relationship between consciously experienced desire and goal-consistent behaviour by situational self-control is lacking. Many empirical studies on ego depletion operationalise successful self-control as behaviour that is consistent with task-related goals set by the researcher (e.g., performance or persistence on a difficult, boring, or uncomfortable task, Baumeister et al., 1998; Muraven et al., 1998), or with long-term personal goals (e.g., limiting consumption of unhealthy food to manage weight, Kahan, Polivy, & Herman, 2003; Zyphur, Warren, Landis, & Thoresen, 2007). Goal-consistent behaviour in these, and other, ego depletion studies is assumed to reflect successful suppression or overcoming of immediate desires (e.g., the desire to quit the task to relieve discomfort, or the desire to indulge in food presented for consumption). However, the strength of the desire is often not measured, but assumed to be a constant for all participants.

One study however, has assessed conscious desire in the context of ego depletion. In particular, Hofmann, Vohs, and Baumeister (2012) conducted an experience sampling study in which participants reported the desires they experienced, whether the desires conflicted with personal goals, whether they attempted to resist the desires, and whether the desires were enacted. Results provided support for the strength model of self-control; after having recently resisted a desire, subsequent attempts at resistance were less likely to be successful (Hofmann, Vohs, et al., 2012). These findings support the conceptualisation of self-control as being the effortful overcoming of desire that conflicts with a long-term goal. However, the

study did not provide evidence about the interaction between ego depletion and the *strength* of the subsequent desire. The study presented in Chapter 4 of this thesis, however did test whether the strength of experienced temptation to indulge in unhealthy snack food predicted intake equally for those with high and low situational inhibitory control. The results did not support this moderation, but neither did they suggest that individuals with lower inhibitory control reported lower experienced temptation to indulge. However, conclusions about situational self-control resources and experienced temptation or desire to indulge from this study were confounded by the inclusion of an intervention aimed at retraining implicit food evaluations. This limitation is addressed by the study presented in Chapter 5, which will be introduced in more detail in Section 1.2.2.2.

Other issues have led to doubts about the validity of the strength model of self-control. For example, the ego depletion effect on self-control performance has been shown to be attenuated by personal beliefs about willpower and by enhanced motivation to control behaviour (Hagger, Wood, Stiff, & Chatzisarantis, 2010; Muraven & Slessareva, 2003). Inzlicht and Schmeichel (2012) argue that if self-control truly resembled a resource, then these psychological factors should not be able to overcome depletion of that resource. In addition, the exact nature of the self-control resource is unknown. While some evidence has suggested a physiological basis to ego depletion (e.g., a reduction in blood glucose; Gailliot et al., 2007), more recently, researchers have disputed this (e.g., Beedie & Lane, 2012; Inzlicht, Schmeichel, & Macrae, 2014; Molden et al., 2012). These questions have paved the way for alternative conceptualisations of situational self-control, such as the process model.

1.2.2.2 The process model. The process account of self-control offers an alternative explanation for situational fluctuations in self-control performance to the one proposed by the strength model. While the strength model attributes the effect of self-control depletion on subsequent self-control performance to a reduced capacity to effortfully overcome desires

(Muraven & Baumeister, 2000), the process model attributes this effect to a shift in priorities and motivations (Inzlicht & Schmeichel, 2012). Namely, following one act of self-control, individuals become more motivated to satisfy immediate desires, and simultaneously become less motivated to control these desires (Inzlicht & Schmeichel, 2012). From a dual-process perspective, the process model predicts that ego depletion results in an increase in the strength of impulses toward rewarding stimuli arising from the impulsive system, and an accompanying decrease in the strength of the motivation to control behaviour in line with goals arising from the reflective system. Critically, the process model makes different predictions to the strength model about the interaction between situational self-control and desire for unhealthy stimuli. While the strength model predicts that ego depletion should render unhealthy desires more influential on behaviour as individuals lack the resources to inhibit or overcome them, the process model predicts that ego depletion should increase the strength of desire for unhealthy or appetitive stimuli (Inzlicht et al., 2014).

Several studies provide evidence for a link between ego depletion and processing of stimuli associated with reward or pleasure. For example, Schmeichel, Harmon-Jones, and Harmon-Jones (2010) showed that ego depletion predicted increased incentive sensitivity (i.e., individuals were more motivated toward, pursued, and experienced more positive feeling in response to, incentives), and facilitated the perception of reward-related stimuli. Furthermore, Wagner, Altman, Boswell, Kelley, and Heatherton (2013) showed that ego depletion among current dieters led to greater activity in the orbitofrontal cortex (an area of the brain associated with processing reward value) when viewing pictures of food. However, whether ego depletion indeed leads to lower experienced desire to indulge in unhealthy, but immediately rewarding, stimuli has not yet been tested. Chapter 5 presents the results of a study that tested alternative predictions about the relationship between situational self-control capacity and desire for unhealthy snack foods. Namely, it explored whether behaviour is

more strongly driven by desire for unhealthy foods after completing an initial act of self-control (in line with the strength model), or alternatively whether individuals experience weaker desire for those foods (in line with the process model). The study goes further than the one presented in Chapter 4 in that it experimentally manipulates, rather than measures, situational capacity for self-control. Furthermore, Chapter 5 focuses on desire strength primarily, without the confounding influence of an intervention as in Chapter 4. The results presented in Chapter 5 provide partial support for both strength and process models of self-control. Following from this study, the study presented in Chapter 6 tested similar predictions about the relationship between dispositional self-control and experienced desire for unhealthy snack food. The proposed mechanisms behind this relationship concerning dispositional self-control differs from the one concerning situational self-control, and is therefore discussed separately in the following Section 1.2.3.

1.2.3 Dispositional Self-control

1.2.3.1 Traditional versus contemporary conceptualisations of trait self-control.

As well as varying situationally as a result of temporary depletion, the capacity for self-control also varies between individuals in a dispositional manner. Individual differences in self-control, as measured by self-report questionnaires, have been shown to predict a range of adaptive behaviours and positive life outcomes, including academic and work performance, personal adjustment, interpersonal functioning, lower alcohol abuse, and lower psychopathology (De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Tangney, Baumeister, & Boone, 2004). In the domain of healthy eating and weight management, trait self-control has been found to predict lower BMI, healthier eating patterns, and physical activity levels (Crescioni et al., 2011; Junger & van Kampen, 2010). While the exact nature of the relationship between situational and dispositional self-control capacity is not clear, some argue that individuals with higher trait self-control may be less sensitive to

ego depletion (Gillebaart & de Ridder, 2015; Salmon, Adriaanse, De Vet, Fennis, & De Ridder, 2014), or have a larger reserve of self-control resources (e.g., Dvorak & Simons, 2009; Muraven & Baumeister, 2000; Muraven, Collins, Shiffman, & Paty, 2005). However, others have argued that trait and state self-control operate independently (Muraven, Pogarsky, & Shmueli, 2006).

In line with dual process models of behaviour and with traditional conceptualisations of self-control, trait self-control is often defined as the ability to effortfully overcome or inhibit unhealthy desires and impulses in order to act in accordance with long-term goals (De Ridder et al., 2012; Gillebaart & de Ridder, 2015). However, as with the research on situational self-control, this effortful overcoming of unhealthy desire is usually inferred from behaviour that researchers assume involves overcoming desire (e.g., healthy eating as a result of overcoming desire for unhealthy food, regular physical activity as a result of resisting the desire to engage in sedentary behaviour), rather than from actually assessing individual experiences of desire strength. One exception to this is another experience sampling study by Hofmann, Baumeister, et al. (2012). In this study, participants were asked to report on their desires as they arose during the day. Results revealed that rather than trait self-control moderating the relationship between desire strength and goal-consistent behaviour, participants with higher trait self-control reported less frequent and intense desires that conflicted with their goals. These results support an alternative conceptualisation of self-control. That is, individuals with higher trait self-control were able to enact goal-consistent behaviour effortlessly as they did not experience unhealthy desires with the same frequency and intensity as those with lower trait self-control.

The experience sampling design used by Hofmann, Baumeister, et al. (2012) meant that the researchers did not have control over participants' exposure to unhealthy stimuli that have the potential to elicit goal-conflicting desires. Therefore, it is not clear whether the lower

desire experienced by individuals with higher trait self-control is solely attributable to habitual avoidance of unhealthy stimuli, or because individuals with higher trait self-control do indeed experience less intense desire than individuals with lower trait self-control when encountering those stimuli. The empirical study presented in Chapter 6 sought to address this issue by examining whether individuals with higher trait self-control experienced weaker desire to indulge in unhealthy snacks when these were presented to them in a controlled laboratory-based environment. The findings supported a conceptualisation of self-control as relatively effortless, as individuals with higher trait self-control experienced weaker desire to indulge in unhealthy snack food, which mediated the relationship between trait self-control and lower snack consumption. This relationship may be due to several possible mechanisms. First, it is possible that individuals with higher trait self-control habitually respond to temptation stimuli in a goal-consistent manner, which may subsequently change the way they experienced desire in response to those stimuli in future (Gillebaart & de Ridder, 2015). Indeed, reinforcement of a cue-behaviour link (e.g., practicing a stop response to a food cue) can lead to devaluation of that cue (Hofmann, Deutsch, Lancaster, & Banaji, 2010; Houben, Nederkoorn, Wiers, & Jansen, 2011; Veling, Aarts, & Stroebe, 2013), which is related to lower experienced temptation, as demonstrated in Chapter 2. Alternatively, the relationship between trait self-control and lower desire could be attributable to differences in the cognitive activation of long-term goals in response to temptation cues, which can lead to devaluation of temptation cues (Ferguson, 2008; Fishbach, Friedman, & Kruglanski, 2003). The following Section 1.2.3.2 discusses the theory behind the latter mechanism proposed to account for the relationship between trait self-control and desire. This theory provides the basis for the study presented in Chapter 7.

1.2.3.2 Counteractive control theory and temptation-elicited goal activation. As noted previously, at the core of self-control is a conflict between long-term goals and

immediate temptations, or stimuli that provide the opportunity for immediately rewarding behaviours that are counterproductive to the pursuit of the goal (Kotabe & Hofmann, 2015). Goals are cognitive representations of desired states, and can be conceptually activated intentionally, or automatically, by environmental cues (Austin & Vancouver, 1996; Kruglanski et al., 2002). Counteractive control theory provides a perspective on the role of cognitive accessibility of this long-term goal concept in the self-control of behaviour. The theory proposes that temptation cues in the environment (e.g., chocolate cake), automatically activate a mental representation of the goal concept that is threatened (e.g., healthy weight management), especially for individuals with high self-control (Fishbach et al., 2003). This increased cognitive accessibility of the goal in turn facilitates goal-consistent behaviour by directing attention and resources toward goal pursuit (Fishbach et al., 2003; Kruglanski et al., 2002). Indeed, previous studies have found that increased accessibility of the goal of weight management in response to temptation cues (e.g., cake) in a lexical decision task, is related to self-reported self-regulatory success at weight management (Fishbach et al., 2003; Papies, Stroebe, & Aarts, 2008). In addition, increasing goal accessibility in response to temptations by practicing implementation intentions (e.g., “when I see chocolate cake, I will think of dieting”), has been shown to effectively reduce unhealthy snack consumption measured using self-report snack diaries (Kroese, Adriaanse, Evers, & De Ridder, 2011; Van Koningsbruggen, Stroebe, Papies, & Aarts, 2011). This echoes findings from literature on goal priming, which involves the presentation of goal-related stimuli with a view to automatically activate a cognitive representation of that goal and facilitate goal-consistent behaviour. For example, Bargh, Gollwitzer, Lee-Chai, Barndollar, and Troetschel (2001) demonstrated that activating a goal concept (e.g., achievement) by priming individuals with goal-related words facilitates performance on goal-related tasks.

A possible mechanism through which enhanced cognitive goal accessibility can facilitate goal-consistent behaviour is via counteractive evaluation. This term, coined by Ferguson (2008), refers to the phenomenon whereby cognitive activation of a goal promotes evaluation of goal-relevant stimuli in a manner that facilitates goal pursuit. For example, increased cognitive accessibility of a goal of weight management is predicted to promote a more positive evaluation of goal-facilitative stimuli (e.g., vegetables, gym), and a more negative evaluation of goal-threatening stimuli, or temptations (e.g., chocolate cake). This evaluation pattern is proposed to promote the approach of stimuli that facilitate goal progress, and the avoidance of stimuli that are detrimental to goal progress (Ferguson & Wojnowicz, 2011). For example, Connell and Mayor (2013) demonstrated that among individuals who initially had positive affective ratings of junk foods (e.g., soft drinks, high sugar cereals), increasing the accessibility of a health goal led to a devaluation of hedonic properties of those foods, such that they were rated as less pleasant and less enjoyable. Additionally, Fishbach, Zhang, and Trope (2010) found that increasing the cognitive accessibility of an achievement-related goal through priming made implicit evaluations of concepts related to leisure activities that may interfere with goal pursuit (e.g., beach, partying, socialising) more negative.

Ferguson (2008) suggested that counteractive evaluation in response to goal activation may be correlated with skill at achieving the relevant goal. This was demonstrated in a series of studies. For example, following priming with a dieting goal to increase cognitive goal accessibility, individuals implicitly evaluated goal-facilitative stimuli (e.g., gym, vegetables) more positively. This relationship was stronger for individuals with higher self-reported success at the goal of weight management. By extension, it is possible that this pattern may be particularly evident in individuals with higher dispositional self-control, and thus better at enacting behaviour consistent with goals. Specifically, individuals with higher self-control

may evaluate goal-threatening stimuli (e.g., unhealthy food) more negatively following goal activation, compared to individuals with lower self-control. As such, it is possible that heightened goal accessibility in response to temptation cues may be responsible for the relationship between higher trait self-control and lower desire to indulge in unhealthy snack food observed in the study presented in Chapter 6. The empirical study presented in Chapter 7 explores how goal accessibility in response to environmental temptation cues relates to the strength of subsequent temptation to indulge in and consumption of unhealthy snack food. Furthermore, the study tests how these relationships vary between individuals with different levels of self-control. The findings suggested that individuals with higher trait self-control experience lower temptation to indulge in unhealthy snack food and consume lower amounts of snack food when the goal of healthy eating was highly cognitively accessible than when cognitive goal accessibility is low. However, overall, higher trait self-control did not correlate with heightened cognitive goal accessibility, or lower temptation and consumption of unhealthy snacks.

1.3 Conclusion and Summary of Chapters

This thesis contributes to the literature on self-control of unhealthy snacking by presenting a series of studies that provide insight into the interplay between self-control concepts, desire for unhealthy snack food, and its automatic precursors. The following empirical chapters are either published manuscripts, or manuscripts submitted for publication (listed on the declaration of co-authorship) and can be read as stand-alone papers. As a result, some arguments and evidence may be reiterated as they apply to the studies reported. Additionally, there may be minor inconsistencies in the analytical approach as a result of revisions based on the input of external peer reviewers.

While previously, theorists had proposed that desire is in part predicted by positive implicit evaluations of relevant stimuli, Chapter 2 presents the first empirical test of this

relationship. It was found that a negative implicit evaluation of unhealthy snack food predicted lower temptation to indulge, which mediated the relationship between negative implicit food evaluations and lower intake of unhealthy food.

Following these findings, the studies presented in Chapters 3 and 4 tested computer-based tasks aimed at retraining implicit food evaluations to reduce both temptation to indulge, and consequential snack intake. Findings of these studies revealed that interventions modifying implicit food evaluations may be more successful if targeted at individuals with lower trait self-control, or when implemented in situations where individuals lack inhibitory control resources. The study presented in Chapter 4 also addressed questions about how situational self-control interacts with a conscious temptation to indulge in unhealthy food in predicting snack food intake. The findings did not support the moderation of the relationship between temptation to indulge in unhealthy snack food and subsequent consumption by situational inhibitory control, but nor did they suggest that those with higher inhibitory control experienced less intense temptation to indulge.

The study presented in Chapter 5 subsequently assessed whether experimentally-manipulated situational self-control moderated the relationship between desire strength and snack food consumption, or alternatively, whether desire strength mediated the relationship between self-control and consumption. A similar question about the relationship between self-control and desire and subsequent behaviour was addressed by the study presented in Chapter 6, however, this study focused instead on self-control as a trait rather than situational depletion. Findings suggested that individuals with higher dispositional self-control did indeed experience less intense desire when encountering stimuli which conflict with a higher order goal, supporting a conceptualisation of self-control as being relatively effortless.

The final empirical study presented in Chapter 7 tested counteractive control theory, which provides a potential explanation for the relationship between trait self-control and

lower desire observed in Chapter 6. Namely, the theory predicts that individuals with higher trait self-control experience less intense temptation to indulge in unhealthy snack food as a result of heightened cognitive goal accessibility in response to temptation cues. While the findings suggested a relationship between heightened goal accessibility and lower temptation to indulge and consumption among individuals with higher trait self-control, higher trait self-control did not correlate with heightened cognitive goal accessibility, or lower temptation and consumption of unhealthy snacks overall.

Finally, Chapter 8 presents an integrative discussion of the findings presented in this thesis. Specifically, it outlines the theoretical and practical implications of the work presented, discusses the methodological limitations and contributions, and presents the implications of the findings for the broader conceptualisation of self-control. Directions for future research are also proposed.

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CHAPTER 2: Reduce Temptation or Resist it? Experienced Temptation Mediates the Relationship Between Implicit Evaluations of Unhealthy Snack Foods and Subsequent Intake[1]

A more negative implicit evaluation of unhealthy food stimuli and a more positive implicit evaluation of a weight-management goal have been shown to predict lower consumption of unhealthy food. However, the associations between these evaluations, temptation to indulge, and consumption of unhealthy food remain unclear. The current study investigated whether temptation would mediate the relationship between implicit food and goal evaluations and consumption (resembling an antecedent-focused route to self-control of eating), or whether those evaluations would moderate the relationship between temptation and consumption (resembling a response-focused route). A sample of 156 women (17-25 years) who tried to manage their weight through healthy eating completed two implicit association tasks assessing implicit food and goal evaluations, respectively. Intake of four energy-dense snack foods was measured in a task disguised as a taste-test, and participants reported the strength of experienced temptation to indulge in the snacks offered. Negative implicit food evaluation was associated with lower snack intake, and temptation mediated this relationship. Implicit goal evaluation was unrelated to both temptation strength and snack consumption. The findings contribute to an understanding of how negative implicit unhealthy food evaluation relates to lower consumption, namely through the mediation of temptation to indulge in those foods.

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2.1 Introduction

Desires abound in everyday life. However, pursuit of desired stimuli can conflict with long-term interests or goals, posing a self-control dilemma, turning those desires into temptations. Given the increasing prevalence of obesity and associated health problems (World Health Organization, 2011), a self-control dilemma that is particularly pertinent to address is that of maintaining a healthy diet despite the temptation to consume tasty but unhealthy food (Fishbach, Friedman, & Kruglanski, 2003). Many individuals try to limit intake of unhealthy food for the purpose of managing their body weight (Kruger, Galuska, Serdula, & Jones, 2004; Timperio, Cameron-Smith, Burns, & Crawford, 2000). However, it is often difficult to enact eating behaviour consistent with weight management goals due to our evolutionary preference for, and the rewarding properties of, unhealthy foods high in fat, sugar, and salt (Cohen & Farley, 2008). To further an understanding of the processes involved in the self-control of eating behaviour, the current study investigated two possible predictors of temptation to indulge in unhealthy food: implicit evaluations of unhealthy food, and implicit evaluations of weight management goal stimuli, and explored associations between these variables and consumption of unhealthy food.

Recent research has identified desire, or temptation strength, as an important predictor of effective regulation of eating behaviour. For example, Hofmann, Vohs, and Baumeister (2012) asked participants to carry an electronic device for one week which periodically prompted them to report desire-related experiences in the preceding 30 minutes. Participants reported feelings of desire (e.g., to indulge in unhealthy food), conflict with personal goals (e.g., weight-management), attempts to resist (i.e., exertion of self-control), and whether resultant behaviour was goal-consistent. Results revealed that attempts to resist were less likely to result in goal-consistent behaviour when desires were stronger. A similar study found that instances where current dieters lapsed in dietary control by indulging in unhealthy

food were preceded by a stronger reported experience of temptation compared with instances of successful dietary control (McKee, Ntoumanis, & Taylor, 2014). In fact, the most common reason cited by a sample of overweight and obese individuals for eating unhealthy snacks was that they were perceived as highly tempting (Cleobury & Tapper, 2013). Even individuals who can generally keep behaviour in line with valued goals have trouble resisting strong temptations. This was demonstrated in a recent study, where participants trying to manage weight through healthy eating were asked to complete a lab-based taste-test as a measure of unhealthy snack consumption (Haynes, Kemps, Moffitt, & Mohr, 2014). Participants also rated the extent to which they felt tempted to eat the food offered. Stronger temptation was related to higher snack food intake, which importantly, remained significant when controlling for trait self-control.

Despite evidence attesting to its importance in goal pursuit, the determinants of temptation strength are understudied. Furthermore, the way that temptation and implicit evaluations of food and goal stimuli relate to one another, and to eating behaviour, are unknown. Two paths to resolving self-control dilemmas have been identified in the literature; one involves reducing the temptation to indulge in unhealthy behaviour, and the other requires the individual to overcome or resist that temptation (Hoch & Loewenstein, 1991; Hofmann & Van Dillen, 2012). This distinction parallels one proposed in the emotion regulation literature, between two routes via which undesired emotional states can be regulated (Gross, 1998). The former is an antecedent-focused regulation route involving the prevention of the internal experience of emotion before it arises. In the context of dietary self-control involving implicit food or goal evaluations, this would involve a reduction in the temptation to engage in unhealthy eating behaviour, such that the relationship between implicit evaluations and eating behaviour would be mediated by temptation. The latter route requires response-focused regulation and involves the moderation of the outward, observable

expression of internal states. This is similar to resisting an unhealthy temptation or desire once it has arisen, such that the strength of the relationship between temptation and eating behaviour would be moderated by implicit evaluations.

The implicit evaluation of food is one variable related to the regulation of eating behaviour. Incentive theory proposes that stimuli or states associated with positive affect become an incentive which an individual will pursue (Bindra, 1974; Bolles, 1972). Accordingly, individuals' implicit evaluations of a stimulus (i.e., the extent to which the stimulus is associated with positive affect) have been found to predict the tendency to approach that stimulus across time and situations (e.g., Chen & Bargh, 1999; Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Duckworth, Bargh, Garcia, & Chaiken, 2002; Ferguson & Bargh, 2008). In the area of healthy eating, research has shown a correlation between a more positive implicit evaluation of unhealthy food and lab-based choice and actual purchase of unhealthy over healthy food items, higher intake of unhealthy snack food in lab-based tasks or self-report snack diaries, higher levels of weight gain, and higher BMI (Ayres, Prestwich, Conner, & Smith, 2010; Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007; Dube, 2007; Friese, Hofmann, & Wanke, 2008; Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008; Perugini, 2005; Prestwich, Hurling, & Baker, 2011; Richetin, Perugini, Prestwich, & O'Gorman, 2007). However, not all studies have found this relationship (Czyzewska & Graham, 2008; Karpinski & Hilton, 2001; McKenna, 2010; Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010). In fact, one study reported that obese participants showed a more negative implicit evaluation of unhealthy snack food than those in lower BMI categories (Roefs & Jansen, 2002). In addition, Ayres, Conner, Prestwich, and Smith (2012) found that implicit food evaluation no longer predicted choice of unhealthy food after controlling for explicit ratings of palatability (e.g., how pleasant and enjoyable eating the food is). While it has been demonstrated that automatic affective

reactions can influence behaviour in the absence of conscious awareness (Winkielman, Berridge, & Wilbarger, 2005), Hofmann and Van Dillen (2012) have argued that those automatic positive affective reactions can themselves give rise to conscious desire or temptation to indulge. The experience of temptation may therefore play at least some part in the relationship between implicit evaluations of stimuli and subsequent behaviour toward them in self-control dilemmas. However, to date, the associations between implicit food evaluation, temptation, and consumption, have not been investigated.

In line with incentive theory (Bindra, 1974; Bolles, 1972), just as individuals implicitly evaluate concrete, tangible objects (e.g., chocolate cake), they also implicitly evaluate abstract stimuli, including goal concepts (Ferguson, 2007). While the mental activation of a goal concept leads individuals to prepare the execution of goal-consistent behaviour and has been shown to correlate with lower experienced temptation to engage in goal-inconsistent behaviour (Haynes et al., 2014), the attached positive valence of the goal is responsible for turning that preparation into motivation, and subsequent action toward that goal (Custers & Aarts, 2005a, 2005b). Therefore, individuals will be motivated to enact goal-consistent behaviour to the extent that the goal is associated with positive affect (Custers & Aarts, 2005a; Ferguson, 2007). This link between positive goal valence and goal-consistent behaviour has been demonstrated in both experimental and correlational studies. For example, Custers and Aarts (2005b) manipulated the pairing of a goal of ‘puzzle solving’ with either positive or negative affect in an evaluative conditioning task. Participants for whom the goal was associated with positive affect expended more effort on a task that was instrumental to achieving the goal (Custers & Aarts, 2005b). Similarly, a study measuring the evaluation of a pre-existing goal found a correlation between a more positive implicit evaluation of the goal and motivated behaviour toward that goal (Custers & Aarts, 2007). Participants who were primed with the goal of socialising and evaluated that goal as more

positive, expended more effort on a puzzle task that would give them a chance to win tickets to a student party. Similar findings have emerged in the eating and weight-management domain. Individuals with a more positive implicit evaluation of the goal of weight management reported being better able to resist eating tempting food over a one week period, and consumed less unhealthy food in a laboratory-based taste-test (Ferguson, 2007). Notably, the implicit evaluation of the goal concept was a stronger predictor of unhealthy food consumption than implicit evaluation of unhealthy food, which did not correlate with either measure of consumption. While results of this study suggest that a more positive goal evaluation may facilitate overcoming temptation, the strength of experienced temptation itself was not measured. The cognitive accessibility of the goal of weight-management has been shown to correlate with lower temptation to indulge in unhealthy foods (Haynes et al., 2014); however, it is unclear whether implicit goal evaluation correlates with a weaker experience of temptation, or whether it moderates the relationship between experienced temptation to indulge in unhealthy food and intake of unhealthy food.

The current study had two aims. First, we investigated whether a more negative implicit evaluation of unhealthy food and a more positive implicit goal evaluation were related to weaker temptation to indulge in unhealthy snack food. Second, we explored the associations between each of these implicit evaluations, temptation to indulge in unhealthy snack food, and snack food consumption. Specifically, we explored whether temptation would mediate the relationship between both implicit food and goal evaluations and intake of unhealthy snack food (suggesting antecedent-focused self-control), or whether a more negative implicit evaluation of unhealthy food and more negative implicit goal evaluation would moderate the relationship between temptation and snack intake (suggesting response-focused self-control). As some previous research (e.g., Ayres et al., 2012) has suggested that implicit unhealthy food evaluation may no longer predict unhealthy food consumption

incrementally over explicit ratings of palatability, we further examined whether temptation would still mediate the relationship between implicit unhealthy food evaluation and snack intake after controlling for participants' explicit evaluation of unhealthy foods.

2.2 Method

2.2.1 Participants

One hundred and ninety-two women aged 17 to 25 years (M = 19.60, SD = 2.23) were recruited from Flinders University. Participants were recruited on the basis that they identify themselves as being motivated to manage body weight by avoiding consumption of unhealthy foods and were told the study investigated the relationship between language processing and taste perception. One hundred and thirty first-year psychology student volunteers participated for course credit, and the remaining paid volunteers received a $15 honorarium. The mean body mass index (BMI) of the sample was 23.10 (SD = 2.17), which is classified as in the healthy weight range. Only women were recruited, as they have higher levels of food liking and craving than men (Coelho, Jansen, Roefs, & Nederkoorn, 2009; Fishbach et al., 2003; Harderwijk, 2010; Kroese, Adriaanse, Evers, & De Ridder, 2011; Van den Bos, 2011).

2.2.2 Materials

2.2.2.1 Implicit evaluation of unhealthy snack food. Implicit evaluation of unhealthy snack foods was measured with a computer-administered single category implicit association task (SC-IAT, Karpinski & Steinman, 2006). The task requires participants to sort stimuli belonging to three categories (positive, negative, and unhealthy food) using two evaluative categories (positive and negative). The two evaluative categories appear at the top left and right corners of the screen, and the word stimuli are presented one by one in the centre of the screen. Participants sort the positive and negative stimuli into positive and negative categories respectively, by pressing a key designated to the position of the evaluative category on the screen (left or right). In the remaining trials, participants are

instructed to sort the food stimuli into the positive category for half of the trials, and the negative category for the other half. The task is easier when the concept ‘unhealthy food’ and the attribute with which it is paired, are more strongly associated. Therefore, the food + positive pairings are generally made more quickly than the food + negative pairings, which indicates a more positive implicit evaluation of food.

The task consisted of 24 practice trials, followed by two blocks of 72 experimental trials each, which were each preceded by three buffer trials. The two experimental blocks were presented in counterbalanced order (Nosek, Greenwald, & Banaji, 2007). In the practice block, only positive and negative attribute words were categorised. In the food + positive block, food words and positive words were categorised on one response key, and negative words were categorised on another. In the food + negative block, positive words were categorised on one response key, and food and negative words were categorised on the other. Response bias was minimised by presenting food words, positive words, and negative words at unequal frequency in each block, so that 58% of correct responses were on one key, and 42% on another. This resulted in 30 presentations of food words in each block; 30 presentations of negative words and 12 presentations of positive words in the food + positive block; and 30 presentations of positive words and 12 presentations of negative words in the food + negative block (Nederkoorn et al., 2010; Olson & Fazio, 2004).

As used in previous research, the target category was labelled “food”, and the positive and negative evaluative categories were labelled “I like”, and “I dislike”, respectively (Craeynest, Crombez, Haerens, & De Bourdeaudhuij, 2007; Houben & Wiers, 2007; Nederkoorn et al., 2010; Olson & Fazio, 2004). The target words included six unhealthy food words: chocolate, cake, ice-cream, chips, pizza, and hamburger and are similar to those used in previous studies (e.g., Fishbach, Zhang, & Trope, 2010; Richetin et al., 2007; Roefs, Herman, MacLeod, Smulders, & Jansen, 2005; Roefs & Jansen, 2002; Roefs et al., 2006).

The evaluative stimuli for the positive category included romantic, pleasure, rainbow, sunlight, peace and friend; and for the negative category included accident, sickness, abuse, alone, fear, and pain. These stimuli were selected from previous IAT studies (e.g., Karpinski & Steinman, 2006; Olson & Fazio, 2004; Roefs et al., 2005). Between the positive and negative categories, the stimuli were matched on number of syllables, word type (i.e., noun, adjective), frequency, and arousal (Bradley & Lang, 1999). All words were presented in lower case letters.

Each block was preceded by instructions. The category labels remained at the top of the screen on the same side as the appropriate response keys (i.e., 'z' for left, '/' for right) throughout the tasks. Each word appeared centred on the screen, and the order of presentation of the words was randomised within each block. The word remained on the screen until the participants responded. The inter-trial interval was 400ms. Accuracy and response times were recorded.

2.2.2.2 Implicit evaluation of the goal of successful weight management. The weight management SC-IAT was identical to the food SC-IAT except that a "weight management" target category was used. The target words (thin, slim, slender, lean, fit, and healthy) were similar to those used in previous research (e.g., Fishbach et al., 2010; Vartanian, Herman, & Polivy, 2005).

2.2.2.3 Snack intake. A taste test was used to measure snack intake (e.g., Coelho et al., 2009). Participants were presented with four full bowls of pre-weighed popular energy-dense snack foods. The bowls contained 80g of M&Ms (Mars, 2050 kilojoules [kJ]/100g), 30g of original salted chips (Smiths, 2190kJ/100g), 30g of Cheese Twisties (Smiths, 2080kJ/100g), and 80g of mini choc-chip cookies (White Wings, 1959kJ/100g). Using a Latin square procedure with four orders, the placement position of the four bowls from left to right was counterbalanced across participants. Each bowl was accompanied by one paper-

pencil format rating sheet containing six questions about the sensory attributes of the foods (e.g., “How sweet is this product?”). Ratings were completed on 100mm visual analog scales, ranging from “not at all” to “extremely”. Participants were given 10 minutes to taste as much food as they needed in order to accurately rate the foods while the experimenter was out of the room. To measure food consumption, the pre- and post-taste test weight of each bowl was recorded. Food intake in grams was multiplied by the number of kilojoules (kJ) per gram in each food. Intake in kJ for each food was summed to give total intake in kJ.

2.2.2.4 Temptation experience. A temptation score was obtained by averaging the responses to the question: “How much were you tempted to eat each of the foods presented in the taste-test?” for each food. Participants responded on 7-point Likert scales, ranging from 1 (*not at all*), to 7 (*extremely*) for each food.

2.2.2.5 Hunger. Participants’ subjective hunger levels were assessed with a single item: “Please indicate the place on the scale which best reflects your current level of hunger”. Responses were collected on a 7-point Likert scale ranging from 1 (*not hungry at all*), to 7 (*extremely hungry*).

2.2.2.6 Motivation. The extent to which participants were motivated to regulate eating in order to manage weight was measured using a 4-item self-report scale (e.g., “I choose certain food items to avoid gaining weight”, Sproesser, Strohbach, Schupp, & Renner, 2011). The scale requires participants to indicate how often each item is true for them on 5-point Likert scales, ranging from 1 (*never*), to 5 (*always*). An average motivation score was calculated for each participant, with higher scores indicating higher motivation to regulate eating for weight management. The scale’s internal-consistency coefficient alpha was acceptable in the current study, Cronbach’s a = .80; and comparable with previous research, Cronbach’s a = .89 (Sproesser et al., 2011).

2.2.2.7 Explicit evaluation of unhealthy food. To assess explicit food evaluation, participants were asked to rate how much they liked eating six unhealthy foods (i.e., chocolate, cake, ice-cream, chips, pizza, and hamburger) on a 7-point Likert scale ranging from 1 (*not at all*), to 7 (*extremely*) (Hoefling & Strack, 2008).

2.2.2.8 Awareness of purpose of taste-test. Participants were asked to respond to the question "What do you think was the purpose of the taste-test?" using an open-ended response format. Participants were categorised as being aware of the taste-test's purpose if their response referred to the assessment of food intake, the self-control of eating, or resisting temptation.

2.2.3 Procedure

Testing was conducted in a quiet room in the Applied Cognitive Psychology Laboratory. Participants were tested individually, with each session running for approximately 30 minutes. Participants were asked to eat something 2 hours before the scheduled time of the study, and to refrain from eating again until the study to equalise hunger levels across participants. The hunger scale was completed first, followed by the two implicit association tasks presented in counterbalanced order, and then the taste test. Participants were then asked to complete the temptation, motivation, explicit food evaluation, and taste-test awareness questions, and to disclose background information (i.e., age, height and weight).

2.2.4 Data Analysis

2.2.4.1 Computing implicit food and goal evaluation. Scores were calculated using the D600 algorithm (Greenwald, Nosek, & Banaji, 2003) modified for application to single-category IATs (Karpinski & Steinman, 2006). Participants with an error rate greater than 20% in either food + positive or food + negative trials were excluded from food SC-IAT analyses (n = 20); and participants with an error rate greater than 20% in either goal +

positive or goal + negative trials were excluded from goal SC-IAT analyses (n = 33) (Karpinski & Steinman, 2006). A total of 48 participants had an error rate greater than 20% on either the food or the goal SC-IAT. Trials with response times of less than 350ms or more than 10000ms were also discarded (Karpinski & Steinman, 2006), which accounted for 4.96% and 5.01% of the food and goal data respectively. Incorrect responses on the remaining trials were replaced with the mean of response times from that block plus an error penalty of 400ms (Karpinski & Steinman, 2006). Error trials made up 10.1% of the food data and 13.2% of the goal data. Mean response times on positive trials (food or goal paired with positive) were subtracted from the mean response times on negative trials (food or goal paired with negative). The difference between response times on positive and negative trials was divided by the standard deviation of all correct response times on food trials for the food SC-IAT, and goal trials for the goal SC-IAT (Karpinski & Steinman, 2006). Higher scores indicate a more positive implicit evaluation of the target stimuli of the respective SC-IAT.

2.2.4.2 Statistical analyses. An independent-samples t-test was conducted to compare snack intake between participants who indicated awareness of the purpose of the taste-test and those who did not. Simple correlations were used to explore relationships between the variables of implicit food and goal evaluations, snack intake, temptation, hunger, BMI, motivation, and explicit food evaluation. To test whether temptation mediated the relationship between implicit evaluation and intake, several hierarchical regression analyses were conducted: firstly, to establish a relationship between the predictor (implicit evaluation) and mediator (temptation), secondly, between the predictor and the outcome (food consumption), and finally, to explore whether the predictor was related to the outcome with the mediator variable in the model. A second set of regression analyses with implicit food evaluation was then run identical to the first, but including explicit food evaluation as a covariate. To investigate whether the relationships between implicit evaluations and snack

intake were moderated by temptation, a hierarchical regression analysis was conducted. The predictors (implicit evaluation and temptation) were centred, from which an interaction term was computed (product of predictors) (Cohen, Cohen, West, & Aiken, 2003). The predictors were first regressed on intake, and then the interaction term was added to the model.

2.3 Results

2.3.1 Relationships Between Variables

2.3.1.1 Effect of awareness on snack intake. An independent-samples t-test (corrected for unequal variances) revealed that participants who were aware of the purpose of the taste-test did not consume significantly more kilojoules (n = 31, m = 1065.11, sd = 820.85) than participants who were not aware (n = 161, m = 894.54, sd = 820.85), t(34.32) = 1.12, p = .27.

2.3.1.2 Correlations between implicit food and goal evaluation, temptation, and intake of unhealthy food. Correlation analyses revealed that hunger was positively correlated with both snack intake and temptation (Table 2.1), and was therefore entered as a covariate in subsequent analyses. Snack intake was positively correlated with temptation. Implicit food evaluation was positively correlated with implicit goal evaluation, snack intake, temptation, and explicit food evaluation. Implicit goal evaluation was positively correlated with BMI and motivation, but by contrast was not correlated with either snack intake, or temptation. Consequently, no further analyses were conducted on the relationships between implicit goal evaluation and outcome variables.

Table 2.1.

Correlations between variables

		1	2	3	4	5	6	7	8
1	Implicit food evaluation		.30**	.15*	.14†	.01	.04	.10	.18*
2	Implicit goal evaluation			-.01	-.02	.05	.19*	.15††	.05
3	Intake (kJ)				.31**	.21*	.12	- .15††	.27**
4	Temptation					.38**	.05	.07	.75**
5	Hunger						-.03	.02	.27**
6	BMI							.05	.08
7	Motivation								.01
8	Explicit food evaluation								

†† $p < .08$, † $p < .07$, * $p < .05$, ** $p < .001$.

2.3.2 Mediation Analysis

To investigate whether the relationship between a more negative implicit food evaluation and lower snack intake was mediated by temptation strength (i.e., resembling antecedent-focused self-control [Figure 2.1]), a series of hierarchical regression analyses were conducted. Hunger was entered as a control variable at Step 1 in each model. To estimate pathway *a*, implicit food evaluation was regressed on snack intake. A more negative implicit food evaluation emerged as a significant predictor of lower food intake, $\beta = .15$, $t(171) = 1.99$, $p = .05$, R^2change = .02. A separate regression equation was estimated to test pathway *b*, regressing implicit food evaluation on temptation. Results showed that participants with a more negative implicit food evaluation reported feeling less tempted by the food, $\beta = .14$, $t(171) = 2.11$, $p = .04$, R^2 change = .03. Finally, a regression model was estimated with snack intake as the dependent variable, and temptation and implicit food evaluation entered simultaneously as predictors, R^2change = .07, *F change* (2, 168) = 6.60, *p*

= .002. Temptation was a significant predictor of intake, β = .25, t(171) = .25, p = .003. However, implicit food evaluation no longer significantly predicted snack intake, β = .11, t(171) = 1.53, p = .13. These analyses show that variations in the experience of temptation account for the relationship between implicit snack food evaluation and snack intake. A Sobel test showed that the overall indirect effect of implicit food evaluation on intake approached significance, z = 1.67, p = .09.

We subsequently investigated whether temptation still mediated the relationship between implicit food evaluation and intake when explicit food evaluation was included as an additional covariate in the analysis. A similar pattern of results was found. When we controlled for explicit food evaluation, a more negative implicit food evaluation was still a marginally significant predictor of lower food intake, β = .14, t(171) = 1.85, p = .07, R^2 change = .02, but explicit food evaluation was not, β = .11, t(171) = 1.40, p = .16. Results of a separate equation showed that both a more negative implicit, and explicit food evaluation contributed to participants reporting feeling less tempted by the food (implicit: β = .10, t(171) = 1.68, p = .09, R^2 change = .01; explicit: β = .46, t(171) = 7.46, p = <.001). Finally, when temptation and implicit food evaluation were entered simultaneously as predictors of snack food intake in a separate regression model, R^2change = .06, *F change* (2, 167) = 5.25, p = .001, temptation significantly predicted intake, β = .25, t(171) = 2.64, p = .01, but implicit food evaluation, β = .11, t(171) = 1.52, p = .13, and explicit food evaluation, β = -.01, t(171) = -.08, p = .93, did not. Importantly, temptation still predicted snack intake when controlling for explicit food evaluation alone, β = .27, t(171) = 2.85, p = .01, R^2 change = .04. Thus, even after controlling for explicit evaluation of unhealthy food, variations in the experience of temptation still accounted for the relationship between implicit snack food evaluation and snack intake. However, results of a Sobel test showed that the indirect effect of implicit food

evaluation on intake controlling for both hunger and explicit food evaluation was not significant, z = 1.35, *p* = .18.

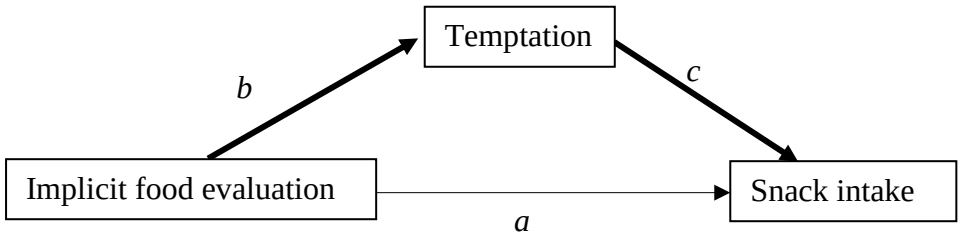

Figure 2.1. Mediation of the relationship between implicit evaluation of snack food and intake of unhealthy snack food by temptation. *Note.* Bold arrows denote significant relationships.

2.3.3 Moderation Analysis

To test whether implicit food evaluation moderated the relationship between temptation and snack intake, a hierarchical regression analysis was conducted. The covariate (hunger) and predictors (implicit food evaluation and temptation) were first regressed on the outcome variable (snack intake), and then the interaction term (product of the predictors) was added to the model. Temptation was a significant predictor of snack intake, *B* = 113.89, *t*(167) = 3.01, *p* = .003, but implicit food evaluation did not significantly predict intake, *B* = 107.23, *t*(167) = 1.53, *p* = .13. The interaction term (product of temptation and implicit food evaluation) was not a significant predictor of snack intake, *B* = 13.05, *t*(167) = .26, *p* = .80, and did not result in a significant increase in snack intake variance explained with the predictors already in the model, R^2 *change* = .00, *F change* (1, 167) = .07, *p* = .80. Therefore, individuals' implicit food evaluation did not moderate the relationship between temptation and consumption of snack food.

2.4 Discussion

Many individuals experience a conflict between the temptation to indulge in unhealthy but tasty snack food, and the goal of healthy weight management. Implicit evaluations of unhealthy food and the weight-management goal-concept have previously been found to be related to indices of unhealthy eating behaviour, including self-reported and lab-based measures of food intake, self-reported resistance of unhealthy food temptations, weight gain, and BMI (Ayres et al., 2010; Conner et al., 2007; Dube, 2007; Friese et al., 2008; Hofmann et al., 2008; Perugini, 2005; Prestwich et al., 2011; Richetin et al., 2007). The current study contributed to an understanding of the relationship between these implicit evaluations and both the experienced temptation to consume, and the consumption of unhealthy snack food in a sample of young women motivated to manage weight through healthy eating.

Results suggest that the implicit evaluation of unhealthy food resembles an antecedent-focused route to self-control of eating: its relationship with snack consumption was accounted for by experienced temptation or desire to indulge in unhealthy food (Gross, 1998; Hoch & Loewenstein, 1991; Hofmann & Van Dillen, 2012). Consistent with previous research (Ayres et al., 2010; Conner et al., 2007; Dube, 2007; Friese et al., 2008; Hofmann et al., 2008; Perugini, 2005; Prestwich et al., 2011; Richetin et al., 2007), individuals who implicitly evaluated unhealthy food stimuli more negatively tended to report being less tempted by the snack food offered, and also consumed less of it. Results suggest that the relationship between a more negative implicit evaluation of unhealthy snack food and lower snack consumption is mediated by the strength of temptation to indulge in unhealthy snacks. Like implicit food evaluation, explicit food evaluation was related to a higher reported experience of temptation. Nevertheless, temptation still predicted snack intake over and above the explicit evaluation of snack food. Furthermore, the relationship between a more

positive implicit food evaluation and higher snack intake was also still accounted for by temptation, even after controlling for explicit food evaluation. Thus, in contrast to Ayres et al. (2012), we found that implicit food evaluation predicted snack intake incrementally over explicit food evaluation. This discrepancy could be attributable to differences in the explicit unhealthy food evaluation measures used. In particular, Ayres et al. (2012) suggest that their explicit measure of palatability reflects affective properties, and hence, likely shares more variance with implicit food evaluation than liking measures such as the one used here, which also include cognitive components. Further research into the mediation of the implicit food evaluation – intake relationship by temptation which takes affect versus cognitive laden explicit food evaluations into account would be valuable.

Results of a moderation analysis however, showed that the relationship between temptation to indulge and subsequent snack consumption does not vary according to individuals' implicit evaluation of food. Together, these findings suggest that the relationships between implicit food evaluation, temptation, and snack consumption resemble antecedent-focused regulation. The current study was correlational, and therefore, does not evidence causality. Experimental manipulation of implicit food evaluation is needed to confirm whether implicit negativity toward unhealthy snack food can prevent the experience of strong temptation to indulge, and subsequently lead to lower snack consumption.

Implicit evaluation of the goal of weight management was found not to correlate with either temptation or unhealthy snack intake. This result contrasts with previous findings revealing that a more positive implicit evaluation of a goal concept was a stronger predictor of both lower unhealthy snack intake, and higher self-reported frequency of 'resisting tempting foods', than the implicit evaluation of food stimuli (Ferguson, 2007). A critical difference between the current study and that of Ferguson (2007), is that we specifically recruited individuals who were motivated to manage their weight through healthy eating. We

specified this inclusion criterion because we were interested in presenting a self-control conflict to participants – one between indulging in unhealthy but tasty snack food, and the long-term goal of healthy weight management (Hofmann & Kotabe, 2012). The current results show a positive relationship between motivation to manage weight through healthy eating and implicit evaluation of the goal of weight-management, suggesting that sampling from the higher end of motivation may yield more positive implicit goal evaluation. The sampling differences between the current study and that of Ferguson (2007) may be responsible for the divergent results regarding the relationship between implicit goal evaluation and food intake. The current sample may likely have a more limited range of implicit goal evaluations.

Interestingly, BMI was positively correlated with implicit goal evaluation, but not with implicit food evaluation. Thus, individuals with a higher BMI evaluated the goal of weight management more positively. However, as the current study was correlational, the direction of this relationship cannot be determined. Future research could usefully determine whether having a higher BMI affects the implicit evaluation of the goal of weight management, or vice versa.

The results of the current study have implications for the design of interventions which modify aspects of implicit cognition to enhance healthy regulation of eating behaviour. Modification of implicit cognitive processes like implicit food evaluation to facilitate healthy behaviour, offers benefits over the training of conscious strategies. Implicit processing, by definition, occurs without cognitive control or awareness (Bargh, 1997; Wilson, Lindsey, & Schooler, 2000). Therefore, modifying implicit processes offers a potential way of facilitating healthy behaviour while preserving limited cognitive resources for more cognitively effortful processes, such as the effortful inhibition of unhealthy behavioural impulses and the initiation of healthy alternatives (Carver, 2005; Muraven & Baumeister, 2000). Our finding that

participants' implicit evaluation of snack food predicted their snack intake, is consistent with a body of research which suggests that changing people's implicit evaluation of unhealthy food from positive to negative may enhance successful regulation of eating behaviour (e.g., Ayres et al., 2010; Conner et al., 2007; Dube, 2007; Friese et al., 2008; Hofmann et al., 2008; Perugini, 2005; Prestwich et al., 2011; Richetin et al., 2007). Several studies have employed an evaluative conditioning procedure to modify implicit evaluation of unhealthy food. By presenting a stream of pictures or words on a computer screen, in which the unhealthy food stimuli are repeatedly paired with negatively valenced affective stimuli (e.g., obese body shapes, heart disease, etc.), and healthy or neutral stimuli are paired with positive or neutral affective stimuli, participants acquire a more negative implicit evaluation of unhealthy snacks (Hollands, Prestwich, & Marteau, 2011; Lebens et al., 2011). Subsequent effects on choice of fruit over unhealthy snacks have, however, varied: while Hollands et al. (2011) demonstrated that evaluative conditioning training promoted choice of fruit over unhealthy snacks, Lebens et al. (2011) did not. Previous research has not, however, examined the effect of modification of implicit food evaluation on individuals' temptation to indulge in unhealthy food. Although correlational in nature, the current study nevertheless suggests that changing implicit food evaluation to become more negative may reduce consumption of unhealthy foods by reducing the extent to which individuals feel tempted by it. Further studies into the modification of implicit food evaluation are needed to validate this causal hypothesis.

Examining the ways in which other modifiable implicit cognitive processes relate to both temptation and eating behaviour may help to identify targets for a program of cognitive modification tasks which simultaneously enhance both antecedent- and response-focused regulation strategies. For example, attentional biases have been successfully retrained toward healthy foods to increase consumption of healthy foods relative to unhealthy options (Kakoschke, Kemps, & Tiggemann, 2014), and away from chocolate stimuli to decrease both

subjective craving (an intense, specific desire) for, and consumption of, chocolate (Kemps, Tiggemann, Orr, & Grear, 2014). It is unclear, however, whether the effect of attentional bias modification on consumption can be primarily accounted for by its effect on craving or desire – therefore representing an antecedent-focused strategy of regulation; or whether it affects behaviour at a response-focused level, moderating the effect of craving or desire on subsequent consumption. Classifying implicit modifiable cognitive factors as resembling antecedent- or response-focused pathways to behavioural regulation could inform the development of a program of cognitive modification tasks which simultaneously reduce the strength of, and enhance the ability to overcome, the temptation to indulge in unhealthy behaviour.

Like all studies, the current study has a number of limitations. First, the temptation measure was administered after the taste-test, and thus prompted participants to retrospectively report on the temptation they had experienced prior to the taste-test. This was intended to prevent the perceived temptation from influencing intake. However, participants could have based their judgment of temptation on the amount of snack consumption, thereby inflating the correlation between these two variables. To circumvent these methodological issues, future studies could comprehensively address the temporality of the variables by using a time series design, whereby assessment of implicit food evaluation, temptation, and intake are taken at multiple time points, thereby providing the opportunity to examine the within-subjects correlations between them (Roe, 2012). Second, snack consumption was assessed in a controlled laboratory-based setting after a 2-hour period of fasting. This design was intended to provide control over variables which have been suggested by previous research to affect eating behaviour (e.g., diet-related cues (Papies & Hamstra, 2010), pre-load (Herman, Polivy, & Esses, 1987), food variety (Rolls et al., 1981), portion size (Hill & Peters, 1998), etc.). However, to increase ecological validity, future research could usefully explore

associations between implicit food evaluation, temptation, and snack intake in a more naturalistic setting. Third, the current study recruited a sample of young female university students, as previous research has shown that the goal of weight management is common among this population (Fishbach et al., 2003; Wardle et al., 2004; Wardle, Haase, & Steptoe, 2005). Nevertheless, to demonstrate the generalisability of the relationships shown in the current study, it would be valuable to investigate them among a more diverse sample of weight-concerned individuals.

In conclusion, the current study contributes to an understanding of the relationship between individuals' implicit evaluation of unhealthy food and their consumption of such foods. Namely, the findings suggest that the relationship between a more negative evaluation of unhealthy food and lower snack intake is mediated by experienced temptation to indulge in that food.

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CHAPTER 3: Inhibitory self-control moderates the effect of changed implicit food evaluations on snack food consumption[2]

The current study used a modified implicit association test (IAT) to change implicit evaluations of unhealthy snack food and tested its effects on subsequent consumption. Furthermore, we investigated whether these effects were moderated by inhibitory self-control. A sample of 148 women (17-25 years) motivated to manage weight through healthy eating completed an IAT intervention, and pre- and post-intervention IATs assessing implicit evaluations of unhealthy food. The intervention IAT trained participants to pair unhealthy food stimuli with either positive or negative stimuli. A task disguised as a taste-test was used to assess consumption of unhealthy snack foods. Inhibitory self-control was measured using a self-report scale. As predicted, the implicit evaluation of unhealthy food became more negative from pre- to post-training among participants in the food negative pairing condition; however, there was no corresponding change in the food positive pairing condition. The effect of the training on snack consumption was moderated by inhibitory self-control with only participants low in inhibitory self-control having lower snack intake following the food negative training. This finding is consistent with dual-process models of behaviour which predict that self-control capacity renders impulses less influential on behaviour. Furthermore, it suggests that an intervention that retrains implicit food evaluations could be effective at reducing unhealthy eating, particularly among those with low inhibitory self-control.

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3.1 Introduction

Despite the negative health consequences resulting from overconsumption of food high in fat, sugar, and salt, many individuals find it difficult to regulate their eating behaviour in line with long-term health or weight-management goals (Cohen & Farley, 2008; Fishbach, Friedman, & Kruglanski, 2003; World Health Organization, 2011). Due to their rewarding sensory properties, unhealthy foods are generally associated with positive affect, and this implicit positivity toward food stimuli drives approach behaviour toward them (Chen & Bargh, 1999; Cohen & Farley, 2008; Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997; Duckworth, Bargh, Garcia, & Chaiken, 2002; Ferguson & Bargh, 2008). However, the relationship between a more positive implicit evaluation of unhealthy food (i.e., association of food with positive affect) and subsequent consumption depends on individual differences in control resources. A stronger relationship exists between implicit evaluations and subsequent behaviour among individuals with lower capacity for impulse inhibition (Hofmann, Friese, & Roefs, 2009).

3.1.1 Dual Process Models of Behaviour

Dual process models posit that behaviour is determined by two interacting systems. On the one hand, the impulsive system drives behaviour through an automatic appraisal of a stimulus in terms of its affective and motivational properties (Strack & Deutsch, 2004). For example, a more positive implicit evaluation of food has been shown to predict choice of unhealthy over healthy food and higher intake of unhealthy snack food (Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007; Friese, Hofmann, & Wanke, 2008; Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008). On the other hand, the reflective system guides behaviour through long-term goals and personal standards (e.g., Deutsch & Strack, 2006; Strack & Deutsch, 2004). When a conflict between these two systems arises, higher order inhibitory processes need to be employed to ensure behaviour is consistent with

personal standards rather than being guided by unhealthy impulses (e.g., inhibition of automatic impulses to eat unhealthy food such that behaviour is consistent with a goal of weight management) (Deutsch & Strack, 2006; Strack & Deutsch, 2004). Success at achieving control over impulses is dependent on available cognitive resources which vary between individuals and across situations (Deutsch & Strack, 2006; Strack & Deutsch, 2004).

3.1.2 Inhibitory Control

Weaker inhibitory control, or the inability to inhibit unwanted impulsive reactions, has been associated with obesity and intake of unhealthy food in a laboratory setting (Guerrieri, Nederkoorn, & Jansen, 2007; Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006). However, it has been argued that inhibitory control itself does not determine behaviour, but rather that low inhibitory control may allow impulses (e.g., automatic evaluations of stimuli) to have a more potent influence on behaviour (Hofmann et al., 2009). This is evidenced in findings demonstrating that inhibitory control moderates the relationship between implicit evaluations of appetitive stimuli (e.g., food, alcohol), and subsequent consumption. For example, Hofmann et al. (2009) showed that for individuals with lower inhibitory control, positive implicit attitudes towards candy were more strongly related to subsequent candy intake than for individuals with higher inhibitory control. Similarly, Nederkoorn, Houben, Hofmann, Roefs, and Jansen (2010) found that only among participants with lower inhibitory control did an implicit preference for snack food predict higher weight gain over one year. Likewise, in the alcohol domain, more positive alcohol evaluations predicted higher levels of alcohol use and alcohol problems, but again, only among those with low inhibitory control (Houben & Wiers, 2009). However, these studies were correlational in nature.

Other studies that have experimentally manipulated response inhibition capacity have shown support for its causal role in moderating the effect of implicit evaluations on

behaviour. For example, randomising participants to a high cognitive load or resource depletion condition subsequently limited their capacity for inhibitory control over impulses relative to participants randomised to a low cognitive load or resource depletion condition (Friese et al., 2008; Hofmann, Rauch, & Gawronski, 2007). These manipulations of state inhibitory control capacity were shown to moderate the relationship between implicit snack attitudes and subsequent choice of unhealthy over healthy snacks and snack consumption in a lab-based task, such that individuals with low capacity for inhibitory control showed a stronger relationship between their impulses and behaviour than those with higher inhibitory control capacity (Friese et al., 2008; Hofmann et al., 2007).

3.1.3 Manipulating Impulses: Implicit Food Evaluations

While previous studies have manipulated inhibitory control to explore its causal role in moderating the relationship between impulses and behaviour, impulses have not themselves been manipulated. As noted by Houben and Wiers (2009), research needs to determine the causality of the relationship between implicit evaluations and behaviour at the same time as investigating the moderating role of inhibitory control. In line with findings of previous studies (e.g., Friese et al., 2008; Hofmann et al., 2009; Hofmann et al., 2007; Nederkoorn et al., 2010), experimentally manipulating implicit evaluations of food is likely to show a change in implicit evaluations for all individuals, but a corresponding change in consumption is likely to occur only for those low in inhibitory control. By contrast, despite a change in implicit evaluations, a corresponding change in eating behaviour is not likely to be observed among individuals with high inhibitory control, evidencing a dissociation between impulses and behaviour.

A number of previous studies have attempted to modify implicit evaluations. One way of achieving this is to use evaluative conditioning, which repeatedly pairs a conditioned stimulus (CS; e.g., unhealthy food), with unconditioned stimuli (US) which evoke either

positive or negative affective reactions (e.g., general positive or negative images or words) (De Houwer, Thomas, & Baeyens, 2001). For example, participants presented with unhealthy food stimuli paired with aversive images of negative health consequences of consumption subsequently evaluated those foods more negatively (Hollands, Prestwich, & Marteau, 2011; Lebens et al., 2011). This paradigm has also been applied in the alcohol domain, where presenting participants with alcohol-related stimuli paired with negative concepts resulted in a more negative implicit evaluation of alcohol (Houben, Havermans, & Wiers, 2010; Houben, Schoenmakers, & Wiers, 2010).

Another approach to changing implicit evaluations is through a modified version of an implicit association test (IAT). This task requires participants to respond to one type of CS and negative US with one response key and to a comparison category CS and positive US with a separate response key (Ebert, Steffens, von Stulpnagel, & Jelenec, 2009). This training procedure works on the same principle as evaluative conditioning in that it provides contingent pairings of CS and US. However, in contrast to evaluative conditioning, which requires participants to simply watch a stream of pictures presented on a computer screen, the modified IAT requires participants to actively categorise the stimuli. A study using a modified IAT conducted in the consumer choice domain found that individuals trained to pair one brand of candy with negative stimuli and another brand with positive stimuli, consequently evaluated the negatively-paired brand more negatively than the comparison brand (Ebert et al., 2009). IAT re-training has also been reported to successfully modify implicit evaluations of the self, and of mathematics (Ebert et al., 2009; Forbes & Schmader, 2010)

Implicit evaluation modification using evaluative conditioning or a modified IAT has achieved variable success in affecting subsequent behaviour toward CS. While some studies have shown effects of implicit evaluation training on subsequent behaviour, including alcohol

consumption (Houben, Havermans, et al., 2010; Houben, Schoenmakers, et al., 2010), healthy snack choices (Hollands et al., 2011; Walsh & Kiviniemi, 2013), and motivation toward solving math problems (Forbes & Schmader, 2010), a number of studies have not (Ebert et al., 2009; Lebens et al., 2011). These inconsistent findings regarding the training of implicit evaluations on subsequent consumptive behaviour may be attributable to individual differences in inhibitory control. Given that previous research has shown that impulses affect behaviour to a greater extent among individuals with low inhibitory control, the effect of implicit evaluation interventions on snack intake may be greater in these individuals (e.g., Friese et al., 2008; Hofmann et al., 2009; Hofmann et al., 2007; Houben & Wiers, 2009; Nederkoorn et al., 2010).

3.1.4 The Current Study

The current study aimed to investigate the moderating role of inhibitory self-control in the effect of changed food evaluations on subsequent food intake. In line with previous findings, we predicted that implicit food evaluations would become more negative among participants who were trained to pair food with negative stimuli, while implicit food evaluations would become more positive among participants trained to pair food with positive stimuli. However, because individuals with low inhibitory control are less successful at regulating impulses so that their behaviour is in line with goals or personal standards, we expected that the intervention would only affect subsequent consumption of unhealthy snacks for participants with low inhibitory self-control. The current study used a modified IAT to change implicit evaluations of unhealthy food. This ensured that participants were paying attention to the critical CS-US pairings by requiring them to actively categorise stimuli rather than simply viewing them being presented on the computer screen, as occurs in evaluative conditioning.

3.2 Method

3.2.1 Participants

One hundred and forty-eight women between the ages of 17 and 25 years (M = 19.49, SD = 1.82) were recruited from Flinders University. The study advertisement targeted individuals motivated to manage weight through healthy eating. This recruitment strategy was used as dual process models posit that motivation to control impulses (reflected in a goal of healthy eating for weight management) is important in the regulation of behaviour by the reflective system (Fazio & Towles-Schwen, 1999). Only women were recruited, as they have higher levels of food liking and craving than men (Cepeda-Benito, Fernandez, & Moreno, 2003; Zellner, Garriga-Trillo, Rohm, Centeno, & Parker, 1999). One hundred and seven first-year psychology student volunteers participated for course credit, and the remaining paid volunteers received a $15 honorarium. The mean body mass index (BMI) of the sample was 22.55 (SD = 3.76).

3.2.2 Design

The study used a 2 (training condition: positive, negative) x 2 (time: pre-training assessment, post-training assessment) mixed factorial design. Participants were randomised to either the food positive or the food negative training IAT. Participants (but not the experimenter) were blinded to the training conditions. Implicit food evaluations and snack intake were dependent variables. Inhibitory self-control was tested as a moderator.

3.2.3 Materials

3.2.3.1 Implicit food evaluation. The modified implicit association test (IAT) consisted of three phases: (1) a pre-training assessment of implicit evaluations of unhealthy food, (2) a modified IAT training phase, and (3) a post-training assessment of implicit evaluations of unhealthy food (e.g., Kemps, Tiggemann, Martin, & Elliot, 2013). Implicit evaluation of unhealthy snack foods was measured and modified with a recoding-free IAT

(IAT-RF, Rothermund, Teige-Mocigemba, Gast, & Wentura, 2009). In the IAT-RF, the response keys assigned to the target category change between trials rather than between blocks, as in the traditional IAT. This prevents participants from recoding into a two-category sorting task whereby the target category is grouped with one evaluative category on the basis of salience or familiarity. Instead, participants must respond to the target stimulus based on its semantic category membership. This makes the IAT-RF a more valid assessment of implicit associations with the target concept (Houben, Rothermund, & Wiers, 2009; Rothermund et al., 2009).

Participants sorted word stimuli belonging to three categories: two evaluative categories (positive and negative, labelled “I like” and “I dislike”, respectively), and the target category (“food”). The evaluative category labels (“I like”/”I dislike”) better reflect personal evaluations and decrease the influence of normative social evaluations of target stimuli compared with the traditional “positive/negative” or “pleasant/unpleasant” labels (Olson & Fazio, 2004). They have also been used in previous research (e.g., Craeynest, Crombez, Haerens, & De Bourdeaudhuij, 2007; Houben & Wiers, 2007; Nederkoorn et al., 2010). The positive evaluative stimuli were: holiday, pleasure, rainbow, gift, peace and friend; the negative evaluative stimuli were: accident, sickness, abuse, dead, fear, and pain. The food stimuli were chocolate, cake, ice-cream, chips, pizza, and hamburger, similar to those used in previous studies (e.g., Richetin, Perugini, Prestwich, & O'Gorman, 2007; Roefs, Herman, MacLeod, Smulders, & Jansen, 2005; Roefs & Jansen, 2002; Roefs et al., 2006). The stimuli between evaluative categories were matched on number of syllables, frequency, and arousal (Bradley & Lang, 1999), and were selected from previous IAT studies (e.g., Karpinski & Steinman, 2006; Olson & Fazio, 2004; Roefs et al., 2005). All words were presented in lower case letters.

The evaluative category labels appeared fixed at the top left and right hand corners of the computer screen, and the food category label switched between the top left and right hand corners of the screen randomly throughout the task, so that it appeared on the same side as the positive label on 50% of food trials, and on the same side as the negative label on the remaining 50% of food trials. Word stimuli were presented individually in the centre of the screen. Participants were asked to respond by pressing a key designated to the position of the word's category on the screen (left or right). The task is easier when the concept 'food' and the attribute with which it is paired at the top of the screen are more strongly associated. Therefore, trials which required a response to food words with the same key as trials with positive words were expected to elicit a quicker response than those requiring a response with the same key as negative words, indicating a more positive implicit food evaluation.

***3.2.3.1.1 Pre-training implicit food evaluation*.** The pre-training implicit association test (IAT) consisted of three blocks. The first was a practice block consisting of 24 trials, which required participants to categorise positive and negative word stimuli into their respective categories. Each positive and negative stimulus was presented twice. In the second practice block (36 trials), participants were required to categorise stimuli into both evaluative categories (i.e., positive and negative), and the target category (i.e., food). The response key assigned to evaluative categories (left and right) remained constant throughout the task, and was counterbalanced between participants. The response assignment of the target category however, switched randomly between trials, sharing a response key with the positive category on half of the trials (congruent trials), and sharing a response key with the negative category on the remaining half of the trials (incongruent trials). Each positive, negative, and food stimulus was presented twice. The third block was identical to the second, with the number of trials increased to 144, such that each positive, negative, and food stimulus was presented eight times. Three buffer trials were presented at the beginning of the test block and again

after a short break halfway through the test phase. The buffer trials presented one positive, one negative, and one food word ("evil", "sunlight", and "hotdog", respectively). These gave participants a chance to re-focus their attention on the task after reading the instructions.

Each block was preceded by a standardised set of instructions presented on the screen, which included a list of the words belonging to each category and the appropriate key responses for the evaluative categories. Participants were instructed to respond to each stimulus word as quickly and accurately as possible. On each trial, the category labels appeared at the top of the screen on the side of the appropriate response key. They were displayed 1500ms before presentation of the stimulus. Participants responded to the stimulus by pressing the appropriate response key (i.e., left 'z', or right '/'). The target stimulus remained on the screen until the participant responded. The inter-trial interval was 400ms. Accuracy and response times were recorded. The order of presentation of stimulus words was randomised within each block.

3.2.3.1.2 Modified IAT training. The training task resembled the third block of the pre-training IAT, except that participants randomised to the food positive condition paired food words mainly with positive words, while participants randomised to the food negative condition paired food words mainly with negative words. Participants in the food positive condition completed three blocks of 72 trials each (216 total), where 90% of the trials were congruent (food + positive), and 10% were incongruent (food + negative). Those in the food negative condition completed the same task, except the contingencies were switched: 90% of trials were incongruent (food + negative), and 10% were congruent (food + positive). Mirroring previous research (Kemps et al., 2013; Wiers, Rinck, Kordts, Houben, & Strack, 2010), a 90:10 response distribution was used to prevent a response bias from developing, and to reduce the obviousness of the contingency while still effectively training associations between food and positive or negative concepts.

***3.2.3.1.3 Post-training implicit food evaluation*.** The post-training measure of implicit food evaluation was identical to the third block of the pre-training IAT.

3.2.3.2 Snack intake. Intake of unhealthy snack food was assessed with a taste test (Coelho et al., 2009). Participants were presented with four full bowls of pre-weighed popular energy-dense snack foods: 80g of M&Ms (Mars, 2050 kilojoules [kJ]/100g), 30g of original salted chips (Smiths, 2190kJ/100g), 30g of Cheese Twisties (Smiths, 2080kJ/100g), and 80g of mini choc-chip cookies (White Wings, 1959kJ/100g). The placement position of the four bowls from left to right was counterbalanced across participants using a Latin square procedure with four orders. One paper-pencil format rating sheet containing six questions about the foods' sensory attributes (e.g., "How sweet is this product?"), answered on 100mm visual analog scales (ranging from "*not at all*" to "*extremely*") accompanied each bowl of food. The taste-test was presented to participants using a standardised verbal script, to avoid potential biases: "The next task is a taste-test. Please rate the sensory properties of each of the four snack products by placing a small vertical line on the scales provided. Please taste as much of the products as you need to make your ratings as accurate as possible. You will have 10 minutes to complete the task, which should be ample time. Once you have completed your ratings, feel free to go back and sample more of the products (any leftover will be thrown away), but please do not change your initial ratings. I will be in the next room setting up for the next participant." The pre- and post-taste test weight of each bowl was measured using sensitive and reliable weight scales, to measure intake without participants' knowledge. Food intake in grams was multiplied by the number of kilojoules (kJ) per gram in each food, and summed to give total intake in kJ.

3.2.3.3 Hunger. A single item was used to assess subjective hunger: "Please indicate the place on the scale which best reflects your current level of hunger". Responses were made on a 7-point Likert scale ranging from 1 (*not hungry at all*), to 7 (*extremely hungry*).

3.2.3.4 Inhibitory self-control. Inhibitory self-control was measured using the 6-item inhibitory self-control scale (De Ridder, de Boer, Lugtig, Bakker, & van Hooft, 2011). The scale assesses the domain-general ability to inhibit unwanted behavioural impulses that are detrimental to long-term interests but bring immediate pleasure (e.g., "I am good at resisting temptation"). Participants respond by rating the extent to which each statement represents them on 5-point likert scales ranging from 1 (*not at all like me*) to 5 (*very much like me*), with higher scores indicating higher levels of inhibitory self-control. De Ridder et al. (2011) demonstrated the predictive validity of the inhibitory self-control scale, showing that low inhibitory self-control predicted behaviours that are driven by unhealthy impulses (e.g., smoking cigarettes, drinking alcohol). Internal consistency of the scale was adequate, Cronbach's α = .68, although slightly lower than that observed in previous research, Cronbach's α in two different samples = .76, .78 (De Ridder et al., 2011).

3.2.3.5 Awareness of taste-test purpose. Awareness of the purpose of the taste test measure of intake was assessed with a single open-ended probe question. Participants were asked "What do you think was the purpose of the taste-test?" and were categorised as being aware of the taste-test's purpose if their response referred to the assessment of food intake, self-control of eating, or resisting temptation.

3.2.4 Procedure

Participants completed the experiment individually in the Applied Cognitive Psychology Laboratory. Each session ran for approximately 45 minutes. Participants were told that the experiment would investigate the relationship between language processing and taste perception. To equalise hunger levels, participants were asked to eat something 2 hours before their scheduled session, and to refrain from eating again until the experiment. Participants first completed the hunger scale, followed by the pre-training IAT, the training task, post-training IAT, and taste test. Subsequently, participants were asked to complete the

measures of inhibitory self-control and taste-test awareness, and to disclose background information, including age, height and weight.

3.2.5 Data Analysis

3.2.5.1 Calculating IAT scores. IAT scores from block 3 of the pre-training assessment and the post-training assessment were calculated using the D600 algorithm (Greenwald, Nosek, & Banaji, 2003), following the procedure specified for the analysis of single-category IATs by Karpinski and Steinman (2006). Namely, participants with an error rate greater than 20% were excluded from analysis (n = 22). However, the inclusion of these participants in analyses did not change the pattern of results. Trials with response times of less than 350ms or more than 10000ms were also discarded. Incorrect responses on the remaining trials were replaced with the mean of the response times from that block plus an error penalty of 400ms. Mean response times to food stimuli on congruent trials (where the food category shared a response key with positive category) were subtracted from the mean response times on incongruent trials (where the food category shared a response key with negative category). The difference between congruent and incongruent trials was divided by the standard deviation of all correct response times in the food trials to adjust for the effect of response variability on scores (Greenwald, Nosek, & Banaji, 2003; Karpinski & Steinman, 2006). Higher IAT scores indicate a more positive implicit evaluation of unhealthy snack food.

3.2.5.2 Statistical analyses. Independent samples *t*-tests were conducted to compare the training conditions on baseline variables of age, BMI, hunger, pre-training implicit food evaluations, and inhibitory self-control; and to compare intake between participants who were aware and those who were not aware of the purpose of the taste test. The percentage of participants indicating awareness of the taste test purpose was compared between conditions

using a chi square analysis. A one-sample *t*-test was conducted to assess whether pre-training IAT scores were significantly different from zero.

As hunger and BMI have been found to play a role in implicit food evaluations, inhibitory control, and eating behaviour (Hofmann et al., 2009; Nederkoorn, Guerrieri, Havermans, Roefs, & Jansen, 2009; Seibt, Häfner, & Deutsch, 2007), we controlled for these variables in statistical analyses.

A mixed model ANOVA compared changes in pre- to post-training implicit associations between training conditions, and a univariate ANOVA compared intake between the training conditions. Multiple regression analyses were conducted to assess the main effects of inhibitory control, pre- and post-training food evaluation, and change in implicit food evaluation from pre- to post-training on snack intake.

The SPSS macro PROCESS was used to test whether inhibitory control moderated the effect of training condition on both post-training implicit evaluations controlling for pre-training implicit food evaluations, and snack food consumption.

3.3 Results

3.3.1 Preliminary Analyses

Descriptive statistics for baseline variables are shown in Table 3.1. Comparison of these variables between participants assigned to the food positive training condition and the food negative training condition revealed no significant differences. Participants evaluated unhealthy food positively at pre-training, and a one-sample *t*-test revealed that the pre-training implicit evaluation score was significantly different from zero, $t(125) = 7.80$, $p < .001$, $d = 1.40$, 95% CI (0.07, 0.12).

Intake of snack food was significantly higher among participants who indicated awareness of the purpose of the taste test ($n = 20$, $m = 1459.38$, $sd = 1216.18$) than those who were not aware, ($n = 128$, $m = 835.13$, $sd = 608.67$), $t(20.51) = -2.25$, $p = .04$, $d = .65$, 95%

CI (-1201.59, -46.91). Therefore, in line with Coelho, Jansen, Roefs, and Nederkoorn (2009), participants who indicated awareness of the purpose of the taste-test were excluded from analyses of intake as they did not complete the taste-test measure of intake as intended.

Four outliers were detected in food consumption data. Deleting or changing these did not exert a significant effect on the results: namely, any significant results did not change to non-significant, and vice versa. Therefore, these participants were retained for analysis.

3.3.2 Main Effects

3.3.2.1 Effect of IAT training on change in implicit food evaluation. A 2 (training condition: food + positive, food + negative) x 2 (time: pre-training, post-training) mixed model ANOVA was conducted to assess the effect of the training on implicit food evaluation. As predicted, there was a significant interaction between training condition and time, $F(1, 124) = 5.00$, $p = .03$, partial $\eta^2 = .04$. Paired samples *t*-tests revealed that participants trained to associate food with negative words showed a significant decrease in IAT scores (Figure 3.1), indicating a more negative implicit food evaluation at post-training than at pre-training, $t(61) = 3.88$, $p < .001$, $d = .46$, 95% CI (0.04, 0.11). However, participants trained to associate food with positive words did not show a significant change in implicit food evaluation following the training, $t(63) = 0.19$, $p = .85$, 95% CI (-0.04, 0.05).

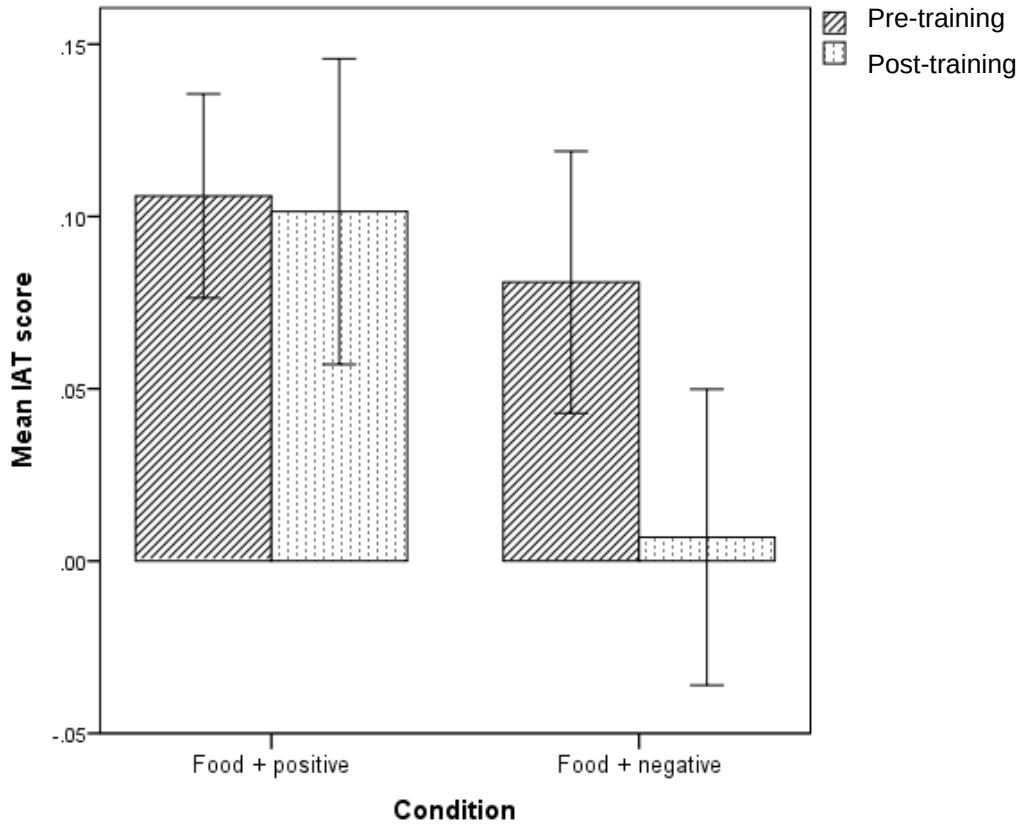

Figure 3.1. Mean pre- and post-training IAT scores (with standard errors) for the positive and negative training conditions.

3.3.2.2 Effect of IAT training, inhibitory control, and implicit food evaluations on snack food consumption. A univariate ANOVA revealed that the training conditions did not differ significantly on snack consumption (Table 3.1), $F(1, 120) = 1.22$, $p = .27$. Results of four separate regression analyses showed that neither inhibitory control, $\beta = -0.04$, $t(3, 119) = -0.43$, $p = .67$, 95% CI (-33.24, 21.38); pre-training implicit food evaluation, $\beta = 0.12$, $t(3,103) = 1.24$, $p = .22$, 95% CI (-305.80, 1329.58); post training implicit food evaluation, $\beta = 0.14$, $t(3,103) = 1.45$, $p = .15$, 95% CI (-155.22, 997.39), or change in implicit food evaluation from pre- to post-training, $\beta = -0.06$, $t(3,103) = -.058$, $p = .57$, 95% CI (-768.30, 421.57), significantly predicted snack consumption.

Table 3.1

Descriptive statistics by training condition

Variable	Sample	Training condition	
		Food positive	Food negative
	m (sd)	*m (sd)*	*m (sd)*
Age	19.54 (1.81)	19.65 (1.76)	19.53 (1.86)
BMI	22.55 (3.76)	22.39 (3.44)	22.73 (4.08)
Hunger	3.20 (1.55)	3.09 (1.43)	3.31 (1.66)
Pre-training implicit food evaluations	0.09 (0.13)	0.11 (0.12)	0.08 (0.15)
Snack food consumption (kJ)	839.18 (608.34)	885.09 (670.49)	785.35 (526.95)
Inhibitory self-control	17.22 (3.94)	17.09 (3.92)	17.36 (3.99)
% aware of taste-test purpose	14	11	15

Note. $P > .05$ and 95% confidence intervals did not contain zero for independent samples *t*-tests of condition differences, and for chi-square comparison of percentage aware of taste-test purpose.

3.3.3 Moderation of Training Effects by Inhibitory Self-control

3.3.3.1 Moderation of IAT training effect on change in implicit food evaluation.

The SPSS macro, PROCESS (Hayes, 2012), was used to test whether inhibitory self-control moderated the effect of training on post-training implicit food evaluations while controlling for pre-training levels. The predictors (training condition and inhibitory self-control) were first regressed on the outcome variable (post-training implicit food evaluation), and then the interaction term (product of the predictors) was added to the model. The interaction term (product of training condition and inhibitory self-control) did not significantly predict implicit food evaluation at post-training, $B = -0.002$, $t(120) = -0.30$, $p = .76$, 95% CI (-0.02,

0.01), indicating that the effect of training condition on implicit food evaluation did not vary according to participants' inhibitory self-control levels.

3.3.3.2 Moderation of IAT training effect on snack intake. A similar analysis was conducted to assess whether inhibitory self-control moderated the effect of training on consumption of unhealthy snacks. The interaction term (product of training condition and inhibitory self-control) was a marginally significant predictor of intake, B = -52.95, $t(117)$ = -1.94, p = .05, 95% CI (-106.92, 1.02). To explore this interaction, simple slopes were estimated at plus ("high") and minus ("low") one SD from the sample mean for inhibitory self-control. As shown in Figure 3.2, training condition predicted snack food intake among participants with low inhibitory self-control, such that those in the food negative condition consumed less snack food than those in the food positive condition, B = 320.24, $t(117)$ = 2.08, p = .04, 95% CI (15.58, 624.91). However, training condition did not predict snack food intake among participants with high inhibitory self-control, indicating that snack intake among those with high inhibitory self-control was not affected by the training they completed, B = -105.35, $t(117)$ = -0.68, p = .50, 95% CI (-410.78, 200.08).

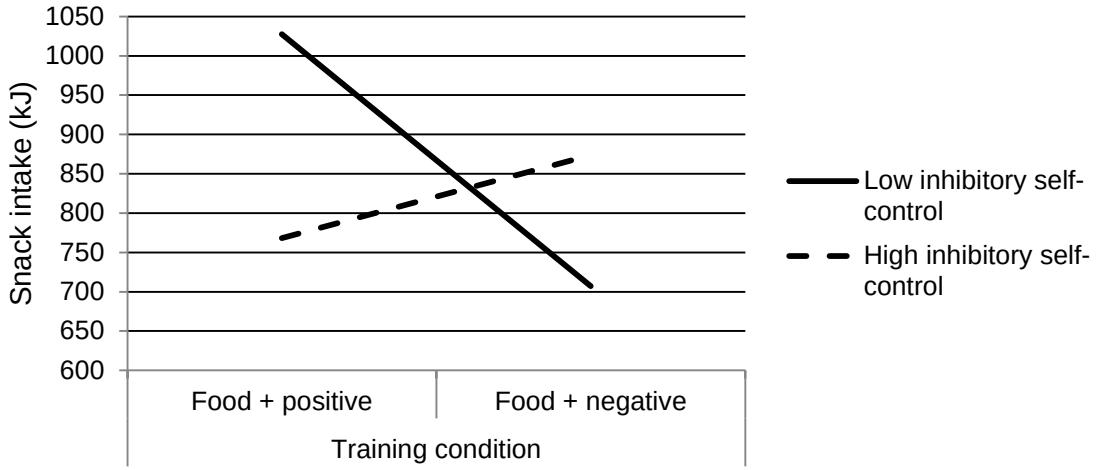

Figure 3.2. Effect of training condition on snack intake by inhibitory self-control.

3.3.4 Additional Analysis of Awareness of Taste-test Purpose

Because there was a significant difference in snack intake between participants who were aware of the purpose of the taste test and those who were not, we re-ran the previous analysis including awareness as an additional predictor. The two-way interaction term representing the product of training condition and awareness was a significant predictor of snack intake, B = -725.65, $t(132)$ = -2.08, p = .04, 95% CI (-1415.35, -35.95), indicating that awareness of the purpose of the taste test moderated training effects on snack intake. As shown in Figure 3.3, simple slopes analysis revealed that among participants who indicated awareness of the taste test purpose, training condition fell just short of significance in predicting snack food intake, with participants in the negative training condition eating more than those in the positive training condition, B = -608.06, $t(132)$ = -1.86, p = .06, 95% CI (-1253.21, 37.10). However, training condition clearly did not predict snack food intake among participants who did not indicate awareness of the taste test purpose, B = 117.59, $t(132)$ = 0.95, p = .34, 95% CI (-127.78, 362.97). In addition, the two-way interaction term representing the product of training condition and inhibitory control was not statistically significant, B = -49.25, $t(132)$ = -1.65, p = .10, 95% CI (-108.25, 9.76), indicating that with all participants included in the analysis, inhibitory control did not moderate training effects on intake. Furthermore, the three way interaction term (product of training condition, inhibitory self-control, and awareness) was not a significant predictor of intake, B = -45.02, $t(132)$ = -0.44, p = .66, 95% CI (-245.32, 155.28), suggesting that the moderation of training on intake by inhibitory self-control did not significantly differ between participants aware and those not aware of the taste-test purpose.

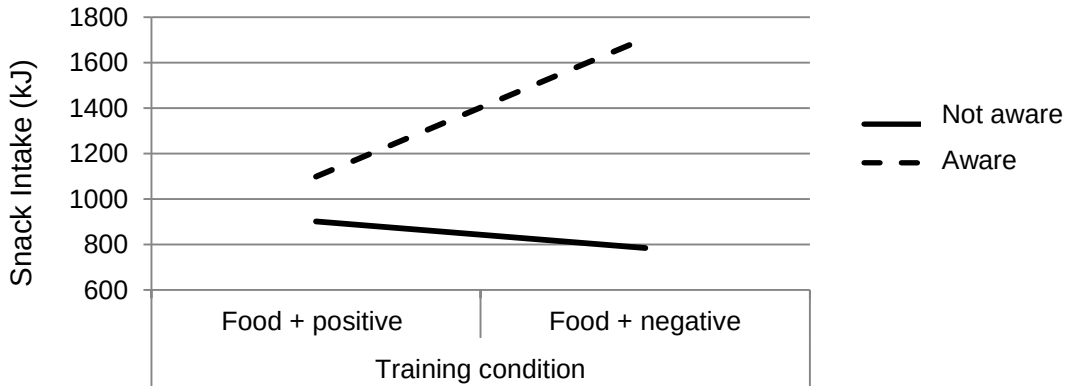

Figure 3.3. Effect of training condition on snack intake by awareness of taste-test purpose.

3.4 Discussion

The current study used a modified IAT to change implicit evaluations of unhealthy food and tested its effects on subsequent intake of unhealthy snack foods. The intervention successfully modified implicit food evaluations; however a corresponding effect on snack food intake was only found among participants with low inhibitory self-control.

3.4.1 Effect of Training on Implicit Food Evaluations

As expected, participants assigned to the food negative training condition showed a significant change in their implicit food evaluations from pre- to post-training in the negative direction. These results are consistent with previous studies showing that repeated pairing of appetitive stimuli with negatively valenced stimuli changes implicit evaluations of those stimuli to become more negative (e.g., Ebert et al., 2009; Houben, Havermans, et al., 2010; Houben, Schoenmakers, et al., 2010; Lebens et al., 2011).

Participants in the food positive training condition in contrast, showed no change in their implicit food evaluations. Some studies have shown a change toward a more positive implicit evaluation of a food category following the pairing of food CS with positive US (e.g., Lebens et al., 2011); however, in contrast to the current study, these studies trained participants to develop positive attitudes toward healthy foods. The absence of an effect of food positive training on implicit food evaluations here may have been due to a ceiling effect:

participants in our sample already evaluated unhealthy food very positively at pre-training. The training may therefore only be effective at reversing an existing implicit positive food evaluation, rather than making it stronger. A similar finding occurred in the alcohol domain (but showing a floor effect), where participants were trained to associate alcohol with negative concepts. Participants already showed a negative implicit evaluation of alcohol at pre-training, and subsequently showed no significant change in implicit alcohol evaluations from pre- to post-training (Houben, Havermans, et al., 2010).

3.4.2 Moderation of Training Effects by Inhibitory Self-control

As predicted, implicit evaluation training affected snack intake only for participants low in inhibitory self-control. Specifically, training participants with low inhibitory self-control to pair food with negative stimuli led them to consume less unhealthy snack food. It is likely that their lower inhibitory control ability rendered the change in implicit food attitudes more influential on subsequent eating behaviour (Hofmann et al., 2009; Hofmann et al., 2007). The lack of training effects for participants with high inhibitory self-control could be attributable to their enhanced capacity to inhibit unwanted impulses toward unhealthy food and act in a manner consistent with their personal standards for healthy eating (Hofmann et al., 2009; Hofmann et al., 2007). The current findings support previous research which has demonstrated the moderating role of state inhibitory control, both measured (Hofmann et al., 2009) and experimentally manipulated (Friese et al., 2008; Hofmann et al., 2007), in the relationship between individuals' pre-existing implicit food evaluations and subsequent eating behaviour. The current study extends this correlational work, in demonstrating for the first time the moderating role of trait inhibitory self-control in the effect of experimentally-manipulated implicit food evaluations on subsequent food consumption. Thus, the results suggest that interventions targeting implicit food evaluations may only be effective at changing subsequent food consumption for individuals low in inhibitory self-control.

By contrast, inhibitory self-control did not moderate the effect of training condition on post-training implicit food evaluation after controlling for pre-training levels. This indicates that the training protocol was effective at changing implicit evaluations of food for all participants regardless of their level of inhibitory self-control. While individuals with higher inhibitory self-control would be expected to be able to inhibit unwanted impulses and act in a manner consistent with personal goals (e.g., limit unhealthy snack intake despite positive evaluations of food, supported by the current results) (Deutsch & Strack, 2006; Strack & Deutsch, 2004), there is no reason to expect that their impulses themselves would be more resistant to change than for individuals with lower inhibitory self-control, which is consistent with the finding that inhibitory self-control moderated the effect of training on snack food consumption, but not implicit food evaluations.

3.4.3 Theoretical Implications

Theoretically, the finding that inhibitory self-control moderates the relationship between experimentally manipulated implicit food evaluations and subsequent food intake supports dual process models of behaviour which posit that inhibitory control of impulses (an operation of the reflective system) moderates the effect of impulses on behaviour (Deutsch & Strack, 2006; Strack & Deutsch, 2004). Furthermore, although the effect of impulse change (i.e., modification of implicit evaluations of unhealthy food) on subsequent consumptive behaviour depends on inhibitory self-control, modification of impulses themselves does not. This demonstrates that operations of the impulsive system are no more resistant to change among individuals with high inhibitory self-control than those with low inhibitory self-control, but rather that those with high inhibitory self-control evidence a dissociation between these impulses and subsequent behaviour. This would hold true even in the direction that would promote an increase in unhealthy behaviour, that is, a more positive implicit food evaluation, as demonstrated by the finding that participants with high inhibitory self-control

ate less food in the food positive than the food negative training condition. In contrast, snack consumption among participants with low inhibitory self-control was consistent with the expected effects of the training conditions: those in the food positive condition ate more than those in the food negative condition. A similar dissociation between impulses and eating behaviour has been observed among individuals high in eating disorder symptomatology. In particular, Ellis, Kiviniemi, and Cook-Cottone (2014) recently showed that only for individuals with low levels of eating disorder symptomatology did implicit affective associations with fruit predict their choice of fruit over snacks. This is consistent with both dual process models, and with the current findings, as eating disorder symptomatology is in part characterised by high levels of self-control over eating (Ellis et al., 2014).

Impulse control is a multifaceted construct. The current study focused on just one aspect of impulse control, namely, trait inhibitory self-control. By contrast, Hofmann et al. (2009) tested three subcomponents of impulse control: inhibitory control, executive attention, and affect regulation, and demonstrated that each of these constructs independently moderated the relationship between implicit candy attitudes and subsequent intake. Future research could consider testing the moderating role of the various impulse control subcomponents in an experimental design which manipulates implicit food evaluations as was done in the current study, and thus contribute to a more comprehensive understanding of the different aspects of impulse control.

3.4.4 Practical Implications

The observation that inhibitory self-control moderates the effect of experimentally manipulated implicit food evaluations on snack intake suggests that interventions that aim to modify implicit attitudes toward food to reduce unhealthy eating behaviour may be most suitable for individuals with low levels of inhibitory self-control. By contrast, interventions that aim to increase the cognitive accessibility of the goal of weight management as a means

of reducing unhealthy eating may be better suited to individuals high in self-control. In support, a correlational study by Haynes, Kemps, Moffitt, and Mohr (2014) showed that cognitive accessibility of the goal of weight management predicted snack intake among individuals with high levels of trait self-control, but not those with low self-control. Previous interventions aimed at changing implicit food evaluations as well as those aimed at increasing cognitive goal accessibility have produced inconsistent results (e.g., Ebert et al., 2009; Harderwijk, 2010; Kroese, Adriaanse, Evers, & De Ridder, 2011; Walsh & Kiviniemi, 2013). This may have been because individual differences in self-control were not taken into account. The current findings demonstrate the value of screening individuals for inhibitory self-control so as to tailor interventions to optimise their impact. For example, individuals with low inhibitory self-control are likely to benefit from modification of implicit food evaluations, while individuals with high self-control would most likely benefit from increased cognitive goal accessibility. The inhibitory self-control scale may provide a useful brief screening tool to select individuals for the particular intervention that is likely to be the most effective at reducing unhealthy eating. Future research investigating this possibility would be valuable.

3.4.5 Limitations

Like all studies, the current study is subject to a number of limitations. First, our sample consisted of undergraduate students of mostly normal weight. Given the importance of the development of interventions to manage (over)eating among overweight individuals, future research should endeavour to generalise the current findings to this more representative sample. Furthermore, we did not measure participants' motivation or explicit attitudes toward healthy eating. Instead, participants identified themselves as being motivated to manage weight through healthy eating. Therefore, we cannot be certain that the consumption of participants with high inhibitory self-control is driven to a greater extent by those personal

standards than implicit food evaluations, or whether implicit food evaluations are just less influential on their consumption relative to participants with low inhibitory self-control. Future research along the lines of Hofmann et al. (2007), who assessed the impact of both implicit candy attitudes and personal dietary standards on intake among participants in whom inhibitory control resources had been experimentally depleted, could further elucidate the decision-making processes of those with high versus low inhibitory self-control. Moreover, as analyses in the current study were conducted on a subset of the total sample, a larger sample size may have proven beneficial to provide greater power to detect effects.

Second, because the inhibitory self-control scale was administered after the taste-test, it is possible that participants' food intake may have affected their responses on the self-control scale. However, this scale is a trait measure, and thus should not be reactive to experimental manipulation. In fact, inhibitory self-control scores did not differ between training conditions, nor were they associated with food intake. By contrast, administering the inhibitory self-control scale after the taste-test could have primed the concept of 'impulsivity', which has been found to impact subsequent caloric intake (Guerrieri, Nederkoorn, Schrooten, Martijn, & Jansen, 2009). Nevertheless, counterbalancing the order of all study elements could enable future research to more firmly establish the moderation of the effect of implicit food evaluations on food intake by inhibitory self-control.

Third, we did not assess participants' awareness of the experimental training task contingencies, which could have moderated the effect of training on snack consumption. While some research has indeed found training effects only among participants who are aware of the experimental task contingencies (Field & Duka, 2002), other studies have shown that contingency awareness in cognitive bias modification and evaluative conditioning has no impact on training effects (Baeyens, Eelen, & Bergh, 1990; Field et al., 2007; Field & Eastwood, 2005). We did, however, assess participants' awareness of the purpose of the taste

test. This awareness did moderate the effect of training on intake, such that participants who were aware of the taste-test purpose ate surprisingly more when trained to pair food with negative concepts than when trained to pair food with positive. By contrast, participants who were not aware of the purpose of the taste test showed a pattern of intake consistent with the expected training effects: that is, they ate more when trained to pair food with positive concepts than when trained to pair food with negative; however, this difference was not statistically significant. The unexpected results of participants aware of the purpose of the taste test may be due to reactance bias, in that they may have adjusted their intake in reactance to their suspicions about the experimental manipulation or the taste test. However, this possibility remains speculative as the current study did not include an assessment of participants' awareness of the training task contingencies. Awareness of the purpose of the taste test did not significantly moderate the combined effect of training condition and inhibitory control on intake. Nevertheless, inhibitory self-control no longer significantly moderated the effect of training condition on intake when participants who were aware of the purpose of the taste test were included in the analysis. Taken together, the results of these analyses highlight the importance of considering participants' awareness of the intentionally hidden purpose of a task measuring intake.

Finally, in the absence of a no-training control group, it is not clear whether the observed difference in snack intake between the two conditions is due to an increase in intake among participants in the food positive condition, or a decrease in intake among those in the food negative condition, or both. The inclusion of a control condition could enable more definitive conclusions about the direction of the training effects on implicit food evaluations and food intake.

3.4.6 Conclusion

In conclusion, the current study was the first to demonstrate that inhibitory self-control moderates the relationship between experimentally manipulated implicit food evaluations and subsequent consumption of unhealthy snacks. Theoretically, the results support dual process models of behaviour which posit that the reflective system, represented by inhibitory self-control, renders impulses less influential on behaviour. Specifically, the current study demonstrated that experimentally manipulating impulses (implicit food evaluations) impacted snack consumption among individuals low in inhibitory self-control, but not those with high inhibitory self-control, suggesting that the behaviour of the latter group of individuals is not driven by impulses. In addition, the current study has identified an important individual differences variable that could identify individual suitability for an intervention to reduce unhealthy eating, therefore maximising its impact for the many individuals struggling to regulate eating in line with personal weight-management or health-related goals (Cohen & Farley, 2008; Fishbach et al., 2003).

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CHAPTER 4: The Moderating Role of State Inhibitory Control in the Effect of Evaluative Conditioning on Temptation and Unhealthy Snacking [3]

The current study sought to test the effect of a brief evaluative conditioning intervention on experienced temptation to indulge, and consumption of, unhealthy snack foods. We expected that a training task associating unhealthy food with negative affect would result in lower experienced temptation across the sample, but would lead to lower snack consumption only among individuals with low state inhibitory control. Undergraduate women (N =134) aged 17-25 years were randomised to complete an evaluative conditioning procedure pairing unhealthy food with either positive or negative affect. Snack consumption was subsequently assessed using a taste-test procedure which offered four snack foods for ad libitum consumption. Participants also reported the strength of their experienced temptation to indulge in the foods presented. Additionally, they completed a Stop Signal Task as a measure of state inhibitory control. As predicted, participants in the food negative condition ate less than those in the food positive condition, but this effect was only observed among individuals with low inhibitory control. The same moderation pattern was observed for the effect of evaluative conditioning on temptation: only participants with low inhibitory control reported feeling less tempted by the snack foods in the food negative condition compared to the food positive condition. In addition, temptation mediated the effect of evaluative conditioning on intake for individuals with low inhibitory control. Findings suggest that evaluative conditioning of unhealthy food stimuli could be especially useful for reducing temptation and consumption of unhealthy snacks in situations where individuals experience low inhibitory control capacity.

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4.1 Introduction

The attractiveness and abundance of unhealthy snack foods high in salt, sugar, and fat in our environment increases desire to indulge (Cohen & Farley, 2008; Hill & Peters, 1998; Hofmann, Vohs, & Baumeister, 2012). However, these desires are inconsistent with intentions to eat healthily (Cohen & Farley, 2008; Fishbach, Friedman, & Kruglanski, 2003). Overcoming temptation or desire after it has arisen is effortful and draws upon limited resources (Baumeister & Alquist, 2009; Milyavskaya, Inzlicht, Hope, & Koestner, 2015). Focusing instead on reducing desire to indulge could prove a more efficient and sustainable way of enhancing healthy eating behaviour.

It has been suggested that a positive implicit evaluation of a stimulus can bring about a conscious desire or temptation to indulge in that stimulus when exposed to it in the environment (Hofmann & Van Dillen, 2012). To test this, Haynes, Kemps, Moffit and Mohr (2014) assessed implicit evaluations of unhealthy food, and presented participants with a selection of unhealthy snack foods in a taste-test aimed at surreptitiously assessing snack consumption. Participants were also asked to report the extent to which they felt tempted to eat the foods presented. The findings demonstrated an association between a more positive implicit evaluation of unhealthy snack food and stronger self-reported temptation to indulge in unhealthy snack foods. Additionally, temptation mediated the relationship between implicit food evaluation and subsequent snack intake, suggesting that retraining evaluations of food to become more negative might reduce the experienced temptation to indulge in unhealthy food, and subsequently reduce consumption.

Implicit evaluations have been modified using computer-based evaluative conditioning tasks which consistently present target stimuli (e.g., unhealthy snack food) paired with affective stimuli of either positive or negative valence. The consistent pairing of target and affective stimuli trains an automatic association between the categories, shifting

individuals' implicit evaluation of the target stimuli to become more positive or more negative, depending on the pairing. Previous studies have provided consistent evidence for the efficacy of these retraining procedures in changing implicit evaluations of various stimuli including unhealthy food (Haynes, Kemps, & Moffitt, 2015; Hollands, Prestwich, & Marteau, 2011; Lebens et al., 2011), alcohol (Houben, Havermans, & Wiers, 2010; Houben, Schoenmakers, & Wiers, 2010), the self (Ebert, Steffens, von Stulpnagel, & Jelenec, 2009), and mathematics (Forbes & Schmader, 2010).

Although the capacity of evaluative conditioning to influence subjective temptation to indulge in unhealthy behaviour has not yet been tested, Walsh and Kiviniemi (2013) demonstrated modification of self-reported enjoyment of food stimuli and explicitly reported affective associations (i.e., healthy snack options were reported to be associated to a greater extent with positive affective states like fun and joy, than with negative ones) following evaluative conditioning. When considered in conjunction with the empirical evidence and theory suggesting that desire to pursue or consume stimuli is related to the extent to which those stimuli are associated with positive affect (e.g., Bindra, 1974; Bolles, 1972; Haynes, Kemps, Moffitt, & Mohr, 2014; Hofmann & Van Dillen, 2012), this finding suggests that an intervention that trains associations between unhealthy food and negative concepts may reduce the experienced temptation to indulge in these snacks.

While training an association between unhealthy food and negative concepts is expected to reduce the desire or temptation to consume unhealthy food, this change in experienced temptation may not necessarily translate into healthier behaviour for all individuals across all situations. Indeed, Haynes et al. (2015) found that the effects of an implicit food evaluation retraining intervention on consumption were moderated by self-reported trait inhibitory self-control (i.e., the extent to which participants were generally successful at controlling behaviours that involve inhibiting unhealthy impulses [e.g.,

"resisting temptation"]). This study did not assess experienced temptation or desire to indulge in unhealthy food, but found that implicit food evaluations were successfully modified across the sample, such that participants trained to associate food with negative concepts showed a significantly more negative implicit evaluation of unhealthy food following the training. Among individuals scoring high on trait inhibitory self-control, the training had no significant effect on snack consumption. Only among participants with low trait inhibitory self-control did the retraining affect snack consumption. This may be because impulses (e.g., strong hedonic reactions directing behaviour toward immediate gratification, like positive implicit food evaluations or a strong desire for unhealthy food) have a greater influence on behaviour when individuals lack the resources to overcome them, or are dispositionally low in self-control (Hofmann, Friese, & Strack, 2009; Milyavskaya et al., 2015).

The findings of Haynes et al. (2015) suggest that an intervention aimed at retraining associations between unhealthy food and negative affect may be most effective if targeted at individuals who are dispositionally low in inhibitory self-control. However, the longevity of the effect of evaluative conditioning on consumption behaviour is currently unknown. Thus an intervention implemented in situations where individuals have low inhibitory control resources might be more effective than targeting individuals with lower trait self-control more generally. While some studies have found that evaluative conditioning retraining of implicit alcohol attitudes can reduce self-reported drinking behaviour over a one week period (Houben, Havermans, et al., 2010; Houben, Schoenmakers, et al., 2010), effects of evaluative conditioning of unhealthy food on eating behaviour beyond the intervention have not been established. Furthermore, despite some studies claiming the contrary (e.g., Baeyens, Crombez, Van den Bergh, & Eelen, 1988; Baeyens, Diaz, & Ruiz, 2003), a meta-analysis has indeed suggested that evaluative conditioning effects are susceptible to extinction (i.e., the effect disappears when the conditioned stimulus [e.g., unhealthy food] is encountered without

the critical pairing with the unconditioned stimulus [e.g., negative]), meaning long-term effects on behaviour are unlikely (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010). Therefore, a focus on temporary changes in behaviour as the target of evaluative conditioning might be more appropriate.

The capacity for inhibition of impulses not only varies between individuals in a stable trait-like manner (e.g., assessed with self-report questionnaires as in Haynes et al., 2015), it also varies across situations. Retraining implicit food evaluations could temporarily reduce the temptation to indulge in unhealthy foods and consequently reduce unhealthy snacking in situations where individuals lack strong inhibitory control (reflected in lower state inhibitory control). However, whether evaluative conditioning can indeed reduce the temptation to indulge in unhealthy food, and whether its behavioural effects are in fact moderated by inhibitory control at a situational level has not yet been tested, and was the aim of the current study.

Given that implicit food evaluations and temptation are correlated, and that implicit food evaluations have previously been found to be no less resistant to change among individuals with high rather than low trait inhibitory self-control (Haynes et al., 2015; Haynes et al., 2014), we predicted that evaluative conditioning would affect temptation across the sample. However, we expected that evaluative conditioning effects on intake would vary by situational levels of inhibitory control. Specifically, we expected that only individuals with low state inhibitory control would show significant effects of retraining on snack consumption, as those individuals are purported to lack the resources to inhibit the influence of impulses on behaviour (Hofmann, Friese, & Strack, 2009). In line with previous research supporting the mediation of the relationship between implicit food evaluations and intake by experienced temptation (Haynes et al., 2014), we further expected that the effect of evaluative

conditioning on intake would be mediated by the experienced temptation to indulge in unhealthy food.

4.2 Method

4.2.1 Participants

A sample of 134 women aged 17- 25 years (M = 19.95, SD = 1.95), with a mean body mass index (BMI) of 23.63 (SD = 5.33) participated in the study. The experience of temptation necessitates a conflict between a desire and a valued goal (Hofmann, Baumeister, Förster, & Vohs, 2012). The recruitment advertisement therefore stated that the study sought volunteers who were motivated to manage weight through healthy eating, to ensure that a desire to eat the unhealthy snacks presented would conflict with a personal goal. Inclusion criteria also specified that participants were fluent in English and did not suffer from food allergies, which were listed in the recruitment advertisement and information sheet. Seventy-five first-year psychology student volunteers participated for course credit, and the remaining volunteers recruited from the wider undergraduate university population received a $15 honorarium.

4.2.2 Design

Participants were randomised to either the food positive or the food negative training condition, and were blinded to condition. The dependent variable was snack intake; inhibitory control was tested as a moderator, and temptation as a mediator.

4.2.3 Materials

4.2.3.1 Evaluative conditioning intervention. The computer-based evaluative conditioning task consisted of a sequence of 120 pairs of simultaneously presented words and images. Each pair appeared for 1,500ms, and the word and picture stimuli were aligned vertically in the centre of the screen, with the word stimulus appearing in the top half of the screen and the image stimulus appearing in the bottom half of the screen on 50% of trials, and

the image stimulus on the top and the word stimulus on the bottom for the remaining 50% of trials (Houben, Schoenmakers, et al., 2010; Olson & Fazio, 2001). Critical trials made up half the total number of trials (Houben, Havermans, et al., 2010), and presented unhealthy food words (the conditioned stimuli [CS]) with either positive (the unconditioned stimuli [US], in the food + positive training condition; e.g., pizza + smiling baby), or negative pictures (in the food + negative training condition; e.g., chocolate + rubbish). The remaining 60 trials were filler trials, which presented neutral word stimuli paired with either negative (in the food + positive training condition), or positive (in the food + negative training condition) US pictures. A fixation point (+) was presented in the centre of the screen during the intertrial interval, which lasted 400ms.

The food words were chocolate, cake, ice-cream, chips, pizza, and hamburger, similar to those used in previous studies (e.g., Fishbach, Zhang, & Trope, 2009; Haynes et al., 2014; Richetin, Perugini, Prestwich, & O'Gorman, 2007; Roefs et al., 2006). Neutral words included cube, rectangle, square, triangle, circle, and hexagon. The geometric shape word category was chosen as a neutral comparison because it is likely to be familiar to participants, and has been used as a comparison category to unhealthy food in previous studies (e.g., Ayres, Prestwich, Conner, & Smith, 2010; Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007). The individual shape word stimuli were chosen on the basis that they matched the food words as closely as possible on number of syllables, and were neutral in valence (valence index range of shape words on 10-point scale according to Affective Norms for English Words [ANEW] database = 4.74 - 5.74; Bradley & Lang, 1999). Each word appeared on the screen surrounded by a black border which matched the size of the picture stimuli. The picture stimuli consisted of 6 positive (e.g., nature scene, smiling baby) and 6 negative pictures (e.g., aggressive dog, rubbish) from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005), as previously used for evaluative conditioning

(Houben, Havermans, et al., 2010)[4]. Each word and picture stimulus was presented 10 times during the task. The pairing of words and pictures, and the order of presentation of the pairs were randomised, with the constraint that the stimuli were not repeated on consecutive trials. No two stimuli were paired more than twice.

Following previous studies (Houben, Schoenmakers, et al., 2010; Walsh & Kiviniemi, 2013), participants were informed that the task assessed attention, and were instructed to press the space bar as quickly as possible when a specified target picture or word was presented. The two target stimuli specified for each participant consisted of a neutral word, and either a positive or negative picture which were displayed on the instruction screen as they would appear during the actual trials (i.e., the picture was displayed in the same size, and the word was displayed in the same size, font, and bordered by a black box, as in the actual trials). The inclusion of both a word and a picture target for each participant was intended to maximise participants' attention to both word and picture aspects of the display throughout the task. The attention stimuli combinations were counterbalanced such that the attention target categories were specified in each training condition with equal frequency. The time from the stimulus onset to participants' space bar response on trials containing the attention target was recorded.

Following Walsh and Kiviniemi (2013), evaluative conditioning accuracy scores were calculated as the percentage of correct responses (i.e., pressing the spacebar within 1,000 ms of presentation of an attention stimulus and not pressing the spacebar on trials without attention stimulus presentation).

4.2.3.2 Snack intake. Intake of unhealthy snack food was assessed with a taste test (Coelho et al., 2009). Participants were presented with four full bowls of pre-weighed popular energy-dense snack foods: M&Ms, potato chips, Cheese Twisties, and mini choc-chip

[4] Positive pictures were IAPS numbers 1440, 1603, 1710, 2070, 2311, and 5760; and negative pictures were IAPS numbers 1300, 2811, 2900, 9301, 9373, and 9570.

cookies. To increase generalisability, the foods presented in the taste-test were not identical to the food stimuli presented in the evaluative conditioning task, but were representative of the class 'unhealthy food'. The placement position of the four bowls from left to right was counterbalanced across participants using a 4 x 4 Latin square procedure. Participants were asked to taste some of each of the foods, and rate the foods' sensory properties on a paper-pencil format rating sheet accompanying each one. The rating sheets contained six questions (e.g., "How sweet is this product?"), with responses recorded on 100mm visual analog scales (ranging from "not at all" to "extremely"). Participants were given 10 minutes to taste as much food as they needed in order to accurately rate the foods while the experimenter was out of the room. The experimenter informed participants that they could sample more of the products after the ratings were completed, but were asked not to change their initial ratings. The weight of each bowl was recorded pre- and post-taste-test to assess snack consumption without participants' knowledge. Intake in grams was multiplied by the number of kilojoules (kJ) per gram in each food, and summed to give total intake in kJ.

4.2.3.3 Temptation. A self-report measure of temptation was taken by asking participants "To what extent were you tempted to eat the [Twisties/cookies/chips/M&Ms] presented in the taste-test?" Participants responded on 7-point Likert scales, ranging from 1 (*not at all*), to 7 (*extremely*) for each of the four foods, and responses were averaged to produce the temptation score.

4.2.3.4 Inhibitory control. The stop signal task (SST) (Logan, Schachar, & Tannock, 1997) is a computer-based measure of inhibitory control. Following previous research, the task presented two types of trials: go and stop trials, with go trials making up 75% of the total number of trials (e.g., Guerrieri, Nederkoorn, & Jansen, 2007, 2008; Guerrieri, Nederkoorn, Stankiewicz, et al., 2007; Jansen et al., 2009; Logan et al., 1997; Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006; Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010;

Nederkoorn, Jansen, Mulkens, & Jansen, 2007). The task consisted of 5 blocks of 64 trials each, plus two practice blocks of 10 trials each (Nederkoorn, Braet, et al., 2006). The first practice block taught participants to respond on go trials. They were instructed to press the 'right' key ('/') with their right hand when an X appeared on the screen, and the 'left' key ('z') with their left hand when an O appeared, as quickly as possible without making errors (key assignment to symbol was counterbalanced between participants). The symbols were presented individually for 1500ms in the centre of the screen, preceded by a 500ms fixation point. A blank screen was shown between each trial for 1000ms.

The second practice block introduced the stop task. Participants were told that they would hear a tone on some trials, and that upon hearing this tone, they were not to respond to the visual stimuli. They were told that the stop signal would occur at different times so that it would be more difficult to inhibit on some trials than others, and were told to try to complete the go task as quickly as possible, without waiting for the stop tone. On stop trials, a stop signal (a 100ms 1000Hz tone) was presented. Participants were instructed to withhold their key press response to the symbol shown on the screen when they heard the tone. The stop signal was presented 250ms after visual presentation of the go signal (the O or X symbols), and was presented on X and O trials with equal frequency. The experimental blocks were identical to the second practice block, however, the stop signal delay in the experimental blocks was adjusted dependent on the responses of each individual participant (Logan et al., 1997). When the participant failed to inhibit their response (i.e., pressed the response key when the stop signal is presented), the task was made easier by decreasing the stop signal delay by 50ms on the next stop trial. When the participant succeeded in inhibiting their response (i.e., did not press the response key when the stop signal was presented), the task was made more difficult by increasing the stop signal delay by 50ms on the next stop trial.

This was intended to have participants successfully inhibit responses on approximately 50% of stop trials.

Number of errors on go trials (i.e., incorrect key pressed), reaction times to the visual stimuli on go trials, and the stop delay were recorded. In line with Verbruggen, Logan, Liefooghe, and Vandierendonck (2008)'s SST analysis procedure, outlying reaction times of longer than 2.5 standard deviations above the mean on correct go trials were discarded from data analysis, resulting in a data reduction of 3.38%. Mean reaction times on the remaining go trials were calculated. The stop signal reaction time (SSRT) was calculated by subtracting the stop delay from the reaction time, with a higher SSRT representing lower inhibitory control (Logan et al., 1997).

4.2.3.5 Hunger. Participants were asked to report their current level of hunger on a 7-point Likert scale ranging from 1 (*not hungry at all*), to 7 (*extremely hungry*).

4.2.3.6 Awareness of taste-test purpose. An open-ended question probed for awareness of the purpose of the taste test measure of intake. Participants were asked to indicate what they thought was the purpose of the taste-test. Responses were categorised as indicating awareness if they mentioned assessment of food intake, self-control of eating, or resisting temptation (e.g., "to test whether or not I could resist the food"). Following previous protocols (e.g., Coelho, Jansen, Roefs, & Nederkoorn, 2009; Haynes et al., 2015), and recent findings suggesting that awareness of the taste-test purpose should be avoided as it may influence experimental effects (Robinson, Kersbergen, Brunstrom, & Field, 2014), participants indicating awareness of the purpose of the taste test (n = 29) were excluded from analyses of snack consumption and temptation, as they did not complete the measures as intended.

4.2.3 Procedure

The experiment was conducted in a quiet room in the Applied Cognitive Psychology Laboratory, with each session running for approximately 30 minutes. The experiment was presented to participants as a study investigating the relationship between attention, language, and taste perception. Participants were asked to eat something 2 hours before their scheduled session, and to refrain from eating again until the experiment to minimise variance in hunger levels. Participants completed the hunger scale, followed by the SST, evaluative conditioning, and taste test. Finally, participants completed a questionnaire collecting background information (i.e., age, height, weight) and assessing temptation and awareness of the taste-test purpose.

4.2.4 Statistical Analyses

Six outliers with standardised *z*-scores exceeding 2.5 were detected in the food consumption data. In line with previous research in the area (Houben & Jansen, 2011), these were deleted as they were also identified as influential multivariate outliers in the main analyses (i.e., Cook's distance values for these cases exceeded $4/n\text{-}k\text{-}1$; Fox, 1991). Independent samples *t*-tests were conducted to compare the training conditions on variables of age, hunger, BMI, inhibitory control, temptation, snack consumption, and evaluative conditioning accuracy. The percentage of participants indicating awareness of the purpose of the taste test was compared between conditions using a chi-square analysis. The SPSS macro PROCESS (Hayes, 2012) was used to test whether inhibitory control moderated the effect of evaluative conditioning on temptation and snack intake, and the relationship between temptation and snack intake. Additionally, PROCESS was used to test the mediation of training effects on intake by temptation, at high and low levels of inhibitory control. Moderation and moderated mediation analyses included hunger and BMI as covariates, as these variables have been found to be related to eating behaviour, implicit food evaluations,

and inhibitory control capacity (Hofmann, Friese, & Roefs, 2009; Nederkoorn, Guerrieri, Havermans, Roefs, & Jansen, 2009; Seibt, Häfner, & Deutsch, 2007).

4.3 Results

4.3.1 Preliminary Analyses

Descriptive statistics for all variables between conditions are displayed in Table 4.1. Independent samples *t*-tests revealed no significant differences between conditions on age, hunger, BMI, inhibitory control, snack consumption, or evaluative conditioning accuracy, but a significant difference between conditions on temptation, such that individuals in the food positive condition reported higher temptation than those in the food negative condition. A chi-square test revealed a significant association between condition and awareness of taste test purpose, such that a significantly higher proportion of participants in the food positive condition indicated awareness of the purpose of the taste test.

Table 4.1.

Descriptive statistics of final sample

Variable	Total		Food + negative		Food + positive	
	m (sd)	*n*	*m (sd)*	*n*	*m (sd)*	*n*
Age (years)	20.08 (2.40)	134	20.14 (2.76)	67	20.01(2.00)	67
Hunger	3.48 (1.54)	134	3.48 (1.59)	67	3.48 (1.50)	67
BMI	23.64 (5.33)	134	23.23 (5.23)	67	24.04 (5.45)	67
Inhibitory control (SSRT score)[a]	246.26 (100.97)	132	249.23 (92.03)	67	243.21 (110.07)	65
Temptation [b]	5.52 (1.66)	105	5.16 (1.68)	58	5.81 (1.60)	47
Snack consumption (kJ) [c]	827.41 (515.67)	102	877.15 (489.14)	58	761.84 (547.44)	44
Evaluative conditioning accuracy	0.91 (0.19)	134	0.90 (0.20)	67	0.92 (0.18)	67
% aware of taste test purpose	21.64	134	13.43	67	29.85	67

Note. $p < .05$ for independent samples *t*-test of mean difference between conditions on temptation, $p > .05$ for all other mean differences. $p < .05$ for chi square comparisons of difference in awareness of taste test purpose between conditions.

[a] $n = 2$ missing due to technical issues with saving data. [b] Sample sizes reflect final sample after participants aware of taste test removed. [c] Sample sizes reflect final sample after outliers and participants aware of taste test removed.

Correlation analyses (Table 4.2) revealed a significant positive correlation between snack consumption and both hunger and temptation. No other correlations were significant.

Table 4.2.

Correlations between variables

		1	2	3	4	5
1	Hunger		-.17	.13	.14	.20*
2	BMI			.04	.01	.14
3	Inhibitory control				.03	.01
4	Temptation					.37**
5	Snack consumption					

* p <.05, **p < .001.

4.3.2 Moderation of Training Effect on Snack Consumption

Using the SPSS macro, PROCESS (Hayes, 2012), the predictor variables (training condition and inhibitory control) and interaction term (product of the predictors) were regressed on the outcome variable (snack consumption). There was no significant main effect for training condition, B = 102.77, SE = 101.85 $t(94) = 1.01$, p = .32, or inhibitory control, B = -0.22, SE = 0.53 $t(94) = 0.42$, p = .68, on snack consumption. The interaction term (product of training condition and inhibitory control), however, was a significant predictor of intake, B = 2.22, SE = 1.04, $t(94) = 2.12$, p = .04. To explore this interaction, simple slopes were estimated at plus ("high") and minus ("low") one *SD* from the sample mean for inhibitory control. As shown in Figure 4.1, training condition predicted snack food intake among participants with low inhibitory control, such that those in the food negative condition consumed less snack food than those in the food positive condition, B = -318.57, SE = 144.36 $t(94) = 2.21$, p = .03. However, training condition did not predict snack food intake among participants with high inhibitory control, indicating that snack intake among those with high

inhibitory self-control was not affected by the training they completed, B = 113.04, SE = 143.43, $t(94) = -0.79$, $p = .43$[5].

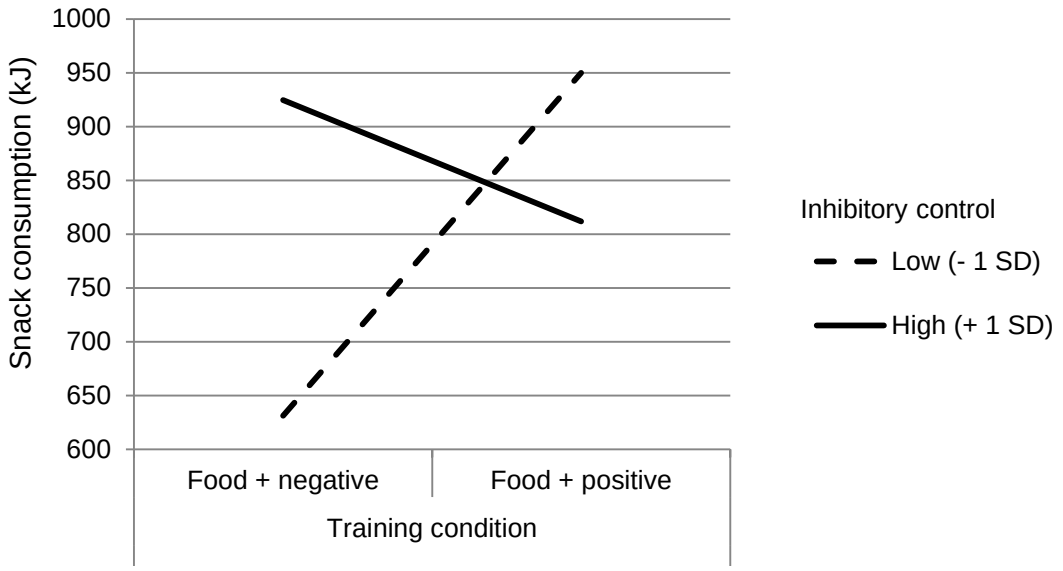

Figure 4.1. Moderation of training effects on snack consumption by inhibitory control.

4.3.3 Moderation of Training Effect on Experienced Temptation

A similar procedure was followed to test whether inhibitory control moderated the effect of evaluative conditioning on temptation. The predictor variables (training condition and inhibitory control) and interaction term (product of the predictors), were regressed on the outcome variable (temptation). Training condition had a marginally significant main effect on temptation, B = 0.59, SE = 0.32, $t(97) = 1.82$, $p = .07$, such that participants in the food positive condition reported higher temptation than those in the food negative condition. Inhibitory control did not predict temptation, B = 0.0002, SE = 0.002, $t(97) = 0.11$, $p = .91$. The interaction term (product of training condition and inhibitory control) was a significant predictor of temptation, B = 0.01, SE = 0.003, $t(94) = 2.03$, $p < .05$. To explore this interaction, simple slopes were estimated at plus ("high") and minus ("low") one *SD* from the sample mean for inhibitory control. As shown in Figure 4.2, training condition predicted

[5] The interaction term was not significant when the analysis was run including participants who were aware of the taste-test purpose, B = 1.52, SE = 0.99, $t(120) = 0.13$, $p = .13$, but the pattern of results remained the same. Namely, at lower inhibitory control, the positive training condition was associated with higher intake, while at higher inhibitory control, the positive training condition was associated with lower intake,

temptation among participants with low inhibitory control, such that those in the food negative condition reported experiencing less temptation to indulge in the food than those in the food positive condition, B = 1.38, SE = 0.47, $t(94)$ = 2.97, p = < .01. However, training condition did not predict temptation among participants with high inhibitory control, indicating that temptation among those with high inhibitory self-control was not affected by the training they completed, B = -0.01, SE = 0.46, $t(94)$ = -0.02, p = .98[6].

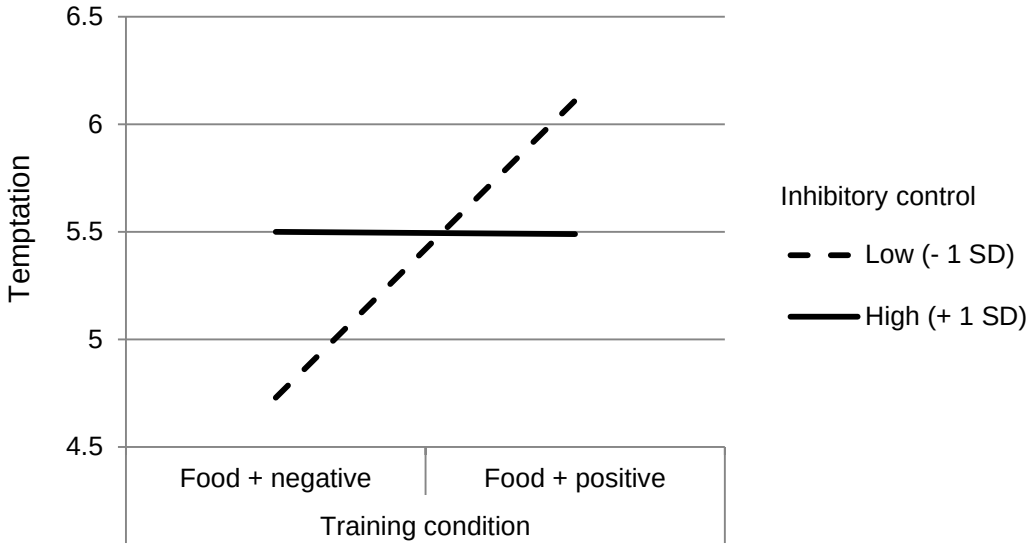

Figure 4.2. Moderation of training effects on temptation by inhibitory control.

4.3.4 Moderation of the Temptation-Intake Relationship

A third moderation analysis was conducted regressing the predictors (inhibitory control and temptation) and interaction term (product of predictors) on the outcome variable, snack consumption. Temptation was a significant predictor of snack consumption, B = 103.32, SE = 29.47, $t(94)$ = 3.51, p < .001, but inhibitory control was not, B = -0.27, SE = 0.51, $t(94)$ = 0.54, p = .59. The interaction term did not significantly predict snack consumption, B = 0.27, SE = 0.32, $t(94)$ = 0.83, p = .41, suggesting that the relationship between temptation and intake was not moderated by inhibitory control. Simple slopes

[6] The interaction term was not significant when the analysis was run including participants who were aware of the taste-test purpose, B = 0.004, SE = 0.002, $t(126)$ = 1.28, p = .20, but the pattern of results remained the same: namely, at lower inhibitory control, the positive training condition was associated with higher temptation, while at higher inhibitory control, the positive training condition was associated with lower temptation.

indicated that for individuals with high inhibitory control, higher temptation approached significance as a predictor of higher snack consumption, B = 77.16, SE = 43.59, $t(94) = 1.77$, $p = .08$, while for individuals with low inhibitory control, temptation was significantly related to higher snack consumption, B = 129.48, SE = 42.44, $t(94) = 3.05$, $p < .01$ (Figure 4.3) [7].

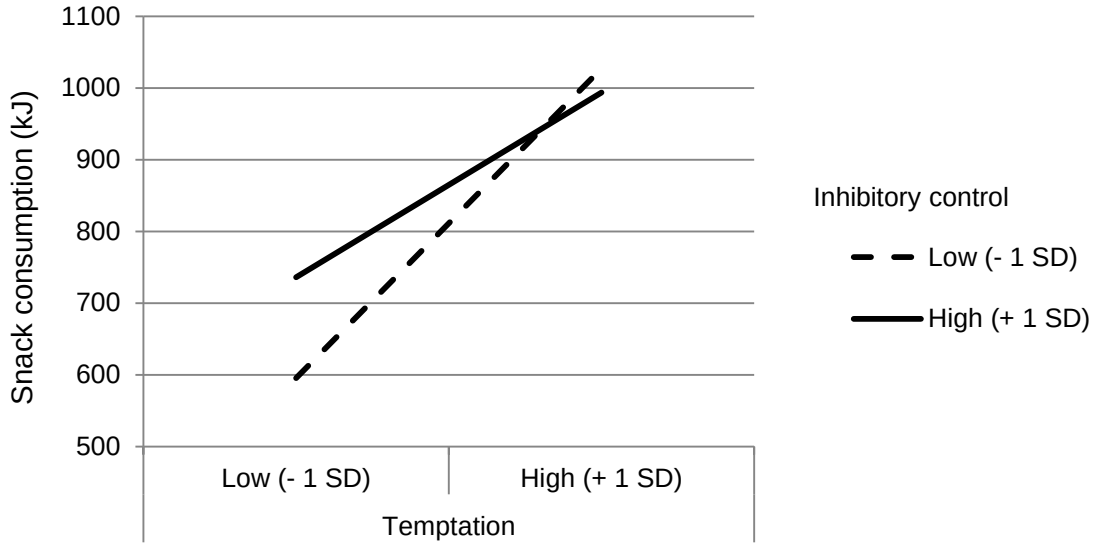

Figure 4.3. Moderation of the relationship between temptation and intake by inhibitory control.

4.3.5 Moderated Mediation Analysis

To explore whether temptation mediated the effect of training on intake for participants with high versus low inhibitory control, PROCESS with 5,000 bootstrap samples was used to estimate the pathways shown in Figure 4.4. The interaction term (product of inhibitory control and training condition) was a significant predictor of temptation, B = 0.01, SE = 0.003, $t(94) = 2.12$, $p = .04$, in the analysis of pathway a. This indicates that the effects of training on experienced temptation to indulge in unhealthy foods varied by inhibitory control level, consistent with the previous moderation analysis showing that temptation was affected by training only among individuals with low inhibitory control. To estimate

[7] Except for the relationship between temptation and intake at high inhibitory control becoming stronger, B = 112.86, SE = 38.09, $t(120) = 2.96$, $p < .01$, the significance of the coefficients did not vary when the analysis was run including participants who were aware of the taste-test purpose, Namely, any significant results did not become non-significant, and vice versa.

pathways *b* and *c*, a separate model was estimated with snack consumption as the outcome. Inhibitory control was found not to moderate the relationship between temptation and intake in the previous moderation analysis, and was therefore not included as a moderator of pathway *b*. Temptation was significantly associated with intake (pathway *b*), $B = 92.05$, $SE = 30.69$, $t(93) = 3.00$, $p = < .01$. With the mediator, temptation, in the model, the condition by inhibitory control interaction term no longer significantly predicted intake, $B = 1.56$, $SE = 1.03$, $t(93) = 1.52$, $p = .13$. In contrast with the finding that inhibitory control moderated training effects on intake, this result indicates that temptation accounted for the effect of training condition on intake for individuals with low inhibitory control[8].

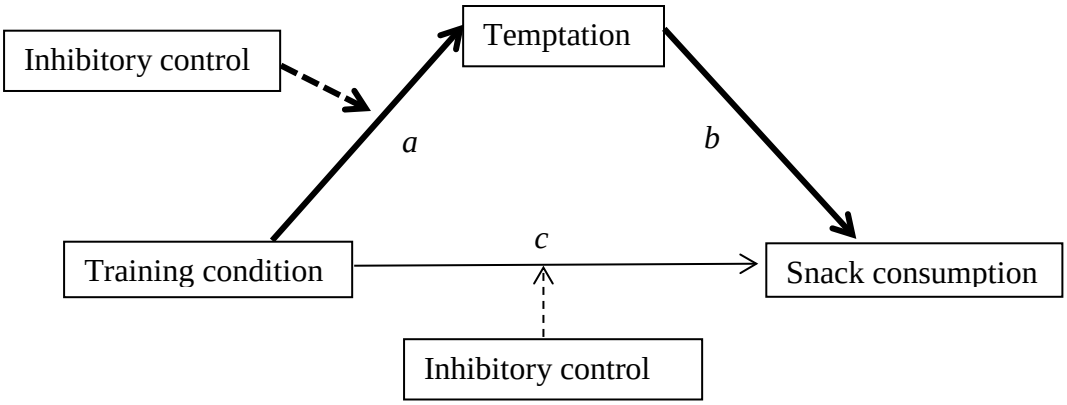

Figure 4.4. Model of indirect effect of training condition on intake by inhibitory control. *Note*. Bold arrows denote significant relationships, bold dashed arrows denote moderation of adjoining relationships by inhibitory control.

Estimates of the overall direct and indirect training effects on intake at high and low inhibitory control are reported in Table 4.3. Training did not significantly and directly affect intake for the entire sample. Instead, only among participants with low inhibitory control did training condition show an indirect effect on intake via the experience of temptation.

[8] Including participants who were aware of the purpose of the taste test in this analysis did not change the significance of the effects. Namely, any non-significant coefficients (including indirect effects) did not become significant, and vice versa.

Table 4.3.

Overall direct and indirect training effects on snack consumption at high and low inhibitory control

Inhibitory control	Indirect effect (*ab*)		Direct effect (*c*)	
	Coefficient estimate (*SE*)	95% CI	Coefficient estimate (*SE*)	95% CI
Low	127.29 (60.17) [a]	35.84, 272.50	191.28 (144.94)	-96.54, 479.10
High	-0.86 (46.53)	-89.84, 98.17	-112.18 (137.69)	-385.60, 161.25

[a] Point estimate significantly different from zero, as 95% CI does not contain zero.

4.4 Discussion

The current study tested the effects of a brief evaluative conditioning intervention on subsequent self-reported temptation to indulge in, and consumption of, unhealthy snack food. Findings suggest that an evaluative conditioning task pairing unhealthy snack food and negative concepts reduces subsequent consumption of unhealthy snack food, but only among individuals with low inhibitory control. Additionally, among individuals with low inhibitory control, temptation mediated the effect of training on intake. Contrary to predictions, effects of evaluative conditioning on experienced temptation were also observed only among individuals with lower state inhibitory control. This suggests that those with low inhibitory control may not be able to prevent the emergence of strong desire to indulge in unhealthy food.

As predicted, inhibitory control moderated the effect of evaluative conditioning on snack food consumption. Specifically, participants in the food negative pairing condition consumed less food than those in the food positive condition, but this effect was only

observed among participants with lower state inhibitory control. Although the current study did not assess implicit food evaluations, this finding is consistent with previous research demonstrating that the behaviour of individuals with lower state inhibitory control (measured using a computer-based task such as the stop signal task, or manipulated by depleting resources available for the inhibition of impulses) is more strongly predicted by implicit evaluations of stimuli than is the behaviour of individuals with higher inhibitory control (Friese, Hofmann, & Wanke, 2008; Hofmann, Friese, & Roefs, 2009; Hofmann, Rauch, & Gawronski, 2007). In addition, Haynes et al. (2015) previously compared the effects of an evaluative conditioning-like intervention involving the retraining of implicit evaluations for individuals varying in trait inhibitory self-control (Haynes et al., 2015). The current study adds to these findings by directly comparing evaluative conditioning effects on behaviour across high and low levels of state inhibitory control, and demonstrating that these effects are moderated by situational inhibitory control ability. The findings suggest that an intervention aimed at retraining affective food associations might be successful at reducing unhealthy consumption not only for individuals with low dispositional inhibitory control, but also for individuals who are low in situational inhibitory control resources.

While previous research has demonstrated that weaker inhibitory control and higher impulsivity are related to obesity and consumption of unhealthy food (Guerrieri, Nederkoorn, & Jansen, 2007; Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006) the current study did not find a main effect of inhibitory control on intake. Researchers have suggested that higher inhibitory control does not influence behaviour directly, but enables individuals to better overcome the influence of impulses (e.g., processes which drive behaviour toward hedonic consumption) on behaviour (Hofmann, Friese, & Roefs, 2009). Following this logic, we therefore expected that among individuals with higher state inhibitory control, snack consumption behaviour would not be affected by the training. Instead, results indicated that

snack consumption among high inhibitory control individuals ran counter to the training condition they had completed. Specifically, for individuals with high inhibitory control, those in the food positive condition ate less than those in the food negative condition, although this difference was not statistically significant. Interestingly, a similar pattern has been found in previous studies, where individuals with higher trait inhibitory self-control and higher situational inhibitory resources consumed higher levels of snack food when they were trained to associate food with negative, or when their automatic affective reactions to food were negative, than when food was associated with positive (Haynes et al., 2015; Hofmann et al., 2007). This pattern of results seem to conflict with the current understanding of how inhibitory control resources relate to behaviour (i.e., by allowing inhibition of impulses driving toward unhealthy behaviour, Hofmann, Friese, & Strack, 2009). Although not statistically significant here, the consistency of these puzzling findings suggests that more work is needed to disentangle the processes driving unhealthy food consumption among individuals with high, as well as low, inhibitory control resources and trait self-control.

The current study found that experienced temptation to indulge in the snack food offered for consumption mediated the effect of evaluative conditioning on intake for individuals with low inhibitory control. Consistent with predictions, this finding suggests that evaluative conditioning may reduce unhealthy snack consumption by reducing the temptation to indulge in unhealthy foods. However, contrary to predictions, it was found that evaluative conditioning did not affect temptation equally between participants with high versus low inhibitory control. Instead, only participants with low inhibitory control reported lower temptation in the food negative than the food positive condition. It was expected that evaluative conditioning would have equal effects on temptation among individuals with high and low inhibitory control because it has been previously shown that implicit food evaluations are no less resistant to change between individuals with different levels of trait

inhibitory self-control (Haynes et al., 2015). Although not the same as implicit food evaluations, temptation has indeed been shown to correlate with implicit food evaluations (Haynes et al., 2014), and therefore was expected to be affected by evaluative conditioning in a similar manner, independently of individuals' situational inhibitory control resources. Indeed, this prediction is also consistent with dual process models which predict that inhibitory resources are required to overcome the influence of impulses on behaviour (Hofmann, Friese, & Strack, 2009). Impulsive influences include processes which drive toward hedonic consumption and often operate automatically, such as implicit food evaluations. Temptation has also been considered an impulsive determinant, as it gives rise to a hedonic drive toward immediate gratification at the expense of long-term goals (Milyavskaya et al., 2015). It was therefore predicted that high state inhibitory control would enable an individual to overcome the temptation to indulge in unhealthy food (i.e., reflected in a moderation of pathway *b*, Figure 4.4). Instead, results suggested that higher inhibitory control capacity may enable individuals to inhibit affective associations with unhealthy food from becoming elaborated to a conscious desire or temptation to indulge (i.e., reflected in moderation of pathway *a*, Figure 4.4), although it is unclear whether the evaluative conditioning in the current study indeed resulted in a change in affective associations. It may be that those with higher inhibitory control are better able to downregulate associations between food and positive affect that may have been strengthened by the food positive training, to prevent strong desire or temptation from emerging, rather than being able to overcome that desire and act in accordance with long-term goals.

In terms of practical implications, the results of the current study suggest that situational dips in inhibitory control ability could provide a window through which to implement evaluative conditioning as a means of reducing unhealthy snacking. It is known that retraining implicit food evaluations can reduce unhealthy snacking among individuals

with low dispositional inhibitory self-control (Haynes et al., 2015). However, because the longevity of behavioural effects following retraining is presently not known, targeting situational dips in inhibitory control and effecting a short term change in behaviour may be preferential. For example, at times when individuals tend to have low levels of inhibitory control (e.g., after an initial act of self-control, or when coping with stress or negative mood; Muraven & Baumeister, 2000) completing a short task aimed at retraining affective food associations may be useful at reducing temptation to consume unhealthy snacks in the short-term. This could involve, for example, a portable version of an evaluative conditioning task (e.g., a smartphone app) which may provide a temporary reduction in the strength of temptation experienced and in subsequent consumption when individuals are depleted of inhibitory control resources. Other strategies aimed at enhancing an association between unhealthy food and negative affect may also be useful. For example, formulating and practicing implementation intentions has been shown to strengthen associations between unhealthy cues and a healthy goal (e.g., "If I see chocolate cake, then I will think of my goal of healthy eating"), and result in positive effects on goal-directed behaviour (e.g., lower unhealthy snack intake) (Kroese, Adriaanse, Evers, & De Ridder, 2011; Van Koningsbruggen, Stroebe, Papies, & Aarts, 2011). In a similar way, implementation intentions could be used to strengthen an association between unhealthy food and an unpleasant or unappetising cue, potentially strengthening a food – negative association and reducing temptation and consumption. Although such interventions may have temporary effects on temptation and behaviour, individuals still may become desensitised to repeated use of these strategies. Baeyens, Eelen, Crombez, and Van den Bergh (1992) found that evaluative conditioning effects for some stimuli started to decrease with high numbers of critical pairings. Thus finding practical ways of implementing evaluative conditioning and

related strategies into everyday life and investigating whether they remain effective with repeated use will be important considerations for future research.

The current study is subject to several limitations. First, participants' awareness of the evaluative conditioning contingencies was not assessed. The automatic basis of evaluative learning has been questioned (Brunstrom & Higgs, 2002), and some studies have found training effects in evaluative conditioning, and also cognitive bias modification only among individuals who are aware of the experimental contingencies (e.g., Attwood, O'Sullivan, Leonards, Mackintosh, & Munafò, 2008; Field & Duka, 2002; Pleyers, Corneille, Luminet, & Yzerbyt, 2007). However, many other studies have shown that training effects in evaluative conditioning and cognitive bias modification are unaffected by contingency awareness (e.g., Baeyens, Eelen, & Bergh, 1990; Field et al., 2007; Field, Duka, Tyler, & Schoenmakers, 2009; Field & Eastwood, 2005; Fulcher & Hammerl, 2001; Kemps, Tiggemann, & Hollitt, 2014; Kemps, Tiggemann, Orr, & Grear, 2014). Nevertheless, it is possible that awareness of the contingent appearance of food with either positive or negative stimuli in the current study may have influenced subsequent temptation and consumption. Without information about contingency awareness, it is unclear whether the evaluative conditioning effects were due to changes in explicit associations between unhealthy food and positive or negative affect, rather than implicit changes. Second, it is not known whether an actual change in affective associations (either implicit *or* explicit) occurred following the evaluative conditioning task as this was not assessed. Although previous studies in applied domains (e.g., Hollands et al., 2011; Houben, Havermans, et al., 2010; Houben, Schoenmakers, et al., 2010) have demonstrated consistent effects of evaluative conditioning on changing implicit food evaluations, this does not rule out the possible involvement of explicit processes. Although the current results are informative about the effects of a potential retraining intervention for

individuals lacking situational inhibitory control resources, the mechanism underlying the intervention's effect on temptation and snack consumption remains to be determined.

In conclusion, the current study demonstrated the moderating role of state inhibitory control in the effect of an evaluative conditioning intervention on temptation and consumption of unhealthy snack foods. Specifically, completion of a training task associating negative stimuli with unhealthy snack foods resulted in lower self-reported temptation to indulge in, and consumption of, unhealthy snacks presented for ad libitum intake, but only among individuals with low state inhibitory control. The findings contribute to our understanding of how inhibitory control operates in inhibiting aspects of the impulsive processing of food cues which pre-empt behaviour toward unhealthy snack food. Finally, findings suggest that an intervention aimed at retraining affective associations with unhealthy snack food might be most useful when implemented in situations where individuals lack the control resources to minimise unhealthy snacking.

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CHAPTER 5: Too depleted to try? Testing the process model of ego depletion in the context of unhealthy snack consumption[9]

The process model proposes that the ego depletion effect is due to (a) an increase in motivation toward indulgence, and (b) a decrease in motivation to control behaviour following an initial act of self-control. In contrast, the strength model attributes the effect to a depletion of resources, meaning that individuals are less able to overcome desires and act in a manner consistent with goals. The current study sought to test these alternative accounts. A sample of undergraduate women (N = 156) was randomised to complete a depleting e-crossing task or a non-depleting task, followed by a lab-based measure of snack intake, and self-report measures of motivation and desire strength. In partial support of the process model, ego depletion resulted in lower motivation to control intake, but not in higher snack consumption, or stronger desire. Motivation to control intake was more strongly predictive of intake for those in the non-depletion condition, while for participants in the depletion condition, snack consumption was more strongly predicted by desire, thus providing partial support for the strength-based account of ego depletion. However, depletion did not significantly moderate the effect of desire on intake, indicating that desire may be an appropriate target for reducing unhealthy behaviour across situations where self-control resources vary.

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5.1 Introduction

Exertion of self-control over eating behaviour is required on a daily basis, due to the availability and affordability of immediately rewarding, but unhealthy snack foods. These foods present a choice between satisfying urges to consume the food for immediate hedonic gratification, and controlling those urges to act in a manner consistent with long-term goals, like healthy weight management. Following one act of self-control, the ability to enact self-control is temporarily depleted, such that self-control attempts are less likely to be successful, an effect termed 'ego depletion' (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Understanding the mechanisms underlying ego depletion is important so as to prevent self-control failures and improve outcomes in a variety of behavioural domains, including academic and work performance, overspending, smoking, alcohol and drug abuse, relationship problems, as well as unhealthy snacking.

One explanation for the ego depletion effect that has dominated the literature, is that proposed by the strength model (Baumeister et al., 1998). This model conceptualises the ability to control behaviour as a limited resource, and one that is domain-general in nature. After an initial act of self-control, a subsequent self-control attempt is less likely to be successful due to the depletion of this limited resource. Research has suggested a physiological basis for ego depletion, attributing it to a reduction in blood glucose (Gailliot et al., 2007), but others have disputed this explanation (e.g., Molden et al., 2012). The strength model has therefore been criticised on the basis that there is a lack of direct evidence for what constitutes a self-control resource.

Inzlicht and Schmeichel (2012) proposed an alternative explanation for the ego depletion effect. According to their process model, the detriment to self-control performance following an initial self-control act is due to a shift in priorities and motivation. After one act of self-control, individuals become more motivated to indulge and satisfy immediate desires,

and simultaneously become less motivated to control their urges. Inzlicht and Schmeichel argue that it is adaptive for individuals to balance periods of control and leisure, so that after enacting control, individuals become more motivated toward rest and indulgence of impulses. Thus, according to the process model of ego depletion, rather than lacking the resources to overcome desires and enact behaviour in line with motivations following one act of self-control, individuals are instead motivated to seek immediate gratification, and experience reduced motivation to control those urges.

Inzlicht, Schmeichel, and Macrae (2014) suggest that depletion increases desire for unhealthy or appetitive stimuli. However, the evidence in support of an increase in desire or motivation toward indulgence accompanying depletion is mixed. For example, Schmeichel, Harmon-Jones and Harmon-Jones (2010) showed that depletion increased incentive sensitivity (i.e., increased motivation toward, pursuit of, and positive feeling in response to obtaining incentives) and facilitated the perception of reward-related stimuli (i.e., participants were quicker to detect a dollar sign in an array of symbols when depleted). In addition, Wagner, Altman, Boswell, Kelley and Heatherton (2013) found that dieters who completed a depletion task showed greater activity in the orbitofrontal cortex (an area of the brain thought to be associated with processing reward value) when viewing pictures of food, than did dieters who were not depleted.

By contrast, other studies have found that desire is more influential on behaviour when individuals are depleted. Although not quite the same as motivation toward approaching or indulging in unhealthy foods, positive implicit attitudes toward such foods have been shown to predict stronger desire and preference for those foods (e.g., Dube, 2007; Friese, Hofmann, & Wanke, 2008; Haynes, Kemps, Moffitt, & Mohr, 2014; Perugini, 2005). Moreover, Hofmann, Rauch, and Gawronski (2007) found that for participants in a depletion condition, more positive implicit food evaluations predicted higher intake of candy in a lab-

based taste test, whereas for those in a non-depletion condition, implicit food attitudes did not predict intake. These results therefore suggest that when depleted, individuals lack the ability to overcome impulses or desires toward unhealthy behaviour. Friese et al. (2008) reported similar findings: positive implicit evaluations of potato chips predicted higher consumption in a taste-test, but only when participants were depleted. Furthermore, Hofmann, Vohs, and Baumeister (2012) conducted an experience sampling study requiring participants to respond to smartphone-administered questionnaires multiple times a day over a one week period. Participants were asked to report whether they had recently experienced a desire from a variety of domains (e.g., food, spending, etc.), whether they had attempted to resist that desire, and whether or not they had enacted behaviour consistent with their desire. Similar to the findings of studies examining implicit food attitudes, depletion (inferred from a recent attempt at self-control of desire) predicted lower success in overcoming desire. These findings are consistent with the strength model of self-control, suggesting that ego depletion is associated with a weakened ability to overcome desires that conflict with self-control goals, rather than with a lower desire.

The process model not only proposes that ego depletion shifts motivation toward indulgence, but also that it reduces motivation to control behaviour in line with long-term goals. Proponents of the model have drawn support from studies demonstrating that enhancing motivation to control behaviour can help to overcome the effects of depletion on self-control performance. By contrast, Inzlicht and Schmeichel (2012) argue that if ego depletion is attributable to a reduction in resources (as proposed by the strength model), motivation should not be sufficient to overcome the ego depletion effect. To test this prediction, Muraven and Slessareva (2003) randomly assigned participants to a depletion or non-depletion condition. Participants were also assigned to receive an incentive for performance on a second self-control task (e.g., through the provision of a strong justification

or a financial incentive for good performance), or to receive no incentive. Findings revealed that incentivising performance on a second self-control task reduced the ego depletion effect, such that depletion no longer detrimentally impacted self-control performance when motivation to control behaviour was enhanced. In addition, Walsh (2014a) found that ego depletion could be attenuated by priming a self-control goal. Individuals who completed an initial self-control task showed more impulsive purchasing in a second task than those who had completed a non-depleting control task. However, when a self-control goal was primed, depletion no longer resulted in more impulsive purchasing. Nevertheless, these findings should not necessarily be interpreted as evidence for a motivational account of ego depletion. As suggested by Baumeister and Vohs (2007), other manipulations (e.g., forming implementation intentions, watching a humorous video, etc.) have been shown to overcome the ego depletion effect, but that does not mean that ego depletion is in essence a lack of implementation intentions, or a lack of humour. In the same way, an interaction between motivation and depletion cannot be taken as conclusive evidence for the process account of self-control.

Instead, an alternative interpretation is that rather than motivation helping to overcome resource depletion, it could be that depletion allows motivation to have a greater effect on behaviour. Specifically, when in a non-depleted state, individuals are better able to implement behaviour in line with goals or motivations. In contrast, when depleted, individuals lack the resources to do so and instead are driven by desires for indulgence. This is the interpretation that Hofmann et al. (2007) put forward for their finding that participants in a non-depletion condition showed behaviour consistent with their restraint standards (i.e., those with the goal to manage weight through healthy eating ate less), whereas those in a depletion condition showed no effect of restraint standards on unhealthy food intake.

To our knowledge, only two studies have compared motivation to control behaviour between participants who had been depleted and those who had not. Specifically, in their experience sampling study, Hofmann et al. (2012) found that depletion did not increase the likelihood of attempting to resist a desire. Instead, depletion was associated with a higher likelihood that an attempt to resist desire would be successful, suggesting that depletion primarily affects ability, rather than motivation, to engage in self-control (Hofmann et al., 2012). In contrast, Walsh (2014a) randomised participants to a goal-priming or control condition in a task prior to completing a depletion or non-depleting task. Participants reported their commitment to a goal of healthy eating following the depletion manipulation. The authors did not report an overall effect of depletion on goal commitment. However, this effect was moderated by goal priming: in the goal priming condition, depleted and non-depleted participants showed no significant difference in goal commitment; however, in the non-goal priming condition, depletion resulted in lower goal commitment compared to the non-depleted condition. Moreover, lowered commitment to the goal of healthy eating mediated the effect of depletion on consumption of an unhealthy snack food, thus suggesting that the depletion effect is due to a shift in motivation, in support of the process model.

The current study sought to test the effect of ego depletion on motivation to control eating behaviour in a specific situation (i.e., when faced with unhealthy snack foods for immediate consumption) and strength of desire for those unhealthy foods. We also sought to test the interactions between ego depletion and motivation, and ego depletion and desire strength, in predicting unhealthy snack consumption. In so doing, we aimed to test the strength model and process model alternative accounts of ego depletion in an eating domain. A dual-task paradigm was employed, whereby participants were randomised to complete either an initial depleting or non-depleting task, and then all participants completed a self-control task: a taste-test measure of unhealthy snack consumption. We recruited a sample of

young women who held the goal of healthy eating for weight management to ensure that the taste-test would represent a valid test of self-control. Whether ego depletion affects motivation to control behaviour in a specific self-control situation has to date not been tested. Walsh (2014a) assessed general commitment to a self-control goal, by asking participants to rate the importance of the goal of healthy eating, and how committed and determined they were to achieve that goal. In contrast, evidence for a difference in motivation to control behaviour in a specific situation as measured in the current study (i.e., by asking participants to rate their motivation to control or limit their intake of unhealthy food during the taste test measure of intake), would provide stronger support for the process model of ego depletion. According to this theory, depleted individuals were expected to experience lower motivation to control behaviour specific to a situation following an initial self-control task compared with non-depleted individuals. By contrast, Hofmann et al. (2012) tested the interaction between depletion, desire, and self-control attempts, in predicting self-control outcomes, and found support for the strength model of self-control across various behavioural domains (e.g., tobacco, spending, media use, eating) with a naturalistic, self-report study design. The current study however, sought to test this interaction specifically in a controlled lab-based study of unhealthy food intake. This allowed for control over aspects of the food environment that may influence desire and intake (e.g., food variety, portion size, allowed eating time, etc.) that was not possible in Hofmann et al.'s study due to their naturalistic design.

If the process model of self-control were supported, we would expect depletion to reduce motivation to control snack intake in the taste-test, and for this motivation to mediate the ego depletion effect on intake. Additionally, we would expect depletion to result in lower self-reported strength of desire to indulge in the foods in the taste test, and for desire to also mediate the ego depletion effect on intake. In contrast, if the strength model of self-control were supported, we would expect only individuals in a depleted state to show eating

behaviour consistent with desires, while individuals in the non-depletion condition should show eating behaviour consistent with their motivation to control their intake. This would suggest that non-depleted individuals in the non-depletion condition have the resources to control eating behaviour in line with motivations for their behaviour and overcome strong desires to indulge, while the eating behaviour of depleted individuals would be more consistent with the strength of desire experienced.

5.2 Method

5.2.1 Participants

A sample of 156 females was recruited from the undergraduate student population at Flinders University. Advertisement materials stated that the study aimed to investigate the relationship between attention and taste perception, and asked for female volunteers who were: (a) motivated to eat healthily to manage weight, (b) fluent in English, and (c) had no food allergies. The sample was aged between 17 and 25 years (m = 19.53, sd = 2.07), with a mean body mass index (BMI) of 22.48 (sd = 3.79). The majority of participants were first-year psychology student volunteers who participated for course credit (n = 110). The remainder of the sample (n = 46) were recruited from the wider undergraduate student population, and received a $10 honorarium for participating.

5.2.2 Design

The experiment employed a between-subject design, with participants randomly assigned to the two depletion conditions (depletion, control). The outcome measures included snack food consumption, and self-reported strength of desire and motivation to control intake.

5.2.3 Materials

5.2.3.1 Depletion task. The e-crossing task was used to manipulate ego depletion (Baumeister et al., 1998; DeWall, Baumeister, Stillman, & Gailliot, 2007; Walsh, 2014b). Participants were told that the task was designed to measure attention to task-relevant stimuli.

In the first phase, participants in both the depletion and non-depletion conditions completed the same crossing out task. They were provided with a page of text, and instructed to cross out each instance of the letter ‘e’. In line with previous research, the text was taken from a statistics text, selected for its technical style to minimise interest in the content and distraction from the task (Baumeister et al., 1998). Participants were provided with written instructions, and given the opportunity to ask questions of the experimenter before beginning the task. After 5 minutes, participants were provided with a second set of instructions and a new page of text. Participants in the non-depletion condition were instructed to complete the same crossing out task as in the first phase. Participants in the depletion condition were instructed to cross out each letter ‘e’, except if the ‘e’ was followed immediately by another vowel in the same word, or if a vowel appeared two letters before the ‘e’ in the same word. The complex rule administered in the depletion condition required participants to exercise self-control to inhibit the crossing-out response practiced in the first phase. The second phase of the task also lasted 5 minutes.

5.2.3.2 Snack food consumption. A taste-test was used to measure consumption of unhealthy snack food. Participants were presented with four bowls of popular energy dense snack foods (i.e., cheese Twisties, original salted potato chips, M&Ms, chocolate chip cookies). The placement of the bowls from left to right was counterbalanced across participants with a Latin square procedure with four orders. Participants were instructed to taste some of each of the foods in order to rate their sensory properties (e.g., “How sweet is this product”) on 100mm visual analog scales on a rating sheet accompanying each bowl. Participants were informed that they would be given 10 minutes to taste and rate the foods while the experimenter was out of the room, and were advised that they could sample more of the products after the ratings were completed, but were asked not to change the initial ratings. The pre- and post-taste-test weights of the bowls were compared after the participants had left

the laboratory in order to gauge intake. Intake in grams was multiplied by the number of kilojoules (kJ) per gram in each food, and summed for the total measure of snack consumption.

5.2.3.3 Motivation to control intake during taste-test. Participants were asked to indicate the extent to which they were motivated to control or minimise their intake of the snacks presented during the taste-test. Responses were recorded on a 7-point Likert scale, ranging from 1 (*Not at all*), to 7 (*Completely*) for each of the four foods. A mean motivation to control intake score was calculated.

5.2.3.4 Desire strength. Participants were asked to indicate the extent to which they felt tempted and how much they wanted to eat each of the foods presented during the taste test on two 7-point Likert scales ranging from 1 (*Not at all*), to 7 (*Completely*) for each of the four foods. Mean responses to these questions were calculated, with higher scores indicating a stronger desire to consume the foods.

5.2.3.5 Hunger. Self-reported hunger was assessed on a single 7-point Likert scale ranging from 1 (*not hungry at all*), to 7 (*extremely hungry*), and included as a covariate in analyses as it has been shown to affect food consumption (Haynes et al., 2014; Rogers & Hardman, 2015).

5.2.3.6 Depletion manipulation check. Participants were asked to indicate the extent to which the second phase of the crossing-out-letters task was effortful, exhausting, required concentration, and required them to break a habit. Responses were recorded on four 7-point Likert scales ranging from 1 (*Not at all*), to 7 (*Completely*).

5.2.4 Procedure

Participants completed the experiment individually in a quiet room in the Applied Cognitive Psychology Laboratory. Participants were asked to eat something 2 hours before their scheduled session, and to refrain from eating or drinking anything apart from water until

the experiment to equalise hunger levels. The hunger measure was administered first, followed by the e-crossing task and then the taste test. Finally, the remaining self-report measures were administered.

5.3 Results

5.3.1 Preliminary Analyses and Main Effects of Depletion

Table 5.1 presents descriptive statistics for the manipulation check variables, hunger, BMI, and the main outcome measures between the depletion and non-depletion conditions. Independent samples *t*-tests revealed that participants in the depletion condition rated the second e-crossing task as more effortful and exhausting, requiring more concentration, and required them to break a habit to a greater extent than participants in the non-depletion condition. The conditions did not significantly differ on hunger or BMI.

Contrary to predictions, independent sample *t*-tests showed that the conditions did not significantly differ on desire strength or snack intake. However, in line with the process model of ego depletion, participants in the depletion condition reported significantly lower motivation to control intake than those in the non-depletion condition. This pattern of results remained the same using a univariate ANOVA including hunger as a covariate to compare conditions on desire, $F(2, 153) < 1$, $p = .89$, motivation to control intake, $F(2, 153) = 4.83$, $p = .03$, and snack intake, $F(2, 153) < 1$, $p = .59$.

Table 5.1

Difference between depletion and non-depletion conditions on all variables

Variable	Condition		*t*	*df*	*p*
	Non-depletion	Depletion			
Hunger	3.31 (1.60)	3.21 (1.40)	.42	154	.67
BMI	22.37 (3.83)	22.58 (3.79)	.34	151	.74
Manipulation checks					
Exhausting	3.19 (1.46)	4.01 (1.48)	3.48	154	.001
Effortful	4.09 (1.68)	4.83 (1.45)	2.96	154	.004
Requires concentration	3.63 (1.68)	4.36 (1.55)	2.82	154	<.01
Requires breaking a habit	3.73 (1.71)	4.91 (1.28)	4.87	154	< .001
Snack consumption	887.45 (492.30)	847.51 (531.94)	.49	154	.63
Desire strength	4.11 (1.32)	4.16 (1.37)	.24	154	.81
Motivation to control intake	3.53 (1.49)	3.05 (1.35)	2.06	154	.04

5.3.2 Interactions Between Depletion Condition, Desire Strength, and Motivation to Control Intake

Two moderation analyses were conducted to explore the two way interactions between depletion and both motivation to control intake and desire strength in predicting snack consumption, controlling for hunger [10]. The SPSS macro PROCESS (Hayes, 2012) was used to test these interactions.

In the analysis of the moderation of the motivation – snack consumption relationship by depletion condition, motivation approached significance as a predictor of intake, with higher motivation to control intake surprisingly predicting higher snack consumption, B = 164.04, $t(151) = 1.76$, $p = .08$. Depletion condition also had an unexpected effect on snack consumption, with participants in the depletion condition consuming lower amounts of snack food than those in the non-depletion condition, B = -497.66, $t(151) = 2.41$, $p = .02$. As predicted, depletion significantly moderated the relationship between motivation and intake, B = 132.30, $t(151) = 2.29$, $p = .02$. Simple slopes analysis exploring the relationship between motivation and intake between depletion conditions revealed that in the non-depletion condition, motivation predicted lower snack consumption, B = -100.57, $t(151) = 2.53$, p = .01, while in the depletion condition, motivation did not significantly predict consumption, B = 31.73, $t(151) = 0.75$, $p = .45$ (Figure 5.1).

[10] Running analyses without hunger as a covariate did not change the pattern of results, namely, none of the significant coefficients became non-significant, and vice-versa, except for the significance of the interaction term (motivation x depletion) increasing to $p = .05$.

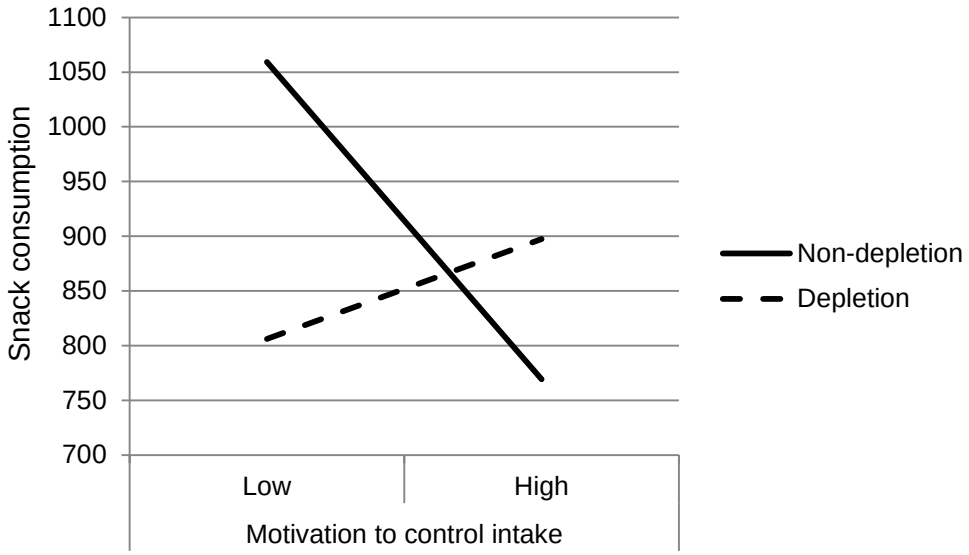

Figure 5.1. Interaction between motivation to control intake and depletion condition in predicting snack consumption.

In the analysis of the moderating role of depletion in the relationship between desire and snack consumption, depletion did not significantly predict intake, $B = 358.66$, $t(151) = 1.38$, $p = .17$, but desire strength predicted higher snack consumption, $B = 208.32$, $t(151) = 2.19$, $p = .03$. The relationship between desire and intake was not significantly moderated by depletion, indicated by a non-significant interaction term, $B = 75.52$, $t(151) = 1.26$, $p = .21$. Simple slopes analysis was conducted to explore the relationship between desire and snack consumption between the conditions (Figure 5.2). In the non-depletion condition, the relationship between desire and snack consumption was not significant, $B = 57.29$, $t(151) = 1.33$, $p = .18$. In the depletion condition however, stronger desire predicted higher snack intake, $B = -132.81$, $t(151) = 3.10$, $p = .002$.

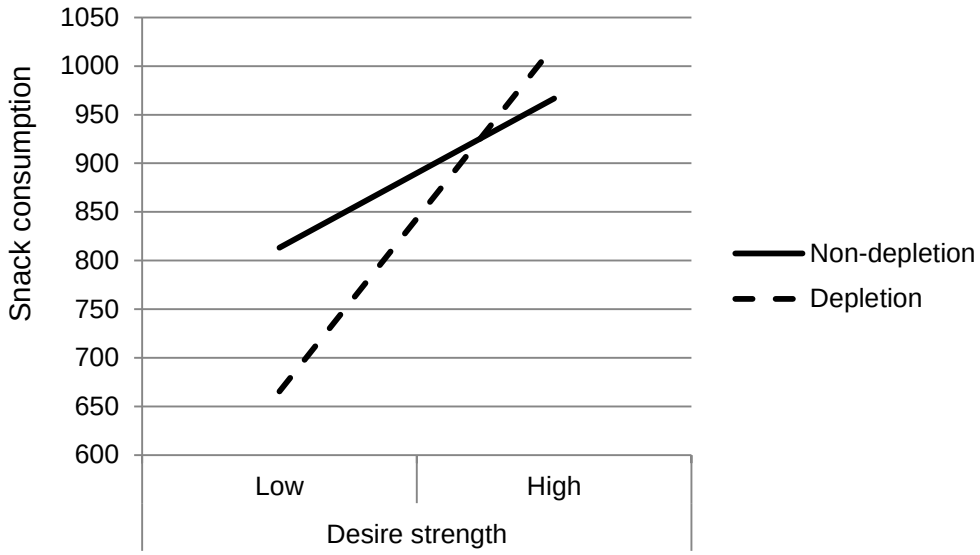

Figure 5.2. Interaction between desire and depletion condition in predicting snack consumption.

5.4 Discussion

The current study sought to test two alternative accounts of ego depletion: the strength model and the process model. Partial support was found for both models. Specifically, in support of the process model, depletion resulted in lower motivation to control intake. However, the prediction that depletion would result in stronger desire for the snack foods offered during the taste test was not supported. The findings were also partially consistent with the strength model of self-control. Specifically, only for participants in the non-depletion condition did higher motivation to control intake correlate with lower snack consumption, suggesting that participants had the resources to enact that motivation or attempt to limit their consumption. However, depletion did not significantly moderate the effect of desire on snack consumption. In line with the strength model, it was predicted that desire would predict intake only when participants were depleted, indicating that they lacked the resources to overcome this desire. While the pattern of results was consistent with this prediction, the test of moderation was not statistically significant, suggesting that the relationship between desire and snack intake does not significantly vary according to ego depletion.

The finding that participants in the depletion condition reported lower motivation to control their intake of unhealthy foods during the taste test is consistent with the process model of ego depletion. However, our depletion manipulation did not have a significant effect on snack intake. Therefore, we were unable to test whether motivation to control intake indeed mediated the relationship between ego depletion and subsequent self-control. While Hofmann et al. (2012) found no significant difference in the likelihood of a self-control attempt between depleted and non-depleted participants, Walsh (2014a) did find that depletion decreased participants' ratings of commitment, determination, and importance of the goal of healthy eating. The current findings are consistent with those of Walsh (2014a), and extend them in an important way. In contrast to Walsh (2014a), we specifically sought to recruit individuals who were motivated to manage their weight through healthy eating to ensure that the taste-test presented a self-control dilemma. Since depletion has a temporary effect on self-control performance, we thought it important to investigate situation-specific motivation by asking participants to rate their motivation to control or limit their intake of unhealthy food during the taste test. In contrast, Walsh assessed general motivation toward the goal of healthy eating. If the process model is accurate, we would expect a difference in motivation to control behaviour specific to the self-control test presented, which was supported in the current study. Further research which simultaneously examines both general goal commitment and situation-specific motivation would be valuable to test how they interact, and to determine whether they are differentially impacted by ego depletion.

The finding that ego depletion did not increase the strength of desire to consume the unhealthy foods offered during the taste test is inconsistent with the process model. Previous evidence for the effect of depletion on desire is mixed. Some studies have shown that depletion increases incentive sensitivity, and increases neural activity in reward-related centres among dieters when exposed to food cues (Schmeichel, Harmon-Jones, & Harmon-

Jones, 2010; Wagner, Altman, Boswell, Kelley, & Heatherton, 2013), while others have revealed differences in the strength of the relationship between hedonic processing of food cues and subsequent self-control of eating behaviour between depleted and non-depleted individuals (e.g., Friese et al., 2008; Hofmann et al., 2007). The current study was the first to assess self-reported desire between depleted and non-depleted participants. Taken together with previous findings, the current results suggest that increased incentive sensitivity and food reward activity in depleted compared to non-depleted individuals may not necessarily translate into increased subjective desire to indulge in unhealthy but immediately gratifying snack foods.

Consistent with the strength model of self-control, the current study showed that while depletion did not have a significant main effect on snack consumption it did moderate the interaction between motivation to control behaviour and subsequent self-control of eating behaviour. Only in the depletion condition did a higher motivation to control intake predict lower snack consumption. These results suggest that when not depleted, individuals have the resources to enact behaviour consistent with their motivation toward self-control. Additionally, the pattern of results suggested that when depleted, individuals lack the resources to overcome strong desire, demonstrated by the significant relationship between desire strength and intake observed only in the depletion condition. However, the test of the moderation of this relationship was not significant, suggesting that the strength of the desire – snack consumption relationship did not significantly vary between conditions. The current pattern of results mirrored that of Hofmann et al.'s (2012) experience sampling study. Specifically, they found that participants who had not recently enacted self-control (i.e., who were not depleted) were better able to enact behaviour consistent with their attempts to self-control, and to overcome desire. In contrast, when depleted, participants' attempt to control behaviour was not predictive of their behaviour, which was instead more strongly predicted

by their immediate desires. The current study adds to this evidence for the strength model of self-control in the eating domain, by testing these interactions using a lab-based study design which allowed experimental control over aspects of the food environment.

In a practical sense, the findings of the current study suggest that reducing desire for indulgence in unhealthy stimuli may be the best way to facilitate healthy eating behaviour, regardless of self-regulatory resources. Only for participants in the non-depletion condition did a high motivation to control intake reduce snack food consumption. Desire was a significant predictor of snack consumption, and while it appeared to more strongly predict intake in the depletion condition, the moderation was not significant. This suggests that desire may, albeit weakly, affect behaviour even when individuals possess higher levels of self-regulatory resources. Therefore, to facilitate healthy behaviour across situations, an appropriate focus for interventions could be to reduce desire for unhealthy stimuli. For example, previous studies have suggested that changing the way appetitive stimuli are processed at an automatic level could reduce desire for, and subsequent intake of unhealthy food. In particular, chocolate cravings have been shown to be related to an attentional bias for chocolate-related cues, and retraining attentional biases away from those cues can reduce both cravings and subsequent intake (Kemps & Tiggemann, 2009; Kemps, Tiggemann, Orr, & Grear, 2014). Similarly, positive implicit evaluations of unhealthy food have been shown to predict stronger experienced temptation to indulge in unhealthy food and subsequent intake (Haynes et al., 2014). While some studies have shown that retraining those implicit evaluations can produce healthier food choices (Hollands, Prestwich, & Marteau, 2011; Walsh & Kiviniemi, 2013), others have shown that retraining implicit food evaluations may only reduce temptation strength and intake of unhealthy food among individuals with low inhibitory control (Haynes, Kemps, & Moffitt, 2015a, 2015b). Future research should further

explore strategies to reduce the desire for unhealthy but immediately rewarding stimuli, in order to facilitate goal-consistent behaviour.

In conclusion, the current study tested the process model of ego depletion in an eating domain. Findings revealed partial support for the model: ego depletion reduced the motivation to control behaviour, but did not increase desire for appetitive stimuli. We also found partial support for the strength model. Specifically, only when not depleted were individuals able to act according to their motivation to control intake. By contrast, under depletion conditions, the relationship between desire strength and snack intake was stronger than when participants were not depleted. However, depletion did not significantly moderate the relationship between desire and snack consumption, suggesting that desire may be an appropriate focus for facilitating healthy behaviour across different self-control conditions. Further research will be required to elucidate the precise nature of the potential ‘resource’ underlying ego depletion.

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CHAPTER 6: Does Trait Self-control Predict Weaker Desire for Unhealthy Stimuli? A Lab-based Study of Unhealthy Snack Intake [11]

Traditionally, self-control has been conceptualised as the effortful overcoming of desires in order to enact goal-consistent behaviour. Several researchers have suggested that instead, self-control is effortless, as individuals with high self-control experience less intense desire that conflicts with valued goals. The current study tested whether the relationship between trait self-control and snack intake was mediated by desire strength, or whether those with higher trait self-control were better able to overcome desire to indulge in unhealthy food, controlling for aspects of the food environment and goal motivation. A sample of women with the goal of eating healthily for weight management (N =134) completed a lab-based assessment of snack food consumption and self-report measures of desire strength and trait self-control (generic self-control, and both inhibitory and initiatory subcomponents). As expected, desire strength mediated the relationship between generic self-control and intake, such that higher self-control was related to lower snack intake indirectly via lower desire strength. The relationship between desire and intake was consistent across self-control levels. The same pattern of results emerged for both inhibitory and initiatory self-control. These findings support the contemporary conceptualisation of self-control as being effortless due to the reduced strength of unhealthy desires.

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6.1 Introduction

Trait self-control predicts a wide variety of adaptive behaviours and positive outcomes, including academic and work performance, personal adjustment, interpersonal functioning, healthy eating behaviours, and lower levels of alcohol abuse (De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Tangney, Baumeister, & Boone, 2004). The traditional conceptualisation of self-control is that it enables an individual to effortfully overcome unhealthy desires or impulses in order to act in a way that is consistent with valued long-term goals (De Ridder, de Boer, Lugtig, Bakker, & van Hooft, 2011; Hofmann, Baumeister, Förster, & Vohs, 2012). However, an alternative conceptualisation suggests that individuals with higher trait self-control enact goal-consistent behaviour effortlessly (Gillebaart & de Ridder, 2015). Rather than having to effortfully overcome unhealthy desires to act in accordance with higher order goals such as healthy eating, individuals with high self-control actually experience less frequent and intense desires to indulge in unhealthy behaviour that conflict with those goals.

Hofmann et al. (2012) recently tested these alternative models of self-control. Participants completed an experience sampling procedure in which they carried an electronic device for one week that regularly prompted them to report their desires in the preceding 30 minutes. They also reported the strength of the desire, whether it conflicted with an alternative goal, whether they tried to resist the desire, and whether their behaviour immediately following was goal-consistent. Results revealed that trait self-control did not moderate the relationship between desire strength and goal-consistent behaviour, running contrary to the conventional view of self-control. Instead, participants with high trait self-control reported experiencing less frequent and less intense desires conflicting with their goals. Desire mediated the pathway to goal-consistent behaviour. These results therefore support the alternative conceptualisation of self-control as being effortless, as individuals

with higher trait self-control did not experience strong conflicting desires that needed to be effortfully overcome.

Two possible interpretations of Hofmann et al.'s (2012) finding that high trait self-control predicts lower desire have been proposed. These possibilities are not mutually exclusive. The first interpretation is that trait self-control was associated with less desire because individuals with higher self-control are more likely to avoid situations where unhealthy desires might arise (e.g., walking down the chocolate aisle in the supermarket) (Gillebaart & de Ridder, 2015; Hofmann et al., 2012). Here, the potential to experience strong desire in response to tempting cues remains the same across levels of self-control; however, individuals with high self-control report lower desire because they encounter potentially problematic desirable stimuli less frequently.

A second possible explanation for Hofmann et al.'s (2012) findings is that individuals with high self-control actually experience less intense desire when faced with unhealthy stimuli. This relationship between trait self-control and lower experience of desire could be attributable to two mechanisms. The first is that individuals with higher trait self-control are said to repeatedly enact goal-consistent responses to environmental cues (e.g., unhealthy snack food), resulting in the automatisation of these responses so that they are effortlessly performed (Baumeister & Alquist, 2009; Gillebaart & de Ridder, 2015). This could change the way they experience desire in response to those unhealthy cues in future (Gillebaart & de Ridder, 2015). Indeed, a meta-analysis revealed that generic trait self-control more strongly predicted automatic behaviours (i.e., behaviours that are performed efficiently and unintentionally without awareness and conscious control, such as habitual snacking and addictive behaviours like smoking and alcohol use), than controlled behaviours (i.e., those that require conscious intention or deliberation, such as quitting smoking or making plans) (De Ridder et al., 2012). The relationship between trait self-control and lower intake of

unhealthy snacks has also been shown to be mediated by habit strength (Adriaanse, Kroese, Gillebaart, & De Ridder, 2014). Research has demonstrated that reinforcement of a cue-behaviour link (e.g., practicing the inhibition of behavioural response to a food cue) influences the subsequent processing of that cue (e.g., the implicit evaluation of that food cue becomes more negative) (Hofmann, Deutsch, Lancaster, & Banaji, 2010; Houben, Nederkoorn, Wiers, & Jansen, 2011; Veling, Aarts, & Stroebe, 2013). A negative automatic evaluation of a stimulus has been linked to lower desire and temptation for that stimulus (Haynes, Kemps, Moffitt, & Mohr, 2014a; Hofmann & Van Dillen, 2012). Therefore, individuals with higher trait self-control could experience less desire when encountering unhealthy stimuli as a result of their habitual goal-consistent responses to those stimuli.

An alternative mechanism underlying the relationship between experienced desire and trait self-control could be a difference in the activation of higher order self-control goals between individuals with high and low trait-self-control. Goals are internal representations of desired states (Austin & Vancouver, 1996). Control theory posits that behaviour is guided by hierarchically organised goals. Through a process of negative feedback, the individual's current state is continuously compared to a desired goal state, which guides behaviour with the aim of reducing the discrepancy between the current and the goal state (Carver & Scheier, 1982; Powers, 1973). Extending this theory, counteractive control theory predicts that encountering a disturbance (e.g., unhealthy snack food) to a higher order goal (e.g., healthy eating or weight management goal) promotes stronger accessibility of that higher order goal. This higher goal accessibility promotes goal-consistent behaviour by directing attention and resources toward reducing the discrepancy between the current state and the goal state (Fishbach, Friedman, & Kruglanski, 2003). Some (e.g., Fishbach et al., 2003; Papies, Stroebe, & Aarts, 2008), but not all (Haynes, Kemps, Moffitt, & Mohr, 2014b), previous research in this area has found a relationship between higher goal accessibility in response to

disturbance cues and self-control. This activation of a higher order goal may reduce the desire for unhealthy stimuli, as it has been shown to shape individuals' implicit evaluations of goal-relevant and goal-disturbing stimuli (Ferguson, 2008), which contribute to experienced temptation (Haynes et al., 2014a). Indeed, this relationship between self-control and both higher goal accessibility and lower desire is supported by research showing that individuals with high trait self-control report lower conflict between higher order goals and immediate desires (Hofmann et al., 2012). One behaviour (e.g., eating unhealthy food) may undermine one goal (e.g., weight management or staying healthy), while serving other goals (e.g., goal of enjoying food, experiencing positive emotions) simultaneously (Kelly, Mansell, & Wood, 2015). Lower conflict between the goal of weight management and goals served by indulging in unhealthy food predict weight fluctuations and loss of control over eating (Rosenhead & Mansell, 2015). Individuals with higher trait self-control may therefore experience less desire when encountering unhealthy stimuli because they are better able to activate or attend to their higher order self-control goals, reducing goal conflict.

Regardless of the potential mechanism underlying the relationship between trait self-control and desire, it remains to be determined whether higher trait self-control does indeed relate to experiencing less intense desire when encountering unhealthy stimuli. This was beyond the scope of the research conducted by Hofmann et al. (2012). Their experience sampling design allowed participants control over their environmental exposure to desirable stimuli. Therefore, it is possible that lower desire experienced by those with higher self-control could be attributable to those individuals shaping their environments so that they did not encounter unhealthy foods (e.g., avoiding situations where tempting foods are available).

The current study therefore sought to test how trait self-control relates to the desire to consume, and actual consumption of, unhealthy foods. Specifically, we presented participants with unhealthy snack foods for ad libitum consumption in a laboratory setting while

controlling aspects of this food environment (e.g., food variety, portion size, allowed eating time, etc.). This allowed us to isolate the strength of desire to indulge in unhealthy foods independently of participants' tendencies to control their exposure to unhealthy food stimuli. We recruited a sample of women with the motivation to eat healthily to manage weight, and statistically controlled for the strength of this motivation, as this may affect the extent to which the consumption of unhealthy snack food constitutes a self-control dilemma. We also measured variables which have been shown to affect the strength of desire to consume unhealthy foods and consumption, in order to statistically control for their effects (i.e., hunger, BMI, and general liking of the foods presented; Haynes et al., 2014a; Mela, 2006; Rogers & Hardman, 2015).

We expected that higher trait self-control would be related to lower desire strength to indulge in unhealthy snack foods, and that this desire strength would mediate the pathway between trait self-control and snack intake. An alternative hypothesis in line with the conventional view of self-control was also tested, namely, that self-control would moderate the relationship between desire strength and snack intake. Furthermore, in addition to assessing generic trait self-control, we assessed two specific types of self-control: inhibitory and initiatory. Inhibitory self-control has been found to more strongly predict behaviours requiring inhibition of impulses, like smoking and alcohol consumption, while initiatory self-control more strongly predicted exercise and hours spent studying (De Ridder et al., 2012). As the inhibition of impulses is required to limit consumption of unhealthy snack food, we expected that inhibitory self-control would be more strongly related to desire for unhealthy food than initiatory self-control. However, we predicted that generic trait self-control would be more highly predictive of desire than the inhibitory component alone. This is because the formation of automatised responses to unhealthy food cues that may be partly responsible for

the self-control of eating is likely to require initiatory mechanisms (i.e., forming adaptive responses and routines), as well as inhibitory ones.

6.2 Method

6.2.1 Participants

The sample consisted of 134 women between the ages of 17 and 25 years (M = 20.08, SD = 2.40) recruited from the student population of an Australian university. Advertisement materials for the study stated that participants must be motivated to manage weight through healthy eating. This inclusion criterion was specified to ensure that the sample included women for whom eating unhealthy snacks constituted desire that conflicted with a goal. Only women were recruited, as they have higher levels of food craving and overeating than men, but are more likely to be motivated to manage weight through healthy eating (Burton, Smit, & Lightowler, 2007; Cepeda-Benito, Fernandez, & Moreno, 2003; Wardle et al., 2004). Seventy-five first-year psychology student volunteers participated for course credit, and the remaining volunteers received a $15 honorarium.

6.2.2 Materials

6.2.2.1 Hunger. A single self-report question was used to assess participants' current level of hunger. Responses were made on a 7-point Likert scale ranging from 1 (not hungry at all), to 7 (extremely hungry).

6.2.2.2 Snack intake. Intake of unhealthy snack food was assessed with a taste test (Coelho et al., 2009). Participants were presented with four full bowls of pre-weighed popular energy-dense snack foods: M&Ms, Cheese Twisties, mini choc-chip cookies, and potato chips. The placement position of the four bowls from left to right was counterbalanced across participants using a Latin square procedure with four orders (order 1: M&Ms, Twisties, cookies, chips; order 2: chips, M&Ms, Twisties, cookies; order 3: cookies, chips, M&Ms, Twisties; order 4: Twisties, cookies, chips, M&Ms). Participants were asked to taste some of

each of the foods, and rate the foods' sensory properties on a paper-pencil format rating sheet accompanying each one. The rating sheets contained six questions (e.g., "How sweet is this product?"), with responses recorded on 100mm visual analog scales (ranging from "not at all" to "extremely"). Participants were given 10 minutes to taste as much food as they needed in order to accurately rate the foods while the experimenter was out of the room. The experimenter informed participants that they could sample more of the products after the ratings were completed, but were asked not to change their initial ratings. Participants were not given explicit instructions about the order in which to taste the foods. The weight of each bowl was recorded pre- and post-taste-test to assess snack consumption without participants' knowledge. Intake in grams was multiplied by the number of kilojoules (kJ) per gram in each food, and summed to give total intake in kJ.

6.2.2.3 Desire strength. For each snack food, participants were asked to indicate on two 7-point Likert scales for each food, the extent to which they felt tempted to eat, and how much they wanted to eat each food presented during the taste test. Participants' mean responses to these questions were calculated, with higher scores indicating a stronger desire to consume the foods offered in the taste-test.

6.2.2.4 Self-control. Generic trait self-control was measured using the 36-item self-control scale, which assesses the domain general ability to override a dominant behavioural tendency in order to serve a higher order goal (e.g., "I refuse things that are bad for me"). Participants indicate the extent to which each statement represents them, on 5-point Likert scales ranging from 1 (*not at all like me*), to 5 (*very much like me*), with higher scores indicating higher trait self-control. Internal consistency coefficient alpha for the scale was high in the current study, Cronbach's a = .90; and was consistent with previous research, Cronbach's a = .89 (Tangney et al., 2004).

The 6-item inhibitory self-control scale and the 4-item initiatory self-control scale (De Ridder et al., 2011) derived from items from the generic trait self-control scale, were used to assess inhibitory and initiatory self-control, respectively. Internal consistency of the scales was adequate, Cronbach's *a* = .72 (inhibitory), *a* = .76 (initiatory), and consistent with previous research, Cronbach's *a* = .76, .78 (inhibitory), *a* = .65, .68 (initiatory) (De Ridder et al., 2011).

6.2.2.5 General liking of snack foods. Participants were asked to rate the extent to which they liked each of the four unhealthy foods presented during the taste-test on separate 7-point Likert scales, ranging from 1 (*not at all*), to 7 (*extremely*). A mean liking score was calculated.

6.2.2.6 Motivation. The extent to which participants were motivated toward regulating eating for weight management was assessed using a 4-item motivation scale (e.g., "I choose certain food items to avoid gaining weight; Sproesser, Strohbach, Schupp, & Renner, 2011). The scale requires participants to indicate the frequency with which each behaviour applies to them on 5-point Likert scales, ranging from 1 (*never*), to 5 (*always*). The mean response on the items was calculated, with higher scores indicating stronger motivation to regulate eating for weight management. The scale's internal-consistency coefficient alpha was high in the current study, Cronbach's *a* = .89; and consistent with previous research, Cronbach's *a* = .89 (Sproesser et al., 2011).

6.2.3 Procedure

Participants completed the experiment individually in the Applied Cognitive Psychology Laboratory and were told that the experiment would investigate the relationship between eating styles and taste perception. To equalise hunger levels, participants were asked to eat something 2 hours before their scheduled session, and to refrain from eating again until the experiment. Participants first completed the hunger scale; followed by the taste-test, and

measures of trait self-control, motivation, desire strength, and food liking. Finally, they were asked to disclose background information including age, height and weight[12].

6.3 Results

6.3.1 Correlations

Zero-order correlations between variables of generic self-control, inhibitory and initiatory self-control, hunger, general liking, desire strength, intake, and BMI are presented in Table 6.1. Generic self-control was significantly negatively correlated with general liking of the foods, desire strength, and snack intake, and positively with both inhibitory and initiatory self-control. Inhibitory self-control was negatively correlated with liking, desire strength, and snack intake, and positively with initiatory self-control. Initiatory self-control negatively correlated with snack intake, and the negative correlation between initiatory self-control and desire approached significance. Hunger was positively correlated with desire strength and snack intake, and negatively with motivation. Desire strength was positively correlated with snack intake, and negatively with motivation. The correlation between hunger and BMI approached significance. General liking of the foods was positively correlated with snack intake, and positively correlated with desire strength.

[12]A computer task was administered in between the hunger measure and taste-test, the results of which are discussed elsewhere (Haynes, Kemps, & Moffitt, 2015b). Controlling for participants' assignment to experimental condition in the computer task did not affect the results of the mediation and moderation analyses, and therefore have reported without the condition as a covariate.

Table 6.1

Relationships between all variables

	Generic self-control	Inhibitory self-control	Initiatory self-control	Hunger	BMI	Liking	Desire strength	Snack intake (kJ)	Motivation
Generic self-control		.87***	.80***	-.01	-.15	-.18*	-.27**	-.28***	-.01
Inhibitory self-control			.70***	.01	-.09	-.22*	-.29***	-.27***	-.06
Initiatory self-control				-.03	-.12	-.09	-.16†	-.22**	-.03
Hunger					-.17†	.13	.19*	.20*	-.29***
BMI						.05	.04	.10	.01
Liking							.82***	.30***	-.15
Desire strength								.39***	-.22*
Snack intake (kJ)									-.14
Motivation									

† p = .06, * p < .05, **p < .01, *** p <.001.

6.3.2 Moderation of Self-control – Intake Relationship by Desire Strength

The moderation of the relationship between desire strength and intake by self-control was tested using the SPSS macro, PROCESS (Hayes, 2012). The predictor variables (desire strength and generic self-control), covariates (general liking, hunger, and motivation[13]), and interaction term (product of the predictors) were regressed on the outcome variable (snack consumption). There was a significant main effect of self-control on snack consumption, B = -116.71, $t(126) = 2.28$, $p = .03$. The interaction term (product of desire strength and self-control) was not a significant predictor of intake, $B = 6.73$, $t(126) = 0.75$, $p = .46$, suggesting that the relationship between desire strength and snack intake did not vary according to generic self-control levels.

Similar analyses were conducted to assess the moderation of the relationship between desire strength and intake by inhibitory and initiatory self-control, respectively. In the analysis of the moderating role of inhibitory control, there was a significant main effect of inhibitory self-control on snack consumption, B = -115.02, $t(126) = 2.21$, $p = .03$, and in the corresponding analysis of initiatory self-control, the main effect of initiatory self-control was significant, B = -104.52, $t(126) = 2.08$, $p = .04$. The interaction between desire strength and neither inhibitory self-control, $B = 5.50$, $t(126) = 0.55$, $p = .58$, nor initiatory self-control, B = 7.55, $t(126) = 0.73$, $p = .47$, predicted snack consumption, suggesting that the relationship between desire strength and snack intake did not vary according to levels of inhibitory or initiatory self-control.

6.3.3 Mediation of Self-control – Intake Relationship by Desire Strength

The PROCESS macro was also used to test whether desire mediated the relationship between self-control and snack intake (Figure 6.1). The predictor (generic self-control) and covariates (general liking, hunger, and motivation) were regressed on the mediating variable

[13] BMI did not significantly correlate with desire, intake, or the self-control measures, and was therefore not included as a covariate in moderation and mediation analyses. Including BMI as a covariate did not change the pattern of results.

(desire), showing that stronger self-control predicted weaker desire to consume the food in the taste-test after controlling for the covariates (pathway *a*, Figure 6.1), B = -1.71, $t(128)$ = 2.97, p = .01. A second regression model was estimated, regressing the predictor (generic self-control), mediator (desire), and covariates on the outcome variable (snack intake). Desire strength was a significant predictor of snack intake (pathway *b*, Figure 6.1), B = 27.59, $t(127)$ = 2.18, p = .03, as was self-control, B = -218.44, $t(127)$ = 2.33, p = .02 (pathway *c*, Figure 6.1). The indirect effect of generic self-control on snack intake through desire strength was -47.11 (SE = 31.21). The 95% confidence interval of the estimated indirect effect did not contain zero (-131.28, -5.04), indicating that the mediation was significant.

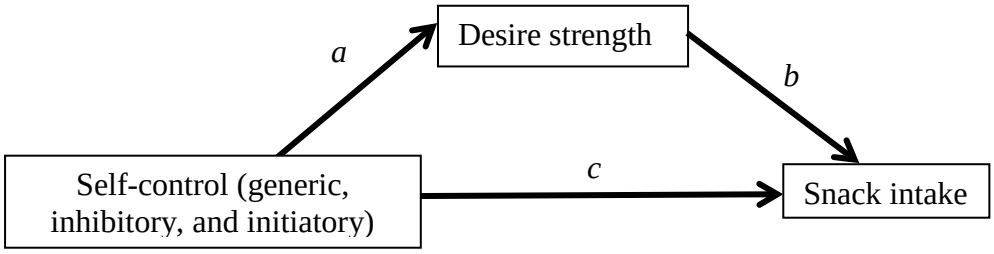

Figure 6.1. Mediation model pathways: effect of trait self-control on snack consumption via desire to consume foods offered for consumption.

Similar analyses were conducted to assess whether desire strength mediated the effect of inhibitory and initiatory self-control, respectively, on snack consumption, also shown in Figure 6.1. In the analysis of inhibitory control, stronger inhibitory self-control predicted weaker desire to consume the food in the taste-test after controlling for the covariates, B = -1.36, $t(128)$ = 2.53, p = .01, and in the corresponding analysis of initiatory self-control, stronger initiatory self-control approached significance as a predictor of desire strength, B = -1.10, $t(128)$ = 1.86, p = .06 (both pathway *a*, Figure 6.1). In the second regression model testing effects on snack intake, desire strength was a significant predictor of snack intake in both inhibitory self-control, B = 28.09, $t(127)$ = 2.23, p = .03, and initiatory self-control analyses, B = 30.25, $t(127)$ = 2.41, p = .02 (both pathway *b*, Figure 6.1). Snack consumption

was significantly predicted by both inhibitory, B = -179.81, $t(127) = 2.29$, $p = .02$, and initiatory self-control, B = -171.83, $t(127) = 2.03$, $p = .04$ (both pathway *c*, Figure 6.1). The estimated indirect effects of inhibitory self-control and initiatory self-control on snack intake through desire strength was -38.26 (SE = 24.90), and -33.17 (SE = 25.10), respectively. The associated 95% confidence intervals of the estimated indirect effects for neither inhibitory (-106.51, -4.22), nor initiatory self-control (-101.19, -0.32), contained zero, indicating that both the effects of inhibitory and initiatory self-control components on snack intake were mediated by desire strength.

6.4 Discussion

The current study showed that trait self-control was related to weaker desire to indulge in unhealthy snack food among individuals with a goal of healthy eating for weight management. Additionally, desire strength mediated the pathway between trait self-control and goal-consistent behaviour (i.e., lower snack consumption). These results support and extend those of Hofmann et al. (2012). Rather than being able to overcome desire to indulge in unhealthy behaviour, individuals with higher trait self-control experience less intense desire to indulge in unhealthy behaviour. It is this reduction in desire that contributes to goal-consistent behaviour (i.e., lower consumption of unhealthy snack food). The current findings therefore support alternative conceptualisations of self-control as being effortless. In an important extension of the findings of Hofmann et al. (2012), our design allowed us to conclude that when faced with potentially tempting stimuli (e.g., an assortment of unhealthy snack foods), trait self-control is related to the strength of desire to indulge. The results of the current study therefore reveal that the lower desire experienced by individuals with higher trait self-control found by Hofmann et al. (2012) is not exclusively due to individuals shaping their environment in such a way as to avoid exposure to potentially tempting stimuli. Instead, these individuals do experience less desire than those with low trait self-control when faced

with the same unhealthy stimuli, even after controlling for aspects of the food environment and motivation that may influence eating behaviour.

Both inhibitory and initiatory subtypes of self-control predicted lower snack consumption and lower desire strength in the current study. Furthermore, the effect of both components of self-control on intake was mediated by desire strength. These findings were contrary to the expectation that inhibitory, but not initiatory self-control would predict desire strength for unhealthy snack food. Our prediction was based on previous research suggesting that inhibitory self-control is more predictive of behaviours requiring inhibition of unhealthy behaviours (i.e., limiting the intake of unhealthy snack food) than initiation of healthy ones (De Ridder et al., 2011). However, the revised conceptualisation of self-control as effortless and resulting in less frequent and intense unhealthy desires may be attributable to the initiation of repeated goal-consistent responses to environmental triggers (e.g., unhealthy snack food) which eventually become automatic. It is these habitual goal-consistent responses to unhealthy food which could be responsible for reducing the extent to which individuals experience a desire to indulge in that food in future, due primarily to a change in the automatic evaluation of food stimuli (Gillebaart & de Ridder, 2015). It has also been argued that some self-control behaviours involve a combination of both inhibitory and initiatory processes (de Boer, van Hooft, & Bakker, 2011). Perhaps in the case of unhealthy snacking, a high level of inhibitory self-control is required to inhibit impulses to consume and therefore enact a goal-consistent response to unhealthy snacks before a habitual response to unhealthy snacks is established. Over time, a high level of initiatory self-control may then enable the automatisation of this goal-consistent response. Therefore, a combination of both self-control components may be important to reduce desire for unhealthy foods, which was supported by the current findings.

Although inhibitory and initiatory self-control were highly correlated in the current study, previous research has demonstrated a meaningful distinction between these types of self-control (de Boer et al., 2011). In addition, the construct validity of the subscales assessing inhibitory and initiatory self-control used here is supported by confirmatory factor analysis (De Ridder et al., 2011). However, they were derived from research which did not specifically aim to formulate measures to assess the inhibitory and initiatory components of self-control, but merely to demonstrate that they could be differentiated in the prediction of different types of behaviour (De Ridder et al., 2011). The similarity in findings between inhibitory and initiatory self-control in the current study may be attributable to measurement issues. Therefore, the future development of scales to assess inhibitory and initiatory components of self-control would be valuable in providing a clearer picture of how they each relate to desire strength.

The current results, and those of Hofmann et al. (2012) support an alternative conceptualisation of self-control as being effortless. They do however seem contrary to a body of literature suggesting that individuals with higher inhibitory capacity are better able to overcome impulsive influences on behaviour, and act in a goal-consistent manner (e.g., Haynes, Kemps, & Moffitt, 2015a; Hofmann, Friese, & Roefs, 2009; Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010). Impulsive influences include automatic evaluations of a stimulus, such that a more positive implicit evaluation predicts the tendency to approach that stimulus (Chen & Bargh, 1999). A desire for consumption of unhealthy snacks has also been suggested to be an impulsive determinant of behaviour, as it is activated automatically by environmental cues, and drives behaviour toward immediate hedonic gratification to the detriment of long-term goals (Milyavskaya, Inzlicht, Hope, & Koestner, 2015). Although a more positive implicit evaluation of a stimulus is suggested to be related to a stronger desire for it (Haynes et al., 2014a; Hofmann & Van Dillen, 2012), the two are not one and the same.

Additional research is needed to investigate how impulses relate to conscious desire to indulge in unhealthy stimuli, and whether this relationship is moderated by trait self-control as well as by state inhibitory control. This may account for our discrepant findings that individuals with higher inhibitory abilities are able to overcome impulses toward unhealthy stimuli (i.e., a more positive implicit evaluation), and that individuals with high trait self-control experience less desire to indulge in unhealthy stimuli in the first place.

The mechanism through which individuals with higher trait self-control come to experience less intense desire for unhealthy stimuli is also an important question for future research. Two possibilities have been raised. First, individuals with high trait self-control may experience less desire as a result of automatisation of goal-consistent behaviour. Consistent reinforcement of a cue-behaviour link (e.g., inhibition of behavioural responses to an unhealthy food cue) can change the implicit evaluation of that cue (e.g., implicit evaluation of that food becomes more negative), which has been shown to relate to lower experienced temptation (Haynes et al., 2014a; Hofmann et al., 2010; Houben et al., 2011; Veling et al., 2013). The habitual goal-consistent responses to unhealthy stimuli among those with high trait self-control may therefore be responsible for their lower desire for unhealthy stimuli (Baumeister & Alquist, 2009; Gillebaart & de Ridder, 2015). Second, individuals with high trait self-control may instead be better at activating and accessing internal representations of higher order goals, like healthy eating. Control theory proposes that behaviour is guided by a process of negative feedback in which the individual's current state is continuously compared to a desired goal state (Carver & Scheier, 1982; Powers, 1973). This process is responsible for guiding behaviour toward reducing the discrepancy between current and desired goal states. Therefore, a higher accessibility of a goal state (e.g., the goal of healthy eating or weight management) can facilitate goal-consistent behaviour in response to disturbances (e.g., unhealthy stimuli like unhealthy snack food) (Fishbach et al., 2003).

Higher goal accessibility may therefore account for the lower desire for unhealthy stimuli experienced by those with high self-control, as it has been shown to promote devaluation of unhealthy stimuli (Ferguson, 2008). Thus effortless self-control in individuals high in trait self-control may be explained by lower goal conflict between hierarchically organised goals (e.g., higher order goals, like healthy eating for weight management, and lower order goals served by eating unhealthy food, like eating enjoyment).

These potential mechanisms underlying the relationship between trait self-control and desire offer avenues for enhancing goal consistent behaviour, in part by lessening the experienced desire for unhealthy stimuli. Particularly, training individuals low in trait self-control to automatise goal-consistent responses to unhealthy stimuli, or alternatively to activate representations of more highly valued goals (e.g., being healthy, or healthy weight management), may be effective. Interventions which promote effortless self-control by weakening the desire for unhealthy stimuli would be advantageous, as they would not draw upon the limited and fluctuating store of self-control resources needed to control behaviour (Baumeister & Alquist, 2009; Milyavskaya et al., 2015). Such interventions could be useful in a variety of behavioural domains that have been linked to lower self-control over desires, including not only eating behaviours, but also addictive and compulsive behaviours, unsafe sexual behaviour, and work performance (De Ridder et al., 2012; Tangney et al., 2004). However, in addition to exploring ways of reducing desire, future research should also explore the question of how individuals are able to overcome strong desire once it has arisen, since trait self-control does not appear to explain this process.

The current study has contributed to evidence in favour of a revised conceptualisation of self-control as effortless. Specifically, we have revealed evidence that rather than individuals with high trait self-control being better able to overcome desires for unhealthy behaviour which conflict with valued goals, they instead experience less intense desire, which

in turn leads to goal-consistent behaviour. However, the mechanism underlying the way in which individuals with higher trait self-control come to experience less intense desire to indulge warrants further exploration. In particular, future investigations could explore ways of training individuals to establish automatic goal-consistent behavioural responses to unhealthy cues, or to activate representations of more highly valued goals, and test whether they effectively reduce the strength of desire to indulge in unhealthy behaviour.

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CHAPTER 7: Resisting Temptation of Unhealthy Food: Interaction Between Temptation-Elicited Goal Activation and Self-Control [14]

Counteractive control theory suggests that the cognitive accessibility of a goal in response to a temptation cue predicts self-regulation of behaviour consistent with that goal. The current study provided a novel test of this effect in the eating domain, exploring the moderating role of trait self-control. A sample of 124 women (18-25 years) completed a lexical decision task to assess cognitive accessibility of the weight-management goal after food temptation priming. Eating self-regulation was operationalised as unhealthy snack food intake measured in a task disguised as a taste-test. Participants completed trait self-control and temptation experience intensity measures. Cognitive accessibility predicted lower food intake, but only among high self-control participants. The relationship was mediated by temptation experience intensity: participants with high cognitive accessibility felt less tempted, and subsequently ate less food. Results suggest that changing the processes underlying the temptation experience, rather than the cognitive accessibility of a goal may more effectively enhance self-regulation among low self-control individuals.

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7.1 Introduction

Although once assumed a potent influence on behaviour, there is substantial evidence to suggest that between 58 and 95% of variance in dietary behaviour is left unaccounted for by intentions alone (e.g., Armitage & Conner, 1999; Carels et al., 2001; Conner, Norman, & Bell, 2002; Dholakia, 2000; Hall & Fong, 2007; Sheeran, 2002). Understanding the mediators of the relationship between intention and eating behaviour is an important direction for research, and has been the focus of recent theoretical models of health and motivational behaviour.

According to one such theory, counteractive control theory, situational cues can undermine intentions to achieve long-term goals (Trope & Fishbach, 2006). For example, healthy eating intentions can be difficult to follow because eating unhealthy food is immediately rewarding (Cohen & Farley, 2008). Highly palatable, energy dense food offers a temptation for individuals wanting to manage weight through healthy eating, because the immediately rewarding behaviour of eating it conflicts with the longer-term, higher order goal of successful weight management (Fishbach, Friedman, & Kruglanski, 2003). Counteractive control theory proposes that cognitive and behavioural strategies can increase intention-behaviour consistency to serve higher-order weight management goals (Fishbach et al., 2003; Trope & Fishbach, 2006). These counteractive control strategies are enacted in response to temptation cues, which are stimuli offering immediate reward but which threaten long-term goals (Fishbach et al., 2003).

One counteractive control strategy is temptation-elicited goal activation (Fishbach et al., 2003). When an individual is faced with a temptation cue that threatens the attainment of a goal, a mental representation of that goal concept is activated. According to Kruglanski et al. (2002), goals are cognitive – they are represented in conceptual nodes in a semantic network and can be activated intentionally, or by environmental cues (Bargh & Chartrand, 1999,

2000). Different goals compete for resources to become realised, and the cognitive activation of a goal allows cognitive resources to be concentrated into processes that facilitate pursuit of that goal (e.g., evaluation of objects in the environment in a way that facilitates approach behaviour towards goal-facilitative and avoidance of goal-threatening stimuli, Ferguson & Bargh, 2008; Fishbach et al., 2003; Kruglanski et al., 2002). Literature on goal-priming supports this link between goal activation and goal-consistent behaviour. For example, when individuals are exposed to words associated with a goal (e.g., success), their subsequent behaviour is more likely to be consistent with that goal (i.e., performance on an intellectual task is enhanced; Bargh, Gollwitzer, Lee-Chai, Barndollar, & Troetschel, 2001). Therefore, cognitively associating a temptation cue with an incompatible longer-term goal is thought to facilitate effective self-regulation of behaviour in response to that temptation (Bargh & Chartrand, 1999; Bargh et al., 2001).

Support for the role of temptation-elicited goal activation in successful self-regulation of eating comes from a study by Fishbach et al. (Study 4, 2003). A lexical decision task was used to measure the cognitive accessibility of a weight management goal concept following the presentation of temptation-related words. Each trial of the lexical decision task subliminally presented a prime word, either a temptation word relevant to the goal of weight management (e.g., “cake”), or an irrelevant temptation word (e.g., “sex”). This was quickly followed by a probe word, either related to the goal of weight management (e.g., “diet”), a neutral word (e.g., “card”), or a non-word letter string (e.g., “grov”). Participants completed trials with all possible combinations of prime and probe word types, and were asked to indicate whether the probe was a word or non-word letter string. Shorter response latencies on trials with a food prime (as opposed to an irrelevant prime) followed by a weight-management probe indicated higher cognitive accessibility, and therefore, activation of weight-management goals in response to temptation word cues. Among participants who

rated the goal of weight management as highly important, the relationship between food priming and higher cognitive goal accessibility was moderated by perceived self-regulatory success, that is, participants who reported being successful at weight management showed higher cognitive goal accessibility in response to relevant temptation primes than unsuccessful self-regulators. These results suggest that temptation-elicited goal activation is more prominent among those who perceive themselves as successful at self-regulating their behaviour in line with their goal.

Papies, Stroebe, and Aarts (2008) similarly found that participants with a concern for dieting and high self-reported self-regulatory success identified goal-related concepts quicker when following a temptation-related prime than when they followed a neutral prime word in a lexical decision task. To the contrary, participants with a concern for dieting but low self-regulatory success responded slower to the goal probe when it followed the temptation prime compared to when it followed a neutral prime. This study therefore provides further evidence for the relationship between higher goal accessibility and perceived successful self-regulation.

Both Fishbach et al. (2003) and Papies et al. (2008) used the Perceived Self-Regulatory Success Scale to measure self-regulatory success. The scale items ask participants about their perceived progress towards a goal of weight management (e.g., difficulty staying in shape, success at losing weight), but do not refer to self-regulatory behaviours themselves. Thus, although higher scores on this scale are associated with lower body mass index (BMI; Papies et al., 2008), responses to the items may not only reflect an individual's ability to self-regulate behaviour. Instead, responses could be affected by various extraneous factors including personal weight standards, body dissatisfaction, or biology, or could more accurately reflect self-efficacy regarding weight management than actual self-regulatory success.

More recent studies that have measured actual self-regulatory behaviour, rather than perceived progress toward the goal of weight management provide further evidence for the relationship between temptation-elicited goal activation and successful self-regulation of eating (Kroese, Adriaanse, Evers, & De Ridder, 2011; Van Koningsbruggen, Stroebe, Papies, & Aarts, 2011). These studies operationalised self-regulatory behaviour as the intake of unhealthy food assessed by self-report snack diaries. For example, Van Koningsbruggen et al. (2011) found that training weight-concerned individuals to formulate and practice implementation intentions (i.e., practicing the phrase – "The next time I am tempted to eat chocolate, I will think of dieting"), increased cognitive accessibility of the goal of dieting in response to food temptation cues, and decreased reported unhealthy snack intake. Kroese et al. (2011) found that a similar intervention increased cognitive goal accessibility in response to a temptation cue (i.e., the word 'chocolate'), which in turn predicted lower chocolate intake. These findings build upon previous evidence linking temptation-elicited goal activation and eating self-regulation by assessing behaviour rather than perceived goal progress.

Self-report snack diaries provide ecologically valid information about eating behaviour outside of the laboratory. However, they allow participants to exert deliberate control not only over their food intake, but also over their exposure to unhealthy food stimuli. Therefore, they reflect not only an individual's ability to limit intake when immediately faced with unhealthy food, but also the ability to deliberately limit exposure to certain foods (e.g., choosing not to purchase chips while grocery shopping so it is not available for subsequent consumption). To our knowledge, the relationship between cognitive goal accessibility and intake of unhealthy foods when exposure to those foods is not under personal control has not been examined. It is nevertheless important to do so, because individuals trying to manage their weight by limiting intake of unhealthy food will inevitably be faced with immediate

opportunities to indulge in unhealthy food, either when control over exposure to those foods is not available or is impractical (e.g., unhealthy snacks offered at a social function), or when attempts at limiting exposure has failed (e.g., unhealthy snacks are available for consumption in the pantry at home). The current study therefore aimed to test the relationship between cognitive goal accessibility and intake of unhealthy snack food measured using a laboratory-based taste-test. All participants were offered the same amount of food under the same conditions, and asked to taste and rate the foods on several scales. To minimise demand effects, the true purpose of the task (i.e., measurement of intake) was not revealed.

Previous studies have assessed the cognitive accessibility of goal concepts in response to pictures or words representing food temptations. The current study sought to add to this research by investigating cognitive goal accessibility in response to a more ecologically valid temptation cue. Specifically, participants were told that they would be presented with unhealthy snack foods to taste as part of the experiment. Therefore, they would have anticipated a real temptation that threatened their goal of healthy eating for weight management, and one that would be expected to elicit counteractive control.

Cognitive accessibility is proposed to facilitate goal-consistent behaviour by affecting the processing of relevant environmental stimuli. This mechanism was demonstrated by Ferguson (2008), who found that with enhanced cognitive goal accessibility, individuals systematically evaluate goal-relevant stimuli in a way that facilitates successful goal pursuit. This evaluation pattern is proposed to encourage avoidance of goal-threatening stimuli, and approach of goal-facilitative stimuli (Ferguson & Wojnowicz, 2011). For instance, when the goal of weight management is highly cognitively accessible, individuals should evaluate goal-threatening stimuli (e.g., unhealthy snack food) as less attractive, and goal-facilitative stimuli (e.g., exercise or healthy food) as more attractive, than when cognitive goal accessibility is low. However, an individual's automatic evaluations of unhealthy food could

affect the extent to which they feel tempted to indulge in unhealthy food (Hofmann & Van Dillen, 2012). The current study therefore also assessed participants' ratings of the extent to which they experienced temptation or desire to indulge in the unhealthy snack food presented to them. We expected to find results consistent with Ferguson, namely, that higher cognitive goal accessibility would be associated with lower experienced temptation to indulge in the snack food. As positive evaluations of unhealthy food have been found to predict intake of that food (e.g., Ayres, Prestwich, Conner, & Smith, 2010; Hofmann, Gschwendner, Friese, Wiers, & Schmitt, 2008; Richetin, Perugini, Prestwich, & O'Gorman, 2007), we also expected that the experience of temptation would predict snack food intake. Additionally, based on findings of Ferguson (2008) that cognitive goal accessibility predicted goal-consistent evaluations of stimuli (i.e., more positive evaluations of goal-facilitative stimuli), we predicted that the experience of temptation would mediate the relationship between cognitive accessibility and snack intake.

Ferguson (2008) furthermore found that high cognitive goal accessibility activated goal-facilitative evaluations to a greater extent for individuals with high self-control, or skill, in the relevant behavioural domain than for those with low self-control. For example, when primed with a diet-related goal, only individuals with high skill (i.e., high dietary self-control) evaluated goal-facilitative stimuli (e.g., 'vegetables', 'salad', 'gym') as more positive. Self-control refers to the ability to control behaviour and act in accordance with longer-term intentions (Carver, 2005; De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Hoch & Loewenstein, 1991; Tangney, Baumeister, & Boone, 2004). While Ferguson's findings suggest that self-control moderates the relationship between cognitive goal accessibility and goal-consistent evaluation, the role of trait self-control in the relationship between cognitive goal accessibility and goal consistent behaviour (e.g., snack intake) has yet to be explored. Based on Ferguson's findings regarding the influence of

cognitive goal accessibility on evaluative processes related to the successful regulation of eating behaviour, we predicted that cognitive accessibility of the weight-management goal would have a stronger influence both on the experience of temptation to indulge in snack food, and also on the intake of that food, for individuals with high self-control than for those with low self-control.

7.2 Method

7.2.1 Participants

One hundred and twenty-four women between the ages of 18 and 25 years (M = 20.45, SD = 2.29) were recruited from Flinders University. Forty-eight first-year psychology student volunteers participated for course credit, and the remaining paid volunteers received a $15 honorarium. The mean BMI of the sample was 22.81 (SD = 3.64), which is classified as in the healthy weight range. The study advertised for individuals motivated to manage their body weight by avoiding unhealthy foods, as Fishbach et al. (2003) suggest that motivation is necessary for individuals to enact counteractive control processes. Also, only women were recruited into the study, as they have higher levels of liking and craving for food than men (Coelho, Jansen, Roefs, & Nederkoorn, 2009; Fishbach et al., 2003; Harderwijk, 2010; Kroese et al., 2011; Van den Bos, 2011).

7.2.2 Materials

7.2.2.1 Cognitive accessibility of the weight management goal. Following previous research (Fishbach et al., 2003; Kroese et al., 2011; Papies et al., 2008), a computer-administered lexical decision task was used to test the cognitive accessibility of the weight management goal-related concept. Trials consisted of a fixation point (+) that remained on the screen for 2 seconds, followed by a target letter string. Participants were asked to indicate as quickly and accurately as possible whether the preceding letter string was a word (by pressing the ‘z’ key) or non-word (by pressing the ‘/’ key). The word types included goal-

related words, neutral words, and non-words. The keys designated to ‘word’ and ‘non-word’ responses were counterbalanced between participants. Following Fishbach et al. (2003), the task began with 10 practice trials consisting of an equal number of words and non-words, followed by 3 buffer trials, and then the experimental task consisting of 192 trials. Only reaction times to the words in the experimental trials were analysed.

The experimental stimuli consisted of four goal-related words (i.e., diet, slim, thin, and weight) repeated four times each and selected from those used in previous studies of a similar nature (e.g., Fishbach et al., 2003; Kroese et al., 2011; Papies et al., 2008). Neutral words were matched with goal-related words on word type (i.e., noun, adjective), and number of letters, phonemes, and syllables using the MRC Psycholinguistic Database (Coltheart, 1981). Five words that were closest to each goal-related word in relation to indices of frequency, concreteness, familiarity, imageability, and meaningfulness (where available) were identified for use as neutral words. For each group made up of one goal-related and five neutral words, six non-words of equivalent letters and phonemes were selected from the ARC Nonword Database (Rastle, Harrington, & Coltheart, 2002). This resulted in a set of 24 words, and 24 non-words. To replicate Fishbach et al.’s (2003) methodology, each goal-related word trial was repeated four times, to make up the total of 192 trials.

Only correct responses with a reaction-time greater than 300ms and less than 3000ms were included in the final analysis, which resulted in the exclusion of 0.7% of responses (Bargh & Chartrand, 2000). Trimmed scores were also subject to a natural log transformation to reduce positive skew typical of reaction time data (Bargh & Chartrand, 2000). The cognitive accessibility of the goal-related concept for each participant was operationalised as their response time (RT) to goal-related words relative to neutral words (cognitive accessibility = *M* RT neutral – *M* RT goal-related), with higher values indicating greater accessibility of goal concepts relative to neutral.

7.2.2.2 Snack intake. Snack intake was measured using a taste test (e.g., Coelho et al., 2009). Four bowls were filled with pre-weighed popular energy-dense snack foods, so that they each appeared equally full. The foods included 80g of M&Ms (Mars, 2050 kilojoules [kJ]/100g), 30g of original salted chips (Smiths, 2190kJ/100g), 30g of Cheese Twisties (Smiths, 2080kJ/100g), and 80g of mini choc-chip cookies (White Wings, 1959kJ/100g). The placement order of the food bowls from left to right was counterbalanced across participants using a Latin square procedure with four orders. Accompanying each bowl was a 6-item paper-pencil format rating sheet asking participants to rate various sensory attributes of the foods (e.g., "How sweet is this product?"). Ratings were recorded on a 100mm visual analog scale, with anchors labelled as "*not at all*" and "*extremely*". Participants were given 10 minutes to taste as much of the food as they needed to rate the foods accurately while the experimenter was out of the room. The weight of each bowl was recorded after the taste test and compared to the pre-test weight to determine intake of each food in grams. Intake is reported in kilojoules (kJ), derived from multiplying intake in grams by the number of kJ per gram for each food.

7.2.2.3 Temptation to indulge in unhealthy snacks. Participants were asked: "How much were you tempted to eat the [Twisties/chips/cookies/M&Ms] presented in the taste-test?" Responses were collected on a 7-point Likert scale ranging from 1 (*not at all*), to 7 (*extremely*) for each of the four foods. A 'temptation' score was obtained by averaging the responses to each of the four foods.

7.2.2.4 Trait self-control. The 36-item Self-control Scale (SCS) assesses the domain-general ability to interrupt or override a dominant behavioural tendency in order to serve a higher-order goal (e.g., "I refuse things that are bad for me", Tangney et al., 2004). Participants indicate the extent to which each statement represents them, on 5-point Likert scales ranging from 1 (*not at all like me*), to 5 (*very much like me*). Higher scores indicated

higher levels of trait self-control. Internal consistency coefficient alpha for the SCS was acceptable in the current study, Cronbach's *a* = .78; and similar to that reported in previous research, Cronbach's *a* = .89 (Tangney et al., 2004).

7.2.2.5 Motivation. In addition to recruiting only those motivated to manage weight through healthy eating, the extent to which participants were motivated to do this was measured using a 4-item self-report scale (e.g., "I choose certain food items to avoid gaining weight", Sproesser et al., 2011). The scale requires participants to indicate the frequency of each behavioural statement on 5-point Likert scales, ranging from 1 (*never*), to 5 (*always*). An average motivation score was calculated, with higher scores indicating higher motivation to regulate eating for weight management. The scale's internal-consistency coefficient alpha was acceptable in the current study, Cronbach's *a* = .89; and consistent with previous research, Cronbach's *a* = .89 (Sproesser, Strohbach, Schupp, & Renner, 2011).

7.2.2.6 Hunger. Participants were asked: "Please indicate the place on the scale which best reflects your current level of hunger". Responses were measured on a 7-point Likert scale ranging from 1 (*not hungry at all*), to 7 (*extremely hungry*).

7.2.3 Procedure

Participants completed the experiment individually in a quiet room in the Applied Cognitive Psychology Laboratory. Each session ran for approximately 30 minutes. Participants were informed that the experiment was investigating the relationship between eating styles and sensory perception. As a temptation prime, participants were informed that the tasks included tasting and rating different unhealthy snack foods. Thus, they were made aware that they would be faced with a food temptation. To control for hunger levels, participants were asked to eat something 2 hours before their scheduled session, and to refrain from eating again until the experiment. On arrival, participants reported their hunger and then completed the lexical decision task and taste test. They were then asked to complete

measures of temptation to indulge in unhealthy snacks, trait self-control, and motivation; and to disclose background information, including age, height and weight.

7.3 Results

7.3.1 Correlations Between Cognitive Accessibility, Snack Intake, Temptation Experience, Self-Control, Motivation, and Hunger

Correlation analyses explored the relationships between variables. Descriptive statistics are presented in Table 7.1. As predicted, higher temptation to indulge was significantly correlated with lower cognitive accessibility, r = -.22, p =.02, and significantly correlated with higher snack intake, r = .41, p <.001. However, contrary to predictions, cognitive accessibility and intake were not significantly correlated, r = -.14, p = .12, and neither were cognitive accessibility and self-control, r = .04, p =.66. Hunger was significantly positively correlated with intake, r = .21, p =.02, and with temptation, r = .33, p <.001[15]. Finally, motivation was not significantly correlated with either self-control, r = -.02, p =.84, or cognitive accessibility, r = -.02, p =.81, indicating that neither trait self-control nor cognitive accessibility simply reflected motivation to manage weight through healthy eating or importance of the goal of weight management. No other correlations were significant.

[15] Controlling for hunger did not change the statistical significance of any of the analyses in the Results section. Therefore, results of analyses without controlling for hunger are reported.

Table 7.1.

Descriptive statistics for lexical decision task data, snack intake, experience of temptation to indulge, self-control, motivation, and hunger

Variable	*M*	*SD*
Lexical decision task (RT in ms) [a]		
Goal words	519.75	123.41
Neutral words	560.49	174.59
Difference: neutral – goal	42.40	44.21
Snack intake (kj)	1048.76	839.98
Temptation experience	4.38	1.35
Self-control	2.97	0.39
Motivation	3.30	0.97
Hunger	3.66	1.60

[a] Descriptive statistics for lexical decision task data calculated after trimming extreme scores but prior to natural log transformation.

7.3.2 Moderation Analyses

The SPSS macro PROCESS (Hayes, 2012) was used to test whether self-control moderated the effect of cognitive accessibility on both snack intake and temptation to indulge in unhealthy snack foods. The predictors (cognitive accessibility and self-control) were first regressed on the outcome variable (snack intake or temptation to indulge), and then the interaction term (product of the predictors) was added to the model. If the interaction term resulted in a significant increase in variance explained, this indicated a significant moderation effect. To further explore significant moderation models, simple slopes were estimated at plus ("high") and minus ("low") one standard deviation from the sample mean for self-control.

These values showed the estimated strength of the effect of cognitive accessibility on snack intake and temptation to indulge at each level of self-control.

7.3.2.1 Moderating role of trait self-control in the cognitive accessibility – snack intake relationship. Cognitive accessibility was a significant predictor of snack intake, B = -1228.52, $t(120)$ = -2.49, p = .02, but self-control did not significantly predict intake, B = 4.72, $t(120)$ = 0.89, p = .38. In addition, the relationship between cognitive accessibility and snack intake differed according to levels of trait self-control. This is based on the observation that the interaction term (product of cognitive accessibility and self-control) emerged as a significant predictor of snack intake, B = -108.07, $t(120)$ = -2.49, p = .01, and resulted in a significant increase in snack intake variance explained with the predictors already in the model, R^2 *change* = .05, *F change* (1, 120) = 6.22, p = .01. As displayed in Figure 7.1, the relationship between cognitive accessibility and intake was significant and negative when self-control was high, B = -2731.60, $t(120)$ = -2.99, p = .003. However, there was no significant relationship between cognitive accessibility and intake for participants with low self-control, B = 274.57, $t(120)$ = .40, p = .69.

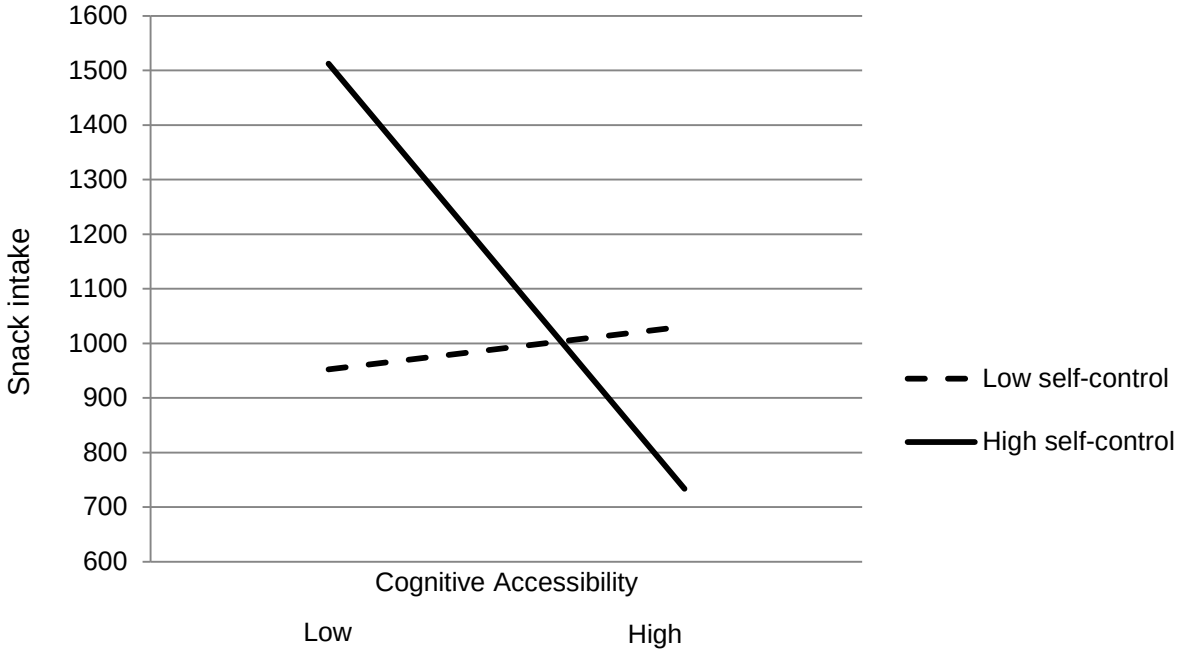

Figure 7.1. Moderation of the effect of cognitive goal accessibility on snack intake (centred) by trait self-control.

7.3.2.2 Moderating role of trait self-control in the cognitive accessibility – temptation to indulge relationship. Likewise, temptation to indulge was significantly predicted by cognitive accessibility, B = -2.58, $t(116)$ = -2.97, p = .003, but not by self-control, B = .002, $t(116)$ = 0.14, p = .89. Self-control also moderated the relationship between cognitive accessibility and temptation to indulge. Temptation to indulge was significantly predicted by the interaction term alone, B = -.15, $t(116)$ = -2.10, p = .04, and adding the interaction term to the model already containing the predictors resulted in a significant increase in variance explained, R^2 *change* = .03, *F change* (1, 116) = 4.42, p = .04. As can be seen in Figure 7.2, cognitive accessibility and temptation to indulge were significantly negatively correlated among participants with high self-control, B = -4.63, $t(116)$ = -3.12, p = .002, but not among those with low self-control, B = -14.09, $t(116)$ = .47, p = .64.

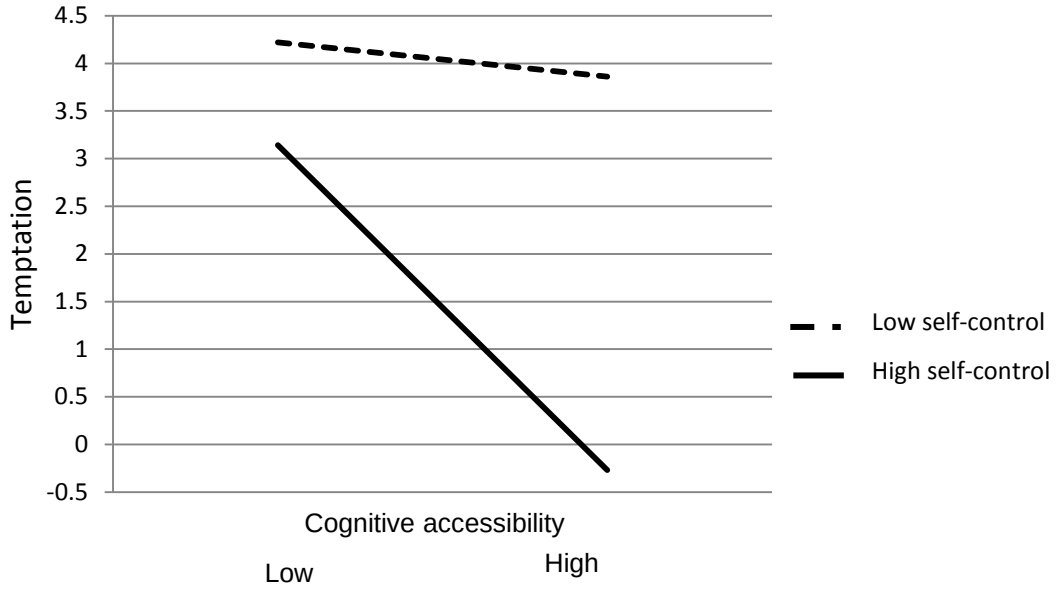

Figure 7.2. Moderation of the effect of cognitive goal accessibility on temptation (centred) by trait self-control.

7.3.2.3 Moderating role of trait self-control in the temptation to indulge – snack intake relationship. Intake was significantly predicted by temptation, $B = 248.17$, $t(116) = 4.60$, $p < .001$, but not by self-control, $B = 4.84$, $t(116) = 0.96$, $p = .34$. Self-control did not moderate the relationship between the experience of temptation to indulge and snack intake, as the interaction term (product of temptation and self-control) did not significantly predict intake, $B = 3.17$, $t(116) = .84$, $p = .40$, and the interaction term did not significantly increase the amount of variance explained, R^2 *change* = .01, *F change* (1, 116) = .70, $p = .40$.

7.3.3 Effect of Cognitive Accessibility on Snack Intake via Temptation at Different Self-control Levels

7.3.3.1 Moderation of the mediation model pathways by trait self-control. PROCESS was also used to investigate whether cognitive accessibility had an indirect effect on snack intake via experienced temptation to indulge for people with different levels of trait self-control. 5,000 bootstrap samples were used to estimate the pathways shown in Figure

7.3. The same procedure used for the simple moderation analyses was used to determine moderation of the mediation model pathways. In the analysis of pathway *a*, the interaction term emerged as a significant predictor of temptation, $B = -.15$, $t(116) = -2.10$, $p = .04$. This indicates that cognitive accessibility has a different effect on temptation to indulge for people with different levels of self-control, mirroring results of the previous analysis. To estimate pathways *b* and *c*, a separate regression equation was estimated with snack intake as the dependent variable. As mentioned previously, simple moderation analysis showed that the interaction between self-control and temptation to indulge did not significantly predict intake, therefore self-control was not included as a moderator of pathway *b*. Temptation to indulge alone had a significant effect on intake (pathway *b*), $B = 229.68$, $t(115) = 4.20$, $p < .001$. With all variables in the model (i.e., self-control, cognitive accessibility, and the interaction term of these two variables), the self-control – cognitive accessibility interaction term no longer significantly predicted snack intake, $B = -75.00$, $t(115) = -1.81$, $p = .07$. This indicated that the strength of the direct relationship between cognitive accessibility and snack intake at pathway *c* did not significantly vary at different levels of trait self-control. Therefore, by including a mediating variable (experience of temptation to indulge in unhealthy snacks), the direct relationship between cognitive accessibility and intake was no longer significant, even for those with high self-control. This suggests that the experience of temptation accounts for the effect of cognitive accessibility on snack intake for those with high self-control.

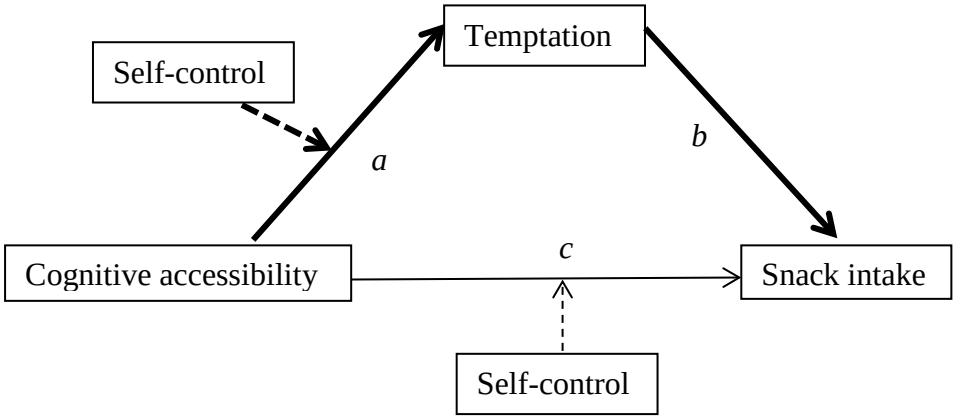

Figure 7.3. Moderated mediation model: Indirect effect of cognitive accessibility on intake via temptation, moderated by trait self-control. *Note:* Bold arrows denote significant relationships. Bold dashed arrows denote moderation of adjoining relationships by self-control.

7.3.3.2 Estimation of overall direct and indirect effects at high and low self-control levels. PROCESS produced estimates of the overall direct and indirect effects of cognitive accessibility on snack intake at high and low levels of self-control, and bias-corrected 95% confidence intervals as statistical tests of those coefficients. These pathways are illustrated in Figure 7.3, and coefficient estimates and confidence intervals are reported in Table 7.2. As reported in the table, only among participants high in self-control did cognitive accessibility have a significant indirect effect on snack intake via the experience of temptation to indulge. For those with low self-control, this indirect effect was not significantly different from zero. However, tests of the direct effect of cognitive accessibility on snack intake revealed that when temptation to indulge was included in the model, cognitive accessibility did not directly affect intake for participants either high or low in self-control. The relationship between temptation to indulge and intake was significant across all participants. This supports that for those with high self-control, the experience of temptation to indulge in unhealthy snacks accounts for the effect of cognitive accessibility on snack intake.

Table 7.2

Overall direct and indirect effects of cognitive accessibility on snack intake at different levels of self-control

	Indirect effect (*ab*)		Direct effect (*c*)	
Self-control	Coefficient estimate	95% CI	Coefficient estimate	95% CI
Low	-103.12	-567.32 to 240.77	372.21	-919.95 to 1664.38
High	-1173.15[a]	-2305.87 to -406.41	-1654.67	-3494.97 to 185.63

[a] point estimate significantly different from zero, as 95% CI does not contain zero.

7.4 Discussion

Temptation-elicited goal activation is a counteractive control process that has previously been found to predict successful self-regulation in the domain of healthy eating and weight-management. The current study contributes to our understanding of the relationship between cognitive accessibility of the weight-management goal and unhealthy snack intake by using a controlled, lab-based measure of intake, and exploring the moderating role of trait self-control. We also explored whether higher cognitive accessibility was related to the extent to which participants reported feeling tempted to indulge in unhealthy foods offered to them, and whether this self-reported temptation would mediate the relationship between cognitive goal accessibility and intake.

Cognitive accessibility was not significantly correlated with the amount of snack food eaten in the taste test across all participants. However, results of moderation analyses revealed that higher cognitive accessibility of the weight-management goal was associated with lower food intake for those high in trait self-control. The relationship was not significant for individuals with low self-control. This finding cannot be explained by differences in motivation to eat healthily or manage weight, as self-control and motivation were not

significantly correlated. Therefore, contrary to previous studies that have found an association between higher cognitive accessibility and perceived self-regulatory success in the weight-management domain (e.g., Fishbach et al., 2003; Papies et al., 2008), or with self-reported chocolate intake (e.g., Kroese et al., 2011; Van Koningsbruggen et al., 2011), the current findings suggest that this may only be true for those who are adept at translating intentions into actions. This is consistent with Ferguson (2008), who found that when cognitive goal accessibility was high, only those with high self-control evaluated goal-facilitative stimuli as more positive.

Perhaps a surprising finding regarding the relationship between self-control and intake was that when cognitive goal accessibility was low, individuals with high trait self-control ate more than those with low trait self-control. Self-control is namely the ability to translate intentions into actions, and scores on the Self-Control Scale have been associated with lower BMI and higher dietary healthiness (Sproesser et al., 2011; Tangney et al., 2004). The current finding is inconsistent with evidence suggesting that decreased cognitive goal accessibility contributes to overeating among unsuccessful restrained eaters (Stroebe, Van Koningsbruggen, Papies, & Aarts, 2013). It also runs counter to goal priming literature more generally, which has shown that priming individuals with goal concepts (i.e., enhancing their accessibility) makes subsequent behaviour more consistent with that goal (Bargh et al., 2001). However, our finding is consistent with Ferguson's (2008) observation that when cognitive accessibility of the weight management goal was high, those with high skill at that goal evaluated goal-facilitative stimuli more positively than those with low skill, but at low goal accessibility, they evaluated goal-facilitative stimuli more negatively. Although evaluations of goal-relevant stimuli are not the same as actual behaviour, they do represent 'evaluative readiness', which Ferguson argues promotes goal-consistent behaviour by influencing approach or avoid motivations toward goal relevant objects (e.g., approach

'vegetables'). These results and our own suggest that the evaluative and behavioural responses to goal-relevant stimuli among individuals with high self-control, or skill at a goal, could be characterised by an increased sensitivity or responsiveness to the activation of personal goals, rather than higher activation or accessibility of goals. When the goal is not activated, those with high self-control may not be able to as effectively regulate their behaviour as when the goal is highly accessible. In contrast, intake for those with low self-control was not related to goal accessibility, suggesting they may be generally less responsive to activation of those goals.

Although the finding that cognitive goal accessibility was related to intake only among those with high self-control is consistent with Ferguson (2008), it is contrary to other findings suggesting that cognitive goal accessibility predicts successful self-regulation for all individuals (Fishbach et al., 2003; Kroese et al., 2011; Papies et al., 2008; Van Koningsbruggen et al., 2011). These divergent results may be due to methodological differences in the priming of temptation. Specifically, previous studies of temptation-elicited goal activation in eating behaviour have presented food pictures or words as temptation primes immediately before the goal words within the same tasks designed to assess cognitive goal activation (Fishbach et al., 2003; Kroese et al., 2011; Papies et al., 2008; Van Koningsbruggen et al., 2011). In contrast, prior to completing the lexical decision task, participants in the current study were told that they would be presented with unhealthy snack foods to taste as part of the experiment. This was intended to provide a more ecologically valid temptation prime in comparison to the word or picture cues presented previously, as participants would have anticipated a real temptation that threatened their goal of healthy eating for weight management. However, while most previous studies presented temptation primes (food pictures or words) subliminally, participants here were made explicitly aware of the temptation prime, which would have permitted conscious activation of the dieting goal.

Thus, our measure of cognitive accessibility could reflect participants' importance of the dieting goal rather than temptation-elicited goal activation. The lack of a control condition cannot rule out this possibility. Specifically, while previous studies compared cognitive accessibility in response to food primes with that to neutral control primes, the current study exposed all participants to one and the same temptation food prime. However, this interpretation is unlikely as cognitive goal accessibility was not related to motivation to regulate eating for weight management. Nevertheless, future research could usefully compare the current temptation prime to a control condition with no temptation priming.

Alternatively, the discrepancy between the current and previous findings regarding the relationship between cognitive goal accessibility and unhealthy snack intake could be attributed to differences in the measurement of eating self-regulation. Unlike other previous studies, the current taste test methodology enabled us to exert control over participants' exposure to unhealthy food during measurement of intake. Specifically, previous studies have used self-report diaries which allow participants to make deliberate decisions regarding their exposure to unhealthy foods (Kroese et al., 2011; Van Koningsbruggen et al., 2011). In comparison, the current methodology assessed participants' immediate behavioural responses when faced with the unhealthy food temptation. Future research should further explore the influence of having control over one's exposure to unhealthy food stimuli on the relationship between cognitive goal accessibility and food intake.

Consistent with predictions, higher cognitive accessibility was related to a lower experience of temptation to indulge in the snack food offered. This is in line with Ferguson's (2008) finding that cognitive goal accessibility influenced evaluations of goal-relevant stimuli, as temptation to indulge in snack food could reflect participants' positive evaluation of that food. It also supports the idea that evaluation of goal-relevant stimuli in the environment may be part of the mechanism behind the effect of cognitive goal activation on

goal-consistent behaviour (Ferguson & Bargh, 2008). Furthermore, and in line with Ferguson's (2008) observation that the relationship between cognitive goal accessibility and evaluation of goal-relevant stimuli was moderated by self-control, the current study similarly found that the relationship between cognitive goal accessibility and temptation was stronger for those with high self-control.

The current study also predicted that the reported temptation to indulge in snack foods offered would mediate the relationship between cognitive accessibility and snack intake. However, the relationships between cognitive goal accessibility and both snack intake and experienced temptation were moderated by self-control. Therefore, self-control was included as a moderator of these pathways in the mediation analysis. We found that, when self-reported temptation to indulge was controlled for, cognitive accessibility was no longer associated with snack intake among individuals high in self-control. This suggests that among participants with high self-control, those with higher cognitive accessibility of the weight-management goal felt less tempted to eat the snack food presented, and in turn, ate less.

These results are consistent with Ferguson's (2008) finding that success at weight management predicted counteractive evaluation of goal-relevant objects when the goal of dieting was made cognitively accessible. Specifically, she found that when the goal of dieting or weight management was made more salient, people more skilled at achieving that goal tended to evaluate goal-facilitative objects more positively than those less skilled. Although Ferguson (2008) only assessed the evaluation of goal-facilitative objects (e.g., gym, vegetables), evaluations of goal-threatening objects (i.e., unhealthy snacks) may follow a similar pattern. The measure of temptation to indulge in unhealthy snacks in the current study could reflect individuals' evaluations of those unhealthy snacks. Among individuals high in self-control, higher cognitive goal accessibility could lead to a devaluing of the food stimuli, which may manifest in a less intense temptation to indulge in it, facilitating goal-consistent

behaviour (i.e., limiting intake of that food). This process may explain why higher cognitive accessibility was only associated with lower intake among participants with high self-control.

The current findings are broadly consistent with counteractive control theory (Fishbach et al., 2003; Trope & Fishbach, 2006). Cognitive goal accessibility in response to temptation affects subsequent goal-consistent behaviour; however, this was only supported among individuals high in self-control. This latter result is nevertheless consistent with research that has shown that individuals with greater skill at achieving a goal show a stronger relationship between goal accessibility and goal-facilitative evaluations of environmental stimuli (Ferguson, 2008). Moreover, the finding that the experience of temptation to indulge mediated the relationship between cognitive goal accessibility and intake among individuals with high self-control fits with previous research suggesting that the evaluation of goal-relevant stimuli may mediate the effect of increased cognitive goal accessibility on goal-consistent behaviour (Ferguson, 2008).

The findings of the current study have implications for the design of cognitive interventions for facilitating self-regulatory behaviour. Intervention studies attempting to 'train' individuals to cognitively activate the goal of weight management in response to temptation cues as a way of facilitating self-regulation have achieved variable success (e.g., Harderwijk, 2010; Kroese et al., 2011; Van den Bos, 2011; Van Koningsbruggen et al., 2011; Webb & Sheeran, 2008). Several studies have used implementation intentions, which involve participants practicing "*If…, then…*" style plans to facilitate goal-consistent behaviour in response to temptation cues (Webb & Sheeran, 2008). For example, participants may practice the implementation intention of: "*If* I am offered chocolate cake at morning tea, *then* I will think about my weight management goal". By repeatedly reading or rehearsing this phrase, the individual may create a link between a temptation cue and the concept of the overarching goal which it threatens, therefore enhancing cognitive goal accessibility when faced with a

food temptation (Webb & Sheeran, 2008). This link, according to counteractive control theory, is expected to facilitate resisting the temptation (Trope & Fishbach, 2006). Some studies have found these implementation intentions effective in reducing consumption of energy-dense foods (Kroese et al., 2011; Van Koningsbruggen et al., 2011). However, other studies have not corroborated these findings. For example, implementation intentions were found not to affect the healthiness of lab-based snack choice, or self-reported snack consumption (Harderwijk, 2010; Van den Bos, 2011). The variable success achieved with implementation intentions may be due to the samples including a combination of individuals with low and high trait self-control.

The current study's findings suggest that interventions aimed at increasing cognitive goal accessibility may not affect food intake across all individuals. An alternative strategy could be to increase the cognitive control abilities which would enable individuals to override the temptation to indulge in unhealthy foods. In support, recent studies have found that training individuals to inhibit responses to tempting cues such as food or alcoholic beverages reduced their subsequent consumption (Houben, 2011; Houben, Havermans, Nederkoorn, & Jansen, 2012; Houben, Nederkoorn, Wiers, & Jansen, 2011; Houben, Wiers, & Jansen, 2011). However, one of these studies found that the reduction in alcohol consumption after response inhibition training was not due to an increase in inhibitory control, but rather to an increased negative implicit evaluation of alcohol-related stimuli (Houben et al., 2012). This suggests that modifying the way individuals evaluate tempting stimuli could be a more direct and potent strategy for facilitating behaviour consistent with long-term goals. The results of the current study similarly suggest that the evaluative processes underlying the experience of temptation to indulge in snack food may be an effective target for intervention, as temptation was related to intake for *all* individuals (not just those with high self-control). Such an intervention may be particularly beneficial for unsuccessful restrained eaters, as their eating

behaviour is mainly driven by enjoyment associated with eating unhealthy food (Stroebe et al., 2013). This idea is echoed by Hofmann and Van Dillen (2012), who advocate the use of strategies designed to change the way individuals evaluate potentially tempting stimuli (e.g., unhealthy snack food) to prevent strong desires or temptations from arising. Such strategies may indeed be preferable to ones which seek to strengthen the ability to restrain or overcome strong desires once they have arisen.

A number of limitations of the current study should be taken into consideration. First, the study was purely correlational. Therefore we cannot conclude a causal link between cognitive accessibility of the weight management goal following unhealthy food temptation and subsequent snack consumption. The direction of this relationship will need to be examined in a well-controlled experimental design. Second, the self-report measure of experienced temptation to indulge in the snacks offered in the taste test was taken retrospectively, after consumption. This was done deliberately to prevent participants' perceived temptation from inadvertently affecting their food intake. However, participants could have adjusted their reports of experienced temptation to be in line with their snack intake. Moreover, participants were instructed to taste each food, which in itself could have affected their experience of temptation. Future research could seek to address these challenges by testing the effect of cognitive accessibility on temptation to indulge, and on snack intake, in separate testing sessions.

Despite these limitations, this study has contributed to our understanding of the processes of counteractive control. In particular, the results add to a growing body of evidence on the relationship between cognitive goal activation in response to temptation cues and subsequent goal-consistent behaviour in the domain of healthy eating for weight management.

7.5 References

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CHAPTER 8: General Discussion

8.1 Introduction

Self-control necessitates a conflict between an impulse or desire toward immediately rewarding behaviour, and a valued long-term goal (Fujita, 2011; Muraven & Baumeister, 2000). Despite the importance of the concept of goal-conflicting desire to an understanding of self-control, much of the research on self-control lacks a comprehensive consideration of the role of desire (Hofmann, Friese, & Wiers, 2008; Hofmann & Van Dillen, 2012). The aim of this thesis was therefore to explore the interplay between self-control, and experienced desire and its automatic precursors, specifically in the context of unhealthy snack food consumption.

Chapter 1 introduced several theoretical perspectives informing an understanding of how self-control relates to desire and its automatic precursors, with a view to providing a background for the subsequent empirical chapters. Chapters 2 – 7 described the results of a series of empirical lab-based studies with their own specific aims drawn from the various theoretical perspectives. Together, these studies contribute to the understanding of how a conscious temptation to indulge in unhealthy food relates to implicit evaluations of food, and how self-control at both situational and dispositional levels relate to desire and its automatic precursors. Namely, the findings demonstrate the complexity of the interplay between self-control and desire. While some of the findings demonstrated that self-control can allow for the overcoming of impulses toward unhealthy food, other findings indicated that individuals with higher self-control also experience lower impulses toward unhealthy food, suggesting a more effortless route to regulation of unhealthy behaviour. The current Chapter 8 will first provide a summary of the main findings and theoretical contributions of the studies, followed by a discussion of their practical implications and associated methodological issues. Finally, the chapter will discuss the implications of the findings for the broader conceptualisation of

self-control. Recommendations for future research will be raised throughout the chapter as they relate to the points discussed.

8.2 Summary of Findings and Their Theoretical Contributions

8.2.1 Dual Process Models of Behaviour

The studies presented in Chapters 2-4 were informed by dual process models, more specifically, the reflective-impulsive model (Strack & Deutsch, 2004), which posits that behaviour is determined by an interaction between impulsive and reflective systems. While the impulsive system drives behaviour toward hedonically rewarding stimuli in a relatively automatically manner, the reflective system is responsible for regulating these impulses through conscious deliberation based on long-term goals and standards (Strack & Deutsch, 2004). The relative influence of these systems on behaviour is determined by self-control. Specifically, when self-control is high, an individual is able to inhibit impulsive influences, and act in accordance with the reflective system (Hofmann et al., 2008). However, when self-control is low, behaviour is driven to a greater extent by impulses than deliberative standards.

The study presented in Chapter 2 sought to test the associations between implicit food evaluations (an impulsive influence on behaviour), conscious temptation to indulge in unhealthy snack food, and actual snack consumption. While a conscious temptation to indulge has previously been argued to be the result of automatic positive affective reactions to relevant stimuli (Hofmann & Van Dillen, 2012), the study presented in Chapter 2 presents the first empirical test of this relationship. The findings demonstrated that a more negative implicit evaluation of unhealthy snack food predicted lower temptation to indulge in snack food offered for consumption. Furthermore, the experience of temptation to indulge mediated the relationship between implicit food evaluations and snack intake. These findings contribute to an understanding of impulsive determinants of behaviour such as implicit evaluations of stimuli. Particularly, the findings demonstrate that the effect of such

evaluations on behaviour can be partly explained by a conscious experience of temptation, rather than through a process that occurs largely outside of conscious awareness.

Following the findings presented in Chapter 2, two studies were conducted to test the effects of two computer-based interventions aimed at retraining implicit food evaluations as a means of reducing snack consumption. Specifically, the studies tested whether training individuals to associate unhealthy food stimuli with positive or negative stimuli affected subsequent snack consumption and whether those effects were dependent on participants' dispositional or situational self-control levels. Specifically, it was predicted that training individuals to associate unhealthy food with negative concepts would reduce snack consumption among individuals with lower self-control but not among individuals with higher self-control. The findings supported these predictions, revealing that the effect of retraining implicit food evaluations affected intake only for individuals with low trait inhibitory self-control (Chapter 3) and individuals with low situational inhibitory control (Chapter 4). These findings are in line with dual-process models of behaviour, namely, with the principle that impulsive processes (e.g., positive implicit evaluations of food) have a stronger influence on behaviour when self-control is low than when it is high (Hofmann et al., 2008).

8.2.2 Situational Self-control

The findings presented in Chapter 4 are also informative for an understanding of situational self-control specifically. In addition to assessing the influence of the retraining intervention on snack consumption, the study assessed its effect on participants' self-reported experience of temptation to indulge in the snack foods presented for consumption. Temptation was not equally affected by the intervention across the sample. Specifically, the food positive training resulted in higher temptation than the food negative training, but only among individuals with lower inhibitory control. While a change in implicit food evaluations

was not measured in this study, the evaluative conditioning intervention was modelled on previous studies that have demonstrated effective modification of implicit evaluations of target stimuli (e.g., Houben, Havermans, & Wiers, 2010; Houben, Schoenmakers, & Wiers, 2010). The finding that the intervention affected temptation for individuals with low but not high situational self-control may therefore suggest that situational self-control enables the down-regulation of automatic appraisals of appetitive stimuli such as unhealthy foods before they emerge as a conscious desire to obtain or consume those foods. This is a novel finding, and although not further pursued in this thesis, future explorations of the down-regulation of automatic reactions to appetitive stimuli could be beneficial in informing our understanding of situational variations in self-control.

Particularly, future research could investigate the trajectory of the automatic responses to unhealthy food between individuals with high versus low situational self-control. Although not previously explored with regards to situational self-control, one study by Gillebaart, Schneider, and De Ridder (2015) investigated conflicts between positive and negative reactions to unhealthy food at different levels of dispositional self-control. The authors argue that the report of desire for temptations is akin to a higher response conflict: a more positive reaction to unhealthy food (which promotes approach of the food) presents a greater conflict with a goal-consistent negative response (promoting avoidance of the food). Individuals with higher trait self-control reported less objective (i.e., lower discrepancy between ratings of positivity and negativity toward unhealthy food) and less experienced (i.e., lower reports of how conflicted, indecisive, and mixed their feelings were about unhealthy food) response conflict toward unhealthy food. The researchers then assessed implicit response conflict using a computer-based mouse tracking task. The task involved the categorisation of unhealthy food pictures as either positive or negative by moving a computer mouse to the corresponding response buttons in the upper corners of the computer screen.

Greater response conflict was indicated by a deviation from the pathway from the food picture to the positive or negative response option, whereby greater deviation from a straight trajectory from the unhealthy food stimulus to the negative response (successful resolution of the response conflict) indicated higher response conflict. The program also recorded the time of the maximum deviation from the trajectory from the unhealthy food stimulus to the negative response. Despite evidence of a relationship between higher self-control and lower explicit response conflict, implicit response conflict was not related to self-control. Instead, the maximum deviation from the non-conflicted response trajectory occurred earlier and was resolved more quickly for individuals with higher trait self-control than individuals with lower self-control. Taken together, these findings suggest that individuals with higher trait self-control are more efficient at down-regulating conflicted responses to unhealthy foods before they are consciously experienced. In the same way, the results of Chapter 4 could be interpreted to reflect that individuals with higher situational self-control are better able to down-regulate automatic positive reactions to unhealthy food stimuli before experiencing a conscious desire for those stimuli. This explanation could usefully be tested by future research using mouse-tracking programs such as the one implemented by Gillebaart et al. (2015) in the context of dispositional self-control.

In addition to providing insight into how situational self-control interacts with implicit food evaluations and experienced temptation, Chapter 4 also allowed for an examination of how situational self-control relates to temptation and subsequent snack consumption. The findings presented in Chapter 4 did not support the moderation of the relationship between temptation to indulge in unhealthy snack food and subsequent consumption by situational inhibitory control, nor did they suggest that those with higher inhibitory control experienced less intense temptation to indulge. The study presented in Chapter 5 sought to further explore the relationship between situational self-control and desire by experimentally manipulating

self-control, and testing two alternative theories about situational self-control and desire: the strength and process models (Section 8.2.2.1).

8.2.2.1 Strength and process models of ego depletion. Self-control can become situationally depleted as a result of prior exertion (Baumeister & Heatherton, 1996; Baumeister, Vohs, & Tice, 2007; Muraven, Tice, & Baumeister, 1998). As such, the study presented in Chapter 5 experimentally manipulated situational self-control by randomising participants to complete either a depleting task or a non-depleting task. This enabled further exploration of the relationship between situational self-control and desire to indulge in unhealthy stimuli by experimentally manipulating, instead of measuring, situational self-control. In particular, Chapter 5 tested competing predictions about the relationship between ego depletion and the desire to indulge in unhealthy snack foods derived from two competing theories: the strength and process models.

The strength model attributes the detrimental effect of prior self-control exertion on subsequent self-control to a depletion of the limited resource required to overcome desire for immediately rewarding stimuli in order to enact behaviour that is consistent with long-term goals (Baumeister et al., 2007; Muraven & Baumeister, 2000). As such, compared with individuals whose self-control is not depleted, the behaviour of individuals who are depleted of self-control should be (a) more strongly influenced by immediate desires, and (b) less consistent with the motivation toward long-term goals. In contrast, the process model makes alternative predictions about the relationships between ego depletion, desire, and motivation. The process model attributes ego depletion to a shift in priorities (Inzlicht & Schmeichel, 2012). Specifically, enacting self-control is predicted to result in an increased motivation to satisfy immediate desire, and an accompanying decreased motivation to control this desire and behave in a manner consistent with goals, which leads to lower goal-consistent behaviour (Inzlicht & Schmeichel, 2012).

The findings regarding self-reported desire to indulge in unhealthy snack foods presented in Chapter 5 did not support either model. Namely, individuals who were depleted did not report a stronger desire to indulge in unhealthy snack food, as predicted by the process model. When depleted, participants' snack consumption was more strongly related to their self-reported strength of desire to indulge in the snacks, than when not depleted. While this finding is in line with the strength model, it was not statistically significant. Therefore, the study's findings regarding desire did not offer strong support for either the strength or process model of ego depletion.

While this was not the main focus of the current thesis, the study presented in Chapter 5 also assessed participants' motivation to control snack consumption to test alternative predictions about the relationship between ego depletion and motivation arising from the strength and process models of self-control. Only one previous study had enabled a comparison of motivation between ego depleted and non-depleted individuals to test the process model's prediction that ego depletion results in lowered motivation to control behaviour. Specifically, Walsh (2014) found that ego depletion decreased participants' ratings of commitment, determination, and importance of the goal of healthy eating, which led to higher snack consumption than a non-depleted control condition. The study presented in Chapter 5 extended this research in an important way. Unlike Walsh, we specifically recruited individuals who were motivated to manage weight through healthy eating. We then assessed the effect of ego depletion on motivation to control behaviour during the taste test measure of intake. This is important because the process model predicts that ego depletion results in a temporary shift in priorities, which may be reflected in a change in motivation to control behaviour in a specific situation (i.e., when presented with an opportunity for consumption of unhealthy snacks, as during the taste test). The results presented in Chapter 5 partly support both the strength and the process models. Specifically, individuals with higher

situational self-control reported lower motivation to control their intake in the taste test, providing support for the process model. However, consistent with the strength model, there was a stronger correlation between motivation to control intake and actual snack consumption among individuals in the non-depletion condition compared with individuals in the depletion condition. While these findings did not clearly support either theoretical model, they did identify motivation as an important variable in differentiating individuals depleted of self-control as a result of prior self-control exertion from non-depleted individuals.

8.3.3 Trait Self-control

After exploring the nature of the relationship between situational self-control depletion and desire in Chapter 5, the focus shifted to dispositional self-control in Chapter 6. Specifically, the study in that chapter tested whether self-control enabled an individual to overcome the desire to indulge in unhealthy snack foods, or whether self-control predicted lower desire to indulge in unhealthy snacks. Findings suggested that individuals with higher dispositional self-control did indeed experience less intense desire when encountering stimuli that conflicted with a higher order goal, which mediated the relationship between higher self-control and lower snack consumption. Therefore, rather than individuals with higher trait self-control being better able to overcome desire to indulge in unhealthy snack food, they instead experienced lower desire to indulge which led to lower snack consumption.

These findings contribute to the current discussion in the literature about the nature of dispositional self-control. Namely, trait self-control is traditionally conceptualised as enabling an individual to overcome desire and act in accordance with long-term goals (De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Gillebaart & de Ridder, 2015; Tangney, Baumeister, & Boone, 2004). In contrast, a more contemporary conceptualisation is that individuals with higher trait self-control experience less intense desire to indulge in immediately rewarding behaviours that conflict with goals, which thus

leads to more goal consistent behaviour. The findings of the study reported in Chapter 6 supported the latter conceptualisation.

The findings presented in Chapter 6 are also consistent with those of an experience sampling study conducted by Hofmann, Baumeister, Förster, and Vohs (2012), where individuals with higher trait self-control reported experiencing less intense and less frequent desires that conflicted with their goals than those with lower trait self-control. However, Chapter 6 extended these findings in an important way. Hofmann, Baumeister, et al. (2012) used an experience sampling design which involved prompting participants to report on their desires as they arose throughout the day. This means that participants were able to regulate their exposure to potentially desire-evoking stimuli, and thus the relationship between self-control and desire could be attributable to the manner in which individuals shape their environment. For example, individuals with higher self-control could be better able to proactively avoid temptations in the environment that threaten goal attainment (e.g., avoid junk food aisle when shopping). Indeed, Ent, Baumeister, and Tice (2015) showed that trait self-control was positively related to frequent, systematic avoidance of exposure to temptations that were detrimental to goal pursuit across a variety of behavioural domains (e.g., work, study, moral behaviour). The study presented in Chapter 5 instead controlled for exposure to potential desire-evoking stimuli in a lab-based design. The design allowed experimental control over a number of variables thought to influence experienced desire for snack food (e.g., portion size, duration of exposure to unhealthy snack foods, food type etc.). The findings of this study therefore make an important contribution to the current discussion of the nature of trait self-control in the literature. First, the findings support the idea that individuals with higher trait self-control do experience less intense desire that conflicts with their goals, rather than being able to better overcome that desire. This is in line with contemporary understandings of trait self-control such as put forward by Gillebaart and de

Ridder (2015). Second, the findings also suggest that the lower desire experienced by individuals with higher trait self-control is at least in part due to altered responses to unhealthy stimuli, rather than solely due to habitual avoidance of stimuli that might provoke desire.

A remaining question is how individuals with higher trait self-control come to experience lower desire. One possibility is that they repeatedly enact goal-consistent responses to temptation cues, which leads to the automatisation of those responses. This may in turn reduce the strength of experienced desire when encountering those stimuli in future. Training the consistent inhibition of responses to stimuli has been shown to lead to a devaluation of those stimuli (Hofmann, Deutsch, Lancaster, & Banaji, 2010; Houben, Nederkoorn, Wiers, & Jansen, 2011; Veling, Aarts, & Stroebe, 2013), which, as shown in Chapter 2, can relate to lower experienced temptation to indulge. However, findings from a study by Gillebaart et al. (2015) discussed in Section 8.3.2, suggest that initial automatic reactions to unhealthy food among individuals with higher trait self-control do not differ from those with lower trait self-control. Instead, individuals with higher trait self-control are better able to down-regulate those automatic reactions before consciously experiencing a response conflict between the desire to indulge and the negative judgment of unhealthy food. Another possible explanation for the relationship between trait self-control and lower desire was explored in the study presented in Chapter 7, the findings of which will be discussed in the following Section 8.3.4.

8.3.4 Counteractive Control Theory and Temptation-elicited Goal Activation

Following the findings of Chapter 6 which suggested a relationship between trait self-control and lower desire for stimuli that conflict with a long-term goal, the final empirical study presented in Chapter 7 sought to test a potential mechanism underlying this relationship. Counteractive control theory predicts that individuals with higher self-control

are more likely than individuals with lower self-control to cognitively activate the concept of their goal when faced with a temptation that threatens that goal. This goal activation promotes goal-consistent behaviour, which is partly attributable to a change in the evaluation of goal-relevant stimuli (e.g., a more negative evaluation of goal-threatening stimuli, and a more positive evaluation of goal-facilitative stimuli). Particularly, the principle of counteractive evaluation suggests that when a goal is highly cognitively accessible, individuals with higher trait self-control subsequently evaluate goal-relevant stimuli in a manner that facilitates goal-consistent behaviour. Given the relationship between a more positive implicit evaluation of unhealthy food and higher reported temptation to indulge in that food, as reported in Chapter 2, higher cognitive accessibility in response to temptation cues could account for the relationship between higher trait self-control and lower experienced desire, as observed in Chapter 6. However, the study presented in Chapter 7 did not replicate this relationship between higher trait self-control and lower experienced temptation to indulge in snack food, and therefore, could not test this potential mechanism. Nevertheless, the findings do have implications for theories of counteractive control and counteractive evaluation themselves.

First, counteractive control theory suggests that heightened accessibility of a goal in response to a temptation cue predicts goal-consistent behaviour (Fishbach, Friedman, & Kruglanski, 2003; Kruglanski et al., 2002). Previous studies have tested this proposition by presenting temptation-related cues (e.g., pictures of food) during a cognitive task measuring cognitive goal accessibility. The study presented in Chapter 7 extended these findings by exploring whether cognitive goal accessibility following a more ecologically-valid temptation prime (i.e., informing participants that they would be presented with unhealthy snack food to taste during the taste test) would result in lower snack consumption. The prime would have presented a real temptation (threat to goal-consistent behaviour) with implications for actual

behaviour, in contrast to the food words and picture primes presented in previous studies. However, in contrast to previous studies that have supported a relationship between cognitive goal accessibility and subsequent behaviour, the current results revealed that higher cognitive goal accessibility was related to lower snack consumption only for individuals with higher trait self-control.

Second, counteractive control theory suggests that individuals with higher trait self-control experience higher cognitive goal accessibility in response to temptation cues than individuals with lower self-control (Fishbach et al., 2003). The results of Chapter 7 did not support this. That is, cognitive goal accessibility was not related to trait self-control. Instead, it appeared that higher self-control enabled individuals to better translate higher cognitive goal accessibility into goal-consistent behaviour – indicated by a relationship between cognitive goal accessibility and lower snack intake among participants with higher trait self-control, but not those with lower trait self-control.

Third, the results of Chapter 7 extend the theory of counteractive evaluation (Ferguson, 2008). Counteractive evaluation is the process proposed to account for the link between heightened cognitive goal accessibility and goal-consistent behaviour (Ferguson, 2008; Ferguson & Wojnowicz, 2011). Specifically, heightened cognitive goal accessibility has been shown to relate to evaluation of stimuli in the environment that facilitates goal-consistent behaviour (i.e., a more positive evaluation of goal-facilitative stimuli, and a more negative evaluation of goal-threatening stimuli; Connell & Mayor, 2013; Fishbach, Zhang, & Trope, 2010). This relationship has been shown to be stronger among individuals with higher self-control (Ferguson, 2008). The results of Chapter 7 show that the effects of cognitive goal accessibility extend to experienced temptation to engage in behaviour that conflicts with the goal. Specifically, individuals with higher trait self-control reported experiencing less intense temptation to indulge in the unhealthy snack food presented when their cognitive accessibility

of the goal of weight management was high, compared to when it was low. However, the experienced temptation to indulge reported by individuals with lower trait self-control was not related to the extent to which the goal of weight management was cognitively accessible. Furthermore, for individuals with higher trait self-control, the effect of cognitive goal accessibility on snack intake was accounted for by the temptation they experienced.

8.3 Practical Implications

Given the prevalence of healthy eating intentions and the hedonically rewarding nature of unhealthy snack foods (Birch, 1999; Cohen & Farley, 2008; Timperio, Cameron-Smith, Burns, & Crawford, 2000), the findings of the current thesis have several practical implications. In particular, they have the potential to inform practical approaches to reduce unhealthy snacking, and to promote the regulation of immediately rewarding behaviour that conflicts with long-term goals more broadly. A common theme arising from the research presented in this thesis is that desire and automatic affective reactions to unhealthy food are important predictors of unhealthy snack intake. Particularly, while some findings suggested that implicit food evaluations may predict subsequent intake only for those with lower trait or state inhibitory self-control (Chapters 3 and 4), others suggested that a conscious desire or temptation to indulge drives unhealthy snack intake despite self-control ability, and that instead, self-control might be related to a lower desire (Chapters 2, 4, 5, 6, 7). In a practical sense, these results highlight the importance of addressing desire in interventions that aim to promote goal-consistent behaviour. The following sections discuss potential avenues for addressing self-control behaviours derived from the findings presented in this thesis.

8.3.1 Retraining Implicit Food Evaluations

One potential avenue for reducing desire to indulge in unhealthy snacks would be to modify individuals' automatic affective reactions to food-related stimuli. Implicit evaluation retraining has previously been shown to affect behaviour toward target stimuli in the health

domain such as alcohol consumption (Houben, Havermans, et al., 2010; Houben, Schoenmakers, et al., 2010) and healthy snack choices (Hollands, Prestwich, & Marteau, 2011; Walsh & Kiviniemi, 2013); however, a number of studies have not demonstrated such interventions to affect behaviour (Ebert, Steffens, von Stulpnagel, & Jelenec, 2009; Lebens et al., 2011). The variable success of implicit evaluation retraining interventions shown in previous studies in modifying subsequent behaviour toward target stimuli could be explained by differences in self-control. As such, the studies presented in Chapters 3 and 4 sought to assess whether an intervention designed to retrain implicit food evaluations would be more effective at modifying behaviour for individuals with lower self-control at a dispositional (Chapter 3) and situational (Chapter 4) level. The results of Chapter 3 in particular showed that retraining implicit food evaluations to become more negative successfully reduced intake for individuals with higher trait self-control, but not for those with lower trait self-control. Therefore, the results suggest that interventions aimed at modifying implicit food evaluations might be best targeted toward individuals with low trait self-control.

In addition to targeting the dissemination of these retraining interventions toward individuals with lower trait self-control, training individuals to use this intervention when they experience temporary dips in self-control may also be a useful approach. The results of Chapter 4 demonstrate that individuals with lower situational inhibitory control who were trained to associate unhealthy food with negative stimuli reported lower temptation to indulge, and ate less snack food, than those trained to associate food with positive stimuli. The findings of this study support the utility of a brief intervention aimed at retraining affective associations with unhealthy stimuli in promoting goal-consistent behaviour temporarily in situations where individuals lack self-control resources.

Potential applications of the intervention techniques tested in Chapters 3 and 4 include the development of a version of the task for dissemination in an online program or

smartphone app. This could be coupled with guidelines to help users identify common situations where they tend to fail to regulate indulgence in immediately rewarding yet goal-conflicting behaviours, or where they have recently enacted self-control and thus have depleted their self-control resources. Upon detecting these situations, the brief and portable intervention could be used to temporarily modify automatic affective associations with problematic stimuli in order to facilitate goal-consistent behaviour. However, additional research is needed to explore whether repeated use of these retraining tasks might lessen their effectiveness.

8.3.2 Enhancing Cognitive Goal Accessibility in Response to Temptations

A second potential approach to reduce desire for, and consumption of, unhealthy snacks is to strengthen the cognitive association between temptation cues (e.g., unhealthy snack food) and the concept of a long-term goal that is threatened by those temptations (e.g., weight management). Previous studies which have aimed to enhance cognitive goal accessibility in response to temptation draw upon counteractive control theory and associated research findings which suggest that cognitive goal accessibility is associated with increased goal-consistent behaviour. The outcomes of interventions based on these principles have, like those aimed at retraining implicit evaluations discussed in the previous Section 8.3.1, achieved variable success. For example, some studies have used implementation intentions to strengthen the association between temptations and the long-term goal which is threatened by those temptations (e.g., “when I see chocolate cake, I will think of my diet”) and have found this to successfully reduce snack consumption and unhealthy snack choice (Kroese, Adriaanse, Evers, & De Ridder, 2011; Van Koningsbruggen, Stroebe, Papies, & Aarts, 2011); however, others have found no significant effect of such implementation intentions on snack consumption or choice (Harderwijk, 2010; Van den Bos, 2011).

The findings presented in Chapter 7 may explain the variable success achieved with these interventions. The findings showed that cognitive accessibility of a goal predicts lower temptation to indulge in, and consumption of, unhealthy food only for individuals with higher trait self-control, but not for individuals with lower trait self-control. Individuals with higher trait self-control are by definition, better able to regulate behaviour to achieve long-term goals. As such, one might argue that developing interventions to facilitate behaviour regulation for individuals with lower trait self-control should be prioritised. Nevertheless, it is not the case that individuals with higher trait self-control enact goal-consistent behaviour in all situations, all the time. Therefore, the development of strategies to enhance cognitive goal accessibility in response to opportunities for indulgence in immediately rewarding but goal-inconsistent behaviour may be a useful way to promote consistently healthier behaviours among individuals with higher trait self-control. In contrast, for individuals with lower trait self-control, strategies such as targeting implicit evaluations of snack food (as discussed in the previous Section 8.3.1) are likely to be more effective at facilitating goal-consistent behaviour.

Strategies aimed at increasing goal accessibility in response to temptations for individuals with high trait self-control could take two approaches. First, it may be possible to implement subtle goal priming in settings where individuals have the opportunity to make healthy or unhealthy choices. For example, Papies and Hamstra (2010) compared the number of free unhealthy food samples consumed by participants who entered a butcher's store where a poster advertising a healthy recipe was present relative to a control condition where the poster was not present Among participants who reported being motivated to manage their weight through healthy eating, the presence of the subtle goal prime was associated with lower consumption of the unhealthy snack samples. This approach to enhancing goal accessibility as a means of facilitating goal-consistent behaviour has the advantage of

affecting behaviour in environments where opportunities for indulgence are present and therefore, where adhering to a goal is particularly pertinent (e.g., canteens, bakeries, etc.). However, goal priming may be unlikely to train an association between goals and temptations to affect behaviour outside of the setting in which it is implemented.

A second approach to increasing cognitive goal accessibility in response to temptations could be to target individual cognitive associations. Training individuals to associate cues that offer temptation with a long-term goal concept could facilitate goal-consistent behaviour when encountering similar cues in the environment. In the same way as the findings of Chapter 3 suggest that interventions that retrain implicit food evaluations would be particularly beneficial for individuals with lower trait self-control, the findings of Chapter 4 suggest that interventions that aim to train a temptation-goal association would be most effective at reducing snacking behaviour for individuals with higher trait self-control. Importantly, given the variable success of interventions that train a temptation-goal association in modifying behaviour as demonstrated in past research, future research should test whether these interventions are indeed more suitably targeted toward individuals with higher dispositional self-control, as is suggested by the correlational evidence presented in Chapter 7. Approaches that train a temptation-goal association could include implementation intentions, such as used in previous research (e.g., Harderwijk, 2010; Kroese et al., 2011; Van den Bos, 2011; Van Koningsbruggen et al., 2011). Alternatively, an intervention aimed at strengthening an association between temptation and goals could take the form of the implicit evaluation retraining interventions presented in Chapters 3 and 4. Namely, individuals could be trained to respond to food stimuli on a computer screen by pressing a key designated to a goal category in an attempt to strengthen this association. The advantage of methods that target cognitive associations is that they are ‘portable’, and offer the potential to influence

goal-directed behaviour in a range of situations in which the individual might face temptations.

8.4 Methodological Issues

The current thesis utilised a mix of experimental and correlational designs in a series of studies conducted in a laboratory. The current section will discuss several methodological contributions and limitations of the work presented in this thesis.

8.4.1 Motivation Toward Long-term Goals

While the key focus of this thesis was to address a relative scarcity of self-control research considering the role of desire, the construct of motivation is also an important function in self-control. Many previous studies in the eating domain assume to measure self-control of eating by assessing intake or weight management outcomes alone, without considering whether participants were motivated to regulate intake (e.g., Friese, Hofmann, & Wanke, 2008; Hofmann, Friese, & Roefs, 2009; Junger & van Kampen, 2010). A consideration of motivation is important as it is central to the concept of self-control – an individual for whom eating unhealthy food does not present a conflict with a valued long-term goal is unlikely to attempt to regulate their intake or to suppress impulses toward such food, and therefore, snack consumption does not represent the outcome of self-control processes. In contrast, the recruitment materials for the studies presented in this thesis specifically sought participants who were motivated to manage weight through healthy eating. This is a methodological strength, as restricting samples to individuals with this motivation reduced the variation in motivation that is likely to influence the extent to which individuals attempt to control intake or suppress their impulses toward unhealthy food. In a practical sense, recruiting individuals who were motivated toward regulating snack consumption ensured that the intervention strategies and recommendations were drawn from research on individuals for whom these strategies are most relevant (i.e., individuals who

would be interested in adopting those strategies to facilitate achievement of weight management or healthy eating goals). The use of this recruitment specification in the current work will hopefully promote a consideration of participants' motivation toward a goal of healthy eating in future research.

Although the studies presented in this thesis did go further than some other studies in recruiting individuals based on their goals for healthy eating, variations in the strength of motivation to regulate eating were not consistently accounted for across the studies. In the same way as possessing a general goal of healthy eating for weight management might influence the regulation of eating behaviour and the suppression of desire or impulses toward indulgence, the strength of the motivation toward that goal may be an important consideration. The work presented here makes a contribution in that it specifically addresses desire: a crucial but often overlooked, variable in examining self-control. However, the field may benefit from studies that simultaneously consider both strength of desire and also the strength of motivation toward the goal with which those desires conflict (e.g., as in Hofmann, Baumeister, et al., 2012; Hofmann, Vohs, & Baumeister, 2012), in order to continue to advance an understanding of self-control.

8.4.2 Measurement of Self-reported Desire and Temptation to Indulge

Another methodological issue that applies across the studies presented in this thesis is the timing of the measurement of conscious reports of desire and temptation experience. The strength of participants' experienced desire and temptation to indulge in the unhealthy snack foods presented during the taste-test was assessed using self-report items administered after the taste-test measure of intake (Chapters 2, 4-7). Although the questions required participants to report retrospectively on their experience of desire specific to the time point when they were presented with the food for the taste test (i.e., before actually eating any of the food), recollections of snack intake may have influenced their report of desire. For

example, participants who consumed high levels of snack food may have inferred that they experienced strong desire to indulge in the foods presented. The presentation of the desire measure after the taste test was intended to protect the validity of this snack consumption measure by avoiding drawing attention to participants' desire experiences, as may have occurred if desire was measured prior to the taste test. However, it is clear that both options have limitations, and the question of where to assess desire relative to assessment of behaviour remains a challenge for future research. Comparing the strength of relationships between desire reports and snack intake between desire-first or consumption-first orders could be useful to examine this methodological issue further. Alternatively, future research could examine the difference in retrospective self-reported desire between conditions where individuals are simply presented with food and asked to rate its perceptual properties, to when they are also asked to taste and thus consume the food. This could inform researchers on how best to design studies using both self-reported desire and consumption measures.

8.4.3 Lab-based Nature of Research

The studies presented in this thesis were conducted in a controlled lab-based setting. This enabled control over a number of environmental variables thought to influence food intake. For example, the taste-test measure of intake was standardised across all studies and is replicable by other researchers. The snack foods presented for consumption were the same across participants in all studies, and were presented in four bowls of equal size, which were filled so they appeared equally full. Participants were given standardised instructions and scales with which to complete the task, and the time provided to complete the task was also standardised. Additionally, the study designs built in control over personal variables likely to affect intake and desire for food such as motivation toward a relevant long-term goal (by recruitment specifications for individuals motivated to manage weight through healthy

eating) and time since last meal (by pre-study instructions asking participants to eat 2 hours before the session).

However, there are limitations to studying intake in a lab-based environment. Specifically, although the purpose of the taste-test measure was obscured from participants by providing a cover story and perceptual rating scales to support this story, a number of participants did indicate awareness of the purpose of the task in open-ended debriefing questions (Chapters 3 and 4). Being aware that food intake is monitored has been shown to significantly affect intake (Robinson, Kersbergen, Brunstrom, & Field, 2014). Furthermore, social desirability bias may be an issue even among participants who did not indicate awareness of the taste-test purpose. The bowls were collected by the researcher after the taste-test which allowed a visual inspection of the amount of food eaten. This may have resulted in some participants restricting their food intake to avoid appearing 'greedy' or 'unrestrained' in front of the researcher. These factors may have affected the conclusions drawn about self-control and desire in the context of unhealthy snacking. This issue is difficult to address as it applies to many common methods of eating assessment (e.g., self-report diaries assessing food intake, self-report questionnaires assessing general dietary healthiness, food choice, etc.; Hebert, Clemow, Pbert, Ockene, & Ockene, 1995; Hebert et al., 1997; Lowe et al., 2009; Maurer et al., 2006; Steptoe, Pollard, & Wardle, 1995). Future research could consider statistically controlling for eating-related social-desirability concerns. Furthermore, in lab-based consumption or choice measures specifically, the use of a cover story and assessment of participants' awareness of intake monitoring is important given the significant influence of this awareness on actual intake.

Although laboratory based research can allow for more stringent control over extraneous variables than ecologically-valid study designs, the conclusions that can be drawn from the studies presented here may be limited by their single session lab-based designs. It

would be valuable to examine patterns of behaviour over time in individuals with lower dispositional self-control, and over repeated instances of situational depletion, rather than isolated instances as assessed in the current thesis. In particular, additional research utilising ecological momentary assessment approaches may provide valuable insight into the complex relationships between desire and self-control addressed in the current thesis. Ecological momentary assessment approaches encompass a variety of methods (including 'experience sampling' as used by Hofmann and colleagues (Hofmann, Baumeister, et al., 2012; Hofmann, Vohs, et al., 2012), that share several key characteristics. The approaches involve collecting data from participants at different time points when prompted. They allow assessment of current or very recent events (e.g., environmental triggers, personal events), experiences (e.g., emotions, desires), cognitions, and behaviours that take place in participants' everyday environments. They allow for collection of data at frequent time points over a period of time, and can follow event-contingent (e.g., each time you experience desire for an unhealthy snack), or fixed-schedule (i.e., device-prompted) reporting schedules. The data allow for comparison between individuals, but also examination of within-subject changes.

Ecological-momentary assessment approaches have been previously applied in studies of self-control and desire by Hofmann and colleagues (Hofmann, Baumeister, et al., 2012; Hofmann, Vohs, et al., 2012), but provide numerous avenues for further exploration and advances to the area of self-control and regulation of unhealthy behaviours. For example, future research could explore the effects of intervention approaches over time, such as those aimed at retraining implicit food evaluations or enhancing cognitive goal accessibility in response to temptations discussed in Sections 8.4. Additionally, incorporating the use of portable devices to present cognitive tasks assessing implicit aspects of cognition (e.g., cognitive goal accessibility) to examine correlations with different events, experiences, and environmental triggers might allow for greater statistical power to detect interactions between

self-control, desire, and goal-directed behaviour. Although the ability to act in a goal-consistent manner is a defining feature of self-control, a direct relationship between self-control and lower snack intake proved elusive in the current work. With the exception of Chapter 6, the studies presented in the current thesis failed to find a direct relationship between self-control (neither dispositional self-control, nor situational self-control, either measured or manipulated) and snack intake. Examining fluctuations in motivation, desire, and controlling for prior self-control exertion using ecological momentary assessment approaches might provide further insight into how self-control relates to behaviour over time and yield a more comprehensive understanding than single-session approaches.

8.5 Is Self-control an Effortful or Effortless Process?

The findings presented in this thesis regarding the relationship between self-control and desire have implications for the conceptualisation of self-control. This section summarises and integrates the findings into a discussion of how, and when, self-control is an effortful process (i.e., when self-control enables overcoming desire or impulses toward unhealthy snack food) versus an effortless process (i.e., when self-control predicts less intense desire or impulses toward unhealthy snack food). Findings that are consistent with either view of self-control will be discussed in turn.

8.5.1 Evidence for Self-control as the Effortful Overcoming of Impulses

Self-control is traditionally conceptualised as being responsible for overcoming impulses toward indulging in behaviour that is inconsistent with the pursuit of a valued long-term goal. This conceptualisation is formalised in theories commonly cited in the self-control literature, such as dual process models, the strength model of self-control, and also in traditional understandings of dispositional self-control (e.g., Tangney et al., 2004) discussed in Section 8.2.

Some of the findings presented in this thesis support the idea that self-control is responsible for effortfully overcoming desire. For example, Chapters 3 and 4 tested the effect of interventions that retrain implicit food evaluations and found that these influenced snack intake for individuals low, but not high, in self-control. Implicit evaluations of unhealthy snack food are thought to promote behaviour toward those foods relatively automatically. Therefore, the finding that this was not the case for individuals with high dispositional (Chapter 3) and situational (Chapter 4) self-control lends support to the notion that self-control enables an effortful overcoming of automatic impulses toward unhealthy but immediately rewarding stimuli on behaviour. However, while the findings of Chapter 5 trended toward showing that the behaviour of individuals with lower situational self-control was more strongly influenced by their desire for unhealthy snacks, the interaction term was not statistically significant. Therefore, the study did not offer support for the conceptualisation of situational self-control as enabling an individual to effortfully overcome desire. Taken together, the findings of Chapters 3 and 4 suggest that self-control may enable overcoming of more automatic impulses toward unhealthy snack food (e.g., positive implicit evaluations), as interventions that retrain those evaluations were shown to affect behaviour when self-control was low but not high, but that self-control may not involve overcoming a *conscious* desire to indulge, as demonstrated in Chapter 5.

8.5.2 Evidence for Self-control as Effortless

In contrast to self-control involving the effortful overcoming of impulses, some of the findings presented in this thesis support the idea that self-control is relatively effortless. For example, self-control is argued to involve the down-regulation or prevention of strong impulses toward goal-conflicting behaviours. Weaker impulses toward goal-conflicting behaviours therefore preclude the need for effortful inhibition in order to regulate behaviour in line with a long-term goal. This conceptualisation is consistent with the process account of

ego depletion, contemporary understandings of dispositional self-control (such as put forward by Gillebaart and de Ridder (2015)), and with counteractive control theory, which were discussed in Section 8.2.

Some of the findings presented in Chapter 4 suggested that situational self-control allows the effortful overcoming of automatic affective reactions trained using a computer based intervention, as discussed in the previous Section 8.5.1.1. However, this study also assessed the influence of the intervention on self-reported temptation to indulge in snack foods presented for consumption. If self-control was an effortful process, individuals with higher self-control would be expected to be able to overcome temptation to indulge in unhealthy snacks (indicated by a significant moderation of the temptation-intake relationship by inhibitory control). However, situational self-control did not moderate the pathway between the experience of temptation and intake. Instead, it moderated the effect of the intervention on experienced temptation. Specifically, the food positive training resulted in higher temptation than the food negative training, but only among individuals with lower inhibitory control. While a change in implicit food evaluations was not measured in this study, the evaluative conditioning intervention was modelled on previous studies that have demonstrated effective modification of implicit evaluations of target stimuli. The moderation of the intervention's effect on temptation by situational self-control may therefore suggest that self-control enables the down-regulation of automatic appraisals of appetitive stimuli (e.g., an implicit association of unhealthy food with positive stimuli) before it emerges as a conscious desire. In this way, the results presented in Chapter 4 are consistent with a conceptualisation of self-control as being effortless.

Findings from Chapter 6 also support the conceptualisation of self-control as being effortless. Findings revealed that rather than trait self-control moderating the relationship between desire and snack consumption (which would be consistent with self-control as

involving effortful overcoming of desire), individuals with higher trait self-control experienced less intense desire to indulge in the snack food presented. Furthermore, this lower desire mediated the relationship between higher self-control and lower snack consumption. These findings suggest that self-control can be a relatively effortless process, as the more goal-consistent behaviour among individuals with higher dispositional self-control was accounted for by lower experienced desire to indulge in unhealthy behaviour.

Chapter 7 did not replicate the relationship between self-control and lower desire shown in Chapter 6. However, the findings do provide evidence for a relatively effortless process by which individuals with high trait self-control deal with temptations in their environment. Namely, results suggest that when the goal of weight management is more highly accessible, individuals with higher trait self-control experience less intense temptation to indulge in unhealthy snacks, and subsequently consume less unhealthy snack food. Thus, when a long-term goal is highly accessible, individuals with higher trait self-control experience less intense temptation to indulge in behaviour detrimental to the goal, leading to goal-consistent behaviour without the need for effortfully overcoming a strong conflicting desire.

In summary, the conceptualisation of self-control as relatively effortless is supported by several findings presented in the current thesis. Findings presented in Chapter 4 suggest that individuals with higher situational self-control may be able to down-regulate automatic affective reactions toward unhealthy food before they manifest as a conscious temptation to indulge. Additionally, Chapter 6 provides evidence for a lower desire to indulge in unhealthy snack foods among individuals with higher dispositional self-control, which contributed to their lower snack consumption. Finally, Chapter 7 provided evidence for a relatively effortless manner in which individuals with higher trait self-control may be able to regulate snack intake. Therefore, the findings presented in the current thesis suggest that self-control

does not solely involve the effortful overcoming of impulses toward behaviour that conflict with a long-term goal. But neither do they suggest that self-control always relates to weaker impulses that conflict with goals (as evidenced in Chapters 4, 5, and 7). Instead, they highlight the complexity of the relationship and interaction between self-control on the one hand; and desire, temptation, and the impulsive precursors of these conscious experiences, on the other hand.

8.6 Conclusion

The current thesis used the context of unhealthy snack food consumption to explore the relationships and interactions between self-control, and desire and its automatic precursors. The six empirical studies presented addressed specific questions about the relationships between self-control, and desire and related constructs, under the umbrella of several complementary theoretical perspectives. The work presented in the thesis illustrates the complexity of the relationships between self-control and desire for unhealthy food, demonstrating that self-control is not always responsible for the effortful overcoming of desire. Instead, some of the findings indicated that individuals with higher self-control at times experience weaker impulses toward or desires to indulge in unhealthy food, thereby demonstrating that self-control does not necessarily require the effortful overcoming of unhealthy impulses.

Although the current thesis explored self-control and desire in the context of unhealthy snack consumption, the relevance of the work presented here extends beyond this particular behavioural domain. Indeed, many other domains are characterised by conflicts between impulses toward immediately rewarding behaviour and long-term goals or interests, such as work and study behaviours; behaviour toward consumptive stimuli such as alcohol and drugs; impulsive spending; and immoral and criminal behaviours. Further exploration and application of the ideas presented in this thesis to these areas where self-control is also

important may foster greater understanding of the mechanisms of self-control, and lead to strategies to improve the successful regulation of behaviour more broadly.

8.7 References

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