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Effects of cognitive distraction on the regulation of human eating behaviour

by

Gemma Mitchell

A Doctoral Thesis

Submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University.

September 2005

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ABSTRACT

In humans, what, when, and how much is eaten is the result of a complex interplay between physiological and psychological dietary controls. The need to identify how these different influences interact is integral to understanding how eating behaviour is regulated in a range of different contexts. In particular, one phenomenon that remains poorly understood is why eating while distracted is associated with increased food intake. The aim of this thesis is to attempt to identify the nature of the potential process that underlies this phenomenon. In Part I, the relationship between dietary strategy, allocation of attention, and amount eaten is explored in three experiments. The results confirm that intake can be predicted by how attention is directed during a meal. Furthermore, contrary to previous accounts that view overeating as a passive behaviour, this research suggests that individuals may choose to direct their attention strategically in order to control their intake. In Part II, four experiments investigate the possibility that the mechanism underlying the relationship between attention and intake is related to a process akin to ‘sensory-specific satiety’. This term describes the hedonic shift in the sensory properties of a food that occur as it is eaten and which is believed to be important in meal termination. The results suggest that distraction is associated with an attenuation of the rate at which ‘desire to eat’ (both generally and specifically for the food being eaten) declines. Furthermore, although declining pleasantness is reported to remain influential in determining eating cessation when distracted, this response is somewhat inhibited, occurring after a greater amount of food has been consumed. Based on this, the conclusion drawn is that the deficit underlying overeating is one of attention, and that this may lead to overeating by undermining the rate at which satiety develops.

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Finally, my biggest thanks go to my husband, Ker, for all of the errands that he ran for me, and for his continued love and encouragement, unwavering patience, and outstanding ability to crack the whip!

This thesis is dedicated to the memory of
Majorie Margarita Rodrigues Witcomb.

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PART I

CHAPTER 1: HUMAN EATING BEHAVIOUR

1.1. INTRODUCTION

The aim of this thesis is to attempt to identify the nature of the potential mechanism(s) involved in the occurrence of overeating when distracted. Since overeating is one factor that is likely to be contributing to the continuing growth in overweight and obesity in the developing world (Scherwitz & Kesten, 2005), attempts to understand this phenomenon have become increasingly important. Both physiological (e.g., Beglinger & Degen, 2004) and cognitive factors (e.g., Higgs, 2005) have been shown to be involved in the regulation of human eating behaviour. Notwithstanding the importance of physiological controls, this thesis deals with the cognitive factors that may influence eating behaviour. Most specifically, dietary restraint and the allocation of attention. Before reviewing the literature pertinent to each of these factors, this chapter outlines the problem posed by obesity, introduces the physiological models that attempt to explain eating behaviour, and presents evidence to support the proposition that cognitive factors may be equally influential in determining what, when, and how much is eaten.

1.2. THE OBESITY EPIDEMIC

Today, obesity has reached epidemic proportions and is set to surpass tobacco as the number one cause of preventable death (Mokdad, Marks, Stroup, & Gerberding, 2004). While America continues to boast the highest rates of obesity in the world, the prevalence of obesity among adults in Britain is increasing, having trebled in the last 20 years (National Audit Office, 2001). Currently, it is estimated that around 50 per cent of the population is either overweight or obese, 16 per cent of which are among the 6-15 year old age group (Blood Pressure Association, 2004). This is concerning, since obesity has been suggested to have similar effects as twenty years ageing (Sturm, 2002), and is associated with an increased risk for a number of

serious health problems, including Type 2 diabetes and cardiovascular disease (British Heart Foundation, 2004), and certain cancers (Batty et al., 2005). It also represents a huge financial drain on the economy, both directly in terms of the cost of treatment (Finkelstein, Fiebelkorn, & Wang, 2003), and more indirectly due to the consequences of being obese, such as increased sickness absence from work (National Audit Office, 2001).

The likelihood that the growth in obesity over the last few decades is solely attributable to genetic factors is slim. This is because the gene pool can not have changed so rapidly (Berthoud, 2004). Rather, it is more likely that the profound changes in environmental and lifestyle-related factors that have occurred over this time play a contributory role, interacting with genetic predispositions in order to change the way in which food intake is regulated (Ravussin & Bogardus, 2000; Shell, 2002).

1.3. THE HOMEOSTATIC MODEL OF EATING REGULATION

The earliest models of human and animal eating behaviour were based on the principles of homeostasis. This concept, attributed to the French physiologist Claude Bernard (cited in Mela & Rogers, 1998) in the late 1800's, but given its name from the Greek words meaning 'steady' and 'same' by Walter Cannon (1932), describes the ways in which the body acts to maintain a stable internal state in spite of environmental variations and disturbances. Homeostasis is believed to be achieved through the operation of a series of automatic control mechanisms which provide every cell in the body with exactly what each one requires. Based on this, simple 'energy depletion – repletion' models of eating behaviour (e.g., Friedman, & Stricker, 1976) propose that meal initiation and termination occur in response to the presence or absence, respectively, of a biological need for nutritional sustenance. Central to these models is the belief that the body has a 'set-point' – the ideal level at which the variable being regulated should be maintained, and that negative feedback will occur if the level of the variable in question falls below this set-point. Thus, eating will be initiated when negative feedback (in this case, hunger) signals that energy reserves have fallen below the critical set-point. Conversely, when fuel

reserves are replenished, negative feedback (satiety) signals eating cessation. These principles have also been applied to explain instances where foods high in specific nutrients are sought out and ingested, e.g., iron (McLoughlin & Hassanyeh, 1990) - a behaviour thought to reflect the body's drive to replenish a particular nutritional deficit (Richter, Holt, & Barelare, 1938).

In order to provide a simple description of a homeostatic system, the analogy of a temperature thermostat in a house is often used. Similarly, Kennedy (1953) proposed that the body-weight of rodents is controlled by a fat thermostat – or 'lipostat'. This control mechanism can sense how much fat there is on the body and adjust eating and energy expenditure accordingly to maintain a 'set-point'. However, a limitation of such homeostatic models is that the exact nature of the control mechanisms involved is unclear. Hervey (1959) simply suggested that a 'satiety signal', transmitted through the bloodstream and detected by the hypothalamus, was involved in this feedback mechanism. Similarly, following a series of experiments in which mutant (by virtue of the *ob* gene) and normal mice were grafted together, Coleman (1973) theorised that some unknown satiety factor, usually absent in the *ob* mouse, but having crossed into the bloodstream from the normal mouse, was responsible for signalling when to start and stop eating.

1.4. CAN HOMEOSTASIS EXPLAIN OBESITY?

The concept of homeostasis dominated early thinking about hunger and eating behaviour. Although intuitively attractive, it became increasingly clear that not all eating behaviour could be explained by this concept (e.g., Russek, 1981). A series of early studies carried out with rats failed to find a clear physiological basis of the eating behaviour of rats (Levitsky, 1970; 1974; Levitsky, Faust, & Glassman, 1976). Since then, research has continued to support the proposition that eating behaviour is not tightly controlled by set-point mechanisms. In particular, bouts of overeating and obesity have been difficult to reconcile with the idea that hunger and eating are compensatory processes that function to maintain the body's energy at an ideal set-point. Research inconsistent with such a view has shown, for example, that food intake fails to fall following a period of over-feeding (Levitsky, Obarzanek,

Mrdjenovic, & Strupp, 2005), when breakfast is added (Feldman & Levitsky, cited in Levitsky, 2002), when the energy density of food increases (Kendall, Levitsky, Strupp & Lissner, 1991), and can occur in the absence of hunger (e.g., Mattes, 1990).

The dominant view developing in the early 1970s, and one which to a large extent continues to prevail, was that aberrant eating behaviour is more a problem of behaviour than biology. Thus, research sought to identify those behaviours that were leading to obesity. Schachter (1971) compared the eating behaviour of obese and normal weight individuals and found that the eating behaviour of the obese was influenced by external cues, such as the sight or smell of food. This research confirmed the existence of a dichotomy between internal and external controls on eating behaviour, suggesting that the eating behaviour of normal-weight individuals was responsive to internal cues, while in contrast, such cues had less influence on the eating behaviour of obese individuals.

The simplicity of this framework was central to both its initial appeal and later its limitations. Although it attracted much attention, it became greatly overextended and failed to provide an adequate explanation of the differences in eating behaviour between groups of individuals with differing weights. Indeed, replications were elusive and evidence mounted to suggest that not all overweight individuals were externally responsive and, similarly, that not all normal-weight individuals were internally responsive (e.g., Nisbett & Temoshok, 1976; Rodin & Slochower, 1976).

Around the same time that Coleman (1973) was conducting research with the *ob* mice and advocating the existence of ‘set-points’ for body-weight, Nisbett (1972) was similarly arguing this case in humans. Specifically, he proposed that obese individuals are overweight not because they are insensitive to internal cues, as Schachter (1971) had suggested. Rather, they simply require more energy by dint of the fact that their physiologically determined set-points for body-weight are higher than those of normal-weight people. However, due to societal values that favour a lean physique, these individuals are forced to ignore hunger cues and to impose a more cognitive control over their intake in an attempt to achieve and maintain a body-weight that is below their natural set-point. As a result, the obese individual

remains in a constant state of energy depletion, which Nisbett (1972) argued was responsible for the over-reactivity to food observed by Schachter (1971). Thus, it was concluded that behavioural differences between obese and normal-weight individuals are less related to obesity per se, and more to the effects of restrictive dietary practices (for an early review on the internal - external hypothesis see Rodin, 1981). Subsequent studies added further support to Nisbett's (1972) conjecture. Firstly, Rodin (1973) reported that the proof-reading ability of obese individuals was impaired by various external distracters, such as a voice reciting numbers. However, Sinclair, Sorrentino, and Weisz (1990) went on to show that it is only the proof reading ability of *restrained* obese individuals that is impaired by this type of distraction. The proof reading ability of unrestrained obese individuals is unaffected. Secondly, so called 'obese' characteristics have been identified in normal-weight individuals. In particular, Pudel, Metzdorff, and Oetting (1975; cited in Stunkard & Messick, 1985) found that while non-obese individuals tended to decrease their rate of eating during a meal as satiety approaches, and obese individuals did not, a sub-set of non-obese individuals also failed to decelerate their intake. These individuals were referred to as 'latent obese' to reflect the fact that while they may be biologically programmed to be obese, they are able to maintain a normal body-weight by consciously restricting their food intake.

1.5. CURRENT PERSPECTIVE ON THE ROLE OF HOMEOSTASIS

These early studies suggested that an elevated set-point, maintained by homeostasis, may be responsible for the higher body-weight of obese individuals. However, to date, the evidence that such genetically determined set-points exist is slim¹.

¹ Some evidence suggests that a 'set-point' can develop in utero. According to the 'thrifty phenotype hypothesis' (Hales & Barker, 2001), if food is scarce during fetal development, adaptations may occur that prepare the fetus for similar conditions after birth. When such conditions fail to occur after birth, as is the case when born into a calorie-rich environment, the altered 'programming' may predispose the individual to become obese (e.g., Cunningham & Cameron, 2003; Gluckman, Cutfield, Hofman, & Hanson, 2005; Holemans, Aerts, & Van Assache, 2003; Phillips, 2002). However, the extent to which programming is important in terms of the actual incidence of obesity, as opposed to the risk, remains the topic of debate.

Furthermore, it is now generally accepted that the basic homeostatic model is overly simplistic and does not acknowledge the role played by external factors in the regulation of food intake. In evolutionary terms, the operation of a homeostatic system was important as it ensured that enough energy was ingested to fuel the requirements of the organism and to ensure survival throughout periods of scarcity. However, in contrast, there was no evolutionary pressure to develop a mechanism that would defend against excess adiposity. As Berthoud (2004) and De Castro and Plunkett (2002) have argued, in today's 'obesogenic' society with the abundance of cheap, easily obtainable, highly palatable and highly calorific food, the operation of a negative feedback homeostatic system is likely to be difficult and present little defence against obesity.

Consequently, De Castro and Plunkett (2002) have proposed a model of intake regulation that may be considered to be a more reliable representation of the factors influencing human eating behaviour. Taking a reductionist approach, whereby the findings from different areas of human ingestive behaviour are brought together in an attempt to understand the whole, this model takes into account the range of 'compensated factors' such as hunger and stomach contents, which drive how much is eaten, and 'uncompensated factors' such as social facilitation or timing of meals, which affect but are not *affected by* intake. For example, while amount eaten does not affect the number of people present at the meal or the timing of the meal, these factors do affect amount eaten. Meals eaten on weekends tend to be larger than those eaten on weekdays (De Castro, 1991a) and meals eaten with others tend to be larger than those eaten alone (De Castro, Brewer, Elmore, & Orozco, 1990). Therefore, it appears that the operation of a homeostatic system is likely to be overpowered by environmental pressures.

Some individuals do maintain a stable body-weight over their life-span (Berthoud, 2004) and such observations may be taken as evidence that the operation of a homeostatic system is effective in regulating intake over the long-term. However, the extent to which this stability can be attributed to homeostasis, as opposed to the effect of cognitively controlling intake (see section 2.3.) or differences in energy expenditure, is unclear. Notwithstanding this, since obesity does not occur overnight but results from a prolonged period of ingesting more energy than is

expended, by as little as one potato chip a day (Berthoud, 2004), it is unlikely that the operation of a long-term homeostatic system is sensitive enough to prevent weight gain when food is abundant. Therefore, food intake may be influenced by what can be described as a ‘settling’ (for a review see Levitsky, 2002; Shell, 2002), as opposed to a ‘set’ point. Settling points may be determined by an interaction between genetic, environmental, and cognitive factors. As our environment becomes increasingly obesogenic, these settling points are likely to rise.

1.6. SUMMARY

Obesity is reaching epidemic proportions in developing countries around the world, and is particularly prevalent in the UK. In this chapter, evidence has been reviewed suggesting that this increase in overweight may be related to the inability of a homeostatic system to successfully regulate food intake in an environment of caloric abundance. One of the consequences of this is that, faced with expanding waist-lines, many individuals are choosing to engage in cognitively-driven behaviours to combat the effects of a sub-optimal homeostatic system. The next chapter introduces the concept of ‘dietary restraint’ - a cognitively-controlled behaviour that interacts with biologically-driven controls to influence food intake.

CHAPTER 2: DIETARY STRATEGIES AND OVEREATING

2.1. INTRODUCTION

The aim of this chapter is to provide an overview of the literature related to dietary restraint. The term ‘dietary restraint’ has been used to describe the behavioural tendency to cognitively restrict food intake in order to lose or maintain weight. More recently, a distinction has been drawn between the restriction of calories in order to avoid weight gain (restraint), and the restriction of calories in order to promote weight loss (dieting). While successful dieting is likely to be associated with health benefits for the overweight or obese individual, it is also associated with costs (Brownell & Rodin, 1994). In relation to this, it is pertinent to note that both behaviours have been associated with bouts of overeating (e.g., see Ruderman, 1986) and with impairments in cognitive processing and attention (e.g., Green & Rogers, 1995). Indeed, in children, dietary restraint has been related to poorer academic performance at school (Brunstrom, Davison, & Mitchell, in press). This is concerning since the two behaviours are increasingly common in both overweight and lean individuals.

In today’s society which views the ultra-lean figure as the ideal, a large proportion of females feel dissatisfied with their bodies and so choose to engage in restrictive dietary practices, despite being of a normal, healthy weight (Hill, Oliver, & Rogers, 1992; Kiefer, Rathmanner, & Kunze, 2005). Girls as young as seven years old have been reported to score highly on a measure of restrained eating (Shunck & Birch, 2004) and a recent survey of 15,526 school children from 196 primary and secondary schools in the United Kingdom revealed that 50 per cent of the 14 - 15 year old females sampled reported that they ‘would like to lose weight’ (Schools Health Education Unit, 2003). Moreover, of these, 25 per cent reported engaging in potentially harmful dietary practices, including missing breakfast on the day of the survey, and missing lunch on the previous day. Because restrained eating is becoming increasingly common among normal-weight adults and children alike, the way in which this behaviour influences subsequent eating regulation has become

the focus of much research. This chapter will begin with a historical overview of dietary restraint, followed by a review of the literature that has expanded this initial concept to draw distinctions between different types of restrained and unrestrained eaters. The literature relating to the circumstances under which overeating has been observed most frequently, and the proposition that overeating is related to decreased attention to dietary control, in both restrained and unrestrained eaters, will then be reviewed.

2.2. THE ORIGINS OF DIETARY RESTRAINT

Nisbett (1972) argued that the external responsiveness of the obese was a consequence of their attempts to restrict their intake below that of their biologically determined set-point. Implicit in this argument was the idea that any individual, irrespective of set-point or body-weight, can override the internal controls governing eating behaviour and control their food intake cognitively. Herman and Mack (1975) were the first researchers to build upon this idea and explore the eating behaviour of individuals with differing levels of dietary restraint. Although a number of questionnaires have been developed which assess the extent to which an individual is restricting their food intake², the Restraint Scale (Herman & Mack, 1975), subsequently termed the Revised Restraint Scale following modification (Polivy, Herman, & Warsh, 1978), was the first to be used to categorise individuals as ‘restrained’ or ‘unrestrained’ eaters. In what would now be considered to be the most widely replicated paradigm in the restraint literature, Herman and Mack (1975) explored the effect of ingesting a food preload on subsequent food intake. In

² The Restraint Scale (Herman & Mack, 1975) was the first questionnaire to be designed that allowed respondents to be classified as restrained or unrestrained eaters, according to their responses to a range of questions assessing dietary control and eating behaviour. Since then further questionnaires have been developed to measure restrained eating, namely the Revised Restraint Scale (RRS; Polivy, Herman, & Warsh 1978), the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985), and the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien, Frijters, Bergers, & Defares, 1986). These scales differ in the extent to which they measure ‘successful’ versus ‘unsuccessful’ attempts at restraint (see section 2.4.1.).

this classic study, participants either consumed a preload consisting of one or two glasses of milkshake, or they received no preload. Following ingestion (if applicable) of the preload, participants took part in a taste-test of various ice creams, eating as much as they wished. The results showed that while the intake of the unrestrained eaters decreased as a function of the size of the preload, the intake of the restrained eaters actually increased along with the increase in preload size. This divergent pattern of intake has been termed ‘counter-regulatory eating’ and has been evidenced in the many subsequent replications of this study (e.g., Herman, Polivy, & Esses, 1987; Hibscher & Herman, 1977; Polivy, Heatherton, & Herman, 1988; Ruderman & Christensen, 1983; for a review see Ruderman, 1986). Therefore, this research was the first to confirm Nisbett’s (1972) hypothesis that the external responsiveness exhibited by the obese participants in Schachter’s (1971) study was actually the result of restrained eating. Thus, the obese-lean dichotomy became superseded by the concept of dietary restraint.

2.3. THE BOUNDARY MODEL OF EATING REGULATION

Herman and Polivy (1984) developed the ‘boundary model of eating regulation’ as a framework within which to conceptualise the differences in eating behaviour observed between restrained and unrestrained eaters. This model was proposed as a description, rather than as an explanation, of the way in which food intake is regulated in each of these groups. The model acknowledges the role of both homeostatic and non-homeostatic principles in the regulation of eating behaviour. It proposes that food intake is maintained within the physiological boundaries of hunger and satiety, but that between these lies a ‘zone of biological indifference’, within which cognitive, social, emotional, and other psychological factors are believed to play a large role in influencing food intake. Importantly, the location of the hunger and satiety boundaries differs between restrained and unrestrained eaters. Specifically, restrained eaters are conceptualised as having lower hunger and higher satiety boundaries than unrestrained eaters. By dint of this fact, restrained eaters also have a larger zone of biological indifference than do unrestrained eaters, and are therefore more susceptible to the influence of non-physiological factors. Furthermore, the boundary model also conceptualises restraint as involving the

imposition of a cognitive diet boundary. This is located somewhere below the restrained eater's physiologically-determined satiety boundary. Thus, restrained eaters are envisaged to control their food intake by terminating their meals when their diet boundary is reached, before satiety is achieved (see Figure 1).

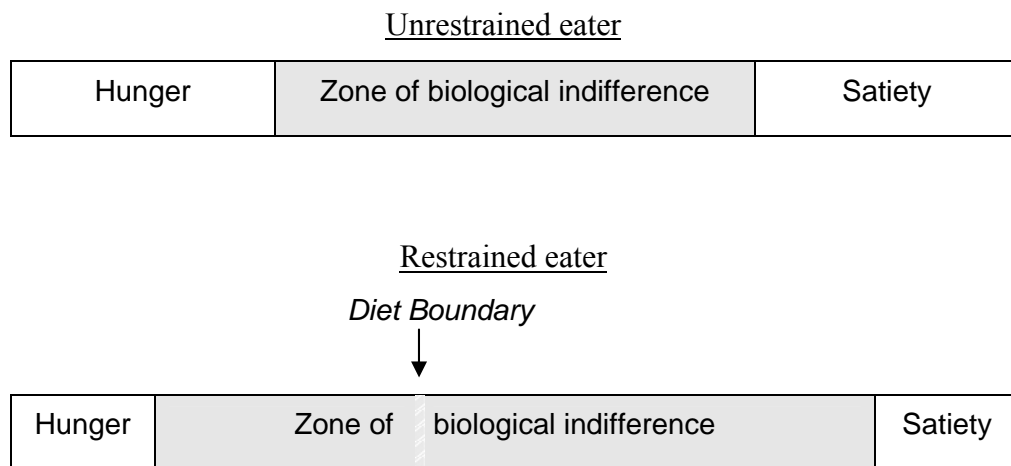


Figure 1. Herman and Polivy's (1984) boundary model of eating regulation.

2.3.1. Transgression of the diet boundary and overeating

The boundary model conceptualises eating behaviour as an interaction between the physiological and cognitive controls that govern eating behaviour. The concept of a 'zone of biological indifference' acknowledges the strong influence that a range of non-physiological factors, such as the eating environment or the characteristics of the particular food available, can exert on the processes involved in regulating energy intake.

Herman and Polivy (1984) suggested that the counter-regulatory bouts of overeating observed in restrained eaters may be most likely to occur when the diet boundary has been transgressed, and when subsequent attempts to limit intake appear worthless. Under these circumstances, eating continues until the (comparatively elevated) satiety boundary is reached. This response has been termed the 'what-the-

hell' effect (Herman & Polivy, 1984), a term which characterises the sense in which dietary goals have been abandoned and restraint has been 'disinhibited'.

While the physical ingestion of a food preload that surpasses the restrained eaters 'allowance' of calories represents one way in which transgression of the diet boundary can occur, it is not the only circumstance under which disinhibited eating may be induced. Rather, simply thinking that the diet boundary has been transgressed by, for example, consumption of a low-calorie preload labelled as high-calorie (Polivy, 1976; Spencer & Fremouw, 1979), or a forbidden food (Knight & Boland, 1989), can cause the restrained eater to temporarily abandon their restraint. Similarly, telling restrained eaters that they will shortly be asked to consume a large amount of food (Ruderman, Belzer, & Halperin, 1985; Tomarken & Kirschenbaum, 1984), or a forbidden food (Knight & Boland, 1989), can also lead to overeating in anticipation of a future transgression of the diet boundary.

Therefore, the 'what-the-hell' effect is conceptualised as an active response to the real, perceived, or anticipated transgression of the diet boundary that is reliant on cognisance of the relationship between actual and 'allowed' consumption. In this sense, the process required to ensure successful regulation can be viewed as being akin to an artificial homeostatic system, whereby success depends on the constant *cognitive* comparison of actual ingested energy with desired energy intake. In restrained eaters, when energy intake reaches the limit of the cognitively defined desirable range, negative *cognitive* feedback signals to them to stop eating. Therefore, implicit in this model is the possibility that overeating may be likely to occur under any circumstances that undermine the cognitive control of intake. That is, when insufficient attention is allocated to maintaining the diet boundary and monitoring food intake.

2.4. THE COMPLEXITY OF RESTRAINED EATING BEHAVIOUR

Restraint Theory (Herman & Polivy, 1984) postulates that individuals differ in the extent to which their eating behaviour is cognitively mediated. Experimental research has focused on the dichotomy between 'restrained' and 'unrestrained'

eaters - those who do and do not attempt to cognitively restrain their food intake³. Based on this, evidence for ‘disinhibited’ overeating has predominantly (although not exclusively; see sections 2.5.2.2. & 2.5.2.3.) been observed in restrained eaters. As a consequence, it has been suggested that restrained eating is causally related to overeating (Field & Colditz, 2001; Polivy & Herman, 1985; Tuschl, 1990; Wardle & Beales, 1988), as the title of the book ‘Dieting makes you fat’ (Cannon & Einzig, 1983) suggests. However, the extent to which restrained eating leads to overeating and overweight, rather than the converse, is unclear (Hill, 2004; Lowe & Timko, 2004a). Furthermore, not all restrained eaters appear to be equally susceptible to bouts of overeating (Dritschel, Cooper, & Charnock, 1993; Lowe, 1993; 1994; 1995; Lowe, Whitlow, & Bellowoar, 1991). Some work presented in Part I of this thesis considers the differences that might exist in the way that restraint is expressed across groups of similarly restrained eaters. Therefore, this section reviews evidence suggesting that dietary restraint should not be viewed as a homogenous construct (for a collection of articles reviewing this issue, see *Appetite*, 14, 1990, pp. 105-143).

2.4.1. Sub-types of restrained eater

Early research comparing the behaviours of restrained and unrestrained eaters did so by classifying individuals into either group on the basis of their scores (high or low) on the Restraint Scale (Herman & Mack, 1975) (and later the Revised Restraint Scale, Polivy et al., 1978). On this basis, counter-regulatory eating was observed in restrained eaters (Herman & Mack, 1975). However, when other scales designed to measure restrained eating have been used, evidence for this disinhibited eating has not been found. Neither the restraint scale of the Dutch Eating Behaviour Questionnaire (Van Strien, Frijters, Bergers, & Defares, 1986), nor the Three Factor Eating Questionnaire (Stunkard, & Messick, 1985) has been associated with counter-regulatory eating in the laboratory (Dritschel et al., 1993; Lowe & Kleifield, 1988; Ouwens, Van Strien, & Van Der Staak, 2003; Van Strien, Clevel,

³ Since restraint is a continuum, individuals within each group differ in the extent to which they are restrained and unrestrained.

& Schippers, 2000; Wardle & Beales, 1987; 1988; Westenhoefer, Broeckmann, Munch, & Pudel, 1994). The reason for this appears to lie in what the scales actually measure. Each one assesses the motivational component of restrained eating, i.e., a desire for thinness (Laessle, Tuschl, Kotthaus, & Pirke, 1989), and the intention to restrain. However, only the DEBQ- and TFEQ-restraint scales have been regarded as ‘pure’ measures of restraint. These scales measure successful restraint, independent of disinhibition, and have been shown to have good validity with respect to various measures of food intake (Wardle et al., 1992). The Restraint Scale, in contrast, contains items relating to weight fluctuation. Therefore this scale tends to measure unsuccessful restraint (Wardle, 1986).

2.4.1.1. Flexible and rigid control

Further analysis of the TFEQ-restraint scale (Stunkard & Messick, 1985) has revealed that the different sub-components of this scale are associated with different behavioural outcomes. Westenhoefer (1991) found that items on the TFEQ-restraint scale can be split into two sub-categories which measure rigid and flexible approaches to restraint. A flexible approach is characterised by the tendency to select smaller portion sizes, being more deliberate in food choices, and eating less after breaking a diet. Conversely, a regimented, ‘all-or-nothing’ eating style, involving calorie counting and strict dieting, characterises the rigid approach. Based on this dichotomy, Westenhoefer (1991) has found that overeating is more likely to occur in those individuals who adopt a rigid control of their eating behaviour, with scores on this scale being positively correlated with those on the TFEQ-disinhibition scale. In contrast, scores on the flexible control dimension tend to be negatively correlated with tendency to overeat (Westenhoefer, 1991). Since then, the validity of the two constructs has been supported by a number of studies that have similarly reported different behavioural outcomes in participants with these different approaches to restraint. For example, using questionnaires to gather information on eating behaviour, Shearin, Russ, Hull, Clarkin, and Smith (1994) found that higher scores on the flexible control sub-scale were associated with lower BMI and with the ability to control body-weight, as assessed by history of weight fluctuation. Conversely, high scores on the sub-scale assessing rigid control

were related to poorer ability to control body-weight, and with greater body dissatisfaction. Similarly, Williamson et al., (1995) have reported a negative relationship between flexible control and BMI. This relationship has also been reported by Smith, Williamson, Bray, and Ryan (1999), who additionally found that flexible control was associated with the absence of overeating, and lower levels of depression and anxiety, while calorie counting, characteristic of rigid control, was associated with higher BMI and overeating while alone.

Further validation of the reliability of these two different types of restraint has been provided by Westenhoefer, Stunkard, and Pudel (1999). Using seven-day food diaries to obtain data on actual food intake, lower self-reported energy intake was found to be associated with flexible control. In addition, lower disinhibition scores, lower BMI, and less frequent and less severe binge-eating episodes were also associated with flexible control, while rigid control was associated with the converse. Similar associations between BMI, disinhibition, excessive concerns with body-shape, and eating disorder symptoms have also been reported in more recent studies (Stewart, Williamson, & White, 2002; Timko & Perone, 2005). Based on this evidence, aberrant behavioural outcomes, such as overeating, appear more likely to occur as a result of a particularly rigid type of restraint, rather than restraint in general. Consequently, it has been suggested that weight loss regimes that promote a more flexible approach to restraint may be more successful in producing long-term weight loss (Westenhoefer & Pudel, 2001).

2.4.1.2. Interaction between restraint and disinhibition scores

The idea that overeating may be related to particular aspects of a restrained eating style, rather than to restraint per se, is consistent with the observation that overeating is better predicted by scores on the Restraint Scale, which measures unsuccessful restraint, than it is by scores on the DEBQ- or TFEQ-restraint scales (Wardle, 1986; see section 2.4.1.). Implicit in this observation is the notion that not all restrained eaters are equally susceptible to failure, the veracity of which has been confirmed in a number of different studies (Ouwens et al., 2003; Van Strien, 1997a; Van Strien, Breteler, & Ouwens, 2002; Van Strien et al., 2000; but see Huon,

Wotton, & Brown, 1991). Based on this, an approach that has proved useful has been to allocate individuals into groups based on a double classification of their scores on two separate measures of dietary behaviour. Specifically, those pertaining to successful (e.g., TFEQ-restraint) and unsuccessful (e.g., TFEQ-disinhibition) dietary control have been used to yield four groups; high restraint / high disinhibition, low restraint / low disinhibition, high restraint / low disinhibition, and low restraint / high disinhibition (e.g., Westenhoefer et al., 1994). Using this approach, dietary restraint (as assessed by the TFEQ-restraint scale) has only been found to be associated with overeating in those individuals who also simultaneously score highly on the measure of disinhibition - the 'unsuccessful' restrained eaters. Restrained eaters who score low on this measure tend to be more successful in controlling their food intake (Haynes, Lee, & Yeomans, 2003; Westenhoefer et al., 1994). A double classification of this kind using the restraint scale of the DEBQ and the combined scores on the DEBQ-emotional sub-scale, DEBQ-external sub-scale, and a measure of bulimic eating behaviour (Eating Disorders Inventory; Garner, 1990) has also shown that restrained eating is associated with problems controlling food intake, but only in those individuals with a simultaneous high susceptibility towards failure (Van Strien, 1997b; 1999).

These findings suggest that the original prediction of Restraint Theory - that restraint leads to overeating - holds true only for a sub-set of restrained eaters. Specifically, those who have a particular tendency towards failure. However, this result can in many ways be considered consistent with Restraint Theory. This is because Restraint Theory's prediction was based on research using the Restraint Scale, which itself simultaneously measures frequency of failure⁴ and which has been advocated to be a more representative measure of the experience of most restrained eaters (Heatherton, Herman, Polivy, King, & McGree, 1988).

⁴ although high scores could also be achieved as a result of successful restraint and therein lies the problem with this scale.

2.4.2. The dichotomy of dieting and restrained eating

A further distinction that can be drawn between groups of similarly restrained eaters is between those who are restricting their intake in order to avoid weight gain, and those who are actively dieting with the aim of achieving weight loss. Early literature on dietary restraint uses the terms ‘restrained eater’ and ‘dieter’ interchangeably to refer to those individuals who score highly on questionnaires measuring restrained eating, irrespective of actual dieting status. However, over the last 15 years, it has become increasingly clear that these behaviours are not synonymous with one another and that this dichotomous view of human eating behaviour is overly simplistic. Rather, restrained (and unrestrained) eating is a more complex phenomenon.

Restraining food intake in order to lose weight and vigilantly monitoring and restricting food intake in order to maintain weight are quite different behaviours. For example, dieting may involve restricted ingestion of all foods, whereas only some foods may be considered off-limits when intake is restrained in order to avoid weight gain (Gonzalez & Vitousek, 2004; King, Herman, & Polivy, 1987). Early research noted differences between active dieters and similarly highly-restrained non-dieters. For example, Cooper and Bowskill (1986) found that dysphoric mood preceded overeating only in dieters, whereas overeating was more likely after dysphoric mood in restrained non-dieters. More recently, dieting has been found to be associated with higher and more heterogeneous scores on measures of restraint and with a greater history of weight cycling (Lowe & Timko, 2004b).

While the prediction made by Restraint Theory (Herman & Polivy, 1984), that restrained eaters will overeat after prior ingestion of a preload is, in the most part, true of the behaviour of non-dieting restrained eaters (e.g., Herman & Mack, 1975; Herman, Polivy, & Esses, 1987; Polivy, Heatherton, & Herman, 1988), restrained eaters who are actively dieting to lose weight appear to be less susceptible to this counter-regulatory eating. In a number of studies, Lowe and colleagues have shown that dieters regulate their intake differently to similarly restrained non-dieters. Specifically, following ingestion of a preload, dieters are generally able to maintain control over their food intake and fail to exhibit counter-regulatory eating.

However, in the absence of a preload, they tend to overeat (Lowe, 1995; Lowe et al., 1991). Restrained eaters do the converse; overeating after ingestion of a preload, but eating very little in the absence of a preload. Lowe (1993) has suggested that these differences are the direct result of the effects of dieting. Since dieters have the added aspiration to lose weight, the preload is likely to present a greater threat to their dietary control than it does to that of similarly restrained non-dieters. In response to this threat, dieters may direct relatively more attention toward the maintenance of dietary restriction and consequently eat less than restrained non-dieters. In contrast, when no preload is ingested and therefore no threat is perceived, the physiological effects of dieting may make it difficult for the dieter to avoid overeating. Under these circumstances, dieters are likely to eat more than their non-dieting counterparts.

Overeating in the absence of a food preload has also been reported in obese dieters (Wardle & Beales, 1988). However other studies have failed to find that dieters respond differently to preloads than restrained eaters (Lowe, 1994; Lowe, Foster, Kerzhnerman, Swain, & Wadden, 2001) or that dieting is associated with bouts of overeating (Presnell & Stice, 2003). It is noteworthy that in these studies, individuals were assigned to a 'dieting condition' as part of the experimental paradigm, as opposed to engaging in self-initiated dieting behaviour. This difference may be an important factor in the discrepancy in the behaviours reported. Prospective studies have confirmed that unsupported dieting, particularly involving radical restraint-related behaviours, such as the use of appetite suppressant and laxatives, is related to greater risk of obesity (Stice, Cameron, Killen, Hayward, & Taylor, 1999; Stice, Presnell, Shaw, & Rhode, 2005). On the other hand, dieting as part of group has been shown to be associated with greater weight loss and less weight gain (Blackburn, 1993) and less impairment in cognitive functioning (Green, Elliman, & Kretsch, 2005; see section 3.6.3.) than unsupported dieting. These differences are likely to be related to the fact that supported dieting as part of an 'official' weight loss program entails a healthier approach to eating behaviour, both nutritionally and psychologically, which may provide some defence against dieting-related susceptibility towards overeating.

2.5. THE ROLE OF ATTENTION IN THE REGULATION OF HUMAN EATING BEHAVIOUR

Central to Herman and Polivy's (1984) boundary model of eating regulation is the idea that overeating will occur when insufficient attention is paid to monitoring intake. Under such circumstances, restrained eaters may continue eating beyond their self-imposed cognitive diet boundary, ceasing only once their satiety boundary is reached. Although it is only the eating behaviour of restrained eaters that the boundary model conceptualises as involving cognitive control, evidence suggests that the intake of unrestrained eaters may also be influenced by the amount of attention that is allocated towards monitoring intake (see section 2.5.1.). The aim of the sections that follow is to review how the eating behaviour of both restrained and unrestrained eaters is affected when attention is directed towards or away from food intake.

2.5.1. Attention to amount eaten

Paying attention to what one is eating may be central to the successful regulation of food intake. Research has explored the effects on amount eaten of attending to both current and past intake and has found that both can be effective in inhibiting intake.

2.5.1.1. Effects of monitoring intake

In one of the first studies to explore the relationship between attention and amount eaten, Collins (1978) offered participants *ad libitum* access to food with either no instruction, or the instruction to record their intake before (i.e., how much they wanted to eat) or after eating all that they wished. A strong main effect of condition was found, with those who were not instructed to monitor their intake consuming more food than those who were. Polivy, Herman, Hackett, and Kuleshnyk (1986) also manipulated the attentional focus of restrained and unrestrained eaters during *ad libitum* access to food. This was achieved by having participants either dispose of their candy wrappers in a half-filled bin as they ate, or instructing them to leave

the wrappers on the table so that both they, and the experimenter, could easily see how much had been eaten. When cues indicating amount eaten were made salient, the intake of both restrained and unrestrained eaters was inhibited. Consistent with this, a recent study found that participants consumed, on average, 73 per cent more soup when eating from self-refilling, compared to normal bowls, although estimates of amount eaten and reported satiety did not differ (Wansink, Painter, & North, 2004). This suggests that visual cues that help to make individuals aware of how much they are eating may be important in inhibiting intake. Indeed, the advice to focus on one's food while eating can often be found in many weight-loss dieting regimes. Therefore, one possibility is that the transgression of the diet boundary may occur passively when visual and/or cognitive cues that signal when to terminate a meal are overlooked. This is likely to be the case when eating occurs in conjunction with another task (see section 2.5.2.).

2.5.1.2. Effects of memory for recent meals

Further support for the possibility that intake is influenced by an awareness of one's eating behaviour also comes from research that has looked at the role of memory for recent meals in eating regulation. Studies of the eating behaviour of patients suffering from severe amnesia have found that not only is hunger rarely reported, but that it also rarely tends to change as a function of eating. Furthermore, these patients can consume extremely large amounts of food, eating multiple meals within a short duration of time (Hebben, Corkin, Eichenbaum, & Shedlack, 1985; Rozin, Dow, Moscovitch, & Rajaram, 1998). However, because the trauma suffered by these patients is severe, a clear link between memory loss and aberrant appetitive responses can not be ascertained with certainty.

Recently, in an interesting pair of studies, Higgs (2002; 2005) has begun to explore the role of memory in the eating behaviour of cerebrally-intact individuals. Specifically, unrestrained females. In the first study, participants were given lunch in the laboratory and then were asked to return between two and four hours later to take part in what ostensibly appeared to be a taste-test of cookies. Prior to the taste-test, half of the participants were instructed to think about their last meal and write

down their thoughts. The remaining participants were given no such instruction. Analysis of the amount eaten revealed that those participants cued to remember their last meal ate significantly less than those who had not been cued. In a similarly designed follow-up study, the effect of memory for a meal eaten the day before was also assessed. Inhibited intake was only found when the meal imagined was recent.

2.5.1.3. Summary

The results of these studies suggest that amount eaten can be inhibited when attention is focused on monitoring intake. Furthermore, this appears to be a general phenomenon, occurring across all individuals irrespective of their particular dietary strategies. In addition, by recollecting recently eaten meals, the amount eaten by unrestrained eaters can also be attenuated. The extent to which this effect similarly occurs in restrained eaters remains to be verified. However, this would appear to be a strong possibility, since inhibited intake in restrained eaters is considered to be most likely to occur when dietary goals are made salient (e.g., Herman & Polivy, 1993; Lowe, 1995). The following section focuses on the effects on amount eaten when attention is distracted away from monitoring intake.

2.5.2. Distraction and overeating

The effects of distraction on subsequent food intake have been studied in a number of ways. Broadly, these can be split into four main areas. Firstly, with regard to research predominantly focusing on the differences between restrained and unrestrained eaters, two areas of the literature are pertinent. Specifically, the effects of 1) extreme mood states, and 2) concurrent cognitive load. Other research has also been conducted that has tended, in the most part, not to include assessments of everyday dietary behaviour, but has explored the effects of eating while distracted across broad samples of the population. These studies have tended to focus on the effects of 3) television viewing, and 4) eating in groups. The literature relating to each of these four areas of research is reviewed in the following sections.

2.5.2.1. The effects of mood

Over the last few decades, a large body of research has accumulated documenting the effects of different mood states on the food intake of restrained and unrestrained eaters. Studies have investigated the effects of general dysphoric mood induced by task failure (e.g., Ruderman, 1985), anxiety (e.g., Herman & Polivy, 1975; Polivy, Herman, & McFarlane, 1994), depression (e.g., Baucom & Atkin, 1981; Frost, Goolkasian, Ely, & Blanchards, 1982), and most commonly, stress (for a review see Greeno & Wing, 1994). Stress has been induced in a variety of ways, including difficult cognitive tasks (Rutledge & Linden, 1998), ego-threats (e.g., via an ego-threatening Stroop task; Lattimore, 2001), and viewing unpleasant and fearful films (e.g., Cools, Schotte, & McNally, 1992; Schotte, Cools, & McNally, 1990). The overwhelming conclusion from these studies has been that restrained and unrestrained eaters respond very differently to extreme mood states - restrained eaters tend to overeat whereas unrestrained eaters tend to undereat, compared to baseline. These effects appear not to be isolated to the adult population, since increased snacking has also been reported in restrained, but not unrestrained children, after giving a videotaped speech (Roemmmich, Wright, & Epstein, 2002).

The results of these experimentally-induced mood manipulation studies are also supported by the findings from studies that are more naturalistic. For example, out of a sample of clinically depressed patients, Polivy and Herman (1976) found that restrained eaters gained weight, while the unrestrained patients lost weight. Evidence from food diary studies have also shown that elevated feelings of depression, anxiety, loneliness, and boredom precede bouts of overeating in dieting females (Cooper & Bowskill, 1986). Self-reported increases in eating and food intake during specific and general stressful events have also been found to be positively correlated with level of restraint (high or low; Weinstein, Shide, & Rolls, 1997) and dieting status (Oliver & Wardle, 1999), with particular increases in sweet and fatty foods during periods of high work stress (as indexed by hours worked per week; Wardle, Steptoe, Oliver, & Lipsey, 2000).

Explanations regarding the mechanism involved in mood-induced overeating have been varied. Physiological explanations have tended to focus around the hormone cortisol, which is secreted during stress and which has been linked with energy regulation. For example, Tataranni et al. (1996) found that food intake in men is dramatically increased by the administration of cortisol. Increased cortisol secretion in women during stress has also been linked with increased food intake, particularly of sweet, high-fat foods, but only in those who were 'high reactors'. When treated as a continuous variable, only a weak correlation between cortisol and food intake was found (Epel, Lapidus, McEwen, & Brownell, 2001). However, although increases in negative mood have been found to be related to increased food intake, such changes in mood do not appear to be related to cortisol reactivity. This implies that although the psychophysiological effects of stress may induce overeating, this may be independent of the effects of negative mood (Epel et al., 2001).

Alternative, psychological explanations include the view that distress-induced eating has a purposive response. That is, it serves to counteract the distress. Some evidence in support of this comes from a study by Polivy et al. (1994), who found that anxious restrained eaters increased their intake of both palatable and unpalatable food, suggesting that eating serves a functional purpose to relieve anxiety that is unrelated to how pleasant the food tastes. Furthermore, Tice, Bratslavsky, and Baumeister (2001) have shown that distress-induced eating can be eliminated if participants believe that their negative mood cannot be changed. Thus, removing the belief that eating enhances mood in turn removes the behaviour.

Although eating before examinations has also been reported as a means of distracting oneself from feelings of stress, tension, and fear (Macht, Haupt, & Ellgring, 2005), little evidence from real-world observations exists to confirm that stress-induced eating is actually associated with any decrease in stress levels (e.g., Wardle et al., 2000). Therefore, the validity of this behaviour as an affect-regulator is questionable. Furthermore, increased intake of unpalatable foods can be stimulated by factors other than mood. For example, simply distracting an individual with television has been shown to lead to increased intake of bad tasting popcorn (Wansink & Park, 2001). Therefore, one possible explanation for these results relates to the way in which the experience of extreme mood states impacts

upon attention. For example, ruminating thoughts related to current concerns tend to consume cognitive resource and are associated with impaired performance on concurrent cognitive tasks (e.g., Rogers & Green, 1993; see section 3.6.3.). In relation to the boundary model, these attention-consuming ruminating thoughts may undermine an individual's ability to monitor their food intake, leading to bouts of eating that continue until the satiety boundary is reached. Indirect support for this idea can be gained from a study by Seddon and Berry (1996) who found that restrained eaters who watched advertisements containing stereotypical images of culturally idealized women ate more food than those who had watched advertisements containing no such images. Because these differences in intake were not mediated by reductions in self-esteem, it is likely that it is through the effects on attention, rather than negative self-affect, that diet- and body-related thoughts undermine dietary control. Similar support can be found in studies that have found overeating during positive mood states, suggesting that negative thoughts may not be the only route through which attention to dietary control is undermined. For example, Cools et al. (1992) found that in addition to fear, feelings of jollity also increased intake compared to a no-mood manipulation. Consistent with this, Patel and Schlundt (2001) found that both positive and negative moods significantly increased food intake in obese women, with a greater effect size observed for the positive compared to negative moods. Furthermore, E. Dove (personal communication, 9th September 2005) has also observed that participants attending a weight-reduction clinic report being distracted during bouts of overeating when stressed. Taken together, these findings suggest that overeating during intense mood states may not be related to the valence of the mood per se, but more to the general effects of mood on attentional resources.

In relation to this idea, a more 'active' explanation comes from the 'escape theory of self-awareness' (Heatherton & Baumeister, 1991), which proposes that when faced with a threat to self, the individual consciously narrows their focus of attention to the immediate environment in order to escape from aversive self-awareness. As a result, meaningful thought is avoided and the normal inhibitions placed on eating (e.g., the diet boundary) are undermined. Thus, with no attention allocated to maintaining dietary control, overeating is likely to occur. In a discussion of this possibility, Schotte (1992) has suggested that ego-threat is not a

prerequisite for overeating, but rather it is the individual's cognitive response to such ego-threats that mediates the effects on food consumption. In response, Heatherton, Herman, and Polivy (1992) have argued that distress-induced overeating does involve reduced self-awareness, but concede that this escape can be both an active and a passive response. That is, an individual may actively narrow their attention to escape from self-awareness, or the distress-inducing procedure itself (e.g., a frightening film) may provide the means by which the individual can 'lose themselves' and for attention to be passively distracted from dietary control.

Lattimore and Maxwell (2004) and Wallis and Hetherington (2004) have both investigated the alternative possibilities that overeating during stress results from either general distraction or as the result of a motivated escape. In both studies, restrained and unrestrained eaters took part in a taste-test after performing variations of the Stroop Task (Stroop, 1935). In the Stroop Task, participants are required to name the colour of ink in which various words appear and the response times to do so are measured. Wallis and Hetherington (2004) investigated the competing hypotheses that overeating results from ego-threat versus reduced attentional capacity by asking participants to perform three Stroop Tasks; an emotional/stress Stroop Task, in which the colour of ego-threatening words had to be identified; an incongruent Stroop Task, in which the colour of colour-name words had to be identified; and a control Stroop Task, in which the colour of neutral words had to be identified. In the case of the incongruent Stroop Task, the written colour word and the colour of the ink in which it appeared did not match (e.g., the word 'pink' appeared written in green). Under these conditions, a high level of cognitive demand is required to correctly colour-name the word as attentional resources must attenuate competing information (for a review on the Stroop effect see MacLeod, 1991). Analysis of response latencies across the three tasks revealed that the incongruent task required the greatest attentional focus. In terms of food intake, significantly more food was consumed after this task (15%) and the ego-threatening task (23%) compared to the neutral task. Amount eaten was compared between restrained and unrestrained eaters on the basis of both their restraint score and their score on the emotional eating scale of the DEBQ. In general, high-restrained eaters ate more after both the ego-threatening and incongruent tasks, compared to the neutral task, while the intake of high emotional eaters was greater

only after the ego-threatening task. Furthermore, in restrained eaters (with simultaneous low emotional eating scores), response latencies were found to be positively related to amount eaten, suggesting that when attentional demands were high, monitoring of dietary restraint was undermined. In relation to the competing hypotheses, the authors conclude that overeating may be unrelated to the experience of threat-induced stress per se, but rather to an impaired ability to monitor intake. In this regard, they argue that both mechanisms of passive distraction and active escape may be involved in overeating in restrained and emotional eaters, respectively.

The study by Lattimore and Maxwell (2004) similarly concluded that both the escape theory and a more general limited attentional capacity model might be involved in stress-induced overeating. In this study, participants were asked to complete a Stroop Task that involved colour-naming either emotionally neutral or ego-threatening words. Cognitive load was manipulated by instructing half of the participants to additionally memorise the words (high load). In the taste-test that followed, restrained eaters in the ego-threatening high cognitive load condition consumed more food than unrestrained eaters in the same condition, and restrained eaters in the high cognitive load condition that required memorisation of neutral words. This result was interpreted as supporting the escape theory since ego-threat appeared to be important in triggering overeating. However, contrary to the predictions of escape theory, analysis of anxiety ratings taken before and after completion of the Stroop Tasks revealed that increased anxiety did not accompany overeating. Therefore, the authors have concluded that a more general model of overeating based on attentional capacity limitations cannot be ruled out and may in fact subsume other more focused explanations, such as the escape theory. Further indirect evidence for this conclusion comes from the finding that while stressful tasks increase anxiety in both restrained and unrestrained eaters, only the amount eaten by restrained eaters is increased during a distracting and cognitively demanding task (Lattimore & Caswell, 2004).

2.5.2.2. *Effects of cognitive load*

A small number of studies have directly investigated the effect of simple, cognitive distracters on the ability to monitor food intake and the subsequent amount of food eaten. In the first of these, Boon, Stroebe, Schut, and Jansen (1997) found no evidence to support the idea that distraction from one's diet results in overconsumption. In two experiments, restrained and unrestrained participants took part in an ice-cream taste-test, while either distracted or not distracted. The distraction task consisted of listening to a radio conversation (that the participants were told they would have to answer questions about afterwards) and to count the number of animal words that featured. In both experiments, no differences in intake were found between restrained and unrestrained eaters, between distracted and non-distracted participants, nor were any significant interactions between the two reported. As a consequence, Boon et al. (1997) raised the question as to how valid Herman and Polivy's (1984) boundary model was, since it implies that cognitive load should induce overeating. However, Boon et al.'s sample included very few individuals that had particularly high restraint scores, and so the absence of any significant effect may be a consequence of sampling.

A subsequent study, incorporating perceived calorie content ('high' versus 'low') as an additional 'distracter', did find evidence that intake may be related to attention. Boon, Stroebe, Schut, and Ijntema (2002) found that when participants were distracted *and* were given a high-calorie food ('double' load), restrained eaters ate significantly more than did unrestrained eaters. When distracted but given a low calorie food ('single' load), the intake of the two groups did not differ significantly. In addition, overall, both restrained and unrestrained eaters ate significantly more when distracted compared to when not distracted. Two further experiments by Ward and Mann (2000) and a subsequent study by Mann and Ward (2004) also provide support for the hypothesis that cognitive load limits an individual's ability to monitor their food intake, thus leading to increased intake. These studies are based on the concept of alcohol myopia (Steele & Josephs, 1990), whereby intoxication narrows the focus of attention such that behaviour is influenced by the instigating pressures that would otherwise be inhibited when sober. In relation to eating behaviour, the authors have shown that high cognitive load narrows attention to the

instigating pressure to eat, at the expense of the inhibiting pressure to maintain restraint. In the first two studies, participants were asked to take part in a taste-test while at the same time responding to a reaction-time task. Cognitive load was manipulated by additionally asking half of the participants to memorise a series of art slides. In both experiments, restrained eaters ate significantly more food when under high, compared to low, cognitive load, supporting the hypothesis that overeating may occur when competing task-demands consume attention leaving little left to monitor and maintain cognitive restraint (Ward & Mann, 2000). On both occasions, unrestrained eaters exhibited the converse behaviour. In the third study (Mann & Ward, 2004), highly-restrained participants only were asked to remember either a one-digit (low load) or a nine-digit (high-load) number during a milkshake test-test. The authors found that food intake was greater under high compared to low cognitive load. However, overeating under high cognitive load could be prevented if the participant's attention was directed towards their dietary behaviour. In this study, this was achieved by asking participants to complete the restraint scale of the DEBQ, having them sit in a room with diet-salient stimuli such as weighing scales, and telling them that the milkshake was high in calories. Taken together, the results of these studies provide support for the idea that passive overeating is likely to occur when insufficient attention is allocated to monitoring food intake.

2.5.2.3. Effects of television viewing

The recent rise in overweight and obesity has led to a large body of research investigating the environmental factors that may play a contributory role (for a review see Stroebele & De Castro, 2004a, and Wansink, 2004). As a result, the effects of more 'real-life' distracters have been studied, both inside and outside of the laboratory. One of the most common forms of distraction while eating is television viewing. A number of studies have found that eating while watching television is associated with increased caloric intake (e.g., Jeffery & French, 1998; Poothullil, 2002), snacking (French, Story, & Jeffery, 2001; Gore, Foster, DiLillo, Kirk, & Smith West, 2003; Tucker & Bagwell, 1991; Tucker & Friedman, 1989) and meal frequency (Stroebele & De Castro, 2004b). Television viewing has even

been found to be associated with meal initiation in the absence of hunger (Stroebele & De Castro, 2004b) and with the consumption of large quantities of bad tasting popcorn (Wansink & Park, 2001). The effect of listening to auditory stimuli on food intake (e.g., a recorded detective story, Bellisle & Dalix, 2001) has been shown to be comparable to that of watching television (Bellisle, Dalix, & Slama, 2004).

Studies with children have also found that television viewing is associated with greater food intake, especially of higher-fat foods (Coon, Goldberg, Rogers, & Tucker, 2001), and with more frequent between-meal snacking (Clancy-Hepburn, Hickey, & Nevill, 1974; Del Toro & Greenberg, 1989; Francis & Birch, 2004). Hours spent watching television has been correlated with rates of obesity in children (Dietz & Gortmaker, 1985; Hill & Peters, 1998). These observations may be confounded by the general lack of physical activity that co-occurs with television viewing and which is implicated as a cause of, and a sustaining factor in, obesity (e.g., Wlodek & Gonzales, 2003). However, a recent study that followed a cohort of 133 3- and 4-year old children for three years has reported that BMI at aged six is poorly predicted by physical activity. Rather, it is better predicted by BMI at the beginning of the study, and hours spent watching television (Jago, Baranowski, & Baranowski, 2004).

The majority of these studies have included no assessment of the extent to which these effects can be predicted by restrained eating. Those that have, have found contradictory results. For example, in one study, Bellisle and Dalix (2001) found a correlation between meal size when distracted and TFEQ-restraint scores. However, in a replication they found no such association (Bellisle et al., 2004). While there is evidence that dietary restraint can emerge at a young age (Shunk & Birch, 2004) and questionnaires designed to assess restrained eating in adults have been modified for use with children (e.g., Carper, Orlet, & Birch, 2000), it would seem unlikely that the relationship between food intake and television viewing observed in children can be accounted for by the effects of the restrictive dietary practices of a minority. Rather, in addition to ‘disinhibiting’ the efforts of restrained eaters to maintain dietary control, distraction while eating is also likely to have a more generic stimulatory effect on the eating behaviour of all individuals.

2.5.2.4. Effects of eating in groups

Another form of distraction during a meal is the presence of other people. Early laboratory-based studies explored the effects of the presence of a confederate who either under- or over-ate. Nisbett and Storms (1974) found that when paired with a low-intake model, individuals ate 29 per cent less than when alone. Conversely, when paired with a high-intake model, they ate 25 per cent more than when alone. Similarly, individuals have been found to eat faster and consume more food in the presence of a fast-eating/high-consumption companion, than in the presence of a slow-eating/low-consumption companion (Rosenthal & Marx, 1979; Rosenthal & McSweeney, 1979). The characteristics of the confederate have also been shown to be influential, with females eating less in the presence of a good-looking male confederate (Mori, Chaiken, & Pliner, 1987) and obese individuals eating more when the confederate was also obese, compared to lean (De Luca & Spigelman, 1979). These studies have focussed on the role of models, rather than distraction per se, and suggest that socially derived norms can account for increased or decreased intake in the presence of others (Herman, Roth, & Polivy, 2003). However, they are important as they suggest that intake is likely to be inhibited when attention is focussed on eating behaviour.

The effect of eating with non-confederates has also been studied. Berry, Beatty, and Klesges (1985) found that the ice-cream consumption of both males and females was increased when eaten in groups of three or four, compared to when eaten alone. Clendenen, Herman, and Polivy (1994) looked at differences in intake when meals were eaten while either alone, with one, or with three other people, and when these were either friends or strangers. Almost double the amount of food was eaten when meals were consumed with others, and those eating with friends ate more dessert than those eating with strangers. Dietary restraint was found to have no effect. The authors suggest that while the mere presence of others can lead to increased intake, this effect may be mediated by the degree of acquaintance between the individuals. This may be because individuals are less concerned about their self-presentation when with friends, and so focus less on their eating behaviour.

More naturalistic investigations of this effect have also been conducted, and observational data from work-site cafeterias, fast-food restaurants and traditional restaurants confirms that individuals tend to eat more when in groups than when alone (Bell & Pliner, 2003; Klesges, Bartsch, Norwood, Kautzman, & Haugrud, 1997). The most substantial amount of work in this area has been conducted by De Castro and colleagues (for a review see De Castro, 1997). Over a series of food diary studies, social facilitation effects on the amount of food consumed have been reported during meals eaten on both weekdays and weekends (De Castro, 1991a; 1991b); at breakfast, lunch, and dinner; in restaurants, at home, and elsewhere; and eaten with or without alcohol (De Castro et al., 1990). De Castro and colleagues have also shown that food intake tends to increase as a function of the number of people present, with increases of over 60 and 70 per cent reported for meals eaten with others compared to those eaten alone (De Castro & Brewer, 1992; Redd & De Castro, 1992). This is believed to occur as a result of an increase in the duration of the meal (De Castro, 1990; 1994; Feunekes, De Graaf, & Van Staveren, 1995; Sommer & Steele, 1997), although meals in the presence of spouse or family tend to be larger due to increased eating rate (De Castro, 1994). Meal duration is likely to increase as a result of social interaction. The widely accepted ‘time extension’ explanation is that the more people present, the longer the meal takes, and the longer the meal takes, the greater the intake. However, this explanation does not shed light on *why* a longer meal should increase intake per se. One possibility is that social interaction, being enjoyable and relaxing, increases meal duration by reducing an individual’s ability (or motivation) to monitor consumption and, as a result, the usual cognitive inhibitions on intake are undermined. An alternative explanation is that satiety signals, such as the decline in the pleasantness of a food that occurs as it is eaten (see section 10.2.3.), are weakened when eating under such circumstances. This latter possibility is explored in Part II. Notwithstanding the nature of the mechanism involved, these studies suggest that attention is integral to the time extension model and to instances of overeating when distracted.

2.6. SUMMARY

It is becoming increasingly clear that human eating behaviour is a complex activity that is influenced by a number of important factors. Restrained eating appears to be associated with paradoxical bouts of overeating that can occur in response to a range of variables, such as ingestion or anticipation of food preloads, intense emotional states, and concurrent cognitive loads. In addition, evidence suggests that unrestrained eaters may be equally susceptible to the effects of distraction and that bouts of overeating under particular environmental conditions may be a general phenomenon to which the population as a whole is susceptible. The nature of the mechanism involved in overeating is as yet unclear. However, characteristic of those circumstances during which overeating occurs is a lack of attention to dietary control. The next chapter reviews evidence that impairments in cognitive functioning are brought about by the presence of preoccupying cognitions, which impair one's ability to attend to a task. Leaning on models of attention and theories of cognitive interference, this chapter goes on to review the extent to which overeating can similarly be viewed in terms of a limited capacity system.

CHAPTER 3: ATTENTION, COGNITIVE INTERFERENCE, AND DIETARY RESTRAINT

3.1. INTRODUCTION

As outlined in the previous chapter, a growing literature exists documenting the circumstances under which bouts of overeating are likely to occur. These include while watching television, engaged in cognitive tasks, eating in groups, or during periods of heightened emotional arousal. The reason why these factors have the potential to increase food intake is unclear. However, one possibility is that the successful regulation of food intake may be undermined when the demands of competing tasks leave insufficient attention to monitor this activity successfully. Although the results of those studies that have explored the relationship between attention and intake (e.g., Boon et al., 2002; Ward & Mann, 2000) have provided convincing support for this proposition, these studies have lacked the rigour found in more general experimental investigations of attention and related cognitive processes. The aim of this chapter is three-fold. Firstly, it will provide an overview of general models of attention and the ways in which efficient cognitive processing can be undermined by interfering cognitions and distraction. Secondly, it will review evidence that impaired cognitive functioning in dieting and restrained eaters results from food- and diet-related preoccupying cognitions. This will then be followed by a final section that considers how this literature might be useful in understanding the mechanisms involved in overeating.

3.2. ATTENTION

The term ‘attention’ is most commonly used to refer to selectivity of processing. Because we are incapable of attending to all of the information that is received by our senses at any one time, attentional processes help us to focus on the important information and to ignore the trivial. Attention can be controlled by both ‘active’ and ‘passive’ processes (James, 1890, cited in Eysenck & Keane, 2000). Active

control occurs under those circumstances where it is the individual's goals that dictate the focus of attention (e.g., reading). In contrast, when the focus of attention is commanded by external stimuli (e.g., a loud noise), this is referred to as passive control. Since passive control does not require any processing effort to decide which stimuli to attend to, it is believed to occur at a faster rate than active control (Yantis, 1998). Active control can take the form of either focused or divided attention. These two types of attention are reviewed in the sections that follow.

3.2.1. Focused attention

Research on focused attention began with the investigation of what has been termed the 'cocktail party effect' (Cherry, 1953). This refers to the phenomenon whereby individuals are able to attend to a single conversation when several conversations are occurring at once. Cherry (1953) found that attention to a given conversation can only be maintained when the attributes of the speaker (e.g., gender, loudness of voice) differ from those of the other speakers. From this, it was concluded that non-attended information receives little attentional processing beyond that of its physical characteristics. This conclusion was further supported by the results of an experiment in which two auditory messages were presented simultaneously, one of which the participant was required to 'shadow' (repeat aloud). Little information regarding the meaning of the 'non-shadowed' message could be recalled, nor were changes in the language in which this message was spoken noted. However, individuals were aware when the message changed from speech to a pure tone (Cherry, 1953).

Using a dichotic listening task, Broadbent (1958) also found that when participants were asked to listen to and recall strings of digits, with the presentation of each digit alternated between ears, recall tended not to be based on the order in which the digits were heard, but rather according to the ear of presentation. This led Broadbent (1958) to propose the 'filter theory'. This postulated that early on in processing, information is either attended to or rejected on the basis of its physical characteristics. However, further studies failed to support this claim. For example, using a dichotic listening task, Gray and Wedderburn (1960) found that information

is not always recalled on the basis of the ear of presentation. Rather, when ‘who 6 there’ was presented to one ear and ‘4 goes 1’ was presented to the other, recall tended to be determined by meaning (i.e., recalled as ‘who goes there’ and ‘4, 6, 1’). In addition, in shadowing studies, non-attended information can be recalled if it is presented in a different sensory modality to that which is being shadowed (e.g., visual versus auditory; Allport, Antonis, & Reynolds, 1972). Therefore, these results suggests that non-attended information is processed more fully than Broadbent’s (1958) early filter theory predicted.

Following this, alternative ‘early filter’ theories were proposed which suggested that the filter may not discard non-attended information, but simply reduce the extent to which it is processed (Treisman, 1964), processing only as much as is required to complete the task, therefore minimising demands on processing capacity (Johnston & Heinz, 1978). In contrast, Deutsch and Deutsch (1963) proposed a ‘late selection’ theory. In this model, all information is processed, and the response is determined by the information that is most relevant. In tests of this latter theory, that involved shadowing one of two simultaneously presented auditory messages and responding to target stimuli in each one, no evidence has been found to support the idea that targets are equally processed and thus equally detected in both messages (Treisman & Geffen, 1967; Treisman & Riley, 1969). Rather, as would be predicted by Treisman (1964) some, but a great deal less, of the target words are detected in the non-shadowed message.

3.2.2. Divided attention

In order to perform two tasks simultaneously, attention must be divided between the two. Welford (1952) argued that performance under dual-task conditions is difficult because of a ‘bottleneck’ in the processing system that makes it hard for responses to two stimuli to be made at once. The ‘psychological refractory period’ refers to the phenomenon whereby if a stimulus to which one is required to respond is followed in close temporal proximity by another stimulus, responding to the latter stimulus will be slowed (Welford, 1952). An alternative explanation is that performance under dual-task conditions may be impaired because of the effects of

interference when two tasks are similar. In a review of the literature, Wickens (1984) has shown that the degree of similarity between tasks is important. For example, when two tasks that require monitoring of target stimuli are presented in the same stimulus modality (e.g., both auditory) performance on one or both is impaired, compared to when the two tasks are from different sensory modalities (e.g., visual and auditory; Treisman & Davies, 1973). Similarly, performance also tends to be poorer if the two tasks share a specific processing component (e.g., they both require a speeded motor response; McLeod, 1977; Pashler, 1990). However, impairments are less likely when one or both of the tasks is well practised. For example, an expert typist can type and shadow speech at the same time (e.g., Shaffer, 1975) – two tasks that would otherwise be expected to be performed poorly due to the similarity in the sensory modality. In some ways, divided and focused attention can be viewed as similar processes, since those aspects of a task that make focussed attention easier (e.g., sensory dissimilarity) are often the same ones that aid performance when attention must be divided.

However, interference effects have been found in tasks that appear to share nothing in common. For example, silent reading interferes with tone detection (Eriksen & Johnson, 1964) and mental arithmetic interferes with perception (Reisberg, 1983). Allport (1980) has suggested that this may be because the similarity in cognitive processing between them has not yet been identified, while Navon (1984) has suggested that it may be the side-effects of two seemingly dissimilar tasks that are interfering with each other. However, in two studies, each involving 12 dual-task combinations of four tasks, that avoided known sources of specific interference, Bourke, Duncan, and Nimmo-Smith (1996) explored the possibility that interference is due to demands on a single common resource. The common resource was characterised as being i) limited, ii) of a fixed amount, iii) split entirely between two tasks, and iv) producing improved performance as its involvement in a given task increases. The results indicated that performance on a primary task varied as a function of the demands of a concurrent, secondary task. From this, a measure of overall task ‘demand’ could be inferred which reflects how strongly it would interfere with any dissimilar task. Although the nature of the general limiting factor is not identified, the results of this study suggest that cognitive functioning may involve a limited pool of processing resources. This is consistent with the

results of studies that have found that performance on one task is inversely related to the difficulty of the other (e.g., Sullivan, 1976).

3.3. LIMITED CAPACITY MODELS OF ATTENTION

Studies of dual-task performance support the idea that attention is a limited cognitive resource. Conceptualised in this way, the extent to which two tasks can be performed together depends on the extent to which each task demands attentional resources. If the combined demands of both tasks do not exceed the limits of the available resource, then performance on both will be unaffected. However, if the limit is exceeded, performance will be disrupted (Norman & Bobrow, 1975). A number of 'limited capacity theories' have been put forth in an attempt to describe the nature of this process. For example, Moray (1967) and Kahneman (1973) both advocate the existence of a general attentional resource that is of limited capacity. However, in both cases, the specific terms used are poorly-defined and no direct evidence to support these hypotheses has been put forth.

Allport (1989) has argued against the view that there is a single, central attentional resource and has instead proposed that attentional functions might be spread across a range of specialised sub-systems. Taking this perspective, it is clear why performance on similar tasks - that would load onto the same sub-system - would be impaired, while performance on tasks that utilise resources from different sub-systems would be unaffected by interference. Again, a limitation of this model is that the number and nature of the specific sub-systems has not been defined. A similar explanation that has gone some way to try and conceptualise the separate sub-systems that might be involved is the working memory model (Baddeley, 1986; 2000; Baddeley & Hitch, 1974). This model has become one of the central constructs in experimental psychology and has been extensively applied to many different areas of research, including cognitive psychology (e.g., Smith & Jonides, 1997), developmental psychology (e.g., Rasmussen & Bisanz, 2005), neuropsychology (e.g., Gruber & Goschke, 2004), and computational modelling (e.g., Cooper, Fox, Farrington & Shallice, 1996). It was originally envisaged as a three-component system. At the centre is a core attentional control system, called

the central executive, which is responsible for monitoring and coordinating performance on a wide range of tasks. Two sub-components, or slave systems, known as the phonological loop and the visuo-spatial sketchpad, are proposed to assist the central executive with the storage and processing of visual and verbal information, respectively. More recently, a new component has been proposed – the episodic buffer (Baddeley, 2000), which is conceptualised as a store that temporarily holds information integrated from a variety of sources. The most important aspect of the central executive, and the three sub-components, is that they all have a limited capacity. Thus, the level of processing that can occur is related to, and constrained by, the amount of cognitive resource that is available within each sub-system. For example, tasks that load onto the visuo-spatial sketchpad, such as spatial tapping, can impair ability to accurately recall patterns (Barton, Matthews, Farmer, & Belyavin, 1995) or reduce imagery vividness (Baddeley & Andrade, 2000). Similarly, language comprehension ability is disrupted by sub-vocal rehearsal, both of which load onto the phonological loop (see Baddeley & Hitch, 1996).

The most important component of the working memory model, in terms of its general influence on cognitive functioning, is the central executive. However, somewhat paradoxically, this has remained the least studied component. This is in part due to the fact that the description of the central executive is vague and it has been used as a ‘ragbag’ (Baddeley, 1996) to account for all instances of strategy selection, planning, and retrieval checking that occur with even the simplest of tasks. However, attempts to specify the central executive in more detail have been made. Baddeley (1986) drew upon Norman and Shallice’s (1986) model of attentional control in an attempt to conceptualise how the central executive - as an attentional controller - might integrate and control action. Norman and Shallice’s (1986) model postulates that a variety of processes are used in action and thought-processes. In the execution of routine activities, a number of automatic schemas (program-like entities that represent well-learned behaviours) may be activated and a mechanism known as ‘contention-scheduling’ selects from the potentially demanding competing schemas which one is to be operative. However, under more novel circumstances, a separate system - the Supervisory Attentional System - takes over, which modulates the operation of content scheduling by providing additional

activation or inhibition of competing schemas. The central executive may work in a similar way, overseeing and readjusting the amount of attention that is allocated to various tasks depending on the circumstances and the demands of competing activities.

3.4. AUTOMATIC PROCESSING

As mentioned previously (see section 3.2.2.), under dual-task conditions, if one of the tasks is well practiced, performance can be improved. The commonest explanation for this phenomenon is that increasing practice leads to some of the processing requirements of the task becoming automatic. As a result, less resource is required to perform this task, leaving more available to allocate to the successful performance of the other, concurrent task. Based on this, a distinction has been drawn between controlled and automatic processing. Shiffrin and Schneider (1977) and Schneider and Shiffrin (1977) suggest that controlled processes have three distinct features. They are i) of limited capacity, ii) require attention, and iii) can be used flexibly in response to changing circumstances. In contrast, automatic processes have no capacity limitations, do not require attention, and are less flexible, being difficult to modify once they have been learned. Over a series of studies, Shiffrin and Schneider (1977) have shown that performance on memory tasks is improved following practice. However, these results are only able to offer a description rather than an explanation of the underlying mechanism. For example, it is unclear whether performance is improved due to a speeding up of the processing involved, or because of an actual change in the type of processing that occurs (e.g., by using short-cuts; Cheng, 1985). Norman and Shallice's (1986) model described previously (see section 3.3.) provides a further framework which also distinguishes between controlled and automatic processes. However, it goes further to separate 'completely' automatic processing (driven by schemas) from 'partially' automatic processing (involving contention scheduling). In this regard, this model provides a more convincing explanation for the fact that some processes are automatic to a greater or lesser extent.

3.4.1. Interference effects

The studies by Shiffrin and Schneider (1977) also found that in addition to aiding performance, automatic processing can also be a hindrance. For example, when the aims of a task change, the automatic shifts in attention that once enabled the task to be performed at speed, may no longer be appropriate and may even lead to errors. Under these circumstances, automatic processing may be considered to be a source of interference.

Automatic processing may not only occur as a result of repeated practice. Rather, attention may automatically shift when stimuli is encountered that is salient, even if this disrupts an individual's ability to perform the task at hand. Klinger (1975) argues that salient stimuli are likely to be related to an individual's 'current concerns', a term used to refer to the cognitive state that occurs from the moment the decision to pursue a goal is taken, to the point at which achievement of, or disengagement from, that goal occurs. During this period, individuals are thought to become sensitised to cues related to their current concerns – that is, they are more emotionally reactive to these cues. As a result, when such a cue is encountered, responses are initiated that strive towards achieving the goal. Under most circumstances, these take the form of an interfering cognitive response whereby thoughts shift away from the original focus of attention, to the current concern.

Klinger (1978) illustrated this phenomenon using a dichotic listening task. Participants were asked to listen to two simultaneously presented 15-minute narratives, one to each ear. Participants used a toggle switch to signal to which ear they were currently listening. At intervals, one of the narratives was modified by inserting words that would be associated with a current concern, while words that would be associated with a non-concern were inserted into the other narrative. A few seconds after concern or non-concern words were presented, the narrative was interrupted and participants were asked to report the last thing that they remembered hearing and their last thoughts. The results revealed that concern-related cues elicited attention since the participants spent more time listening to narratives associated with concerns, recalled those narratives much more often, and reported more thoughts related to these concerns.

Further studies have emphasised the automatic nature of such interference. For example, Hoelscher, Klinger, and Barta (1981) read words or phrases relating to concern- or non-concern-related cues to participants while they slept. They found that upon waking, participants reported more dreams relating to concern-related cues than to non-concern-related cues, suggesting that the effects of concern-related cues on cognitive processing occur without the intercession of waking consciousness or of deliberate decision-making. Similarly, Young (1987; cited in Sarason, Pierce, & Sarason, 1996) showed that the interference effect is not suppressed by inattention. Participants were instructed to respond as quickly as possible, by pressing a button on a computer keyboard, whenever a letter string presented on screen was considered to be an English word. To the left of the letter strings, random words were presented which the participants were instructed to ignore. On occasion, a word related to a concern would appear. Under these circumstances, the time taken to correctly identify a target letter string as an English word was significantly slower than when a non-concern-related word appeared. Thus, even when presented peripherally and participants are instructed to ignore them, salient, concern-related stimuli seem to impose an extra cognitive-processing load that interferes with performance on the main task.

The Stroop task (Stroop, 1935) has been used widely in a number of cognitive research domains to assess automatic processing. In the original version of this task, participants are asked to name the colour of the ink in which a word is written. The words themselves describe colours, which may (e.g., the word 'blue' written in blue ink) or may not (e.g., the word 'yellow' written in blue ink) correspond to the colour of the ink. The time taken to colour name the word is taken as an index of the amount of cognitive interference experienced. Despite the conscious desire to ignore the word, unconscious activation of the word-meaning occurs, interfering with the participant's ability to accurately and efficiently report the colour that they see. Taking the examples cited above, where the words are written in blue ink, colour-naming latencies would be expected to be longer to name the word 'yellow' than the word 'blue'. Because this activation occurs in direct opposition to the participant's intentions, investigators have argued that the activation of the word

occurs automatically and is outside of direct control (for a comprehensive review on the Stroop effect see MacLeod, 1991).

Research with non-colour-related words has also shown that activation of the semantic meaning of the words can interfere with colour-naming ability. For example, individuals who have difficulty controlling their gambling behaviour have been found to suffer cognitive interference when presented with gambling-related words (Boyer & Dickerson, 2003). Other abstinent behaviours have also been found to be associated with significant interference effects. Johnsen, Laberg, Cox, Vaksdal and Hugdahl (1994) asked alcoholics to colour-name neutral (e.g., 'window'), alcohol-related (e.g., 'whiskey'), or mismatched colour words (e.g., 'green' written in yellow). For the alcoholics, reaction times were slower to name the colour of alcohol-related words than of neutral words, presumably because these words were concern-related. Similarly, abstinent smokers have been found to take longer to colour-name smoking-related words than do non-abstinent smokers (Gross, Jarvik, & Rosenblatt, 1993). One model taken from the literature on drug addiction to explain this phenomenon is that proposed by Tiffany (1990). In this model, urges and drug-use behaviours are conceptualised as non-automatic processes that are triggered by automatic action schema. With regard to cigarette smoking, automatic action schema are smoking-related cues, such as the sight or smell of cigarettes. These cues trigger urges that are either in support of the action schema (e.g., I would like to smoke a cigarette now) or attempt to block the action schema (e.g., I do not need, and will not smoke, a cigarette now). Because these urges are non-automatic, they consume processing resources, leaving fewer resources available to deal with the demands of other tasks. Consistent with this, performance on tasks that require non-automatic processing is impaired when cues are present that elicit urges in abstinent drug users (Juliano & Brandon, 1998; Madden & Zwaan, 2001; Zwaan & Truitt, 1998).

3.5. INTERIM SUMMARY

The research reviewed in the preceding sections provides a theoretical overview of attention and the ways in which this can be disrupted by concurrent cognitive

demands. The evidence suggests that in almost all cases, the performance of one task will interact with the performance of another (Norman & Bobrow, 1975). Impaired performance under dual-task conditions is believed to be related to the requirement to share limited cognitive resources across two tasks. Similarly, interfering cognitions induced by salient stimuli or ruminating concerns also disrupt performance by consuming cognitive resources otherwise required to attend to the task. Such ‘limited capacity’ accounts lend themselves to the idea that performance on one task might be used as a proxy for attention to another. This notion is developed further in Experiments 1 and 2 in an attempt to explore the nature of the cognitive process that links distraction with eating behaviour (see section 4.3.).

As stated in section 2.3., dietary restraint is a cognitive activity. It requires the constant cognitive monitoring of food intake against a self-imposed ‘diet boundary’ and the food choices of restrained eaters tend to be heavily influenced by cognitions and beliefs (e.g., Aaron, Mela, & Evans, 1994; Brunstrom & Mitchell, under review). By dint of the fact that restrained eaters allocate more attention to dietary control than unrestrained eaters, it follows that restrained eaters may also exhibit greater impairments under dual-task conditions, as a result of an attenuation of the amount of available cognitive resource. They are also likely to be more susceptible to interfering cognitions related to their ‘current concerns’ (Klinger, 1975), the processing of which also limits cognitive capacity. The following section reviews evidence from a number of different paradigms that have examined the extent to which the performance of dieting and restrained eaters is impaired by the presence of interfering cognitions.

3.6. AUTOMATIC INTERFERENCE IN DIETING, RESTRAINED, AND UNRESTRAINED EATERS

3.6.1. Evidence from the Stroop paradigm

Applied to the concept of restrained eating, those concern-related cues capable of preoccupying attention are likely to take the form of food-, diet-, and body-image-

related stimuli. A number of studies have assessed the cognitive interference effect in restrained eaters and dieters using variations of the Stroop paradigm. Green and Rogers (1993) assessed the time taken to colour-name food-related, body-shape-related, and neutral words in groups of females who were classified as either dieting, non-dieting highly-restrained, or non-dieting low-to-medium restrained eaters. Compared to the low-to-medium restrained eaters, the dieters and highly-restrained non-dieters exhibited significant impairments in colour-naming latencies for the food- and body-shape related words, compared to the neutral words. Similar effects have also been shown to occur in children. From the age of 11 years, both normal weight (Green & McKenna, 1993; Lattimore, Thompson, & Halford, 2000) and obese females (Braet & Crombez, 2003) exhibit significant interference effects when colour-naming food- and/or body-shape-related words.

The idea that the Stroop effect is related to preoccupying cognitions as a result of food abstinence has been directly explored in a number of studies. Since dietary restraint is thought to be associated with restriction of 'forbidden' foods only, Francis, Stewart, and Hounsell (1997) compared the interference effects caused by forbidden (e.g., chips, chocolate, cake) and non-forbidden (e.g., soup, carrots, rice) food words in restrained and unrestrained eaters. Forbidden food words were not found to be associated with longer colour-naming latencies compared to non-forbidden food words in restrained eaters, but a general decrement, compared to unrestrained eaters, was found for the time taken to colour-name both types of food words. One explanation for this effect is that restrained eaters find all food stimuli distracting, not just that related to restricted foods, and that this may reflect the fact that they are in a state of extreme hunger. However, interference in colour-naming latencies for food words has only been observed after 24 hours or more of food restriction (Channon & Hayward, 1990; Green, Elliman, & Rogers, 1996; Stewart & Samoluk, 1997), and although fasting is not uncommon in restrained eaters, only a minority report eating nothing for periods of this duration (Phelps, Andrea, & Rizzo, 1994). An alternative possibility is that while under certain circumstances restraint-related interfering cognitions may reflect a preoccupation with the desire to eat certain foods, under others, the nature of the cognitions may reflect the threat associated with the stimuli. In this regard, the impaired colour-naming latencies observed in anorexic women with food-related words (Green, McKenna, & Desilva,

1994) are more likely to reflect preoccupations with the threat posed by the food, as opposed to a desire to eat it. Further support for this proposition comes from the results of a study by Mahamedi and Heatherton (1993). These authors found that colour-naming latencies for body-related words were significantly longer after consumption of a milk-shake preload, particularly in restrained eaters, possibly reflecting a preoccupation with dietary goals.

The Stroop paradigm requires participants to focus on, process, and respond to salient, concern-related stimuli that may induce preoccupying cognitions. Alternative paradigms whereby the presentation of concern-related stimuli occurs incidentally have also been found to impair performance, suggesting that this interference is a general phenomenon. Newman et al. (1993) conducted a series of experiments assessing the effects of peripherally presented concern-related cues on cognitive processing. The concern-related cues investigated were specific to three particular experimental groups. Thus, the cues were designed to remind i) anxious individuals of their anxieties, ii) individuals with self-concept problems of the discrepancy between the way in which they view themselves as being and how they think they ought to be, and iii) eating- and body-image-disordered individuals of their bodies. In each case, participants had to indicate, as quickly as possible, whether a target character string consisted of letters or digits. On each occasion, presentation of the target string followed that of a warning stimulus that was designed either to trigger the appropriate emotional response or to be neutral. On 75 per cent of the presentations, the strings appeared in the centre of the screen. For the remaining trials, they were presented in one of four peripheral locations. Following emotionally significant warning stimuli, response times to peripherally located strings were significantly slower than following neutral strings.

3.6.2. Evidence from cue-reactivity studies

Analogies are often drawn between the experiences of dieters and those attempting to abstain from drugs, be it alcohol, nicotine, or some other addictive substance. This is because the cognitive effects of abstinence are likely to be similar, irrespective of the substance in question. Indeed, the imagery process underlying

both drug and food craving has been shown to be visual as, consistent with the predictions of the working memory model (see section 3.3.), concurrent loading onto the visuo-spatial sketchpad (that is engaged during craving), is related to reduced craving (Harvey, Kemps, & Tiggemann, 2005; Kemps, Tiggemann, & Hart, 2005; Panabokke, May, Eade, Andrade, & Kavanagh, unpublished).

As a result of these similarities, explanations of drug-use patterns and urges have been applied to the study of restrictive eating behaviours. Green, Rogers, and Elliman (2000) investigated the extent to which Tiffany's (1990) cue reactivity model of drug urges and craving could account for the deficits in performance exhibited by individuals attempting to limit their food intake. Employing a procedure similar to that used to assess the effects of the presence and absence of salient smoking-related cues on the performance of abstinent smokers (Cepeda-Benito & Tiffany, 1996), 32 dieting females were asked to complete a set of cognitive tasks. Seventeen of the participants completed these tasks while in the presence of chocolate, while the remaining 15 females performed the tasks in the absence of chocolate. Despite the presence of salient food stimuli, no impairment in performance was found in the 'cued-group', compared to the 'non-cued group'. However, neither hunger nor desire to eat was increased by the presence of chocolate, indicating that this manipulation is likely to have been ineffective in inducing craving. A second experiment addressed this problem by directly manipulating the extent to which urge-related distracters were attended to. Rather than being an incidental aspect of the testing environment, in this experiment the urge-related distracter formed an integral part of the task itself, a procedure described by Tiffany (1990) and used by Cepeda-Benito and Tiffany (1996). Dieting, highly-restrained non-dieters, and low-to-medium restrained non-dieters were asked to perform a simple reaction-time task on two occasions; once while imagining their favourite holiday and again while imagining their favourite food (the order of which was counterbalanced across participants). Participants were instructed that the imagination of each scenario was their primary task, and that the reaction-time task was their secondary task. Analysis of the data from each reaction-time task revealed that when asked to imagine their favourite food, dieters and highly-restrained non-dieters were significantly slower in responding than the low-to-medium restrained eaters during the first three of the five reaction-time task

blocks. In contrast, no differences were observed between groups when asked to imagine their favourite holiday. Furthermore, a significant correlation was found between reaction times during the food scenario condition and self-reported level of desire to eat. Therefore, these results provide support for the notion that impairments in cognitive functioning observed in dieting and restrained eaters may be related to the activation of urges, which consume processing resources.

This fascinating perspective on dietary restraint was extended in a recent study that tested participants both before and after lunch (Brunstrom & Witcomb, 2004). Tiffany's (1990) model of drug craving predicts that once drugs are taken, the automatic action schema will no longer be activated and consequently cravings abate. The authors hypothesised that if Tiffany's (1990) hypothesis can generalise to dietary restraint, cognitive interference (resulting from the processing of urge-related cognitions) should be present only when tested in an abstemious state. When replete, these cognitions should not be present. Therefore, performance should be unimpaired. In line with this prediction, food imagery was found to cause an impairment in the reaction time performance of highly-restrained eaters, but only before, and not after, a sandwich lunch. Although this finding offers support to the idea that task-irrelevant, urge-related cognitions are dependent on the current energy status (deplete/replete) of the individual, evidence to the contrary suggests that other mechanisms may also be involved in the activation of preoccupying cognitions. For example, Jones and Rogers (2003) assessed performance on a battery of cognitive tasks both before and after eating a high-energy chocolate bar. Although ingestion of the chocolate bar reversed the effects of food-deprivation, and presumably abolished urge-related cognitions, performance was not improved. Rather, performance was further impaired by ingestion of the 'diet-threatening food', and dieters reported a significant increase in the number of food- and dieting-related thoughts that they experienced. Thus, it would appear that while food deprivation may induce preoccupying cognitions via cravings, food consumption might also lead to cognitive interference if ingestion is accompanied by feelings of anxiety or guilt. Consistent with this, Kavanagh, Andrade, and May (2005) have recently proposed the 'Elaborated Intrusion Theory of Desire'. This theory proposes that it is not the initial intrusive urge-related thought that impairs cognitive functioning. Rather, it is the cognitive elaboration of these thoughts, which can be

either positive or negative, that consumes cognitive resource and leads to impaired performance on concurrent tasks.

3.6.3. Deficits on non-food-related cognitive tasks

The performance of dieting, restrained, and unrestrained eaters has also been studied on a range of cognitive tasks in the absence of food- or body-related stimuli. In the first of a series of studies to investigate differences in cognitive performance between groups, Rogers and Green (1993) compared the performance of dieting, non-dieting restrained and non-dieting unrestrained females on a version of the Bakan task (also known as the Rapid Visual Information Processing [RVIP] Task). In this task, single digits are presented on a computer screen in quick succession and participants are required to press the spacebar on the computer keyboard as quickly as possible whenever they see an unbroken series of three even or three odd digits (see section 4.3.2.). This task has a high memory load, requires sustained attention, and has been shown to be sensitive to a range of nutritional and pharmacological manipulations (Edwards, Wesnes, Warburton, & Gale, 1985; Kennedy & Scholey, 2004; Rogers, Green, & Edwards, 1992). The dieters were found to perform significantly worse than the non-dieters, and they also exhibited greater concerns about eating, body-weight and body-shape. These findings were replicated and extended in a subsequent study (Green, Rogers, Elliman, & Gatenby, 1994). Using an extended battery of tasks which assessed reaction time (Simple Reaction Time [SRT] task), memory (free recall task) and motor control/speed (two-finger tapping task), in addition to sustained attention (RVIP task), the performance of dieters was compared with that of low-to-medium, or highly-restrained non-dieters. On all tasks, with the exception of the two-finger tapping task, the dieters performed significantly poorer than the low-to-medium restrained group, while the performance of the highly-restrained females was intermediate between the two. The tapping rate of the dieters was significantly faster than that of the highly-restrained group, but did not differ significantly from the low-to-medium restrained group. This latter finding is important since it suggests that impaired performance on the RVIP, SRT, and free recall tasks can not be attributed to decreased motor ability or motivation to perform the tasks. Rather, the results

suggest that impaired performance is related to the effects of preoccupying cognitions associated with food and body-shape.

An alternative explanation for these results is related to the physiological effects of food restriction on cognitive functioning. The food diaries of the participants in Green et al.'s (1994) study indicated that the dieters were consuming approximately 30 per cent less calories than would have been required to maintain their current weight. However, self-reported food intake is notoriously susceptible to underreporting (see section 16.3.) and so the reliability of these food diaries is cause for speculation. Notwithstanding this, results of short-term fasting studies suggest that nutritional-related impairments are unlikely (for a review see Rogers & Lloyd, 1994), however preoccupations with food are not (Ogden, 1995). Rather, as suggested by the authors, impaired cognitive performance during dieting <http://www.sciencedirect.com/> - hit13 may be related to the stressful psychological effects of imposing and maintaining dietary restraint. Indeed, within the same individual, performance on the RVIP task, SRT task, and free recall task has been found to be impaired when dieting compared to when not dieting (Green & Rogers, 1995), despite the absence of any substantial reduction in BMI (approximately 1kg on average). Similarly, using the same tasks cited previously, in addition to a focussed attention task that assesses distractibility (Smith, 1991), Green, Elliman, and Rogers (1995) found that cognitive functioning did not differ across individuals who missed either one, two, or none of their meals during the 24-hour period prior to testing. Two-finger tapping performance did differ between groups, with those who had been food deprived for the longest exhibiting significantly slower tapping rates than those who had been deprived for a shorter period of time, or not at all. In addition to supporting claims that cognitive impairments in dieters may be unrelated to the physiological consequences of food restriction, this study also provides evidence to suggest that the psychological effects of food restriction are different depending on whether the diet is self-initiated and spontaneous, or imposed. No evidence for preoccupying cognitions was found in this experiment when participants were asked, as a volunteer, to restrict their food intake.

Similar findings have also been reported elsewhere. For example, Bryan and Tiggemann (2001) found little evidence of cognitive impairments in participants instructed to diet for 12 weeks, and actually reported increased psychological well-being in this group. The authors suggest that prescribed diets may not drain cognitive resources in the same way as self-initiated diets do, as they alleviate the need to think continuously about food intake and thus reduce the frequency of preoccupying cognitions. Consistent with this, Green et al. (2005) have recently reported impaired cognitive functioning and increased salivary cortisol levels only in those dieters who were engaged in self-initiated unsupported diets, as opposed to dieting as part of a group or not at all. Evidence from other areas of the restraint literature also suggests that unsupervised dieting is associated with poorer outcomes (i.e., less weight loss or more weight gain) than supervised dieting (Blackburn, 1993; see section 2.4.2.), possibly due to the effects of increased cognitive interference.

Therefore, preoccupying cognitions are considered to be inherent in restrained eating behaviour, and as recent research has confirmed, the psychological experience of deprivation is largely unrelated to actual caloric restriction (Timmerman, 2003). In this regard, restraint-related performance deficits might be conceptualised in a theoretically similar way to those related to anxiety. Models of anxiety-related performance deficits (see Segal, 1996) suggest that the critical reduction in information processing capacity does not come about from a narrowing of attention. Rather, as the literature related to models of attention and dual-task performance suggests, deficits occur within the cognitive system itself, as a result of processing task-irrelevant thoughts. The next section reviews evidence that impaired performance in dieting and restrained eaters is related to an attenuated availability of cognitive resource.

3.6.4. Effects of preoccupying cognitions on the availability of cognitive resource

As outlined in the preceding sections, dieting and restrained eating are associated with deficits on a number of cognitive tasks, both food- and non-food-related. Since

dieting has been associated with preoccupations concerning food and body shape (Warren & Cooper, 1988), it is probable that these cognitions interfere with performance in much the same way that anxiety does (Green et al., 1994; see Segal, 1996). One model that conceptualises cognitive resource in terms of a limited capacity system is that of working memory (see section 3.3.). Indeed, the ability to intentionally suppress intrusive thoughts has been associated with working memory capacity (Brewin & Smart, 2005).

Continuing their exploration into the nature of the performance deficits that are characteristic of restrained eaters, Green and colleagues (Green, Elliman, & Rogers, 1997) explored the relationship between preoccupying cognitions and working memory. Performance on tasks assessing working memory span (amount of information able to be held and recalled from memory), focussed attention, and two-finger tapping rates was compared across groups of dieters, highly-restrained non-dieters, and low-to-medium restrained non-dieters. Measures of affective state (Hospital Anxiety and Depression Scale, HADS; Snaith & Zigmond, 1994) and ratings of appetite (hunger, fullness, desire to eat, and thirst) were also obtained. Dieters were found to have significantly smaller working memory spans than highly-restrained non-dieters and significantly elevated ratings of desire to eat. Attentional focus and tapping rates did not differ significantly across groups. In line with the inferences drawn from the anxiety literature, these results support the idea that diet-related impairments occur as a result of an overall reduction in processing capacity, rather than due to a failure to maintain attentional focus. The reduction in available capacity is hypothesised to have resulted from the processing of task-irrelevant cognitions related to desire to eat.

A subsequent study sought to identify the specific components of working memory that might be affected during dieting. In this study (Green & Rogers, 1998), performance on tasks that specifically loaded onto the visuo-spatial sketchpad, the phonological loop, and the central executive components of working memory were assessed. A measure of body-shape concern was also obtained using the Body Shape Questionnaire (BSQ; Cooper, Taylor, Cooper, & Fairburn, 1987). The results indicated that both the phonological loop and central executive functions were impaired in dieters compared to non-dieters. Moreover, performance on these tasks

correlated with concern with body shape. The results of this experiment provided initial confirmation of the link between dieting, preoccupying cognitions (concerning food, weight, and body-shape etc), and decrements in the phonological loop and central executive functions of working memory⁵. Such findings have been subsequently replicated (Green et al., 2003; Kemps, Tiggemann, & Marshall, in press; Shaw & Tiggemann, 2004; Vreugdenburg, Bryan, & Kemps, 2003), and alternative metabolic explanations, such as reduced concentration of tryptophan (an amino acid involved in concentration) have been ruled out (Green et al., 2003). Taken together, these studies offer very strong support to the notion that the underlying mechanism involved in impaired cognitive functioning in dieters is the presence of preoccupying cognitions concerning food, weight, and body shape.

3.7. INTERIM SUMMARY

The nutritional composition, size, and timing of meals can influence mental performance in complex ways (Gibson & Green, 2002). However, independent of physiological effects, the association between dieting/restrained eating and impaired cognitive functioning appears to be mediated by the extent to which preoccupying cognitions consume cognitive resource. Based on the research cited in the preceding sections, it would seem plausible that failure to maintain restraint under a range of circumstances (see section 2.5.2.) may similarly be governed by a deficit in the amount of cognitive resource that is available to perform this activity. In this regard, the successful execution of a cognitive task and attempts to maintain restraint are likely to represent similarly taxing activities that can be undermined by interfering

⁵ It should be noted that the sub-components of working memory are merely hypothetical constructs. Baddeley's (1986) model of working memory is an analytical tool which provides the means by which observed phenomena can be articulated into a coherent body of knowledge (Harre, 2002). It is not subjected to the usual constraints of scientific realism – that is, the 'phonological loop', for example, is not taken to be a real anatomical structure within the brain. Therefore, the extent to which it is useful to attempt to identify the particular sub-components of working memory that are impaired when dieting is unclear (but see Baddeley, 2002).

cognitions. The next section reviews the literature that has attempted to explore the relationship between attention and overeating.

3.8. ATTENTION AND OVEREATING

The idea that overeating may occur when insufficient attention is allocated to maintaining dietary control is implicit in Herman and Polivy's (1984) boundary model of eating regulation. Other models of general self-control (e.g., Wegner's Ironic Process Theory, 1994) or attentional effort (e.g., Kahneman, 1973; Kanfer & Ackerman, 1989) that have, or can, be offered in explanation of this behaviour are also based on this premise. However, to date, research in this area has been scarce and therefore little direct evidence exists to support this proposition.

The idea that successful restraint is related to the availability of a limited, consumable resource was indirectly suggested by Muraven and Baumeister (2000). They suggested that efforts at self-control of any kind would consume limited resources, or 'self-control strength'. Accordingly, they conceptualised self-control as being akin to a muscle, the strength of which could be depleted by constant use, rendering subsequent attempts at self-control to fail. The possibility that this 'self-control strength' represents working memory capacity was investigated by Boon et al. (2002), in an attempt to examine the extent to which the limited capacity model could explain the process underlying overeating in restrained eaters. In this experiment, restrained and unrestrained eaters took part in an ice-cream taste-test either while distracted by listening to a radio conversation or sitting in silence. Both groups received the same ice-creams, however within each group, half of the participants were told that the ice-cream was 'extra creamy', while the other half were told that the ice-cream was low in calories. Based on the limited capacity hypothesis, Boon et al. (2002) predicted that impairment of cognitive capacity during eating would lead to overeating in restrained, but not in unrestrained eaters, and that this difference should only emerge when the food is perceived to be high calorie. This is because the increased threat to dietary control posed by a high-calorie food is believed to induce resource-consuming, restraint-related cognitions. The results show that distraction was related to increased intake, with those participants who ate while distracted consuming significantly more food than those

who ate in silence, and that this effect occurred irrespective of restraint status or the type (high / low calorie) of ice-cream that participants believed they had received. Following a significant three-way interaction (restraint status / distraction condition / high- versus low-calorie), analysis of simple effects revealed some evidence in support of the limited capacity hypothesis. Specifically, in the high-calorie condition, restrained eaters ate significantly more food than did unrestrained eaters when they were distracted. When not distracted, and when in the low-calorie condition, intake did not differ between the two restraint groups. Therefore, the results were interpreted as suggesting that restrained eaters were successful in realising their intention to restrict their intake of the high-calorie food only when they were not distracted. When distracted, the resulting limitations on cognitive capacity undermined this intention.

3.9. SUMMARY AND RATIONALE FOR PART I

Taken together, the literature reviewed in this chapter suggests that the availability of sufficient cognitive resource and a lack of interfering cognitions is integral to the successful execution of any task. Based on the models of attention reviewed and the documented effects of interference on the performance of dieting and restrained eaters, the possibility that overeating when distracted results from an inability to allocate attentional resource effectively would seem well supported, albeit indirectly. Although the results of Boon et al. (2002) can be considered to be consistent with a limited capacity explanation, a weakness of this study is that no objective measure of working-memory capacity was taken. As a result, the veracity of this explanation cannot be determined. Unfortunately, to date, no further studies have explicitly explored the role of the limited-capacity working memory model in the occurrence of overeating. In part, this is because it has been unclear how to overcome the problematic issue of how to measure attention during a meal.

The aim of Part I of this thesis is to attempt to explore the nature of the cognitive process that links distraction with eating behaviour. Experiments 1 and 2 employ a novel methodology whereby the relationship between food intake and attention to dietary control can be objectively assessed by taking performance on a concurrent

task as an indication of the available cognitive resource. Experiment 3 explores this relationship using an alternative experimental paradigm that has greater ecological validity. In this case, the relationship between attention and amount eaten is assessed by comparing food intake among groups of individuals characterised on the basis of how they choose to engage with a concurrent task while eating.

CHAPTER 4: ASSESSMENT OF ATTENTION DURING A MEAL

4.1. INTRODUCTION

The previous chapter reviewed models of attention and presented evidence that interfering cognitions may impair performance on a range of tasks by consuming cognitive resources otherwise required for the successful execution of the task. In line with this, it has been suggested that overeating may similarly occur when insufficient cognitive resource is available to monitor and control food intake. The various studies that have looked at the relationship between distraction and amount eaten have been detailed in section 2.5.2. While these studies provide evidence that amount eaten may be related to the way in which attention is directed during a meal, the methods used do not easily lend themselves to the scrutiny of this relationship. A handful of studies have attempted to explore this association using subjective assessments of attention obtained during or after a meal. In this section, the results of these studies, along with the problems associated with the particular methodologies used, are reviewed. Following this, the justification for the experimental paradigm employed in Experiments 1 and 2 is outlined*.

4.2. SELF-REPORTED ATTENTION DURING A MEAL

In most cases, attempts to understand how individuals regulate their food intake have relied on procedures that measure ‘cognitive self-statements’ – the self-referent internal speech that typically accompanies any type of information processing task. Typically, researchers have implemented self-talk or thought-sampling techniques to assess the cognitive self-statements of restrained and unrestrained eaters, as well as anorexic and bulimic females (Cooper & Fairburn,

* The material presented in chapters 5 and 6 (Experiments 1 and 2) has been accepted for publication in the journal *Appetite*.

Mitchell, G.L., & Brunstrom, J.M. (2005). Everyday dietary behaviour and the relationship between attention and meal size. *Appetite*, 45, 344-355.

1992). In such procedures, participants are asked to ‘think aloud’ while they are eating, or to write-down their thoughts immediately upon finishing a meal, ignoring any concerns about spelling etc, in order to get a close approximation to the actual ‘cognitive verbiage’. The recalled thoughts are then coded, for example as neutral, food-related, control-related etc. This unstructured approach is believed to elicit an individual’s idiosyncratic thoughts and provide a sensitive measure of their cognitive self-statements.

Using this methodology, Boon, Stroebe, Schut, & Jansen (1998) explored the nature of cognitive regulation in dieting, restrained, and unrestrained females. In the first experiment, participants were shown six food words (french fries, cake, cucumber, chocolate, apple, and cheesecake) and were asked to list the first five thoughts that came into their heads after reading each one. In a second experiment, participants were left alone to take part in a taste-test of three different types of nuts (plain, sugared, and cocktail) after which they were asked to list all the thoughts (maximum of ten) that they had experienced while eating. Under both conditions, food stimuli was found to elicit more eating-control, weight-, and shape-related thoughts in restrained compared to unrestrained eaters. In dieters, the number of thoughts of this nature that were experienced was found to be negatively related to amount eaten. Using a similar technique, Hickford, Ward, and Bulik (1997) reported no differences between restrained and unrestrained eaters in terms of the frequency with which they experienced thoughts related to food. However, restrained eaters tended to evaluate food more positively than did unrestrained eaters, suggesting that the content of their thoughts may be associated with the motivation to eat.

4.2.1. Problems associated with self-report measures

While self-report measures can be useful in assessing what an individual’s cognitions are, relying solely on this type of approach may not be the optimal means of uncovering the mechanisms involved in successful and unsuccessful eating regulation. This is because the actual mental operations involved in controlling food intake may proceed outside of awareness (Yee & Vaughan, 1996).

Thought-listing measures are also likely to be a poor proxy for actual mental resource occupation, as simply reporting a thought gives no indication of the time spent thinking it. In addition, if participants are given a list of thoughts from which they can select those that they have experienced (e.g., Mann & Ward, 2004), selection may be influenced by the suggestion of certain thoughts, while reports of other thoughts not on the list may be inhibited (Mook & Votaw, 1992; see section 16.2.2.). Retrospective reports may also be biased by memory, social desirability effects (see section 16.3.), or by *post-hoc* justifications for behaviour. However, actually asking participants to articulate their thoughts *while* eating is similarly problematic since explicit measurement is likely to influence how attention is allocated (Jansen, Merckelbach, Oosterlaan, Tuiten, & Van Den Hout, 1988) and change the very nature of the thoughts and subsequent eating behaviour. Thus, it is unlikely that such self-report approaches alone will produce a thorough understanding of the process by which cognitions influence eating behaviour.

4.3. JUSTIFICATION FOR THE PROPOSED PARADIGM

Because of the problems associated with self-report measures reported above, an alternative, more objective approach to the assessment of attention during a meal is required. Based on the rationale that interference effects are likely to be observed when two tasks compete for attention (see section 3.2.2.), it was envisaged that a methodology relying on measures of concurrent task performance might be useful. The advantage of this approach is that it obviates the need to use invasive questioning. Individuals are assumed to be allocating more attention to restraint-related cognitions if accuracy on the task is impaired. Therefore, good task performance can be taken as evidence that an individual has committed relatively less attention to dietary control, whereas poor performance can be taken to indicate the converse. Based on this, performance measured across time might reflect the transient state of distraction, while a comparison of performance across groups might reflect a more trait-like characteristic.

Therefore, the aim of Experiments 1 and 2 is to explore an alternative, objective, method of assessing attention during a meal in groups of dieting, restrained, and

unrestrained females. In order to do this, an adapted version of the Rapid Visual Information task (Smit & Rogers, 2000; see section 4.3.2.) was chosen to provide a measure of attention during a meal. In order to ensure that the measure of attention reflected that experienced while eating, performance on the task always occurred concurrently with food intake (see section 4.3.2.)

4.3.1. Distracter task

The distracter task used in Experiments 1 and 2 was an adapted version of the Rapid Visual Information Processing task (RVIP). This task was chosen as it requires an element of executive control to resist distraction (Parasuraman, Warm, & See, 1998). It has also been frequently used in research investigating cognitive functioning in dieters and restrained eaters and has been shown to be sensitive to the effects of preoccupying cognitions (e.g., Green et al., 1994; 1995; Green & Rogers, 1995; Rogers & Green, 1993).

In this task, a continuous stream of single digits (0-9) is presented on a computer screen and participants are instructed to respond, as quickly as possible, whenever they believe that they have detected an unbroken sequence of three even or three odd digits. Data is recorded measuring the number of correct hits, late hits (key depressed too late following a hit sequence of digits), and false hits (key depressed in the absence of a hit sequence of digits) made during each block of the task, along with the reaction times for each correct hit. Figure 2 illustrates the visual display and an example of a 'hit' sequence of digits. Baseline measures of performance were also obtained before (Experiments 1 & 2) and after (Experiment 2) the eating episode.

Traditionally, the RVIP task employs a stimulus presentation rate of 100 digits per minute (one every 600 ms) (e.g., Harakas & Foulds, 2002) or faster (e.g., 200 digits per minute; Hearn et al., 2004), with no inter-stimulus interval. However, in this version, a digit is displayed every 750 ms (80 stimuli per minute). This slower stimulus presentation rate has been used previously by Yeomans, Ripley, Davies, Rusted, and Rogers (2002) and has not been associated with performance ceiling

effects. Indeed, pilot tests revealed that within this dual-task paradigm (whereby participants had the added task of eating a meal while performing the task), the traditional, faster presentation rate was more likely to be associated with performance floor effects.

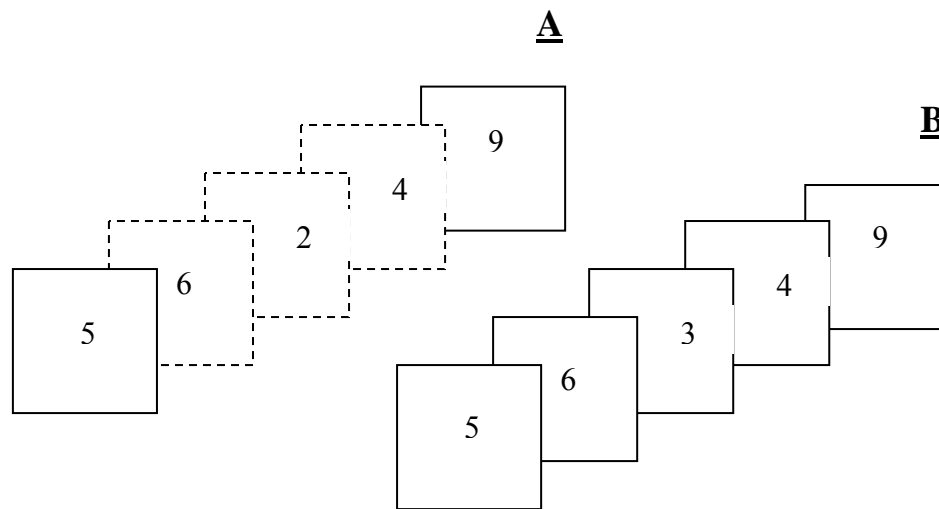


Figure 2. Illustration of the RVIP task. Diagram A illustrates a target sequence of three even digits, highlighted by the dotted line. Participants would be expected to press the space bar on the keyboard as quickly as possible after seeing the number ‘4’. Depression of the spacebar after presentation of the digit ‘9’ would be treated as a late hit. Diagram B illustrates a non-target sequence of digits. No response would be expected. Any response made would be considered to be a false hit.

4.3.2. Iterative eating process

In both Experiments 1 and 2, participants were offered an array of buffet-style foods, from which they were free to choose what, and how much they ate. In order to ensure that task performance occurred in conjunction with ingestion, the task was presented as an iterative series of blocks (see section 4.2.2.). Participants were

instructed to eat a food item during each block⁶, and to continue this process for as long as they wished. At the end of each block, the computer offered the participants five seconds to select either “yes” or “no” (using the mouse) in response to the question, “Do you wish to continue?” During this period, an incremental count of one-second intervals appeared on the screen. If the "yes" response was selected, another block of the RVIP task was initiated and another food item was eaten. This iterative process continued until the “no” response, or neither the "yes" nor the "no" response was selected.

The decision to control food intake in this way is related to how participants might eat when distracted. It has been suggested that over-consumption may occur when participants are constrained by time and are forced to eat faster and take bigger bites (see Poothullil, 1995). Since the requirement to perform the task while eating may have restricted participant’s motor ability, this may have added a sense of time pressure. If given free access to food, participants in the distracted group may have eaten more by dint of this fact. However, by fixing intake (one item per 60-seconds or three items per 120-seconds, as appropriate) amount eaten is unrelated to bite size or speed of eating.

4.3.3. Assessment of dietary behaviour and group classifications

In each of the experiments presented in this thesis, a measure of dietary restraint and disinhibition was obtained from all participants. A number of questionnaires are available to measure these behavioural constructs. Here, the restraint scale of the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien et al., 1986) and the disinhibition scale of the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) were used. These particular scales were chosen for a number of reasons. In relation to the effects of restrained eating on cognitive performance, the DEBQ-restraint scale is the most commonly used scale to assess restrained eating in this context. It is also considered to be a ‘pure’ measure of restraint, containing only

⁶ Experiment 1 and 2 differed in the duration of each block (60 s versus 120 s) and the number of food items to be eaten during each one (1 versus 3, respectively).

those items that assess the extent to which an individual is restraining their food intake (Wardle, 1986). The scale consists of 10 items (see Appendix A). Examples include questions such as “Do you try to eat less at mealtimes than you would like to eat?” and “How often do you try not to eat between meals because you are watching your weight?” All items have a 5-option response format: never (1) seldom (2), sometimes (3), often (4) and very often (5). The score obtained for each response is shown in brackets. Some items that are in a conditional format also have a sixth “not relevant” option. If the “not relevant” response is selected, the item is treated as being unendorsed and so a score of zero is given. The questionnaire is scored by dividing the sum of the response options by the total number of response items that were endorsed. A high score indicates a high degree of dietary restraint.

The disinhibition scale of the TFEQ has been commonly used to assess the consequences of restriction, such as a preoccupation with food and bouts of overeating. This scale was chosen as it has been found to be a better predictor of overeating than restraint alone (e.g., Ouwens et al., 2003; Van Strien et al., 2000; 2002). It consists of 16 items (see Appendix B). Items 1-13 require a “true / false” response and include questions such as “I usually eat too much at social occasions, like parties and picnics” and “When I am with someone who is overeating I usually overeat too”. The remaining three items each have a different four-option response and ask questions such as “Do you eat sensibly in front of others and spurge alone?” (response options; never, rarely, often, and always). For each question, a score of either one or zero is given. The scores across the 16 items are summed to give a measure of tendency to disinhibit. Again, higher scores represent a greater tendency to engage in this behaviour.

Current dieting behaviour was assessed using the single question, “Are you currently dieting to lose weight?” (response: yes/no). This simple question has been found to be a reliable and valid assessment of dieting status. For example, using this method, self-reported dieters and non-dieters have been found to differ in the extent to which they think about weight control and dieting (Boon et al., 1998), the amount of calories expended through exercise (French, Jeffery, & Wing, 1994), the amount eaten after a preload (Lowe, 1995; Lowe et al., 1991) and their frequency of weight cycling (Lowe & Timko, 2004b). Furthermore, Neumark-Sztainer, Jeffrey, and

French (1997) found that nonambiguous, single-item questions such as that used here were better predictors of energy intake than more general single item questions (e.g., “doing anything to lose weight”).

In Experiments 1 and 2, participants were classified as dieters or non-dieters based on their responses to the dieting question. In line with Westenhoefer et al., (1994), non-dieting participants were then further classified into one of four groups on the basis of a double classification of scores (high / low) on both the measures of restrained and disinhibited eating. Accordingly, this process yielded five groups; low-restraint / low-disinhibition (LR/LD), high-restraint / low-disinhibition (HR/LD), low-restraint / high-disinhibition (LR/HD), high-restraint / high-disinhibition (HR/HD), and current dieters.

4.3.4. Subjective measures

In all experiments presented in this thesis, 100 mm visual analogue scales (VAS) were used to obtain measures of appetite and other subjective assessments. These were presented on paper and participants were given instruction in how to complete the scales and were shown an example (see Appendix C). All VAS scales were of a similar format. A question is presented above the 100 mm line, and anchors on the left- and right-hand sides pertain to negative and positive responses, respectively. The participant is required to place a vertical line through the 100 mm horizontal line at the point between the two anchors that represents how they feel. An example of some of the scales used is shown in Appendix D.

4.3.5. Control on pre-experiment food intake

A requirement for participation in each of the experiments reported in this thesis was that the participants must abstain from eating for at least three hours prior to the onset of the experiment (drinks were permitted). This was to ensure that all participants were at least moderately hungry and would be likely to accept the requirement to eat. In order to assess adherence to this instruction, before the

experiment began all participants completed a questionnaire assessing time since last meal (minutes and hours) and a description of what had been consumed at this meal (food and drink). Any participant who had consumed food within the preceding three hours was unable to participate on that occasion and their appointment was re-scheduled for another time.

CHAPTER 5: EXPERIMENT 1

5.1. INTRODUCTION

As outlined in chapters 2 and 3, dieting and restrained eating are cognitive activities, the success of which may rely on the availability of sufficient cognitive resource. A number of variables have been identified that have the potential to trigger a bout of overeating. These include the mere sight (Rogers & Hill, 1989) and smell (Jansen & Van De Hout, 1991) of a food preload, extreme mood states (Cools et al., 1992; Greeno & Wing, 1994), and body-image-related cognitions (Seddon & Berry, 1996). This work has also confirmed a role for distraction in overeating. Researchers have used a range of distraction tasks including listening to a recorded detective story (Bellisle & Dalix, 2001), word counting in a recorded conversation (Boon et al., 2002), and a visual memory task (Ward & Mann, 2000). Generally, these studies show that in the presence of distraction, and compared with little or no distraction, restrained eaters, and albeit to a lesser extent unrestrained eaters, tend to ingest greater quantities of food (e.g., Boon et al., 2002; however, see Boon et al., 1997). Since successful restraint is thought to require cognitive effort (Herman & Polivy, 1984), otherwise irrelevant cognitive activity may impair attempts to maintain control.

It is increasingly clear that momentary self-control is likely to be mediated by a complex set of attentional constraints. However, to date, no study has attempted to measure how individuals differ in their attention to dietary control during a meal. In part, this is related to the problems associated with asking participants to articulate this information while they eat (see section 4.2.1.). As a result, the cognitive process that links distraction with eating behaviour remains unresolved. At least two possibilities exist. First, a distraction task might merely detract attention away from self-control. That is, dietary control is sacrificed passively when one is engaged in other cognitive tasks. A second, more complex proposition, is that dietary control and task performance vie for cognitive resource in much the same way as any other set of everyday tasks do (e.g., talking on a telephone while driving). This is

consistent with the finding that restrained eaters perform worse than unrestrained eaters on standard cognitive tasks while they are asked to imagine their favourite food (Brunstrom & Witcomb, 2004; Green et al., 2000; see section 3.6.2.).

The aim of Experiment 1 is to explore the veracity of these competing hypotheses. Two predictions are made. If a distraction task operates in a passive context, then task performance should be roughly similar across individuals who have and have not overeaten. This is because control is simply relinquished while attention is directed elsewhere. Alternatively, according to a ‘limited capacity’ account, task performance should be elevated in those individuals who overeat and somewhat impaired in those who maintain self-control. In this first experiment, this reasoning is applied to investigate the relationship between overeating and attention to dietary control.

In relation to a targeted comparison, a useful perspective can be gained by exploring how attention is directed in groups of individuals with differing dietary characteristics. As outlined in section 2.4., overeating may not be a general characteristic of dietary restraint. Rather, it tends to occur only in those restrained eaters who also score highly on the disinhibition scale (e.g., Westenhoefer et al., 1994). To date, it remains unclear how this group attends to dietary control during a meal. In addition, Lowe et al. (1991) and Lowe (1995) have found that restrained eaters who are actively dieting to lose weight may regulate their intake differently to restrained (and unrestrained) non-dieters. Specifically, following ingestion of a food preload, dieters are generally able to regulate their intake successfully and fail to exhibit counter-regulatory eating. However, in the absence of a preload, they tend to overeat. Again, one way to develop these findings might be to explore differences in the way that attention is directed. With this aim in mind, in Experiment 1, the relationship between food intake and attention to dietary control (as inferred from performance on a concurrent task, see section 4.3.) is compared in five groups of females; current dieters, and four sub-groups of non-dieters, each differing in their score (high or low) on the DEBQ-restraint and TFEQ-disinhibition scales, separately. In addition, based on the research outlined above, two specific comparisons are made. Firstly, in response to previous observations that restrained eaters with high disinhibition scores have a tendency to overeat (e.g., Westenhoefer

et al., 1994), the amount eaten and the concurrent task performance of this group is compared with that of the other three non-dieting groups. Secondly, following reports that dieters tend to eat more than restrained (and unrestrained) non-dieters in the absence of a preload (e.g., Lowe et al., 1991), the intake and performance of dieters is compared with that of the four non-dieting groups.

5.2. METHOD

5.2.1. Participants

One hundred female undergraduate students at Loughborough University were recruited via e-mail (mean age = 21.09, *SD* = 3.96). All were paid five pounds (Sterling) for their participation.

5.2.2. Design and group classifications

This experiment employed an independent samples design. Participants who were currently dieting to lose weight were allocated to a group of current dieters. The remaining non-dieting participants were allocated to one of four groups using a double classification based on a median split of DEBQ-restraint (low < 2.6, high \geq 2.7) and TFEQ-disinhibition (low < 6, high \geq 7) scores. Accordingly, this process yielded five groups; low-restraint / low-disinhibition (LR/LD), high-restraint / low-disinhibition (HR/LD), low-restraint / high-disinhibition (LR/HD), high-restraint / high-disinhibition (HR/HD), and current dieters. Table 1 provides the mean (*SD*) DEBQ-restraint and TFEQ-disinhibition scores for each of these groups. No measure of body mass index (BMI) was taken in this experiment.

5.2.3. Subjective measures and questionnaires

Hunger and fullness was measured before the meal using 100 mm visual-analogue rating scales, presented on paper. Specifically, participants were asked, “How hungry/full do you feel right now?” The left- and right-hand ends were anchored “not at all hungry/full” and “extremely hungry/full”, as appropriate. At the end of the experiment, participants were asked to complete the restraint scale of the DEBQ, the disinhibition scale of the TFEQ, and the question, “Are you currently dieting to lose weight?” (response: yes/no).

5.2.4. Foods

Participants received three small plates of food and a glass containing 200 ml of water. Plate one contained eight small cheddar-cheese sandwiches made with white bread (62 kcal, 0.26 MJ each). Plate two contained eight small scotch eggs (egg encased in sausage meat and covered in breadcrumbs; 68 kcal, 0.29 MJ each). Plate three contained eight small sausage rolls (sausage meat wrapped in pastry; 54 kcal, 0.23 MJ each). All of the foods were sold by Tesco Stores Ltd. (Cheshunt, UK). Pilot tests confirmed that these foods can be consumed easily within a single block of the RVIP task (60 seconds). Three participants indicated that they disliked two out of the three foods. On this basis, they were excluded from the sample.

5.3. PROCEDURE

Participants were tested between 12 noon and 2 p.m. in individual cubicles in the Ingestive Behaviour Laboratory at Loughborough University, having abstained from eating for at least three hours prior to the onset of the experiment. On arrival, each participant was seated in front of a computer. In this experiment, the RVIP task (see section 4.3.2.) was presented as an iterative series of 60-second blocks, with eight possible hits per block (four unbroken sequences of even digits, and four unbroken sequences of odd digits). After an initial briefing, the participants completed a 60-second practice block of the RVIP task during which visual

feedback was provided. Specifically, the phrase “3 even digits detected” or “3 odd digits detected” was displayed, as appropriate. After this practice block, no feedback was provided. After confirming that they understood the task, the participants completed a second block of the task. This was used to generate a baseline measure of task performance. The participants then rated their hunger and fullness.

After these initial measures, the participants were shown the test foods. They were instructed to eat one food item of their choice during each 60-second block of the task and to continue this process for as long as they wished, selecting “yes” or “no” in response to the question, “Do you wish to continue?” presented at the end of each block (see section 4.3.1.). Upon indicating that they wished to stop, the task terminated and the DEBQ-restraint and the TFEQ-disinhibition sub-scales, and the question assessing current dieting behaviour, were then administered.

For all participants, the number of correct hits recorded during each 60-second block of the RVIP task was recorded. Part-way through data collection, the possibility that hit-rate scores could be inflated by continuous depression of the space-bar was considered. In order to assess the extent to which this might be the case, an adapted version of the program was given to the final 38 per cent of the participants tested. This recorded late hits (key depressed too late following a hit sequence of digits), false hits (key depressed in the absence of a hit sequence of digits), and reaction times for every correct hit.

5.4. RESULTS

5.4.1. Group characteristics of the non-dieting groups

The aim of this experiment was to consider the relationship between task performance and intake in an orthogonal arrangement of high and low restraint and disinhibition scores. Accordingly, each level (high or low) of each measure (restraint or disinhibition) was represented in two groups. A comparison across

these groups revealed only one reliable difference - the disinhibition scores of the LR/HD group were significantly lower than those in the HR/HD group ($t = 2.7$, $df = 41$, $p = 0.10$). Nevertheless, the mean values in Table 1 show that the difference between the LR/HD and the HR/HD group was somewhat marginal (mean difference = 1.76) compared with the differences observed more generally between the two high- and the two low-disinhibition groups (a difference in the order of 5.3). Thus, albeit imperfect, orthogonality was observed across the four contrasting non-dieting groups.

	Five groups				
	LR / LD <i>n</i> = 22	HR / LD <i>n</i> = 14	LR / HD <i>n</i> = 22	HR / HD <i>n</i> = 21	CD <i>n</i> = 18
DEBQ-restraint	2.07 (0.43)	3.17 (0.35)	2.15 (0.48)	3.31 (0.36)	3.64 (0.51)
TFEQ-disinhibition	4.05 (1.62)	4.86 (1.10)	8.86 (1.70)	10.62 (2.48)	10.72 (2.42)
Initial hunger	67.00 (19.09)	73.86 (12.87)	68.00 (16.28)	69.05 (22.25)	71.94 (17.68)
Initial fullness	20.95 (21.36)	13.43 (10.77)	18.05 (13.63)	22.52 (16.59)	18.39 (17.21)

Table 1. Mean (SD) DEBQ-restraint and TFEQ-disinhibition scores, and initial hunger and fullness ratings (mm), taken before the meal, for each of the five groups in Experiment 1.

5.4.2. Subjective measures

At the beginning of the experiment, ratings of hunger and fullness did not differ significantly across the five groups ($F[4,92] = 0.42$, $p = 0.79$, and $F[4,92] = 0.73$, $p = 0.58$, respectively). See Table 1.

5.4.3. Amount eaten

Since one food item was consumed during each 60-second block of the RVIP task, the total number of food items eaten is equivalent to the total number of blocks completed. A one-way ANOVA revealed a significant difference between the amount eaten across the five groups ($F[4,92] = 2.69, p = 0.036$). Two specific comparisons were also made, i) the extent to which the HR/HD group behave differently to the other non-dieting groups, and ii) whether current dieting is associated with a distinct pattern of eating behaviour. In relation to the first of these, a planned comparison revealed that the HR/HD group ate significantly more than the other non-dieting groups (LR/LD, HR/LD, and LR/HD) ($t = 2.57, df = 75, p = 0.012$). A second planned comparison confirmed that the dieting group ate more than the non-dieting groups (LR/LD, HR/LD, LR/HD, and HR/HD), although this difference narrowly missed significance ($t = 1.63, df = 24, p = 0.059$ [1 tailed]). Figure 3 shows the intake of the five groups, separately.

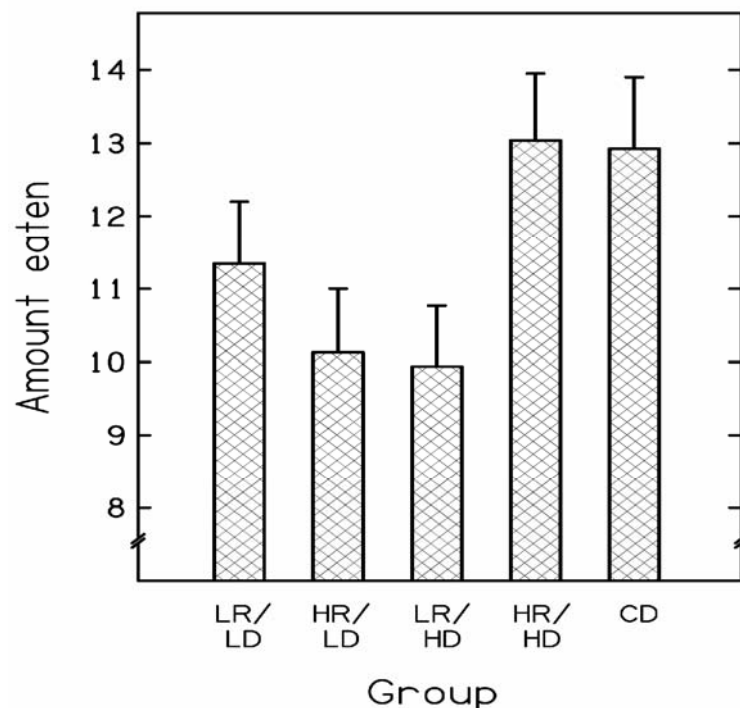


Figure 3. Mean (+/- SEM) number of food portions eaten by each of the five groups in Experiment 1.

5.4.4. Performance

Participants differed in the number of task blocks that they completed (range = 6 - 25). To facilitate a comparison of performance at specific stages within the meal, a quadratic function was calculated that describes the relationship between task performance and block number. Using this equation, for each participant, an estimate of performance was derived at five time intervals during their meal. Stages 1 to 5 correspond approximately to 20, 40, 60, 80, and 100 per cent of the meal. As with measures of intake, planned comparisons were used to assess i) the status of the HR/HD group with respect to the other non-dieting groups, and ii) the status of the current dieters with respect to non-dieters. Firstly, ANOVA (with appropriate weighted contrasts) revealed no significant difference between the performance of the HR/HD group and that of the other non-dieting groups at any stage in the meal (all $p > 0.05$). However, a comparison of the dieting group with the four non-dieting groups showed that the dieters performed significantly better than the non-dieters towards the end of the meal, both at stage 4 ($t = 2.62$, $df = 92$, $p = 0.010$) and at stage 5 ($t = 2.53$, $df = 92$, $p = 0.013$). The same comparison at stage 3 narrowly missed significance ($t = 1.91$, $df = 92$, $p = 0.060$). Figure 4 shows the performance of the five groups at each of the five stages.

Across the five groups, the total number of hits detected at baseline and the mean number of hits detected per block (total hits / number of blocks during the meal) did not differ significantly (both $p > 0.05$). Scrutiny of the additional performance measures revealed little evidence that the sub-sample of participants ($n = 36$) used a response strategy that involved rapid depression of the spacebar. In addition, no significant difference was found in the number of late hits ($F[4,32] = 0.67$, $p = 0.62$), false hits ($F[4,32] = 2.29$, $p = 0.08$), or reaction times ($F[4,32] = 1.57$, $p = 0.21$) across groups.

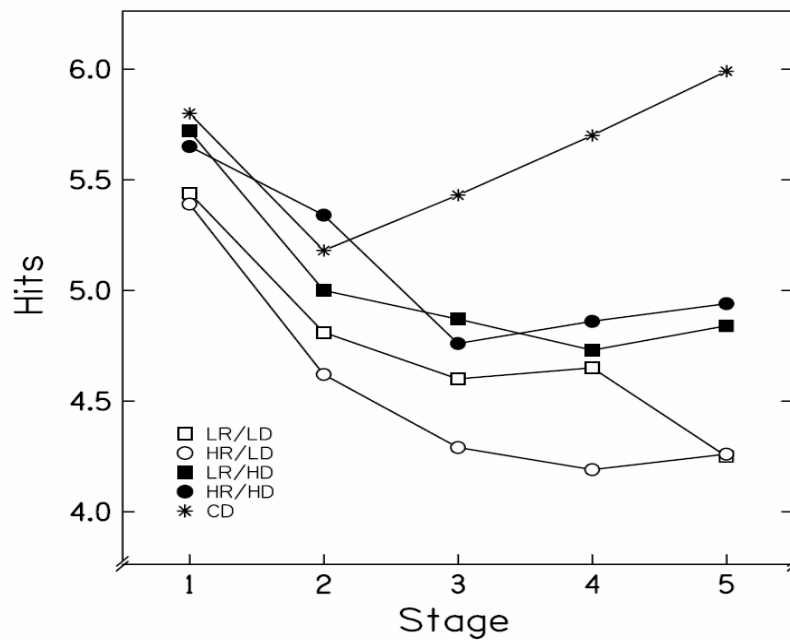


Figure 4. Mean number of hits detected by each of the five groups at five stages during the meal in Experiment 1.

5.4.5. Correlation between intake and performance

To explore the general relationship between intake and task performance, a correlation coefficient was calculated that describes the relationship between the number of food items eaten and the number of correct hits detected on the RVIP task. This analysis revealed little evidence that task performance and food intake are related ($r = -0.04$, $p = 0.70$).

5.5. DISCUSSION

In this experiment, the aim was to establish whether task performance can be regarded as a useful measure of attention to dietary control. Based on a simple comparison of performance and intake, this appears not to be the case. It was found, however, that the groups did not perform equally on the task, which is important because it indicates that they differed in their attention to dietary control. Consistent

with the prediction based on earlier reports (e.g., Westenhoefer et al., 1994), greater food intake was found in non-dieting restrained eaters who have high TFEQ-disinhibition scores (the HR/HD group). This group also outperformed the other non-dieting groups. However, this difference was marginal and not significant. The analysis also confirmed the prediction that the dieters would consume a relatively large amount of food. This group also performed significantly better than the other non-dieting groups as the meal progressed. In addition, with the exception of the HR/HD group who ate a comparable amount of food, the current dieters ate more than the non-dieting groups. This finding is consistent with previous observations that dieters select larger meals when offered free access to food (Lowe, 1995; Lowe et al., 1991).

Notwithstanding this result, the data are difficult to reconcile with the idea that elevated performance represents a simple proxy for attention to dietary control. In particular, it is unclear why the performance of the dieters should *exceed* that of the low-restrained eaters, who need to commit relatively little attentional resource to dietary inhibition. Likewise, if intake is regulated by the amount of attention that is paid to the task, then one might expect the current dieters to eat more than the HR/HD group. They did not.

Some caution is appropriate when comparing performance across individuals in this way. This is because meal size is related to meal duration - those who choose to eat a larger meal may be more susceptible to practice effects, or they may derive greater benefit from changes in levels of blood glucose (Benton & Nabb, 2003). However, in relation to the elevated performance of dieters, practice would seem an unlikely explanation. This is because the dieters ate for roughly the same duration as the HR/HD group, yet they outperformed the HR/HD group during the latter stages of the meal. Likewise, if performance is related to changes in levels of blood glucose then it is unclear why dieters should outperform the HR/HD group, since both groups ate approximately the same amount of food.

Clearly, the groups differed in their performance during the meal. This suggests that aspects of their dietary behaviour interacted with their ability to attend to the otherwise unrelated cognitive task. However, as shown, the results are not easily

characterised in terms of a simple interaction between the attentional requirements of two concurrent tasks (for other examples of where this is the case see Meyer & Kieras, 1997, and Norman & Bobrow, 1975). One possibility is that elevated performance results from a more proactive process. Specifically, individuals may choose to focus their attention on a concurrent task in order to avoid cognisance of their eating behaviour. Indeed, working memory capacity has been associated with the ability to intentionally suppress intrusive thoughts (Brewin & Smart, 2005). In Experiment 2, this possibility is explored by comparing the task performance of individuals who do and do not report, retrospectively, that they used the task in this way. Elevated RVIP task performance in ‘task-users’ can be taken as evidence that the effect of attention on dietary control can be mediated intentionally.

As noted above, current dieters and the HR/HD group ate a similar amount of food. These groups also had almost identical TFEQ-disinhibition scores. Therefore, one possibility is that, contrary to previous accounts (Lowe, 1993; 1995, Lowe et al., 1991), dieters should not be treated as distinct from non-dieting restrained and unrestrained eaters. However, the performance of the dieters suggests that they might be engaging with the task in a different way. This is because they outperformed all of the other non-dieting groups, including the HR/HD group. Therefore, one aim of Experiment 2 is to explore the extent to which dieters strategically use the task, and whether this tendency is manifest equally in non-dieters and the HR/HD group in particular.

5.6. SUMMARY AND RATIONALE FOR EXPERIMENT 2

In summary, the results of Experiment 1 provide some evidence to suggest that attention and food intake may be related, albeit it in a complex manner. Overall, no significant relationship was observed between performance on the RVIP task and the number of food items eaten. However, across groups, the pattern in performance and intake data is consistent with the idea that increased attention to dietary control may be related to decreased food intake. Importantly, the performance of the dieters suggests that the complexity of this relationship may reflect the fact that some individuals choose to engage with the task in a more proactive manner than others,

possibly as a strategy to avoid food-related cognitions. The aim of Experiment 2 is to further investigate the nature of the relationship between intake and attention. To this end, the effects of strategic use of the task and increased caloric threat to dietary goals - two variables that have the potential to influence attention to dietary control - are explored.

CHAPTER 6: EXPERIMENT 2

6.1. INTRODUCTION

Experiment 2 employs a design similar to that used in Experiment 1 to further explore the relationship between attention and intake across five groups of females. The aim of this experiment is two-fold. Firstly, following the pattern of performance and intake data exhibited by the dieters in Experiment 1, one aim is to explore the possibility that individuals strategically engage with a concurrent task in order to avoid cognisance of their eating behaviour, and that this strategy is related to increased food intake. In order to explore this possibility, the intake and task performance of individuals who do and do not retrospectively report that they used the task in this way is compared. Larger meal size and/or better RVIP task performance in ‘task-users’ can be taken as evidence for ‘proactive disinhibition’. Of particular interest is the extent to which this tendency is manifest in each of the groups separately.

The second aim of Experiment 2 is to investigate whether attention and meal size might also be influenced by the extent to which food items present a threat to dietary control. This is because diet-threatening and non-diet-threatening foods are likely to invoke a different set of cognitions. For example, Gonzalez and Vitousek (2004) have reported that dieters associate significantly more guilt and fear with food items than do non-dieters. In a discussion of the mental control of eating, Herman and Polivy (1993) suggest that intake can be inhibited by cognitions relating to the negative features of a food. Indeed, they argue that the “cognitive appraisal of the intended snack or meal, if it includes a full caloric reckoning, may prove to be the best dietary aid” (p. 503). Similarly, Lowe (1993) has suggested that dieters may overeat only under those circumstances where eating control is not obviously challenged. Therefore, in Experiment 2, the relationship between attention and food intake is explored using highly palatable foods that are more likely to be perceived as forbidden and threatening. In order to increase the threat to dietary control associated with choosing to continue to eat, the number of food

items that participants are asked to consume in each block of the RVIP task is also increased from one to three. On this basis, it is predicted that overeating might be less likely to occur in those groups who perceive the food to be more threatening.

In summary, Experiment 2 pursues two issues arising from Experiment 1 with the aim of determining; 1) the extent to which individuals proactively allocate their attention during a meal, and whether this activity is especially common in dieters, and 2) the effects of increased threat on attention to dietary control and food intake.

6.2. METHOD

6.2.1. Participants

Eighty-seven female undergraduate students at Loughborough University were recruited via e-mail (mean age = 20.48, *SD* = 2.63). Each was paid five pounds (Sterling) for their participation in this experiment.

6.2.2. Design and group classifications

As in Experiment 1, this experiment employed an independent samples design. Comparisons were made across five groups of females; dieters, and four groups of non-dieters who each differed in their simultaneous scores on the DEBQ-restraint scale and the TFEQ-disinhibition scale. The participants in this experiment had the same median DEBQ-restraint and TFEQ-disinhibition scores as the sample in Experiment 1 (2.7 and 7.0, respectively). Table 2 provides the mean (*SD*) DEBQ-restraint and TFEQ-disinhibition scores for each of these groups. Participants were also grouped according to whether they reported engaging strategically with the task and comparisons are made between ‘task-users’ and ‘non-task-users’. The mean (*SD*) DEBQ-restraint and TFEQ-disinhibition scores for each of these groups is also shown in Table 2.

6.2.3. Subjective measures and questionnaires

Hunger and fullness was measured at the start of the experiment using the same scales as those used in Experiment 1. Participants were also required to rate their ‘desire to eat.’ Specifically, they were asked, “How strong is your desire to eat right now?” The 100 mm visual-analogue rating scale was anchored “not at all strong” and “very strong” on the left- and right-hand sides, respectively. Three separate 100 mm rating scales were used to measure the extent to which each of the three foods was regarded as forbidden. Participants responded to the question “Please rate how forbidden the following food is to YOU”. Each scale was anchored “Not at all forbidden” and “Extremely forbidden” on the left- and right-hand sides, respectively. Ratings of task difficulty, stress, and anxiety were also obtained using a scale in the range 1 (not at all) to 10 (extremely). This was to explore the possibility that between-group differences in intake are related to differences in arousal, since heightened arousal (e.g., stress) has been associated with overeating (Greeno & Wing; see section 2.5.2.1.). Finally, in addition to the questions assessing restraint, disinhibition, and dieting behaviour, participants were also asked to recall how they directed their attention during the meal. Specifically, they were asked the question, “Did you actively focus your attention on the task so that you did not or could not think about the food?” Participants were asked to respond with either “yes” or “no”. Those who answered “yes” were classified as ‘*task-users*’.

6.2.4. Foods

The meal was presented to the participants on two trays, along with a glass containing 200 ml of water. The first tray held ten Jaffa Cakes (sponge cake covered in plain chocolate with an orange filling, McVities, London, UK; 48 kcal / 0.20 MJ / 8g each) and ten mini Aero chocolate bars (milk chocolate; Nestle; Veyey, Switzerland; 54 kcal / 0.23 MJ / 10g each). The second tray held ten portions of Original Flavour Pringles (salted flavour chips; Procter and Gamble, Mechelen, Belgium; 48 kcal / 0.20 MJ / 11.6g each). A single portion of Pringles comprised four chips. Pilot tests confirmed that these food items can be consumed within the allocated time (three portions per 120-second block of the RVIP task)

and were generally regarded as highly forbidden. During each block, the participants were free to choose the three food items that they consumed.

6.2.5. The adapted RVIP task

The adapted RVIP task used here differs from the version in Experiment 1 in three ways. Firstly, in order to increase the level of threat associated with the decision to continue eating, the number of food items eaten during each block of the task was increased from one to three. To allow sufficient time for three food items to be consumed, the duration of each block was increased from 60 to 120 seconds. This increased the number of possible hits in a single block from 8 to 16 (eight sequences of three even digits and eight sequences of three odd digits). Secondly, to establish greater accuracy, the baseline measure of performance was increased from one 60-second block to one 120-second block, and it was issued both before and after the meal. Thirdly, in Experiment 1, additional measures of task performance (false hits, late hits, and reaction times for correct hits) were recorded while testing a subset of the participants. In this experiment, all participants were monitored in this way.

6.3. PROCEDURE

Testing took place between 2 p.m. and 5 p.m. in individual cubicles in the Ingestive Behaviour Laboratory, at Loughborough University. All participants had abstained from eating for at least three hours prior to the onset of the experiment. After an initial briefing, the participants completed a 60-second practice block of the RVIP task (see section 4.3.2.). Following oral confirmation that they understood the task, they then completed the first 120-second measure of baseline performance. The participants then rated their hunger, fullness, and desire to eat. After this, the meal was presented and participants completed the main section of the adapted RVIP task.

Upon termination of the task, participants completed the second baseline measure, followed by ratings of forbiddingness, task difficulty, stress, and anxiety. Finally, to assess evidence for proactive disinhibition, participants indicated how they directed their attention during the meal (to identify task-users and non-task-users). The DEBQ-restraint and TFEQ-disinhibition questionnaires were then administered, followed by a question assessing current dieting behaviour. A measure of height (cm) and weight (kg) was then taken. Seven participants declined to be weighed.

6.4. RESULTS

6.4.1. Group characteristics

As in Experiment 1, the extent to which the four non-dieting groups represented an independent (orthogonal) arrangement of high and low restraint and disinhibition scores was established. A set of appropriate comparisons across common pairs of groups (e.g., LR/HD and LR/LD for restraint scores) revealed no significant differences (all $p > 0.05$). Current dieters and the HR/HD group had the highest and lowest BMI, respectively. The seven participants who declined to give a measure of BMI did not differ significantly from the other participants in their DEBQ-restraint ($t = 0.92$, $df = 85$, $p = 0.36$) or their TFEQ-disinhibition scores ($t = 1.03$, $df = 85$, $p = 0.31$). Table 2 shows the number of participants in the five groups, together with their associated mean (*SD*) DEBQ-restraint and TFEQ-disinhibition scores, and their mean (*SD*) BMI.

Of interest in this experiment is the extent to which the five groups reported ‘using’ the task and in particular, whether dieters have a greater tendency to engage strategically in the task, especially in relation to the HR/HD group. The analysis confirmed that task-use was reported more often by dieters than by non-dieters ($\chi^2[1, N = 87] = 13.54$, $p < 0.001$). It was also more common in current dieters compared with the HR/HD group ($\chi^2[1, n = 35] = 5.54$, $p = 0.019$). As the number of task-users in each of the five groups differed considerably, the discrepancy in cell sizes prohibited any comprehensive assessment of the interaction between group

and task-use. Therefore, the analysis focuses on differences between task-users and non-task-users, and whether these differences are manifest equally in current dieters and non-dieters.

	Five groups				
	LR/LD	HR/LD	LR/HD	HR/HD	CD
<i>N</i>					
All participants	17	17	18	14	21
Task-users	-	4	6	3	13
Non-task-users	17	13	12	11	8
<i>DEBQ-restraint</i>					
All participants	1.82 (0.55)	3.29 (0.47)	2.08 (0.46)	3.63 (0.61)	3.71 (0.63)
Task-users	-	3.05 (0.29)	2.28 (0.19)	3.67 (1.03)	3.64 (0.56)
Non-task-users	1.82 (0.55)	3.36 (0.50)	1.98 (0.53)	3.62 (0.52)	3.81 (0.77)
<i>TFEQ-disinhibition</i>					
All participants	3.71 (1.72)	4.94 (1.98)	10.56 (1.95)	11.07 (2.06)	11.43 (2.36)
Task-users	-	4.00 (2.58)	10.00 (1.27)	12.67 (1.16)	10.85 (2.64)
Non-task-users	3.71 (1.72)	5.23 (1.79)	10.83 (2.21)	10.64 (2.06)	12.38 (1.51)
<i>BMI</i>					
All participants	22.23 (3.00)	22.49 (1.60)	23.88 (4.05)	21.61 (2.33)	25.77 (4.02)
Task-users	-	23.93 (1.38)	21.93 (2.36)	23.29 (2.63)	25.28 (3.05)
Non-task-users	22.23 (3.00)	22.04 (1.43)	24.85 (4.47)	21.10 (2.12)	26.46 (5.24)

Table 2. For each of the five groups in Experiment 2; group size (*n*) and mean (*SD*) *DEBQ*-restraint scores, *TFEQ*-disinhibition scores, and *BMI*. Separate values are also given for task-users and non-task-users. A single dash indicates that this cell contained no group members.

In general, task-users had significantly higher DEBQ-restraint scores (mean = 3.23, $SD = 0.76$) than non-task-users (mean = 2.77, $SD = 1.01$; $t = 2.13$, $df = 85$, $p = 0.036$). They also had significantly higher TFEQ-disinhibition scores (mean = 9.81, $SD = 3.39$) than non-task-users (mean = 7.82, $SD = 3.95$; $t = 2.24$, $df = 85$, $p = 0.028$). However, the BMI of task-users (mean = 24.06, $SD = 2.83$) and non-task-users (mean = 24.04, $SD = 3.68$) did not differ significantly ($t = 1.19$, $df = 78$, $p = 0.24$). See Table 2.

6.4.2. Subjective ratings

For each participant, a forbiddingness score was derived from the average of the three forbiddingness ratings (one for each of the three foods) taken at the end of the meal. Forbiddingness ratings differed significantly across the five groups ($F[4,82] = 15.77$, $p < 0.001$). *Post-hoc* tests (Tukey) revealed that the LR/LD group found the food significantly less forbidden than the HR/LD group (mean difference = 26.71, $p = 0.006$), the HR/HD group (mean difference = 37.07, $p < 0.001$), and the current dieters (mean difference = 52.81, $p < 0.001$). The same *post-hoc* tests also indicated that the LR/HD group regarded the food to be less forbidden than the HR/HD group (mean difference = 22.13, $p = 0.045$) and the current dieters (mean difference = 37.87, $p < 0.001$), and that the HR/LD group regarded the food to be less forbidden than the current dieters (mean difference = 26.10, $p = 0.004$). See Table 3.

Stress differed significantly across the five groups ($F[4,82] = 3.08$, $p = 0.02$). *Post-hoc* tests (Tukey) revealed that the LR/LD group were significantly less stressed than the current dieters (mean difference = 2.11, $p = 0.034$). Rated anxiety did not differ significantly across the five groups. However task-users reported significantly more anxiety than non-task-users at the end of the experiment ($t = 2.31$, $df = 85$, $p = 0.023$). All other comparisons between the five groups and between task-users and non-task-users failed to reach significance (all $p > 0.05$). See Table 3.

In relation to hunger, fullness, and desire to eat, no significant difference was found across the five groups, or between task-users and non-task-users (all $p > 0.05$). See Table 4.

	5 Groups					Task-use	
	LR/LD	HR/LD	LR/HD	HR/HD	Dieters	Task-users	Non-task-users
Stress	3.41 (2.40)	5.06 (1.85)	4.11 (1.91)	5.50 (2.35)	5.52 (2.42)	5.31 (2.07)	4.48 (2.37)
Anxiety	3.24 (2.22)	3.24 (2.31)	3.44 (2.31)	4.14 (1.75)	4.91 (2.61)	4.69 (2.21)	3.46 (2.31)
Task difficult	6.18 (2.27)	6.77 (1.52)	5.78 (1.52)	6.75 (1.34)	7.14 (1.62)	6.65 (1.62)	6.44 (1.78)
Forbiddingness	18.07 (13.98)	44.63 (24.51)	32.86 (27.05)	55.09 (18.99)	70.81 (21.95)	52.52 (28.18)	41.81 (28.27)

Table 3. Mean (SD) forbiddingness ratings (mm), and mean (SD) stress, anxiety, and task demand scores (1-10), taken at the end of the experiment, for each of the five groups in Experiment 2. Separate values are also provided for task-users and non-task-users.

	5 Groups					Task-use	
	LR/LD	HR/LD	LR/HD	HR/HD	Dieters	Task-users	Non-task-users
Initial hunger	54.59 (27.06)	45.76 (25.96)	57.67 (23.58)	55.07 (22.57)	50.10 (22.31)	50.38 (21.59)	53.39 (25.25)
Initial fullness	35.41 (18.68)	27.18 (25.87)	30.17 (16.55)	28.64 (19.45)	34.48 (21.89)	31.62 (21.52)	31.31 (20.32)
Initial desire	58.06 (27.86)	46.47 (25.91)	62.23 (19.61)	57.57 (23.30)	51.38 (25.53)	50.50 (20.70)	56.89 (24.96)

Table 4. Mean (SD) hunger, fullness, and desire to eat ratings (mm), taken at the start of the experiment, for each of the five groups in Experiment 2. Separate values are also provided for task-users and non-task-users

6.4.3. Amount eaten and task performance across the five groups

Across the five groups, the amount eaten differed significantly ($F[4,82] = 3.38, p = 0.013$). Tukey's *post-hoc* tests revealed that the LR/HD group ate significantly more than the HR/HD group (mean difference = 6.35, $p = 0.005$). See Figure 5, panel a.

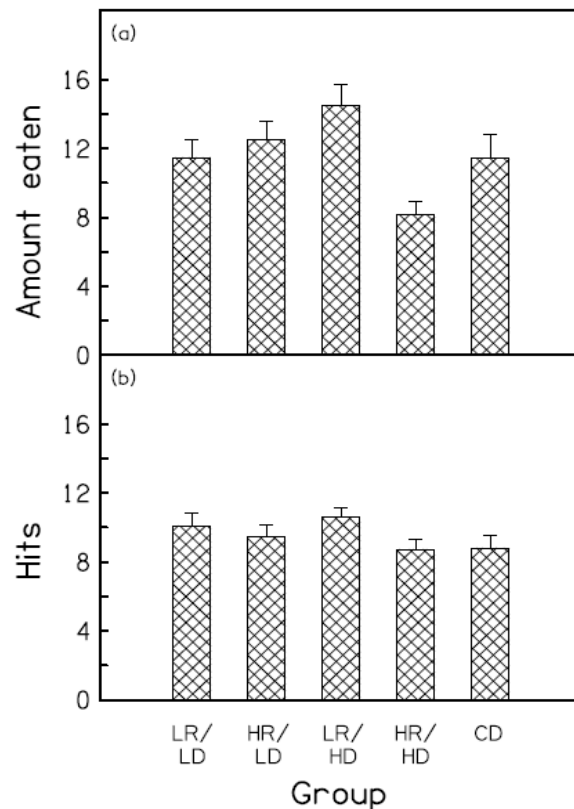


Figure 5. Mean (\pm SEM) number of food portions eaten (panel a) and mean (\pm SEM) hits detected (panel b) by each of the five groups in Experiment 2.

In this experiment, fewer blocks of the RVIP task were completed (mean = 3.92, $SD = 1.74$) than in Experiment 1 (mean = 11.53, $SD = 4.07$). This is because three food items were eaten during every block of the task (compared with one item in Experiment 1). Since 49 per cent of the sample completed three or less blocks, estimating performance at discrete stages (using a quadratic function) is problematic. Instead, the analysis focuses on a comparison of the mean number of hits detected throughout the entire meal (total hits / number of blocks). On this

basis, task performance during the meal did not differ significantly across the five groups ($F[4,82] = 1.41, p = 0.24$). See Figure 5, panel b. Across the five groups, all other comparisons of additional performance measures taken at baseline and during the meal also failed to reach significance (all $p > 0.05$).

6.4.4. Relationship between intake, performance, and subjective measures

As in Experiment 1, the relationship between task performance and food intake was also assessed. Across all participants, the number of correct hits correlated significantly with intake ($r = 0.22, p = 0.039$), indicating that good performance is related to larger meal size. Inspection of the correlation between subjective ratings, intake, and task performance revealed three significant relationships – perceived task demand is negatively correlated with both RVIP task performance ($r = -0.25, p = 0.022$) and amount eaten ($r = -0.28, p = 0.035$), and forbiddingness scores are negatively correlated with RVIP task performance ($r = -0.24, p = 0.023$).

6.4.5. Amount eaten and task performance across task-users and non-task-users

Task-users and non-task-users did not eat significantly different amounts of food ($t = 0.41, df = 85, p = 0.68$). However, since the performance of dieters and non-dieters differed markedly in Experiment 1, it was predicted that dieters and non-dieters might engage with the task in different ways. To identify how dieting behaviour and task-use interact, a two-way ANOVA was conducted with ‘dieting behaviour’ (current dieters/non-dieters) and ‘task-use’ (task-users/non-task-users) as between-subjects factors. Analysis of the amount eaten revealed a significant interaction ($F[1,83] = 4.71, p = 0.03$). A one-tailed t -test confirmed that the non-dieting task-users consumed more food than the non-dieting non-task-users ($t = 1.90, df = 64, p = 0.031$). The intake of the dieting task-users and non-task-users was similar and did not differ significantly ($t = 1.15, df = 19, p = 0.87$). See Figure 6, panel a.

A similar two-way ANOVA was used to assess performance. This revealed a main effect of dieting behaviour ($F[1,83] = 6.66, p = 0.012$) and task-use ($F[1, 83] = 10.02, p = 0.002$). Non-dieters performed better than dieters and task-users performed better than non-task-users. The interaction between these effects was not significant ($F[1,83] = 0.12, p = 0.73$). See Figure 6, panel b.

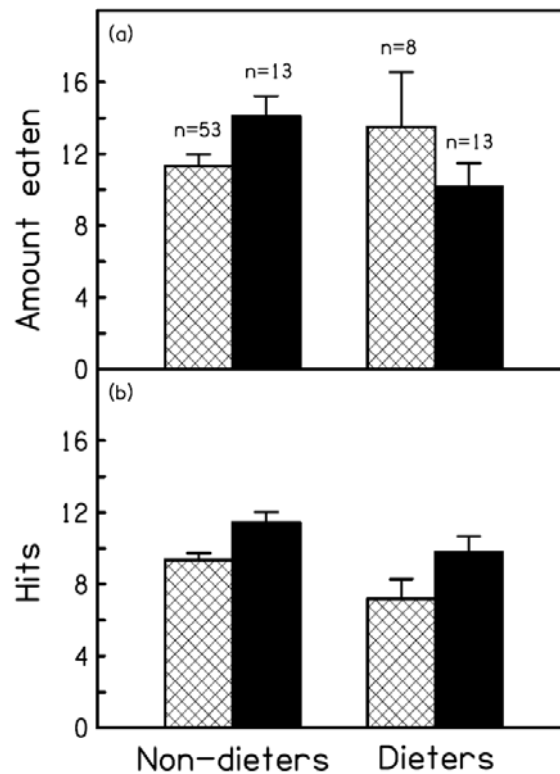


Figure 6. Mean (+/- SEM) number of food portions eaten (panel a) and mean (+/- SEM) hits detected (panel b) by dieters and non-dieters in Experiment 2. Hashed bars represent the non-task-users. Solid bars represent the task-users.

Analysis of the additional performance measures also revealed that during the meal, task-users had significantly faster reaction times than non-task-users ($t = 2.57, df = 85, p = 0.012$). This is consistent with the idea that this group allocated greater attention to the task. Across task-users and non-task-users, all other comparisons of additional performance measures taken at baseline and during the meal failed to reach significance (all $p > 0.05$).

6.5. DISCUSSION

Ostensibly, Experiment 2 was a repeat of Experiment 1. However, in this adapted version, the meal was potentially more threatening to dietary control. Threat was generated by increasing both the relative forbiddingness of the foods and the number of food items to be eaten during each block of the RVIP task. In this context, the LR/HD group ate the most food (significantly more than the HR/HD group). This is consistent with previous reports of overeating in this group (Westenhoefer et al., 1994; Yeomans, Tovey, Tinley, & Haynes, 2004) and with more general observations that prior inhibition, i.e., dietary restraint, is not a prerequisite for overeating to occur (Boon et al., 2002; Pliner, Herman, & Polivy, 1990; Polivy et al., 1986). It was predicted that larger meal sizes would be less likely in those groups who regarded the foods as threatening, since increased threat is likely to result in greater allocation of attention to dietary control. Consistent with this idea, forbiddingness was associated with poorer RVIP task performance (a measure of attention to dietary control), and poorer RVIP task performance was associated with smaller meal size. Furthermore, amount eaten was not related to how stressed or anxious participants were, confirming that between-group differences are unlikely to result from the physiological effects on appetite of heightened arousal (see section 2.5.2.1.). Taken together, these results are not inconsistent with the proposition that threat can reduce meal size by increasing attention to dietary control. In future, this idea could be explored by manipulating threat systematically. Specifically, the relationship between attention and intake might be examined by making a within-subjects comparison of the effects of using threatening and non-threatening foods in two separate test sessions.

The data also suggest that individuals sometimes engage strategically with a concurrent task and that this behaviour is relatively common. Of the participants, 30 per cent claimed that they used the task strategically in order to direct their attention away from the food. Half of these were current dieters. Individuals who claimed to use this strategy performed significantly better on the task compared with those who did not. This association suggests that self-reported task-use is unlikely to represent a *post-hoc* justification offered to explain a participant's eating behaviour. Rather, it appears to reflect a genuine cognitive strategy. In relation to this, evidence from

interview data suggests that some form of active decision-making may be involved in overeating in restrained eaters (Ogden & Wardle, 1990).

Non-dieting task-users consumed more food than non-dieting non-task-users, suggesting that when attention is intentionally diverted, overeating may occur. However, this relationship between larger meals and task-use appears to hold only for the group of non-dieters. In dieters, task-users generally ate less than non-task-users. At present, the significance of this difference is difficult to establish because the group of dieters represents a minority of those participants who were tested. One possible interpretation is that dieting task-users responded to these relatively forbidden foods by directing their attention towards the task. In this way, they were able to ignore the food-related cognitions that otherwise promote disinhibition. Thus, depending on the level of threat to dietary objectives, task-use might serve to facilitate both dietary restriction and dietary disinhibition. Either way, if strategic allocation of attention represents a general phenomenon, then this may have implications for the way in which the process governing overeating, and the role of distracter tasks in studies of overeating are characterised. The issue of proactive processes is investigated further in Experiment 3. For reasons outlined in the following chapters, in this case, the extent to which individual differences in everyday dietary behaviours predict the interaction between attention and eating behaviour was no longer of primary concern.

6.6. SUMMARY

The results of this experiment confirm that the allocation of attention is influenced by increased threat to dietary control and self-reported, strategic use of the task. In this experiment, between-group differences in attention were related to the extent to which the food was regarded as forbidden. Attention also correlated with amount eaten, confirming a relationship between attention and food intake when the food poses a threat to dietary goals. The veracity of the hypothesised strategy of ‘task-use’, and the associated effects on elevated task performance were also confirmed, although the relationship between task-use and intake appears to be complex and differs between dieters and non-dieters.

Along with the results of Experiment 1, the between-group differences observed in Experiment 2 lend themselves to more general speculation regarding the important variations in behaviour that may exist among groups of individuals who exhibit particular dietary characteristics. Therefore, before reporting Experiment 3, which primarily focuses on evidence for proactive processes irrespective of dietary behaviour, the next chapter examines the findings from Experiments 1 and 2 that are pertinent to a discussion of between-group differences in the regulation of food intake.

CHAPTER 7: GENERAL DISCUSSION – EXPERIMENTS 1 & 2

7.1. INTRODUCTION

The primary objective of Experiments 1 and 2 was to explore how attention is directed during a meal, and whether this relates to meal size, in groups of individuals who differ in their particular dietary predilections. This relationship was assessed using a novel methodology whereby task performance during a meal is taken as an indication of attention to dietary control. The results from each experiment have been discussed separately in the previous chapters. However, aspects of the data merit further discussion. In this chapter, two issues are discussed; 1) the effects of perceived threat to dietary control, and 2) whether dieters should be regarded as being distinct from other restrained eaters.

7.2. EFFECTS OF PERCEIVED THREAT TO DIETARY CONTROL

Previously, Lowe (1993) has speculated that dieters will inhibit their intake when they experience a threat to their dietary goals. Consistent with this idea, the dieters ate more and less, respectively, in Experiment 1 and 2 when asked to eat while performing a demanding concurrent task. Overall, in Experiment 2, a significant positive relationship between ratings of forbiddingness and attention to dietary control (task performance), and a significant negative relationship between attention to dietary control and amount eaten was found. However, no systematic relationship between forbiddingness and amount eaten was observed. This indicates that the relationship between perceived threat, dietary control, and intake, is not straightforward. Indeed, in Experiment 2, the LR/LD group rated the food the least forbidden, but they consumed a relatively modest amount of food. Therefore, it would appear to be the case that overeating is influenced by other factors. One possibility is that the HR/HD group may routinely experience mealtime situations in which they either under- or over-eat (Lowe, 1993). Therefore, they may have eaten the most in Experiment 1 and the least in Experiment 2 because they are

accustomed to eating meals that vary considerably in size. A second possibility is that the palatability of the foods is relevant. In particular, compared with bland foods, intake can increase markedly when palatable foods are presented. Moreover, this may be particularly the case in a group of LR/HD eaters (Yeomans et al., 2004), especially when they are offered foods that are high in fat content (Haynes et al., 2003). This possibility is consistent with the observation that the LR/HD group ate the largest meal in Experiment 2. One final consideration is that the forbiddingness of the foods is not the only source of threat that is experienced. In Experiment 2, the general level of threat was increased by raising the number of food items to be consumed in each block to three (compared to one in Experiment 1). This threat may vary both within and across groups. Therefore, one possibility is that a relationship between threat and intake exists. However, this is manifest only when a more inclusive measure of threat is used.

7.3. ARE DIETERS DISTINCT FROM RESTRAINED EATERS?

In section 2.4.2., the differences that may exist between dieting and non-dieting restrained eaters are outlined. In particular, dieters are more and less likely to overeat in the absence and presence of a preload, respectively (e.g., Lowe, 1995; Lowe et al., 1991). Since dieters have the added aspiration to lose weight, one explanation is that the preload presents a greater threat to their dietary control. In response to this threat, dieters direct relatively more attention toward the maintenance of dietary restriction. Consequently, restrained dieters eat less than restrained non-dieters when preloaded. The physiological effects of dieting may also make it difficult to terminate an eating episode when no threat is perceived (Lowe, 1993). Therefore, in the absence of a threatening preload, they tend to eat more than their non-dieting counterparts (Lowe, 1995; Lowe et al., 1991). The important role of perceived threat has also been confirmed by Mann and Ward (2004) who have shown that the intake of non-preloaded dieters will be inhibited if diet-related cues are made salient, even when distracted by a concurrent task.

More recently, it has become clear that non-dieting restrained eaters vary in their tendency to overeat and as such should not necessarily be regarded as a

homogenous group (see section 2.4.1.). Rather, their tendency to overeat may be related to scores on the TFEQ-disinhibition scale (e.g., Westenhoefer et al., 1994; see section 2.4.1.2.). In response to this research, one of the aims of Experiments 1 and 2 was to explore whether dieters are distinct from all kinds of non-dieting restrained eaters, i.e., both the HR/LD and the HR/HD group. These three sub-groups of restrained eaters (dieters, HR/LR, HR/HD) have not been compared within the same experiment previously. The findings indicate similarities between the eating behaviour of dieters and the HR/HD group, but marked differences between the behaviour of dieters and the HR/LD group. One interpretation is that dieters and the HR/HD group represent a similar population, and they differ only in their contemporaneous pattern of food restriction. Consistent with this idea, in both Experiment 1 and 2, the HR/HD group and the dieters tended to have similar (high) disinhibition scores. Based on this evidence alone, it would seem that dieters should not be regarded as distinct from all restrained non-dieters. Rather, it appears that they share certain characteristics that are specific to a particular sub-group of non-dieting restrained eaters.

A few studies have looked at differences in intake and eating behaviour across groups classified according to measures of restraint and tendency toward overeating (Haynes et al., 2003; Lawson et al., 1995; Ouwens et al., 2003; Van Strien, 1997a; 1997b; 1999; Van Strien et al., 2000). However, as far as is known, no previous studies have compared the behaviour of dieters against that of non-dieting restrained eaters who have been classified in this way. This might explain why the tendency for dieters to have high disinhibition scores has failed to receive attention. Inspection of group characteristics in previous studies does suggest that dieters score high on measures of overeating. For example, a study by McLean and Barr (2003) reported a significant difference between the scores of low-, medium-, and high-restrained eaters on the TFEQ-disinhibition scale, with high-restrained eaters having the highest scores. Since 80 per cent of the high-restrained eaters were currently dieting, this indicates that many of the dieters in this sample also had high disinhibition scores.

Perhaps it is not particularly surprising that dieters have high disinhibition scores. This is because high disinhibition scores are also correlated with BMI, which in turn

is associated with those individuals who are dieting to lose weight (Williamson et al., 1995). One interpretation is that the HR/HD group and the group of dieters are delineated only by the fact that the latter are actively attempting to lose weight. In contrast, a HR/LD group may or may not also experience an underlying desire to overeat, but for whatever reason they manage to regularly resist temptation. Consistent with this idea, Lowe et al. (2001) have reported that overweight individuals on a weight-loss programme show a reduction in scores on the Eating-Inventory-Disinhibition scale over time. However, in the laboratory, they still exhibit counter-regulatory eating, illustrating that their latent predisposition toward overeating is intact, even though it is not evident in their everyday eating.

Interestingly, the finding that the participants on the 8-week dieting program failed to reduced their intake following a preload (Lowe et al., 2001) is contrary to earlier reports (Lowe, 1993; 1995; Lowe et al., 1991). One difference between these studies is that Lowe et al. (2001) tested individuals who had been instructed to attend a weight-loss programme, whereas in earlier research the participants tested had begun dieting spontaneously. Consistent with this idea, restrained eaters who are placed on a short-term diet fail to show the expected pattern of overeating that is otherwise found in voluntary dieters when given *ad libitum* access to food in the absence of a preload (Lowe, 1994). Similar findings have been reported in relation to impaired cognitive functioning – deficits are worse in self-initiated dieters (e.g., Green et al., 2005; see section 3.6.3.). Taken together, these results suggest that supported or structured weight-loss dieting does not produce the same effects on eating behaviour that have been observed in self-reported dieters. This indicates that the characteristic behaviour of voluntary dieters should be attributed to their particular dietary predilections rather than to dieting behaviour per se. On the basis of this research, one behavioural characteristic that may be critical, and lacking in Lowe et al's (2001) cohort, is that dieters also report high levels of dietary disinhibition.

Notwithstanding the above, this does not preclude the possibility that individuals who are currently dieting behave differently. In Experiment 1, the current dieters outperformed all of the other non-dieting groups and in Experiment 2, a greater proportion of dieters claimed to be task-users than in the HR/HD group or in non-

dieters in general. Thus, although the dieters and the HR/HD group appear to share similar dietary characteristics (disinhibition scores) and eating behaviours (i.e., they ate a similar amount in each experiment), the dieters were perhaps more opportunistic in the extent to which they directed their attention. It remains to be established whether this reflects a general set of psychological strategies that have been honed by the experience of dieting. Either way, based on the way that attention is directed, this research offers some evidence that current dieters should be regarded as distinct from other kinds of restrained eater. The extent to which important differences exist between dieting and non-dieting restrained eaters should remain an open issue, and attempts to delineate the behaviour of these groups should focus on the way that individuals interact with their cognitive environment.

7.4. SUMMARY AND RATIONALE FOR EXPERIMENT 3

This chapter has discussed two important issues that arose from Experiments 1 and 2. The first relates to the complexity of the relationship between threat, group characteristics, and food intake. The second relates to the differences that may or may not exist between groups of similarly high-restrained eaters. As this discussion has highlighted, both of these issues are highly complex and the relationships observed are not straightforward. While threat appears to be important in the allocation of attention and may provide some protection against overeating, and predilections towards task-use may mediate the occurrence of overeating in groups of similarly restrained eaters, further research is needed to fully understand these relationships. Currently, the available evidence suggests that between-group differences and similarities are a consequence of predilections towards certain attention biases (i.e., a tendency to perceive threat-stimuli, or to engage strategically in concurrent tasks).

A central theme running throughout Experiments 1 and 2 relates to the extent to which eating behaviour can be predicted by the way in which an individual engages with a (compulsory) concurrent task. The aim of Experiment 3 is to investigate this issue further by looking at the relationship between intake and attention when individuals are given more freedom to decide how they allocate their attention

during a meal. The chosen distracter task – a word search – also represents a more similar type of distracter to that which would commonly be encountered in ‘real-life’. With this aim in mind, in Experiment 3, participants can choose if and when they engage with the word search task, and data analysis is primarily centred around these differences.

Consequently, this approach differs quite markedly from that in Experiments 1 and 2. In these cases, it was important to employ a design and method of data analysis that allowed for the differences in eating regulation across different groups of individuals to be established in a manner consistent with previous research (e.g., Haynes et al., 2003; Westenhoefer et al., 1994). In Experiment 3, interactions with an individuals’ particular dietary characteristics are considered to be of lesser importance than the effects of the decision of whether or not to engage with the task. Because of this, the resultant experimental design does not easily lend itself to the same type of between-group analysis (i.e., LR/LD, LR/HD, HR/LD, HR/HD, & dieters) as used previously. In addition, because restraint-related effects are most apparent on tasks of moderate complexity (Kemps et al., in press), the relatively undemanding nature of the chosen concurrent task (a word search) means that between-group differences are less likely to be observed. For these reasons, the effects of dietary behaviour are analysed using regression analysis.

CHAPTER 8: EXPERIMENT 3

8.1. INTRODUCTION

In both Experiments 1 and 2, it was a requirement of the experiment that all participants engaged continuously with the RVIP task, for as long as they wished to eat. This was necessary in order to obtain an objective measure of attention that reliably reflects how attention is allocated *while* eating. The evidence suggests that some individuals might strategically allocate more attention to the concurrent task in order to avoid food-related cognition, and that use of this proactive strategy may influence the amount eaten. However, the extent to which this behaviour is manifest outside of the laboratory is unclear. Therefore, the aim of Experiment 3 is to further explore the use of proactive processes in a context that represents a more ecologically valid eating situation. In relation to this aim, increased ecological validity is achieved in three ways. Firstly, in contrast to the requirement of the previous experiments that food items be eaten at a specified rate (1 or 3 items per block), that may be considered uncharacteristic of ‘normal’ eating behaviour, here participants are given *ad libitum* access to the food. Secondly, a word search task has been chosen to replace the RVIP task as the distracter, since this type of task is more representative of those likely to be engaged in during real-life eating situations. Thirdly, the requirement to engage with the concurrent task is no longer mandatory. Rather, in this experiment, participants are afforded the opportunity to decide if and when they engage with the concurrent task. Of particular interest is whether those individuals who choose to engage with the task while eating consume more food than those who do not, and whether these individuals are more likely to identify themselves as ‘task-users’. In relation to this, a more comprehensive measure of task-use is employed which incorporates an assessment of the motivation behind the use of this strategy.⁷

⁷ This experiment also incorporated a belief manipulation, whereby half of the participants were correctly told that the food was high calorie (regular fat Pringles), and the remaining half were misled into believing that the food was low calorie (reduced fat Pringles). This manipulation failed to have any significant effects on the results. Therefore, for reasons of clarity, this experiment is reported with this variable removed as a factor.

8.2. METHOD

8.2.1. Participants

Ninety female undergraduate students at Loughborough University were recruited via email (mean age = 20.72, $SD = 2.80$). All were paid five pounds (Sterling) for their participation.

8.2.2. Design and group classifications

This experiment employed an independent samples design. Comparisons were made across groups of participants classified according to how they reported engaging with the task. Firstly, participants were grouped according to whether or not they chose to attempt the word search task, and at what point they did this. This yielded three groups; i) those who *did not* engage with the task at all, ii) those who engaged with the task *after* eating, and iii) those who engaged with the task *while* eating. Participants were also grouped according to whether or not they reported engaging with the task proactively, and if so, why. This yielded four groups; ‘non-engagers’ (did not attempt the task at all), ‘non-task-users’ (non-strategic engagement with the task), and two groups of ‘task-users’, who differed in whether they proactively engaged with the task in order to *resist* or *promote* intake.

8.2.3. Subjective measures and questionnaires

Participants were allocated to the groups described in section 8.2.2. on the basis of their responses to two questions. Firstly, participants were asked “Did you attempt the word search task?” (response: yes/no). Those who responded “yes”, were asked to indicate which of the following statements was most applicable to them; a) “I ate all the food I wanted to and then I attempted the word search”, or b) “I attempted the word search while I was eating”. Secondly, participants were asked “Did you ever actively ‘use’ the word search in order to think less about the food?” (response;

yes/no). Those who responded “yes” were then asked to complete the statement “I actively focussed my attention on the word search because it", by selecting one of the following two options; a) “helped me to resist the temptation to eat”, or b) “stopped me feeling guilty and thinking about what / how much I was eating”.

The same rating scales used in the previous experiments were used to assess appetite (hunger, fullness, and desire to eat). Additional 100 mm VAS ratings scales were used to assess mood (“How anxious / stressed / rebellious / alert do you feel right now?”), the pleasantness of the taste of the food (“How pleasant was the taste of the Pringles?”) and attitudes towards the food (“How fattening / healthy / threatening to a dieter / threatening to you do you think this food is?” and “How concerned are you about how much you have eaten?”). Participants were also asked to provide an estimate of how many Pringles they had eaten, and to rate how confident they were that their estimate was accurate (“How confident are you that your estimate is correct?”). These additional measures were included in order to gain an insight into the ways in which those individuals who chose to engage with the task and/or report ‘proactive disinhibition’ might differ from those who did not. As in the previous experiments, all rating scales were anchored “not at all (hungry / fattening / stressed etc)” and “extremely (hungry / fattening / stressed etc)” on the left- and right-hand sides of the line, respectively. Again, the DEBQ and TFEQ scales were administered to assess restrained and disinhibited eating respectively, and a single question assessed current dieting behaviour.

8.2.4. Food

All participants were presented with a small white plate holding 50 ‘Original’ flavour, regular-fat Pringles (salted-flavour chips; Procter and Gamble, Mechelen, Belgium; 12 kcal / 2.9g each), along with a 200 ml glass of water.

8.2.5. Distracter task

In this experiment, the distracter task took the form of a word search. This consisted of a 25 by 25 letter grid, hidden within which were 20 target words. Each word was between five and eight letters in length, and was the name of a sport; archery, dancing, rugby, bowling, darts, rowing, boxing, diving, skating, climbing, fencing, skiing, cricket, fishing, snooker, croquet, hiking, squash, cycling, hockey, and tennis. Target words were written either forwards or backwards, going either up or down, and in either a straight or a diagonal line. A copy of the word search can be found in Appendix E.

8.3. PROCEDURE

Participants were tested between 12 noon and 2 p.m. in individual cubicles in the Ingestive Behaviour Laboratory, at Loughborough University. All participants had abstained from eating for at least three hours. Upon arrival, participants were told that the study was investigating the effects of food on mood. After completing the initial appetite ratings (hunger, fullness, desire to eat) and the ratings of mood (anxiety, stress, rebelliousness, and alertness) the participants were presented with a plate holding 50 Pringles. Participants were instructed that they would be left alone for five-minutes, during which time they must complete a taste-test. This involved eating just one or two of the Pringles and then rating how pleasant they found the taste. Although this procedure would be expected to take under five minutes, participants were told that in order to assess effects on mood, it was necessary that all participants waited for the full duration of the five minute period before the next stage of the experiment could begin. Participants were then shown the word search task and were instructed that they could attempt to complete this during the five minute period, if they wished to do so. It was stressed that this was not an official requirement of the study, rather that the word search was simply provided as a means to pass the time, if desired. Participants were also told that the Pringles were to be discarded at the end of the test session, and so they should feel free to help themselves and eat as many as they wanted. It was made explicitly clear to the participants that the ingestion of more food after the initial taste test and/or

engagement with the task was voluntary. At this point, participants were left to begin the taste-test.

After the five minute period had passed, the remaining Pringles and the word search were removed from the cubicle and the participants were asked to complete the second set of ratings assessing mood (e.g., stress) and a set of ratings assessing their attitude towards the food (e.g., healthiness). At this point, participants completed the questionnaire assessing if, and in what way, they had interacted with the word search task and whether they had engaged in ‘proactive disinhibition’. They were then asked to estimate how many Pringles they thought that they had consumed and to provide a rating of how confident they were that this estimate was accurate. Finally, participants completed the DEBQ-restraint and TFEQ-disinhibition scales, and the question assessing current dieting behaviour, following which a measure of height (cm) and weight (kg) was taken. Five participants declined to take part in this section of the experiment; one engaged with the task while eating, and the remaining four engaged with the task after eating all that they wished to. All participants were then debriefed, paid and thanked for their participation.

8.4. RESULTS

8.4.1. Effects of the decision to engage with the task

8.4.1.1. Group characteristics

Participants were grouped according to how they had reported interacting with the task. This yielded three groups; those who had not engaged with the word search task at all ($n = 11$), those who had attempted the word search task only after they had eaten all that they wished to ($n = 26$), and those who attempted the word search task while they were eating ($n = 53$). Table 5 shows the three groups and the associated mean (*SD*) DEBQ-restraint and TFEQ-disinhibition scores, and BMI. Neither BMI ($F[2,87] = 1.32, p = 0.273$), DEBQ-restraint ($F[2,87] = 0.92, p =$

0.401), nor TFEQ-disinhibition scores ($F[2,87] = 0.88, p = 0.417$) differed significantly across the groups.

	Group		
	No task engagement $n = 11$	Engagement with task after eating $n = 26$	Engagement with task while eating $n = 53$
BMI	22.54 (4.27)	22.70 (2.41)	23.87 (3.55)
DEBQ- restraint	2.46 (0.79)	2.90 (0.98)	2.73 (0.91)
TFEQ-disinhibition	6.00 (3.07)	7.62 (4.22)	7.87 (4.45)
Initial hunger	72.82 (15.48)	65.69 (15.77)	65.72 (20.35)
Initial fullness	15.18 (9.14)	20.23 (18.20)	17.02 (14.02)
Initial desire to eat	71.27 (17.92)	63.50 (18.00)	67.89 (20.88)
Initial pleasantness	75.45 (10.73)	74.35 (15.80)	80.77 (10.88)

Table 5. Mean (SD) BMI, DEBQ-restraint, and TFEQ-disinhibition scores, and baseline ratings (mm) of hunger, fullness, desire to eat, and pleasantness, for the three groups in Experiment 3.

8.4.1.2. Subjective measures

The three groups did not differ significantly in their initial ratings of hunger ($F[2,87] = 0.70, p = 0.497$), fullness ($F[2,87] = 0.59, p = 0.558$), desire to eat ($F[2,87] = 0.72, p = 0.491$), or pleasantness of the taste of the Pringles ($F[2,87] = 2.63, p = 0.078$). See Table 5. Similarly, neither the initial ratings of anxiety ($F[2,89] = 0.140, p = 0.869$), stress ($F[2,89] = 0.542, p = 0.584$), rebelliousness ($F[2,89] = 1.75, p = 0.181$), and alertness ($F[2,89] = 0.029, p = 0.972$) differed significantly across groups. See Table 6 for means (SDs).

	Group		
	No task engagement <i>n</i> = 11	Engagement with task after eating <i>n</i> = 26	Engagement with task while eating <i>n</i> = 53
Anxiety	20.09 (20.34)	20.73 (21.22)	22.87 (20.66)
Stress	21.55 (24.77)	24.31 (20.59)	28.43 (24.35)
Rebelliousness	28.73 (27.35)	17.69 (17.23)	27.47 (24.60)
Alertness	55.27 (17.79)	53.62 (18.93)	54.40 (20.83)
Fattening	70.64 (16.48)	70.27 (16.58)	69.34 (16.88)
Healthy	16.09 (8.17)	16.12 (10.86)	19.30 (14.70)
Threat - general	66.82 (21.88)	70.85 (18.79)	73.00 (19.51)
Threat - self	32.73 (28.78)	49.54 (27.28)	45.34 (30.46)
Concern	19.18 (28.22)	21.92 (23.14)	31.74 (27.61)

Table 6. Mean (SD) baseline ratings (mm) of mood (anxiety, stress, rebelliousness, and alertness) and how the food was evaluated (fattening, healthy, threat, concern), for each of the three groups in Experiment 3.

The change in each mood rating was calculated by subtracting the post-intake mood rating from that taken pre-intake. This gave a single difference score that was then compared across the three groups (word search before / after / not at all) by one-way ANOVA. On this basis, no significant difference was observed across the three groups in the change in anxiety ($F[2,89] = 0.11, p = 0.898$), stress ($F[2,89] = 1.68, p = 0.192$), rebelliousness ($F[2,89] = 0.02, p = 0.979$) or alertness ($F[2,89] = 0.39, p = 0.680$).

Finally, one-way ANOVA also revealed that the three groups did not differ in how fattening ($F[2,89] = 0.44, p = 0.957$), healthy ($F[2,89] = 0.651, p = 0.524$), threatening to themselves ($F[2,89] = 1.27, p = 0.285$), or threatening to a dieter

($F[2,89] = 0.482, p = 0.619$) they perceived the food to be, or in how concerned they were with how much food they had eaten ($F[2,89] = 1.797, p = 0.172$). See Table 6 for means (*SDs*).

8.4.1.3. Amount eaten

Figure 7 shows the amount eaten by those who did not engage with the task ($n = 11$), those who engaged with the task after eating all that they wished ($n = 26$), and those who engaged with the task while eating ($n = 53$). A one-way ANOVA revealed a significant main effect of word search group on the amount eaten ($F[2,89] = 13.36, p < 0.001$).

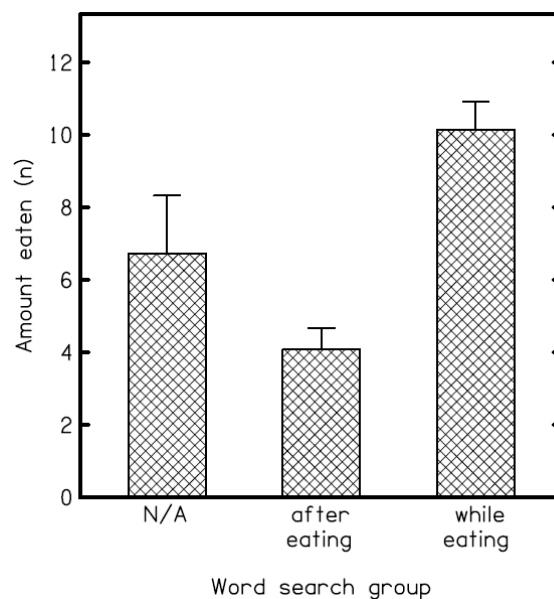


Figure 7. Mean (+/- SEM) number of Pringles eaten by each of the three groups in Experiment 3.

Post-hoc (Tukey) tests revealed only one significant difference – those participants who attempted the word search task while eating ate significantly more food than those who attempted the word search task after eating (mean difference = 6.07, $p <$

0.001). Furthermore, intake did not correlate significantly with the change in any of the measures of arousal (stress, anxiety, rebelliousness, alertness; all $p > 0.05$).

8.4.1.4. Estimated intake and confidence ratings

One-way ANOVA revealed a significant effect of word search group on the participants' estimates of amount eaten ($F[2,89] = 13.47, p < 0.001$). Specifically, in line with the pattern of intake, *post-hoc* (Tukey) tests confirmed that those who ate while engaged with the word search task gave higher estimates of intake than those who did not engage with the word search task (mean difference = 3.79, $p = 0.032$) or engaged with the word search task after eating (mean difference = 5.30, $p < 0.001$). Similarly, analysis of the confidence ratings associated with these estimates also revealed a significant difference across groups ($F[2,89] = 3.183, p = 0.046$). See Figure 8.

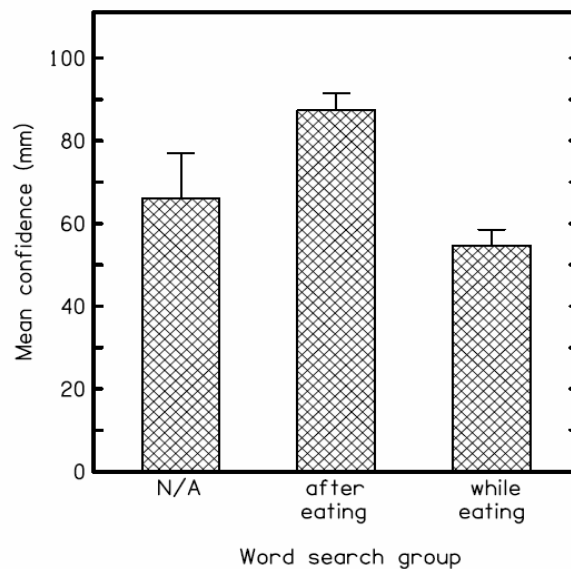


Figure 8. Mean (\pm SEM) confidence ratings for each of the three groups in Experiment 3.

Those who ate while performing the task were the least confident about their estimate, exhibiting significantly lower ratings of confidence than those who engaged with the task after eating (mean difference = 0.40, $p < 0.001$, *post-hoc* Tukey test). However, in terms of the actual accuracy of the estimates (actual intake – estimated intake), the three groups were not found to differ significantly from one another ($F[2,89] = 0.904$, $p = 0.41$), although the trend was in the expected direction; those who ate the least were the most accurate. This was confirmed by the observation that the correlation between the two was highly significant ($r = 0.454$, $p < 0.001$).

8.4.1.5. Relationship between dietary behaviour and the effects of distraction

A secondary aim of this experiment was to determine whether the effects of engaging with the task while eating are more or less evident in those individuals with high scores on the measures of dietary behaviour (i.e., restrained and disinhibited eating). Accordingly, regression analysis was used to determine whether amount eaten is predicted by an interaction between these dietary measures and engagement with the task while eating. Those participants who engaged with the task after having eaten all that they wished to and those that did not engage with the task at all were allocated to a single group. Amount eaten was not predicted by the interaction between task-engagement and scores on either the restraint scale ($t = 1.40$, $b = 1.64$, $s.e. = 1.17$, $p = 0.16$) or the disinhibition scale ($t = 1.26$, $b = 0.32$, $s.e. = 0.26$, $p = 0.21$).

8.4.2. Evidence for proactive disinhibition

8.4.2.1. Group classifications

Eleven participants did not engage with the task at any time during the experiment and so were classified into a single group, labelled ‘*non-engagers*’. Of those participants who did engage with the task, 56 reported that this decision was not

strategic, and so were classified as ‘*non-task-users*’. The remaining 23 participants reported engaging with the task proactively, in order to avoid cognisance of the food, and were subsequently classified as ‘*task-users*’.

Within the group of task-users, 19 participants indicated that they actively ‘used’ the task in order to resist the temptation to eat (12 engaged with the task while eating, and 7 engaged with the task after eating). The remaining four participants reported focusing on the task in order to avoid cognisance of what and how much was being eaten (three who engaged with the task while eating, and one engaged with the task after eating). Because of the small number of participants in this latter group, analyses with these individuals as a separate sub-group of task-users is not permitted. Therefore, the data from these four participants has been removed from the data set, and the resulting analysis concentrates on the differences between three groups; non-engagers, non-task-users, and task-users (to resist temptation)⁸.

8.4.2.2. *Group characteristics*

Across the three groups, DEBQ-restraint ($F[2,83] = 10.26, p < 0.001$) and TFEQ-disinhibition scores ($F[2,83] = 6.46, p = 0.002$) differed significantly. Tukey’s *post hoc* tests revealed that task-users had significantly higher DEBQ-restraint and TFEQ-disinhibition scores than both non-engagers (mean difference = 4.37, $p = 0.013$, and 1.02, $p = 0.004$, respectively) and non-task-users (mean difference = 3.49, $p = 0.004$, and 0.96, $p < 0.001$, respectively). No significant difference in BMI was observed across the three groups ($F[2,78] = 0.854, p = 0.430$). In addition, the number of participants who reported that they engaged with the task proactively did not differ significantly from the number who reported no strategic motivation behind their decision to engage with the task (Fisher’s exact test; $p = 1.0$). Nor was task-use reported more often by dieters compared to non-dieters (Fisher’s exact test; $p = 0.252$).

⁸ Analyses conducted with these four participants included in the ‘task-users’ group produced the same pattern of results. For this reason, and for reasons of clarity, only the results from the analysis conducted with the small sub-set of task-users removed is reported throughout.

8.4.2.3. Subjective measures

No significance differences were observed across the task-users, non-task-users, and non-engagers in the initial ratings of hunger ($F[2,83] = 1.18, p = 0.312$), fullness ($F[2,83] = 2.63, p = 0.769$), desire to eat ($F[2,83] = 0.97, p = 0.383$), or pleasantness ($F[2,83] = 6.85, p = 0.507$). See Table 7 for means (*SDs*).

	Group		
	Non-engagers <i>n</i> = 11	Task-users <i>n</i> = 19	Non-task-users <i>n</i> = 56
BMI	22.54 (4.27)	24.04 (3.35)	23.13 (2.81)
DEBQ- restraint	0.79 (0.79)	3.48 (0.71)	2.53 (0.86)
TFEQ- disinhibition	6.00 (3.07)	10.37 (4.02)	6.88 (4.09)
Initial hunger	72.82 (15.48)	68.84 (11.36)	64.18 (21.26)
Initial fullness	15.18 (9.14)	19.32 (15.42)	18.16 (15.98)
Initial desire to eat	71.27 (17.92)	70.42 (15.39)	64.43 (21.73)
Initial pleasantness	75.45 (10.73)	80.79 (10.97)	77.59 (13.84)

Table 7. Mean (SD) BMI, DEBQ-restraint, and TFEQ-disinhibition scores, and baseline ratings (mm) of hunger, fullness, desire to eat, and pleasantness, for the non-engagers, task-users, and non-task-users in Experiment 3.

In addition, no significant differences were found across the three groups in the initial feelings of anxiety ($F[2,83] = 0.864, p = 0.425$), rebelliousness ($F[2,83] = 0.366, p = 0.695$) or alertness ($F[2,83] = 0.047, p = 0.954$). Table 8 shows these means (*SDs*). A significant difference was found in initial feelings of stress ($F[2,83] = 3.17, p = 0.047$). *Post-hoc* tests (Tukey) revealed that task-users were

significantly more stressed than the non-task-users (mean difference = 14.47, $p = 0.043$). However, in both cases, the level of stress reported was below the neutral point on the 100 mm scale indicating that in general the groups were not stressed. No significant differences were observed across the three groups in the extent to which ratings of anxiety ($F[2,85] = 0.14$, $p = 0.87$), stress ($F[2,85] = 2.61$, $p = 0.08$), rebelliousness ($F[2,85] = 0.74$, $p = 0.48$), and alertness ($F[2,85] = 0.23$, $p = 0.79$) changed from pre- to post-intake.

	Group		
	Non-engagers $n = 11$	Task-users $n = 19$	Non-task-users $n = 56$
Anxiety	20.09 (20.34)	27.26 (26.93)	20.18 (18.41)
Stress	21.55 (24.77)	37.95 (27.56)	23.48 (20.45)
Rebelliousness	28.73 (27.35)	24.63 (24.58)	22.36 (21.97)
Alertness	55.27 (17.79)	56.42 (16.48)	54.80 (21.07)
Fattening	70.64 (16.48)	71.16 (17.67)	68.29 (16.56)
Healthy	16.09 (8.17)	17.37 (10.45)	19.21 (14.68)
Threat - general	66.18 (21.88)	76.00 (16.83)	17.11 (20.34)
Threat - self	32.73 (28.78)	64.00 (18.70)	39.07 (29.84)
Concern	19.18 (28.22)	51.68 (27.57)	20.52 (21.40)

Table 8. Mean (SD) ratings (mm) of initial mood (anxiety, stress, rebelliousness, and alertness) and how fattening, healthy, threatening to a dieter, threatening to self, and how concerned participants were with the amount eaten in Experiment 3. Separate values are shown for the non-engagers, task-users, and non-task-users.

The three groups also differed significantly in terms of how threatening to themselves they regarded the food to be ($F[2,85] = 6.76$, $p = 0.002$) and how concerned they were about how much they had eaten ($F[2,85] = 12.94$, $p < 0.001$).

Post-hoc tests (Tukey) confirmed that both non-engagers and non-task-users regarded the food to be significantly less threatening to themselves (mean difference = 31.3, $p = 0.010$, and 24.9, $p = 0.003$, respectively) and were less concerned about how much they had eaten (mean difference = 32.5, $p = 0.002$, and 31.2, $p < 0.001$, respectively) than did task-users. No significant difference was observed across the three groups in terms of how fattening ($F[2,85] = 0.252$, $p = 0.778$), healthy ($F[2,85] = 0.333$, $p = 0.718$), or threatening to a dieter ($F[2,85] = 0.924$, $p = 0.401$) they regarded the food to be. See Table 8 for means (*SDs*).

8.4.2.4. Amount eaten

A one-way ANOVA revealed no significant difference ($F[2,85] = 0.22$, $p = 0.80$) in the amount of potato chips eaten by the task-users (mean = 8.00, $SD = 4.67$), the non-task-users (mean = 7.88, $SD = 5.82$), and the non-engagers (mean = 6.73, $SD = 5.29$).

8.4.2.5. Estimated intake and confidence ratings

One-way ANOVA also revealed no significant differences across the three groups in relation to the estimated number of potato chips that had been eaten ($F[2,85] = 0.734$, $p = 0.483$), the confidence with which these estimate were given ($F[2,85] = 2.93$, $p = 0.059$), or the accuracy with which these estimate were made ($F[2,80] = 0.657$, $p = 0.521$).

8.4.2.6. Relationship between dietary behaviour and the effects of task-use

Again, regression analysis was used in order to determine whether amount eaten could be predicted by the interaction between scores on the measures of dietary behaviour (i.e., restrained and disinhibited eating) and self-reported use of the task. Those participants who reported that they did not strategically engage with the task were allocated to a single group along with those participants who did not engage

with the task at all. The results of these analyses revealed that amount eaten was not predicted by the interaction between restraint score and task-use ($t = 1.64$, $b = 2.86$, $s.e. = 1.74$, $p = 0.105$) or between disinhibition scores and task-use ($t = 0.26$, $b = 0.09$, $s.e. = 0.34$, $p = 0.79$). Once again, in these models, neither restraint ($t = -0.43$, $b = -0.35$, $s.e. = 0.82$, $p = 0.67$) nor disinhibition scores ($t = 1.68$, $b = 0.29$, $s.e. = 0.17$, $p = 0.096$) predicted the amount eaten.

8.5. DISCUSSION

The aim of this experiment was to further explore the relationship between attention and food intake in a context that is closer to that encountered in real-life eating situations. To this end, in this experiment, participants could choose if, when, and for how long they engaged with the concurrent task. On this basis, those participants who chose to engage with the task while eating ate significantly more than those who engaged with the task after eating. This effect appears to occur irrespective of current dietary behaviour. Furthermore, when asked to estimate how much food they had eaten, those individuals who had engaged with the task while eating were less confident that their estimate was accurate than the other two groups. These results are consistent with the notion that those allocating more attention to the task are, by dint of a limited capacity resource, allocating less attention to monitoring their food intake, resulting in larger meal size and reduced awareness of amount eaten.

While the decision to engage with the task while eating has important implications for the amount of food subsequently consumed, this decision does not appear to reflect proactive disinhibition per se. This is because 59 per cent of the individuals who ate while engaged with the task did not report that their decision to do so was a strategic one. This supports the notion that the process underlying many instances of overeating under everyday distracting circumstances (e.g., eating in groups) may be more passive (e.g., De Castro, 1994). Of course, this does not preclude the possibility that those individuals who choose to engage with a task, proactively or otherwise, may be different from those who do not, and that it is this difference that is related to increased food intake, rather than distraction per se. However, this latter

hypothesis would seem unlikely given the large literature documenting the stimulatory effects of distraction on the food intake of individuals, irrespective of gender, age, ethnicity, weight-status, and dietary behaviour (e.g., Boon et al., 2002; Del Toro, & Greenberg, 1989; Dietz & Gortmaker, 1985; Tucker & Bagwell, 1991; Tucker & Freidman, 1989; see Stroebele & De Castro, 2004a for a review). Rather, these results suggest that the act of engaging in another activity while eating is likely to lead to increased food intake. This has important implications for the way in which the regulation of eating behaviour is viewed and how meal times are constructed.

Notwithstanding this, in line with the results of Experiment 2, a proportion of the participants did report strategically engaging with the concurrent task in order to avoid cognisance of the food. However, under these circumstances, little evidence was found to suggest that this strategy is related to a desire to ‘disinhibit’ or overeat. Rather, 83 per cent of the task-users reported engaging with the task in order to resist the temptation to eat, over half of whom were current dieters. This behaviour may be motivated by how threatening the food is considered to be, since task-users report finding the food significantly more threatening than non-task-users. Whether this strategy is actually successful or not is difficult to determine. This is because intake was very similar across the groups. However, whether this reflects the failure or achievement of the attempts of the task-users to resist the lure of the food is unclear. For example, the fact that the task-users did not eat significantly more than the non-task-users may indicate that they were successful in their attempt to avoid overeating. Had no opportunity for strategic distraction been available, they may have eaten a greater amount. Alternatively, the fact that they did not actually eat any less than those who were not attempting to resist the temptation to eat may indicate the converse – that their strategic attempt to direct attention to the task in order to avoid food intake was unsuccessful. Herman and Polivy (1993) suggest that intake can be inhibited by allocating attention *towards* and not away from food during a meal. Thus, by focusing attention on the task, task-users may have undermined their own attempts to limit their intake. In this regard, it is interesting to note that those individuals who did not engage with the task until they had eaten all that they wished, ate the least. Thus, rather than attempting to limit intake from the onset, a better strategy may be to allocate full attention to ingestion of the desired amount of

food. After this point, further intake may be avoided by strategically diverting attention away from the food. The issue of proactive inhibition and proactive disinhibition is discussed further in chapter 9 that follows.

8.6. SUMMARY

The results of this experiment show that the simple decision to engage with a task while eating can lead to increased food intake, and that this effect occurs irrespective of an individual's particular dietary predilections or self-reported strategy. This finding is in line with the results of numerous studies that have reported the stimulatory effects of distraction on the amount eaten by both restrained and unrestrained eaters (e.g., Boon et al., 2002). As outlined in the preceding discussion, approximately one-quarter of the participants tested were engaging with the task in what they considered to be a proactive and strategic manner, the majority of whom reported doing so in order to resist the temptation to eat. However, it is unclear whether or not such a strategy is successful. This uncertainty is confounded further by the fact that the particular experimental design employed does not allow for an objective measure of attention to be obtained that may indicate whether or not task-users were allocating greater attention to the task than non-task-users⁹. In the next chapter, the concept of proactive *inhibition* and proactive *disinhibition* is discussed in greater depth. Specifically, the evidence from Experiments 1 - 3 is reviewed, along with a brief discussion of the implications of this strategy on the interpretation of previous findings and the existing theories that this concept may subsume.

⁹ This is because in this experiment, engagement with the task and intake did not necessarily occur concurrently, and so the measure of performance (number of words found) is confounded by the time spent engaged with the task.

CHAPTER 9: PROACTIVE INHIBITION AND PROACTIVE DISINHIBITION

9.1. INTRODUCTION

Thus far, the evidence presented suggests that food intake may be related to the amount of attention that is allocated to dietary control. In relation to this, of particular interest is the idea that, for some individuals at least, the allocation of attention is under strategic control. The term ‘proactive disinhibition’ has been used here to describe the use of a strategy whereby attention is allocated away from the food in order to promote overeating. As shown in the previous chapter, ‘proactive inhibition’ – the conscious focus of attention away from the food in order to avoid the temptation to eat – may be an equally common strategy.

The aim of this chapter is to consider the idea of proactive (dis)inhibition within a broader theoretical context. In the first section, supporting evidence from Experiments 1 – 3 is briefly reviewed and the implications for the way in which overeating is understood is discussed. This is then followed by a theoretical discussion of proactive (dis)inhibition based on findings from other areas of cognate research. Specifically, evidence is reviewed suggesting that proactive (dis)inhibition may be related to thought suppression, or that it may be an example of what has been termed ‘escape from self-awareness’ (Heatherton & Baumeister, 1991). In the final section, the possibility that proactive (dis)inhibition can be regarded as a skill honed through experience is considered.

9.2. EVIDENCE FOR, AND IMPLICATIONS OF, THE USE OF PROACTIVE STRATEGIES

The finding that food intake increases under conditions of high cognitive load (Ward & Mann, 2000), or when distracted (e.g., Bellisle & Dalix, 2001; Boon et al., 2002), is well documented. Generally, this is taken as evidence that overeating

occurs passively when dietary control receives insufficient attention. However, one possibility is that these results reflect both passive and proactive disinhibition. A review of the literature suggests that the possibility of proactive disinhibition has not been investigated previously. However, evidence that the performance of abstinent smokers is better when they have no immediate opportunity to smoke suggests that they may be allocating greater attention to the task in order to avoid smoking-related cognitions (Juliano & Brandon, 1998). Furthermore, the idea that, under certain circumstances, attention might be proactively allocated was tentatively suggested in a brief statement made by Herman, Ostovich, and Polivy (1999). The authors conducted a study assessing how attentional focus influences hunger ratings. In this study, hungry and sated participants rated their hunger and fullness both before and during a 'free-think' period (control) and while watching three video clips; a weather report (control), a comedy sketch (absorbing non-food), and a restaurant review depicting appetizing foods (absorbing food). In line with prediction, attentional focus to food cues increased hunger in both groups. However, in the food-deprived group, hunger was greater in the 'weather' condition compared to the 'free-think' condition during which participants were instructed to say their thoughts aloud. The reason why hunger should differ between these two control conditions is unclear. The authors suggest that the nature of the thoughts experienced during the two-minute free-think period may hold the clue. Early on, thoughts about food and hunger were mentioned but these became replaced by other academic and social-related thoughts. Herman et al. propose that these thoughts may have been more absorbing than the weather report and that this may account for the difference in hunger. In relation to the idea of proactive (dis)inhibition, of particular interest is the suggestion made by the authors that "it appears that these deprived participants were (deliberately?) redirecting their attention away from a concern with food, and becoming absorbed in other... concerns" (page 190).

In Experiment 1, the elevated performance of the dieters suggests that many of them might be making use of a proactive strategy. Consistent with this idea, in Experiments 2 and 3, many participants report that they engaged in this kind of behaviour. In Experiment 2, non-dieting task-users ate more than non-dieting non-task-users, consistent with the idea of 'proactive disinhibition'. However, dieting task-users ate less than their non-task-using counterparts, raising the possibility that

under those circumstances that pose a greater threat to dietary control, strategic engagement with the task may be used to facilitate successful restraint. This possibility of 'proactive inhibition' was confirmed in Experiment 3 when participants were asked to report their motivation behind their decision to strategically engage with the task. Of those who reported proactively engaging with the task, 83 per cent stated that they did so in order to resist the temptation to eat, over half of whom were current dieters. The possibility that this behaviour is borne out of a desire to avoid 'diet-threatening' foods was supported by the finding that task-users rated the food as being significantly more threatening to their personal dietary goals, than did non-task-users.

Use of such a proactive strategy is probably only possible in cases where a concurrent task permits different levels of cognitive involvement. For example, a task such as a crossword can receive either cursory attention or it can be extremely engrossing. If proactive disinhibition is commonplace, then an interpretation based solely on a passive account may be too simplistic. Indeed, evidence that certain individuals routinely adopt a proactive approach may have implications for our understanding of a range of phenomenon associated with overeating. For example, one possibility is that mood-induction procedures (e.g., horror / comedy films) have the potential to be used proactively (Cools et al., 1992; Schotte et al., 1990). By this account, a person who overeats might choose to direct greater attention towards the mood-altering media. Similarly, the social facilitation effect of eating in groups (e.g., Clendenen et al., 1994; De Castro, 1990; 1994; Redd & De Castro, 1992) and the relationship between television viewing and intake have both been characterised as a passive process (e.g., Coon et al., 2001; Dietz & Gortmaker, 1985; Gore et al., 2003; Stroebele & De Castro, 2004b), but may involve a proactive element. In future, one way to differentiate between a passive and a proactive process might be to compare the effects of a task associated with variable involvement with the effects of a task that requires continuous non-negotiable cognitive resource (e.g., driving at speed).

9.3. ALTERNATIVE FRAMEWORKS WITHIN WHICH PROACTIVE DIS(INHIBITION) CAN BE CONCEPTUALISED

To date, the possibility that attention may be proactively allocated during a meal, and that this reflects a strategic attempt to promote and/or inhibit food intake, is an idea that has not been suggested previously. However, some commonality exists between this idea and other accounts of overeating that have been advocated in the past. Specifically, two theories stand out that offer a framework within which proactive (dis)inhibition can be considered. The following two sections briefly discuss these possibilities. The first section relates to the similarities between proactive use of a concurrent task and thought suppression. The second section considered whether strategic engagement with a concurrent task represents an example of the behaviour that Heatherton and Baumeister's (1991) Escape Theory has attempted to describe.

9.3.1. Thought suppression

Based on the evidence reviewed above, proactive (dis)inhibition can be regarded as a process akin to thought suppression. This is because both processes are conceptualised as an attempt to avoid certain thoughts from entering consciousness and influencing behaviour. Wegner's (1994) Ironic Process Theory postulates that attempts to suppress thoughts can be counter-productive, paradoxically resulting in an increase in the number of unwanted thoughts that are experienced (Wegner, 1994; Wegner, Schneider, Carter, & White, 1987; Wenzlaff & Wegner, 2000). Suppression of thoughts is believed to require significant cognitive effort. Therefore, the implication is that attempts at thought suppression will be more successful when more cognitive resource is available. Indeed, individual differences in working memory capacity have been found to predict ability to successfully suppress unwanted thoughts (Brewin & Beaton, 2002; Brewin & Smart, 2005). Based on this, Boon et al. (2002) suggested that the bouts of overeating experienced by restrained eaters when under cognitive load could be related to their inability to suppress eating-related thoughts.

However, the concept of proactive (dis)inhibition is based on the premise that engagement with a concurrent task represents a strategy by which either inhibitory or disinhibitory thoughts can be *successfully* avoided. From the data presented, the extent to which such strategies are successful can not be concluded with certainty. However, in a review on the effects of thought suppression, Rassin, Merckelbach and Muris (2000) similarly conclude that not all thought suppression techniques are necessarily associated with negative outcomes. Rather, strategies such as ‘blunting’, whereby threat-related information is avoided, has been found to be related to less intrusive thoughts and less distress. More direct evidence also exists to support the idea that distraction can, in fact, aid the success of attempts at thought suppression. For example, engaging in some form of distraction when an unwanted thought is experienced has been reported to be associated with less obsessional thoughts (Rassin & Diepstraten, 2003).

Whether or not distraction aids or undermines attempts at thought suppression may be related to the type of distraction available. The role played by distracters is discussed by Wenzlaff and Wegner (2000) in a review on thought suppression. They suggest that when individuals attempt to suppress thoughts by directing their attention to aspects of the immediate environment, such as a picture hanging on a wall, this strategy is likely to be ineffective. This is because the distracter can not sustain the individual’s attention and so the unwanted thoughts drift back into consciousness. In this regard, it is noteworthy that the tasks used here are likely to have been successful in holding attention, particularly in the case of the RVIP task, which is specifically designed to measure sustained attention. Therefore, contrary to what the literature on thought suppression may suggest, under these circumstances proactive engagement with a concurrent task may represent a successful thought control strategy.

9.3.2. Escape from self-awareness

Another theory with which the construct of proactive disinhibition / inhibition could be considered synonymous is that of Heatherton and Baumeister’s (1991) Escape Theory. This theory proposes that binge eating is motivated by a desire to escape

from aversive self-awareness, for example feelings of inadequacy. Escape is achieved by limiting attention to the immediate stimulus environment, thereby facilitating a shift from high to low self-awareness. Consistent with this is the finding that following failure on a task, dieters overeat only under those conditions that allow – or promote – low self-awareness (Heatherton, Polivy, Herman, & Baumeister, 1993). Furthermore, attempts to avoid self-focussed attention tend to occur under those circumstances where one's behaviour is discrepant with one's beliefs (Greenberg & Musham, 1981). However, the cognitive activity that is associated with this shift from high to low self-awareness has been poorly specified. In part, this is because self-awareness itself is a difficult construct to measure.

Strategic engagement with the task can be similarly regarded as an attempt to decrease or 'escape from' self-awareness, that may be motivated by either a desire to eat without the associated negative feelings of guilt or failure, and/or a desire to avoid threatening food-related cues and cognitions. Either way, the relationship between attention and overeating might be better couched in terms of this cognitive process, obviating the need to appeal to difficult constructs such as self-awareness. Furthermore, if the concept of proactive disinhibition does indeed subsume Escape Theory - and the elevated performance of the task-users in Experiment 2 can be regarded as a by-product of an attempt to 'escape' - this data may represent the first objective assessment of this otherwise elusive behaviour.

9.4. PROACTIVE (DIS)INHIBITION AS A 'SKILL'

An alternative way in which proactive (dis)inhibition can be viewed is as a generic 'skill'. Conceptualised in this way, the cognitive process underlying proactive (dis)inhibition is not specific to attempts to control eating behaviour per se. Rather, it is manifest in a variety of situations that require cognitive control. This idea is similar to that proposed by Rosenbaum (1983), who described a behaviour called 'learned resourcefulness'. This behaviour consists of a learned repertoire of basic skills that individuals use to successfully regulate aspects of their lives and which represent the foundation of self-regulation. Individuals who score highly on a measure of self-control (the Self-Control Schedule, SCS; Rosenbaum, 1980) tend to

demonstrate clearer and more consistent commitments to goals and employ a range of techniques to cope more effectively with a range of challenging situations.

Evidence from a number of sources suggests that the relationship between specific dietary behaviours and related outcomes is quite complex. For example, Bond, McDowell, and Wilkinson (2001) have suggested that the association between the subscales of the TFEQ and BMI may be non-linear. Thus, high TFEQ-disinhibition scores are not necessarily related to a higher BMI. One reason for this complexity may be related to the particular set of skills that individuals bring to bear when attempting to regulate their eating behaviour. Whether or not their skills are successful is likely to mediate the relationship between tendency to overeat and actual overeating (see Green & Shellenberger, 1991). In this regard, it is perhaps not surprising that the relationship between attention and food intake is often not straightforward. The possibility that overeating after a food preload may be related to lower levels of learned resourcefulness has been explored in one study. In this case, Kirschenbaum and Dykman (1991) found that, contrary to prediction, restrained eaters with high resourceful control skills actually ate more, not less, than their less resourceful counterparts. Why this might be the case is unclear. Nonetheless, this study is important as it highlights the contribution of dispositional factors to the variability in the eating behaviour of restrained (and unrestrained) eaters. Furthermore, it supports the idea that further variability may result from the extent to which individuals choose to strategically engage with a concurrent task as a means of regulating intake.

A number of other frameworks also offer perspectives on the way in which skills influence behaviour. One of these, taken from the marketing literature, proposes that behaviour is governed by three elements; motivation, opportunity, and ability (MOA; MacInnis, Moorman, & Jaworski, 1991). This perspective advocates that individuals are motivated to behave in a certain way when they can discern that this behaviour will serve their goals. The opportunity to behave in this way may or may not exist depending on the environmental circumstances at hand, and the ability to undertake the behaviour in question may be reliant on specific skills. This perspective has been applied to public health (Rothschild, 1999) and recently to explaining food choice (Brug, 2005). The eating behaviour of 'task-users' may be

similarly regarded within such a framework. For example, when motivated to inhibit food intake, a concurrent cognitive task may provide the opportunity to avoid cognisance of the food and resist the temptation to eat. However, the extent to which this strategy is successful is likely to be related to how proficient the individual is in employing such techniques. Proficiency is likely to develop with repeated use. Indeed, after frequently using a task in a specific context (e.g., while watching television) the tendency to engage in proactive (dis)inhibition may become automatic and involuntary (M.R. Lowe, personal communication, February 18th, 2004). In this regard, it is noteworthy that in Experiment 3, only 28 per cent of those participants who ate while engaged with the word search task reported doing so in order to proactively divert their attention. Whether or not this reflects the development of proactive (dis)inhibition into an automatic skill that is subsequently susceptible to underreporting remains to be verified.

9.5. SUMMARY

This chapter has discussed the concept of proactive (dis)inhibition with respect to alternative perspectives on overeating and self-control. The possibility that overeating when distracted may be related to the way in which an individual engages with a concurrent task has not been explicitly suggested previously. However, there are conceptual links between this process, and those of alternative theories that have suggested the likely mechanism by which a breakdown in dietary restraint may occur, and these have been discussed here. An advantage of the current hypothesis is that it lends itself more easily to empirical investigation. Notwithstanding this, the inherent challenge involved in attempting to unpick exactly how individuals are allocating their attention, and the factors involved in this process, remain great. The focus of the research presented in Part II is an attempt to identify the nature of the mechanism(s) that is undermined when attention is allocated - proactively or otherwise - to a concurrent task.

PART II

CHAPTER 10: OVERVIEW OF PART II

10.1. INTRODUCTION

The aim of Part I was to explore how attention and food intake may be related and the cognitive factors that might play a role in mediating this relationship. A number of potentially influential factors were identified in Experiments 1, 2, and 3, including the particular dietary characteristics of the individual, the perceived threat to dietary goals, and the use of proactive strategies. These issues have been discussed in the preceding chapters.

Central to this research is the attempt to identify the nature of the process that is undermined when eating while distracted. With regard to this, the possibility that overeating occurs when insufficient attention is allocated to monitoring intake appears to have been confirmed. Previously, this explanation has been offered to account for the occurrence of bouts of overeating in those individuals who are otherwise trying to restrict their intake (e.g., Ward & Mann, 2000). However, as the research in Part I has shown, the effects of distraction appear to influence intake irrespective of the particular dietary predilections of the individual, implying that some form of monitoring is common to all human eating behaviour.

While monitoring may take the form of the explicit ‘counting’ of the amount of food ingested, an alternative possibility is that it can occur at a more sensory level. A number of orosensory-related processes are thought to be important in determining whether or not a food will be ingested and the amount of food that is consumed. For example, during a meal, a kind of ‘sensory boredom’ develops, whereby the reinforcing value of the food gradually declines until it is no longer considered pleasant and eating ceases. If distraction simply undermines the ability to cognitively monitor food intake, then it is unclear why overeating should occur.

This is because the same hedonic shift in the sensory properties of the food¹⁰ would be expected to have taken place, irrespective of whether ingestion occurred in conjunction with a concurrent task. Under these circumstances, it is unclear why distraction should lead to increased food intake if sensory boredom is indeed experienced. Therefore, one possibility is that the usual decline in the hedonic response to the sensory properties of the food, that otherwise serves to terminate an eating episode, is attenuated when eating while distracted.

The aim of Part II of this thesis is to explore this possibility. Consequently, in this chapter, the literature surrounding the ways in which changes in the pleasantness of a food influence food intake will be reviewed. This literature is pertinent to the aims of Experiments 5, 6, and 7. Experiment 4 focuses solely on the extent to which distraction attenuates changes in appetite (hunger, fullness, and desire to eat) and not pleasantness. However, this experiment is reported in the next chapter - before Experiments 5 – 7 - as it provides the theoretical basis on which these later experiments are based and the justification for the particular methods used therein.

10.2. CHANGES IN PLEASANTNESS AND THE REGULATION OF FOOD INTAKE

The pleasure derived from eating a food is not an intrinsic or constant property of that food. Rather, pleasure is dynamic and is influenced by a range of factors, both innate and learned. For example, preferences for sweet odours and tastes appear to be present from birth (Soussignan, Schaal, Marlier, & Jiang, 1997; Steiner, 1974; 1979; for a review see Steiner, Glaser, Hawilo, & Berridge, 2001). In contrast, preferences for sour and bitter tastes are thought to develop through learned associations and repeated exposure (London, Snowdon, & Smithana, 1979; Mattes, 1994; Rozin & Schiller, 1980; Rozin & Vollmecke, 1986). An individual's liking for a particular food can also vary according to a number of factors, such as the time of day and context in which the food is eaten (see Rozin & Vollmecke, 1986). It can

¹⁰ The terminology used in this chapter, and those that follow, is consistent with that used by M. Hetherington and B. Rolls (e.g., Hetherington & Rolls, 1996; Rolls, 1986).

also vary across both long and short durations of time. For example, studies of the effects of monotonous diets have shown that the pleasantness of a food will begin to decline when it is repeatedly consumed over a long period of time (Hetherington, Pirie, & Nabb, 2002; Lokko, Kirkmeyer & Mattes, 2004; Meiselman, De Graaf, & Leshner, 2000; Rolls & De Waal, 1985; Siegal, 1957). Similarly, in the shorter-term, the pleasure derived from eating a food is related to two processes; ‘alliesthesia’ (Cabanac, 1971) and ‘sensory-specific satiety’ (Rolls, 1986). Alliesthesia and sensory-specific satiety represent two distinct processes that are associated with different outcomes. Whereas alliesthesia results from a reduction in internal need state, generalizes to all foods that predict a reduction of the same need (e.g., protein), and takes time to develop, sensory-specific satiety begins to recover soon after the end of a meal, is specific to the food being eaten, and results from exposure to the specific sensory characteristics of the food. The aim of the following sections is to consider how these two processes influence eating behaviour. This discussion is first preceded by an overview of the distinction between ‘wanting’ and ‘liking’. This is pertinent to a discussion on changes in pleasantness since controversy exists over which of these separate motivational processes such changes reflect. This is therefore central to the aims of Part II since distraction may differentially undermine these separate motivational processes.

10.2.1. ‘Liking’ versus ‘wanting’

It is important to note that central to this literature is a debate concerning the distinction between *liking* a food and *wanting* to eat it. Berridge and colleagues have extensively studied the psychology and neurobiology of sensory pleasure and reward and how this relates to appetite and other motivational disorders, such as drug addiction. It is often assumed that we want the rewards that we like, and we like the rewards that we want (Berridge, 1996). Rational choice theories of motivation view wanting for an outcome as rationally connected to the anticipated liking for the outcome. Thus, if liking changes then so will wanting (Winkielman & Berridge, 2003). However, evidence suggests that this is not always the case. Specifically, while liking corresponds to pleasure and palatability and reflects the hedonic impact of a stimulus, wanting is more closely associated with appetite or

craving and represents the motivational incentive value of a stimulus, regardless of sensory pleasure (for a recent review see Berridge, 2004). A disassociation of this kind has been supported by evidence from the animal literature that has identified differential effects of the neurotransmitter dopamine on liking (measured by hedonic/aversive reaction patterns) and wanting (measured by intake, preference tests, or instrumental behaviour for food) (see Berridge & Robinson, 1998), and the existence of separate brain mechanisms for each of these processes (see Berridge, 1996). Studies with humans have similarly found that certain pharmacological manipulations, such as administration of the opioid antagonist naltrexone, can produce effects that appear to distinguish between liking and wanting. Specifically, following administration of naltrexone, reductions in the pleasantness of foods is observed, while hunger remains unchanged (Fantino, Hosotte, & Apfelbaum, 1986; see Yeomans & Gray, 2002, for a review).

However, in the absence of pharmacological interventions, the extent to which individuals are able to distinguish between these two processes is unclear. Berridge (1996) has argued that this is because the psychological processes underlying behaviour are not directly available to subjective introspection. For example, Rogers and Blundell (1990) suggested that participants should be asked to rate both the pleasantness of the taste of a food and how pleasant it would be to eat the food. Based on this, Hetherington (1993) found that when participants were given *ad libitum* access to either cheese on crackers or chocolate, the ratings of the pleasantness of the taste and the pleasure derived from eating the food were not able to distinguish between these two processes. Rather, the ratings were highly correlated and changed to the same extent. This was the case when all participants were asked to provide both ratings, and when half of the participants provided a rating of pleasantness of taste and the other half provided a rating of the pleasure derived from eating. Individuals have also been shown to have difficulty teasing apart 'desire to eat' and 'pleasantness of taste', with ratings of each declining to the same extent after a meal (e.g., Rolls & McDermott, 1991). One of the reasons that attempts to distinguish between such processes have proved unsuccessful may be related to the fact that, when relying on such subjective ratings, it is unclear exactly what information (hedonic or motivational) participants are drawing upon in order to make such judgements (for a related discussion see section 16.2.1.).

Some evidence for a partial disassociation between ‘liking’ and ‘wanting’ has been found. For example, Hetherington et al. (2002) reported reductions in the rated pleasantness of the taste of chocolate without similar reductions in intake. Furthermore, in a study that used ratings of palatability to assess ‘liking’ and a forced-choice photographic procedure to assess ‘wanting’ (Finlayson, King, & Blundell, 2005) some differences in ‘liking’ and ‘wanting’ for generic food categories, that are dependent on need state, have been reported. For example, when participants were hungry, high-fat savoury foods were found to be ‘wanted’ more than low-fat savoury foods, but no corresponding difference in ‘liking’ was observed. When satiated, the high-fat savoury foods were not ‘wanted’ more than the low-fat savoury foods, but were ‘liked’ more. Similarly, when hungry, high-fat sweet foods were ‘liked’, but were not ‘wanted’, more than low-fat sweet foods. When satiated, both types of foods were ‘liked’ to a similar extent, but the low-fat sweet foods were ‘wanted’ more.

Whether liking or wanting underlies the reduction in pleasure that is experienced as a function of eating remains as issue of debate. This issue highlights the need for caution when attempting to interpret the nature of the process(es) that underlie human eating behaviour. The following sections review two processes that view changing pleasantness in terms of need state (wanting) and hedonic shifts (liking).

10.2.2. Alliesthesia

The term ‘alliesthesia’ (Cabanac, 1971) refers to the phenomenon whereby the pleasure derived from a particular stimulus is mediated by the internal need state of the individual, and how ‘useful’ the stimulus is deemed to be. Alliesthesia can be both positive and negative; positive alliesthesia refers to the increase in the pleasantness of a stimuli that is experienced when internal need state is high. In contrast, negative alliesthesia refers to the reduction in pleasantness that occurs when need state is low. It is considered to be a very basic, biopsychological phenomenon and the principles can be applied to most hedonic experiences. For example, thermal pleasantness may be related to internal thermal state (e.g., Attia,

1984; Cotter & Taylor, 2005), such that the pleasure obtained from taking a hot bath is likely to be dependent on the environmental conditions, i.e., enjoyable on a cold day, but unpleasant on a warmer day. In relation to the regulation of eating behaviour, alliesthesia influences food intake by altering the extent to which the orosensory properties of a food are perceived as pleasurable - greater when hungry (e.g., Lozano, Crites, & Aikman, 1999) and lower when satiated (for a review on the role of alimentary pleasure and displeasure in the drive for food intake, see Fantino, 1984).

Gustatory and olfactory alliesthesia have been extensively studied both in animals (e.g., Cabanac & LaFrance, 1990; 1991) and in human adults (e.g., Cabanac & Rabe, 1976; Marceau et al., 2005; Scherr & King, 1982) and infants (e.g., Soussignan, Schaal, & Marlier, 1999). The standard experimental procedure for such studies involves three stages (e.g., Cabanac & Fantino, 1977). Firstly, hungry participants are exposed to a stimuli and the amount of pleasure it evokes is assessed. This is achieved by asking participants to taste and/or smell the stimuli (e.g., sucrose solutions) and to rate the pleasantness. The physiological usefulness of the stimuli is then altered by the ingestion of a preload (e.g., a glucose solution). At several time-points after this, participants are again exposed to the stimuli and pleasantness is re-assessed, either by subjective or behavioural reactions (as appropriate). The prediction, based on the concept of alliesthesia, is that a reduction in the pleasantness of the stimuli should be experienced, since ingestion of the preload has modified the internal need state. This reduction is only temporary however, since the decrease in internal need state is similarly transient and will re-emerge over time.

Negative alliesthesia is regarded as a post-ingestive, rather than a sensory, phenomenon. As such, the hedonic change that is experienced as negative alliesthesia occurs once the food has been detected by receptors in the gastrointestinal tract (e.g., Cabanac & Fantino, 1977) and possibly with the release of cholecystokinin (CCK – a peptide hormone secreted by the duodenum causing the release of digestive enzymes; Cabanac & Zaho, 1994; Waldbillig & O'Callaghan, 1980), with maximum reductions occurring approximately 30- to 60-minutes post-consumption (e.g., Blundell & Hill, 1988; Cabanac & Fantino, 1977; Soussignan et

al., 1999; Wooley, Wooley, & Dunham, 1972). The extent to which alliesthesia is specific to the nutrient being ingested, as opposed to energy density, remains unclear. While evidence that salty stimuli are less pleasant after sodium chloride loads, but not after carbohydrate loads (Cabanac & Duclaux, 1970) suggests that the effects of alliesthesia may be nutrient-specific, research with other nutrients has failed to find such specificity of effect. Rather, both protein and carbohydrate loads lead to decreased pleasantness of sweet stimuli (which predict the presence of energy) in humans (e.g., Cabanac & Fantino, 1977; Guy-Grand, & Sitt, 1976) and in animals (Cabanac & Lafrance, 1992), suggesting that reductions in pleasantness are non-specific and are related to general current energy needs. In line with this, sweet stimuli tend to taste less pleasant after a recent meal (e.g., Laeng, Berridge, & Butter, 1993; Looy & Weingarten, 1991) and the magnitude of the reduction in pleasantness has been found to increase along with the increasing energy density of the meal (Ruzic, Tisovski, Veljkovic, & Petrovic, 1983).

Alliesthesia has been regarded as a mechanism that may operate to maintain homeostasis and body-weight set-points (see section 1.3.). The idea that food will remain pleasant if an individual is below their biologically determined set-point for body-weight fits with Nisbett's (1972) theory that restrained eaters may be more reactive to food and susceptible to overeating because they are in a chronic state of hunger (see section 1.4.). However, evidence that negative alliesthesia is reduced by weight loss has been contradictory (e.g., Cabanac & Rabe, 1976; Carr & Wolinsky, 1993; Esses & Herman, 1984; Kliefeld & Lowe, 1991). Furthermore, the pleasure gained from eating may be influenced by motivations other than the desire to satisfy a basic, homeostatic motivation. Rather, food intake can be influenced by the amount of monetary reward attached to eating particular foods, such that the pleasure gained from the eating episode is financial (Cabanac, 1995). Similarly, the characteristics of the individual may interact with the operation of this process. For example, having a 'sweet tooth' has been associated with greater negative alliesthesia (Laeng et al., 1993).

Alliesthesia offers a useful mechanism by which the changing hedonic response to the sensory properties of a food can be explained. However, beyond the acceptance of the basic premise on which the concept of alliesthesia is based, the way in which

this process operates to influence eating behaviour is still poorly understood (for an unpublished review see Atton, 2005). In part, this is because few studies have gone beyond looking at the effects of preload ingestion on liking for sweet and salty tastes to investigate alliesthesia within a ‘normal’ meal. Furthermore, the effects of negative alliesthesia on subsequent food intake has also received inadequate attention. In relation to this, the literature on sensory-specific satiety, the second process advocated to describe how eating behaviour is regulated by changing pleasantness, has proved more informative.

10.2.3. Sensory-specific satiety

The term ‘sensory-specific satiety’ describes the decline in pleasure that is derived from a food as a function of eating it (Rolls, 1986), and is implicated as an important factor involved in meal termination (Hetherington, 1996; see section 10.2.3.1.). In a typical investigation of sensory-specific satiety, participants are required to taste a number of food samples and to provide hedonic ratings (e.g., pleasantness, desire to eat, intensity etc) for each one. These measures are taken both before, and at various time-points after one of the foods is eaten to satiety. The particular food eaten to satiety is counterbalanced across participants. Sensory-specific satiety is then assessed by comparing the change in the rated pleasantness of the ‘eaten’ food against that of the ‘uneaten foods’ (those foods not eaten to satiety). While hedonic ratings of the eaten food tend to decline, those of the uneaten foods tend to remain relatively unchanged. The difference in the change in the pleasantness of the ‘eaten’ relative to the ‘uneaten’ foods is what is described by the term ‘sensory-specific satiety’.

Sensory-specific satiety has been demonstrated with a wide range of foods, both those eaten to satiety (e.g., Porrini, Crovetto, Riso, Santangelo, & Testolin, 1995), and those simply tasted (e.g., Raynor & Epstein, 2000) or smelt (Rolls & Rolls, 1997). The finding that sensory-specific satiety can occur under the latter two conditions indicates that the operation of this process occurs independently of post-ingestive consequences and, therefore, contrasts alliesthesia. Sensory-specific satiety effects have been shown to last for up to two hours (Weenen, Stafleu, & De

Graaf, 2005) and can generalise to other foods that are similar in appearance (Rolls, Rolls, & Rowe, 1983; Rolls, Rowe, & Rolls, 1982), taste (e.g., Johnson & Vickers, 1993; Rolls, Van Duijvenvoorde, & Rolls, 1984) and texture (e.g., Guinard & Brun, 1998) to that of the food eaten to satiety. These effects tend not to be related to the intensity of the food (Vickers & Holton, 1996) or to be associated with changes in intensity (Rolls & Rolls, 1997; Rolls et al., 1983). Indeed, it has been suggested that it would not be adaptive for food consumption to lead to a decreased ability to taste foods (Rolls, 1986).

While greater sensory-specific satiety effects have been found for high- compared to low-protein versions of a food (Vandewater & Vickers, 1996), most evidence suggests that the macronutrient content of the food may be less important (Rolls, Hetherington, & Burley, 1988a; Rolls, Hetherington, & Laster, 1988). Neither the energy density (Rolls, Hetherington, & Burley, 1988b), carbohydrate (Rolls, Laster, & Summerfelt, 1989), fat (Miller, Bell, Pelkman, Peters, & Rolls, 2000), or fiber content (Manthey & Vickers, 1996) of matched food samples have been found to differentially effect the development of sensory-specific satiety.

Some evidence suggests that sensory-specific satiety may be influenced by the volume of food that is ingested (Bell, Roe, & Rolls, 2003; Rolls et al., 1998). For example, in one study, greater satiety was found for soup compared to solid foods (melon and cheese on crackers; Rolls, Fedoroff, Guthrie, & Laster, 1990). This possibility would seem plausible since the larger the volume ingested, the greater the sensory stimulation. A range of studies assessing the effects of pharmacological interventions supports this claim. Neither naltrexone (a drug which blocks opioid receptors; Hetherington, Vervaet, Blass, & Rolls, 1991), or alcohol (Caton, Marks, & Hetherington, 2005) has been found to disrupt the development of sensory-specific satiety. Moreover, satisfaction of cravings for chocolate has been shown to be related to the sensory, rather than pharmacological properties of chocolate (Michener & Rozin, 1994) (for a recent review on the role of sensory perception of food on appetite and food intake, see Sorensen, Moller, Martens, & Raben, 2003).

Support for the role of sensory-specific satiety in the termination of meals has come from studies that have shown that meals that are composed of foods that differ in at

least one sensory characteristic (e.g., flavour, texture) tend to be larger and terminated later than those that consist of a single food. For example, Rolls et al. (1984) found that 44 per cent more food and 66 per cent more energy was consumed during a varied four-course meal, compared to a meal consisting of four identical courses. This is because limited variety encourages a decline in pleasantness that is specific to the sensory properties of the food being ingested, while greater variety offers less opportunity for such sensory boredom to develop (Raynor, Niemeier, & Wing, in press). The extensive literature on what have been termed ‘cafeteria diets’ – those that consist of a range of different palatable foods – provide evidence for the association between dietary variety and increased food intake (e.g., Louis-Sylvestre, Giachetti, & Le Magnen, 1984; Rogers & Blundell, 1984) and BMI (McCrory et al., 1999), and as a result have been implicated as one factor that may be involved in the occurrence of overeating and the development of obesity (for a review on the effects of dietary variety and sensory-specific satiety on eating regulation, see Raynor & Epstein, 2001). Indeed, the fact that after eating cessation, food intake can be reinstated by the presentation of a different food (Rolls et al., 1984) suggests that usually meals tend to be terminated before stomach fullness is reached, a finding supported by Poothullil (2002) who reported greater intake when participants were told to eat until full, compared to when they were told to stop eating when they felt satisfied, or when the food stopped tasting pleasant.

10.2.3.1. Reason given for meal termination: evidence for sensory-specific satiety

As the literature reviewed in the previous sections suggest, the pleasure derived from eating a food declines with increasing exposure to its sensory properties. Because of this, hedonic shifts in the sensory properties of a food have been widely considered to be an important factor involved in meal termination. Although generally believed to be the case, with the exception of a handful of studies (Hetherington, 1996; Mook & Votaw, 1992; Tuomisto, Tuomisto, Hetherington, & Lappalainen, 1998; Zylan, 1996) the validity of this assumption has not been investigated. In part, this is likely to be related to the fact that it is unclear exactly

how to assess reasons for meal termination in any way other than the subjective methods previously used.

In each of these studies (Hetherington, 1996; Mook & Votaw, 1992; Tuomisto et al., 1998; Zylan, 1996), participants were asked to rank a set of statements describing reasons for stopping eating into order of importance. In Mook and Votaw's (1992) and Zylan's (1996) studies, participants did this from memory, indicating the main reason why they *usually* stop eating from a list of five or six alternatives (depending on whether the option "I feel full" was included). Using the same procedure, but with an extra hedonic reason added, Hetherington (1996) asked participants to rank seven reasons for meal termination into order of importance immediately after being given *ad libitum* access to food on either one or two occasions (a first and second course) in the laboratory. Most recently, Tuomisto et al., (1998) conducted a diary study that assessed obese individuals' reasons for meal termination for those meals eaten in the 'real world' (i.e., outside of the laboratory). In this case, a much more comprehensive list consisting of 23 reasons (including "other") was used. Across these studies, only that of Hetherington (1996) found that hedonic factors were chosen as the most common option for ending the meal. In the remaining studies, "fullness" (Mook & Votaw, 1992; Zylan, 1996) and the "feeling of having eaten enough" (Tuomisto et al., 1998) were ranked most important. Taken together, these studies suggest that hedonic shifts in the sensory properties of a food may be less important in meal termination than has been previously suggested. However, it is worth noting that only Hetherington (1996) and Tuomisto et al., (1998) measured reasons for meal termination following an actual meal. Furthermore, Tuomisto et al.'s (1998) sample consisted of obese individuals participating in a weight loss program. Therefore, it is perhaps not surprising that the main reason given for meal termination by this group reflects the use of cognitive control (which may or may not also be influenced by social desirability effects; see section 16.3.). Therefore, although Hetherington's (1996) study represents the most reliable assessment of reason for meal cessation conducted to date, the extent to which hedonic shifts in the sensory properties of a food are recognised as being important in determining meal size is unclear. Additional studies in normal-weight participants are required to explore this possibility further.

10.3. THE ROLE OF SENSORY-SPECIFIC SATIETY IN OVEREATING

As described in section 2.5.2., food intake tends to be greater when meals are eaten when distracted. While the nature of the process that is undermined under such circumstances remains to be elucidated, it follows that if sensory-specific satiety is important in meal termination, then overeating when distracted may result from the interruption, or attenuation, of this process. To date, this possibility has not been explored directly. However, preliminary evidence to support this proposition can be found in the literature related to 1) habituation (a process that is functionally similar to sensory-specific satiety), and 2) the effects of beliefs and aberrant eating behaviours on the development of sensory-specific satiety.

10.3.1. Oral and salivary habituation

Habituation theory proposes that repeated exposure to food stimuli leads to decreased responding to the sensory properties of the food, resulting in satiation for that food. A model of oral habituation, developed by Swithers and Hall, has been used in animals to assess changes in pleasantness that occur as a substance is consumed (for a review see Swithers & Hall, 1994). Using intraoral infusions to deliver sweet tasting substances to rat pups, responsivity (measured by lapping, licking, and swallowing behaviours) has been shown to decrease over time. This decline appears to be specific for the substance being ingested, since presentation of a new, different substance restores licking rates. In addition, since the decline in responsivity occurs before post-ingestive effects are likely to have been experienced, the consequent changes are thought to reflect a process akin to sensory fatigue.

Observations from studies with human participants have also shown that changes in pleasantness may be related to experience in the oral cavity as opposed to post-ingestive feedback. Wooley et al. (1972) found that the decline in pleasantness for the taste of sucrose was similar irrespective of whether it had been consumed as part of a caloric or non-caloric solution. Similarly, no differences were found in the changes in pleasantness experienced after eating a low- or high-calorie version of a

dessert (Rolls et al., 1988b; Rolls et al., 1989). Thus, these findings suggest that satiation may begin in the mouth.

A similar process studied in humans is that of salivary habituation. In these studies, a substance is repeatedly presented (commonly a droplet of a flavoured substance is placed on the tongue) and the amount of saliva produced each time is measured. These measurements are often combined with more subjective hedonic judgements. Epstein and colleagues (e.g., Epstein, Wisniewski, deFlavia, & Mitchell, 1995) have run a number of studies showing that both salivation and the rated pleasantness of a taste-cue declines with repeated presentations of the stimulus. Moreover, salivation levels can be restored to baseline levels by presentation of other taste, odour, and non-sensory stimuli (Epstein, Caggiula, Rodefer, Wisniewski, & Mitchell, 1993; Epstein, Mitchell, & Caggiula, 1993; Epstein, Rodefer, Wisniewski, & Caggiula, 1992). Using actual foods (pizza and cheeseburgers), Wisniewski, Epstein, and Caggiula (1992) found that repeated presentations of one of the foods led to reductions in salivation, hedonic judgements, and intake of that food. However, when presented with the other food, these measures all increased. Again, assessments of the magnitude of these effects using low- and high-carbohydrate versions of the same food have led to the conclusion that salivary habituation is determined by repeated exposure to the sensory features of a food, and not to energy content (Epstein et al., 1993). However, manipulations of fat content have shown that habituation occurs faster for high-fat foods (Myers & Epstein, 1997) and is attenuated in patients with bulimia nervosa (Wisniewski, Epstein, Marcus, & Kaye, 1997). In addition to salivary habituation, habituation of operant, motivated responding (button pressing to earn points and gain food) has also been observed in both children (ages 8-12; Epstein et al., 2003) and adults (Ernst & Epstein, 2002), as has habituation of facial muscle responses (Epstein & Paluch, 1997).

10.3.1.1. Salivary habituation and distraction

Following habituation to a food cue, the presentation of a distracting stimulus, for example a video game, can act as a dishabituator – restoring responding to baseline levels (e.g., Epstein et al., 1992). The presence of distracting stimuli *during*

habituation trials has also been shown to exert a powerful influence, undermining the development of habituation itself. An early study found that participants who received a distracter noise between two presentations of lemon juice showed greater salivation to the second lemon juice presentation than did subjects who received repeated lemon juice presentations with no distracter (Corcoran & Houston, 1977). Epstein et al. (1992) have similarly shown that playing a computer game during the two-minute intervals between habituation trials can prevent habituation to a lemon juice stimulus from developing. Moreover, habituation in children has also been shown to be attenuated by listening to an audio book during stimuli presentations (Epstein et al., 2003).

The complexity of the distracter task appears to influence the extent to which habituation is inhibited. Using memory search tasks that require either controlled or automatic processing to identify target letters in search frames, Epstein, Paluch, Smith, and Sayette (1997) have shown that the rate of habituation is attenuated when greater attentional resource is required to perform the task (controlled processing). When less attentional resource is required, as in the case of the automatic search tasks, no difference was found between this group, and those who completed the habituation trials with no distraction. More recently, this effect has been replicated in children (Epstein, Saad, Giacomelli, & Roemmich, 2005). Using similar (easy versus hard) memory search tasks, habituation to visual and olfactory food cues was found to differ between groups.

10.3.2. Cognitive influences: effects of beliefs and aberrant eating behaviour

Cognitions can interact with, and potentially override, the influence of orosensory stimuli on food preference and choice. Rozin and Fallon (1987) describe one process by which this can occur as ‘ideation’ – a term used to refer to the knowledge about the origin or nature of foods. Ideation is argued to play a major role in either the acceptance or rejection of a food. For example, individuals may reject a food if they do not like the appearance of the kitchen in which it has been prepared. Similarly, dieters may avoid eating high-fat foods because of the consequences to their weight loss aspirations if they do so. Recent evidence

suggests that these diet-related cognitions and negative attitudes to food can undermine the extent to which positive flavour preferences can be learnt (Brunstrom, Higgs, & Mitchell, 2005; Brunstrom & Mitchell, under review).

Research has identified a neurophysiological basis for the phenomenon of sensory-specific satiety. Specifically, activity in the orbitofrontal cortex - the site believed to represent the pleasantness of tastes, smells, textures and associated visual stimuli - has been shown to decrease as a food is eaten (Kringelbach, O'Doherty, Rolls, & Andrews, 2000; for a review see Rolls, 2004; 2005). Furthermore, explicit awareness that a food has been eaten does not appear to be necessary for the expression of sensory-specific satiety, since even amnesic patients report decreased liking for a food previously consumed, despite no memory of having eaten (Higgs, Williamson, & Humphreys, 2005; see section 2.5.1.2.). However, this does not preclude the possibility that cognitions can influence this phenomenon. Indeed, despite being a reliable phenomenon, there is some evidence that sensory-specific satiety is susceptible to disruption by cognitions. Studies of this phenomenon in eating disordered patients have found that sensory-specific satiety is attenuated in bulimics, but more pronounced in anorexics (Hetherington & Rolls, 1988). Moreover, the extent to which sensory-specific satiety is demonstrated in these groups appears to be related to their attitudes towards the food. Rolls et al., (1992) gave participants *ad libitum* access to food on two occasions. In each case the food consisted of either a low-energy or a high-energy salad preload. Non-eating disordered participants demonstrated sensory-specific satiety after eating both types of salads. In contrast, bulimic participants showed signs of sensory-specific satiety only for the low-energy salad, whereas in the anorexic participants this was demonstrated only after eating the high-energy salad. One possible explanation for these results relates to the way in which attention is likely to have been directed during the meal. In the case of the bulimics, when faced with a high-calorie food (characteristic of those foods eaten during a binge; Allison & Timmerman, in press), attention may have been directed away from the food, as is believed to be the case during a binge-eating episode (e.g., Heatherton & Baumeister, 1991). In contrast, under these circumstances, anorexics are likely to allocate more attention to the food due to the high threat that it poses to them.

To date, the possibility that the development of sensory-specific satiety in non-eating disordered participants can be influenced by cognitions has received only minimal attention. Miller et al. (2000) assessed the extent to which sensory-specific satiety was reported when participants ate potato chips that were explicitly labelled as either 'normal' or 'fat-free'. Under these circumstances, no significance differences were reported. The authors concluded that the effects of labels had no influence. However, a limitation of this study is that the potato chips differed in more than just their explicit label. Rather, those labelled as fat-free were in fact made with olestra, a fat substitute, while those labelled as 'normal' were made with the standard ingredients. Therefore, since any potential effects of cognitions can not be disentangled from the effects of the sensory properties of the food, no real conclusions can be drawn.

10.4. SUMMARY

Physiological cues are important in appetite regulation. However, the effect of these direct controls on meal size is modulated by the influence of more indirect, cognitive controls (Smith, 1996). Sensory-specific satiety is believed to be an important factor involved in regulating meal size and meal termination. This being the case, it follows that one way in which distraction may lead to overeating is by undermining the operation of this process. Despite the absence of any direct evidence, the available literature suggests that the rate at which sensory-specific satiety develops during a meal may be attenuated when attention is allocated elsewhere. The aim of Part II of the thesis is to explore this possibility. Across four experiments, the effect of distraction on the attenuation of appetite ratings, sensory-specific satiety, and the reasons given for meal termination is explored. As in Experiment 3, consistent with observations that distraction-related overeating occurs in both restrained and unrestrained eaters (see section 2.5.), the focus of these experiments is on the general effects of distraction, as opposed to between-group differences per se. Therefore, the interaction between dietary behaviour and the effects of distraction are assessed using regression analyses. As stated previously, although this chapter has discussed the effects of pleasantness in the regulation of eating behaviour, an investigation of the effects of distraction on

‘sensory-specific satiety’ is theoretically preceded by an investigation of the effects of distraction on changes in ‘general satiety’*. This is in line with the common observation that changes in satiety are often abated when distracted (see Mela & Rogers, 1998). When food is not readily available, this can lead to individuals ‘forgetting’ to eat. When food is available, this may have the converse effect.

* The material presented in chapters 11 & 12 (Experiments 4 & 5) has been submitted to the British Journal of Nutrition for review.

CHAPTER 11: EXPERIMENT 4

11.1. INTRODUCTION

At the end of Part I it was stated that in order to further understand why meal size tends to be larger when eating while distracted, it might be helpful to explore whether those potential processes that otherwise regulate intake under no-distraction conditions are similarly operative when distracted (see section 9.5.). In this regard, one potential process is ‘sensory-specific satiety’. However, as a precursor to investigating whether distraction attenuates the rate at which such ‘specific satiety’ develops, the aim of this initial experiment is to explore whether measures of ‘general satiety’ are attenuated when distracted. Everyday observations suggest that when distracted, satiety signals are attenuated (e.g., individuals may skip meals because they are too engrossed in a task to notice their increasing hunger). Likewise, *during* a meal eaten when distracted, changes in hunger may be similarly attenuated. Therefore, in order to assess the extent to which cognitive activity limits or interacts with the ability to monitor satiety signals, changes in hunger, fullness, and desire to eat are compared between groups of individuals who have eaten while either distracted or sitting in silence. In this way, the effects of distraction on a range of general satiety measures can be determined. In contrast to the aims of the experiments previously reported in this thesis, rather than investigating the relationship between distraction and amount eaten, this experiment represents the first step towards attempting to identify the nature of the process that underlies this association.

11.2. METHOD

11.2.1. Participants

Eighty-eight female undergraduate students at Loughborough University were recruited via email (mean age = 19.52, *SD* = 1.69). All were paid five pounds (Sterling) for their participation.

11.2.2. Design and group classifications

The experiment consisted of an independent samples design. Participants were randomly assigned to either a ‘distraction’ or a ‘no-distraction’ condition.

11.2.3. Subjective measures and questionnaires

Participants completed a number of 100 mm visual-analogue rating scales that were identical to those used in previous experiments. Ratings of hunger, fullness, and desire to eat were obtained in order to assess changes in ‘general satiety’. Visual-analogue rating scales were also used to assess how healthy, forbidden, and threatening each of the participants regarded the food to be (ends anchored “not at all” and “extremely” on the left- and right-hand sides, respectively), and participants were also asked to report how many Jaffa Cakes they would have ideally liked to have eaten. The purpose of these measures was to explore whether changes in satiety are related to attitudes towards the food. In line with each of the experiments reported in Part I, participants also completed the restraint scale of the Dutch Eating Behaviour Questionnaire (DEBQ: Van Strien et al., 1986), the disinhibition scale of the Three Factor Eating Questionnaire (TFEQ: Stunkard & Messick, 1985), and a question assessing their current dieting status: “Are you currently dieting to lose weight?” (response: yes/no). The possibility that participants were strategically ‘using’ the task in order to avoid cognisance of the food was also assessed in the same way as in Experiment 3. Specifically,

participants were asked to respond (“yes” or “no”) to the question, “Did you ever actively “use” the task in order to think less about the food?”.

11.2.4. Food

In this experiment, participants were asked to consume a fixed quantity of food. Specifically, each participant ate five Jaffa Cakes (McVities, London, UK; 48 kcal / 8g each) – a chocolate covered snack product that is a widely available in the UK. The decision to control the amount of food that is ingested was related to the nature of the hypothesis being tested. Because the aim of this experiment is to explore the effects of distraction on *developing* satiety, it was important to assess this before participants were satiated and after all participants had consumed the same amount of food. Since distraction during a meal has been associated with increased intake, allowing participants to eat to satiety is likely to have resulted in differences in intake and sensory experience across groups, that would confound any reasonable comparison of changes in satiety. A similar argument has been put forth by Raynor and Epstein (2001) in response to methodological concerns that comparisons across obese and non-obese participants (e.g., McCrory et al., 1999; Snoek, Huntjens, von Gemert, De Graaf, & Weenen, 2004) may be unreliable due to the likely differences in intake between groups when asked to eat to satiety.

11.2.5. Distracter task

The distracter task was a commercially available computer game called ‘Pong’ (produced by Atari inc). The game was displayed on a 14-inch colour television. In ‘Pong’, the player is represented on the screen by a coloured cursor. The player can move the cursor using a joystick. The activities of the computer are represented by a different coloured cursor. Respectively, the player and the computer assume right and left positions across the screen. During the game, the player and computer ‘bounce’ a virtual ball between them (see Figure 9 for an illustration). One point is awarded to either player when the opponent fails to return the ball. The first player to score 21 points wins the game.

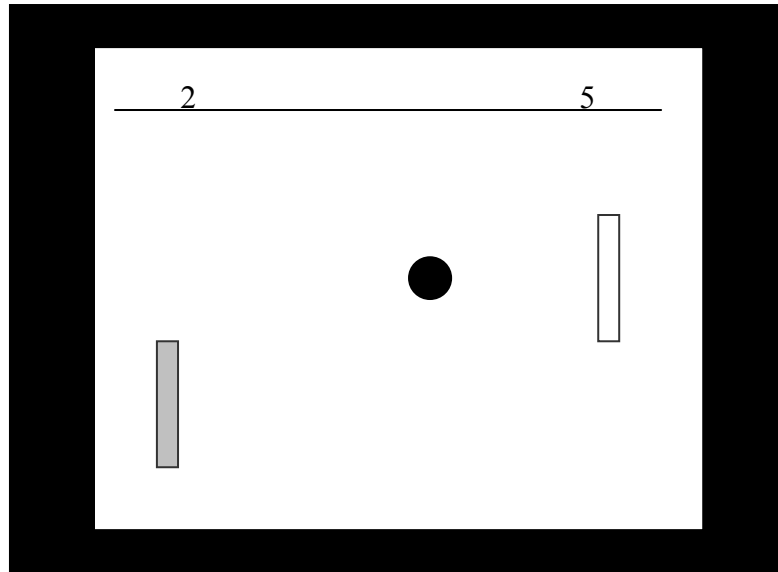


Figure 9. Illustration of the computer game, Pong. The grey cursor represents the computer and the white cursor represents the participant. The 'ball' is represented by the black circle. The score for each player is displayed at the top of the screen.

This game was chosen for two reasons. Firstly, stress has been associated with bouts of overeating (e.g., Greeno & Wing, 1994). Therefore, in order to minimise the possibility of confounding the effects of distraction with the effects of stress, a task that would be unlikely to be regarded as stressful was required. In this regard, 'Pong' represents an appropriate task, as it is simple and requires little cognitive effort. This task also affords participants the opportunity to reset the game at any point – an option that is likely to minimise any stress that may otherwise be experienced in relation to poor performance. Secondly, it is important that the task is likely to be equally engaging for all participants. This is because complex tasks can attract varying amounts of cognitive resource and, as the results of Part I suggest, under such circumstances some individuals may engage in strategies whereby they proactively allocate greater amounts of attention to concurrent tasks in order to avoid cognisance of other environmental or behavioural factors. However, with more simple tasks, variable levels of engagement are unlikely since successful execution of the task demands only a specific amount of cognitive resource and allocating any more than this is unlikely to improve performance.

Therefore, by choosing such a task, it is anticipated that the amount of attention allocated to the game will be similar across individuals and that less proactive involvement will be reported.

11.2.6. Iterative eating procedure

As in Experiment 1 (see section 4.3.1.), participants were required to eat one item of food every 60 seconds. In order to achieve this, a PC displayed the prompt “Please eat a Jaffa Cake now”, accompanied by three loud auditory tones, at the end of every 60-second interval, indicating to the participant that it was time to eat another Jaffa Cake. This procedure terminated after five trials (at which point all of the food had been eaten).

11.3. PROCEDURE

Participants were tested between 2 p.m. and 6 p.m. in individual cubicles in the Ingestive Behaviour Laboratory at Loughborough University, having abstained from eating for at least three hours. On arrival, participants were randomly allocated to the distraction or the no-distraction condition. They were then briefed about the procedure. In particular, when completing ratings of hunger, fullness, and desire to eat, they were told to “not think too hard. Just go with your instantaneous response”. After confirming that they understood these instructions, participants completed the initial ratings of hunger, fullness, and desire to eat.

Participants were then left alone for five-minutes. During this period they were required to eat five Jaffa Cakes, at the rate of one every 60-seconds. Those participants allocated to the no-distraction condition completed this procedure while sitting in silence. Those allocated to the distraction condition completed it while playing ‘Pong’. At the end of the fifth 60-second interval (after all five Jaffa cakes had been consumed) participants completed a second set of hunger, fullness, and desire to eat ratings. Following this, participants reported the number of Jaffa Cakes that they would have ideally liked to have eaten and completed ratings assessing

how healthy, forbidden, and threatening they found this food. They were then issued with the DEBQ-restraint and TFEQ-disinhibition sub-scales, and a question assessing current dieting behaviour. If the participant consented, a measure of height (cm) and weight (kg) was also taken. Five participants declined to be weighed; three in the distraction group and two in the no-distraction group. All participants were then paid, debriefed, and thanked for their participation.

11.4. RESULTS

11.4.1. Group characteristics

Table 9 shows the mean (*SD*) BMI, DEBQ-restraint and TFEQ-disinhibition scores, and initial ratings of hunger, fullness, and desire to eat for the distraction and no-distraction groups separately.

	Group	
	Distraction <i>n</i> = 44	No-distraction <i>n</i> = 43
BMI	22.60 (2.78)	23.41 (3.34)
DEBQ-restraint	2.76 (0.77)	2.61 (0.86)
TFEQ-disinhibition	6.80 (4.50)	7.35 (3.49)
Initial hunger	58.14 (21.27)	61.93 (23.87)
Initial fullness	26.25 (19.46)	22.56 (20.93)
Initial desire to eat	52.57 (27.17)	59.00 (24.37)

Table 9. Mean (SD) BMI, DEBQ-restraint, and TFEQ-disinhibition scores, and mean (SD) initial hunger, fullness, and desire to eat ratings (mm), for the distraction and no-distraction groups in Experiment 4.

One participant in the no-distraction group failed to eat all five Jaffa Cakes and so her data were excluded from the analysis. The participants in the distraction and no-distraction groups were very similar (see Table 9). Across groups, BMI ($t[77] = 1.19, p = 0.24$) and scores on the DEBQ-restraint ($t[83] = -0.90, p = 0.37$) and the TFEQ-disinhibition scales ($t[83] = 0.74, p = 0.46$) did not differ significantly. The number of participants reporting that they were currently dieting to lose weight was small ($n = 7$), as was the number of participant who reported engaging in ‘proactive (dis)inhibition’ ($n = 5$). Therefore, in each case, the small sample sizes did not permit analyses with these variables as separate factors.

11.4.2. Effects of distraction on the change in hunger, fullness, and desire to eat

The distracted and non-distracted groups provided similar baseline ratings of hunger ($t[83] = 0.78, p = 0.45$), fullness ($t[84] = -0.85, p = 0.40$), and desire to eat ($t[84] = 1.16, p = 0.25$). See Table 9 for means (SD s). The change in hunger, fullness, and desire to eat was calculated by subtracting the initial rating from the second, final rating. These changes (mean [SD]) are represented in panels a, b and c of Figure 10.

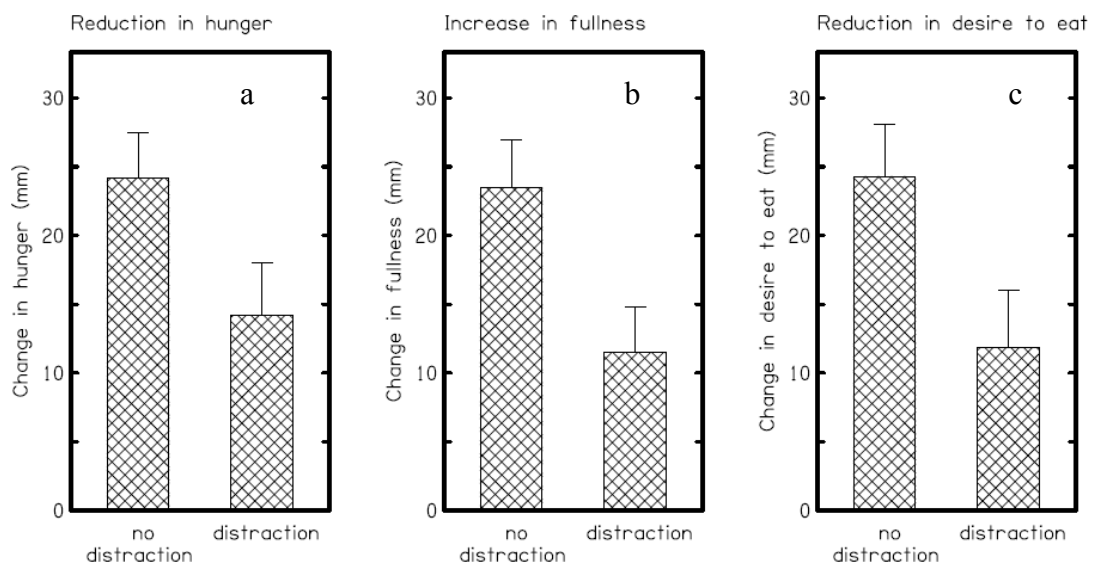


Figure 10. Mean (\pm SEM) change in hunger (panel a), fullness (panel b), and desire to eat (panel c), for the distracted and the non-distracted group in Experiment 4.

Analysis of these change scores revealed that non-distracted participants reported a significantly greater increase in fullness ($t[83] = -2.50, p = 0.014$) and a significantly greater reduction in desire to eat ($t[84] = 2.09, p = 0.040$) than did the distracted participants. They also experienced a greater reduction in hunger. However, this difference narrowly missed significance ($t[83]= 1.95, p = 0.055$).

11.4.3. Other subjective measures

The two groups did not differ significantly in how healthy ($t[83] = 0.89, p = 0.38$) or how forbidden ($t[83] = 0.58, p = 0.56$) they regarded the food to be at the end of the experiment. Likewise, no significant difference was found between the groups in the number of Jaffa Cakes that they reported they would have ideally liked to have eaten ($t[83] = -0.81, p = 0.42$). However, the no-distraction group tended to rate the food as more threatening than did the distraction group ($t[83] = 2.18, p = 0.032$). See Table 10 for means (*SDs*). Furthermore, the change in desire to eat experienced by this group correlated significantly with how forbidden they regarded the food to be ($r = -0.306, p = 0.046$). No other correlations between subjective measures and changes in satiety were found (all $p > 0.05$).

	Group	
	Distraction <i>n</i> = 44	No-distraction <i>n</i> = 43
Healthy	19.66 (17.62)	23.23 (19.92)
Forbidden	34.50 (23.59)	37.74 (28.14)
Threatening	19.39 (24.28)	31.30 (26.72)
Ideal intake	3.57 (2.27)	3.20 (1.96)

Table 10. Mean (SD) ratings (mm) of how healthy, forbidden, and threatening the food was regarded to be, and the estimate of ideal intake (n), for both groups in Experiment 4.

11.4.4. Relationship between dietary behaviour and the effects of distraction

As in Experiment 3, regression analyses were used to determine whether the effects of distraction (in this case, changes in hunger, fullness, and desire to eat) are predicted by an interaction between dietary measures (i.e., DEBQ-restraint and TFEQ-disinhibition scores) and condition. In every case, the interaction term failed to reach significance (p values in the range 0.232 – 0.412).

11.5. DISCUSSION AND RATIONALE FOR EXPERIMENT 5

The aim of Experiment 4 was to assess the effect of distraction on changes in appetite. The data indicate that changes in fullness and desire to eat are attenuated by the presence of a distracter task. Further, this phenomenon appears to be universal, as little evidence was found to suggest that it is predicted by different kinds of everyday dietary behaviour (as measured using the DEBQ-restraint and the TFEQ-disinhibition sub-scales). Ratings of the perceived forbiddingness and healthiness of the Jaffa Cakes did not differ significantly between the groups. However, compared to the distracted group, the non-distracted group rated the food as being more threatening, and change in desire to eat correlated with forbiddingness ratings. The reason why the non-distracted group should find the food more threatening is unclear. However, this may be because these participants had greater opportunity to reflect on this aspect of the food. Indeed, Herman and Polivy (1993) have suggested that the cognitive appraisal of a food can only be achieved when full attention is allocated to it.

The results suggest that the distracter task might inhibit the opportunity to attend to the visceral sensations associated with the development of satiety, and that this stalls the general change in satiety that normally occurs during a meal. This result stands in contrast to that of previous research that has found that watching an engaging (non-food) video is related to a greater reduction in hunger (Herman et al., 1999). However, the study cited differs in its methodology to that reported here, since the participants in that study did not actually consume any food while watching the video. Furthermore, the authors acknowledge that when attention is

directed to a concurrent task during a meal, subjective hunger and eating behaviour are likely to interact in a complex way (p.192), implying that under such circumstances, it is unlikely that hunger would be reduced or that intake would be inhibited.

An alternative explanation is that the effects of distraction are more specific. As outlined in section 10.2.3., sensory-specific satiety (Rolls, 1986) normally occurs when the same food is consumed repeatedly. However, this process might be attenuated when food is experienced in conjunction with distraction. Evidence in support of this possibility can be found in the literature on salivary habituation, a process that is functionally quite similar to sensory-specific satiety, and which has been shown to be arrested by distraction (Epstein et al., 1997; 2005; see section 10.3.1.1.). In this experiment, changes in desire to eat were compared across the two groups. The procedural decision to focus on a single food makes it difficult to determine the extent to which distraction influences a change in desire to eat that is specific to the Jaffa Cakes only, or whether distraction influences the tendency to desire a variety of foods. Therefore, Experiment 5 incorporates this comparison, thereby enabling an assessment of the specific and general effects of the distracter task.

CHAPTER 12: EXPERIMENT 5

12.1. INTRODUCTION

The term ‘sensory-specific satiety’ is used to describe the phenomenon whereby the pleasure derived from eating a food declines as it is eaten, while that derived from other ‘uneaten’ foods remains relatively unchanged (see section 10.2.3.). An assessment of the extent to which a food is regarded as pleasant tasting, and the strength of the current desire to eat that particular food, gives a measure of satiety that is *sensory-specific*. In contrast, assessments of hunger, fullness, and desire to eat (that is not directed at a particular food item) give an indication of *general satiety*. An assessment of ‘general satiety’ in Experiment 4 revealed that, in the most part, non-distracted participants experience a bigger increase in satiety than do distracted participants. However, of interest is whether these differences are, in actual fact, a reflection of an attenuation of sensory-specific satiety - a process thought to be important in meal termination and, if disrupted, could lead to increased meal size (see section 10.3.).

Therefore, the first aim of Experiment 5 is to ascertain the extent to which the changes in ‘general satiety’ observed in Experiment 4 can be attributed to changes in a specific satiety for Jaffa Cakes. In order to do this, the experimental paradigm used in sensory-specific satiety experiments is adapted for use here. The methodology used in this experiment does differ slightly from that used in ‘classic’ sensory-specific satiety experiments in two ways. Firstly, evidence for a specific food-related satiety is typically assessed after participants have eaten until satiated. However, if participants are allowed to eat to satiety, then one might assume that the process involved in the development of sensory-specific satiety has taken place. At this point, there is little sense in making a comparison of the effect of distraction versus no distraction. Therefore, in this experiment, intake is again fixed to five portions. Secondly, evidence for sensory-specific satiety is based on the difference in the change in ratings for an ‘eaten’ food compared with those for ‘uneaten’ foods, with the ‘eaten’ and ‘uneaten’ foods being counterbalanced across

participants. Here, these foods were not counterbalanced. Rather, the Jaffa Cakes represent the ‘eaten’ food for all participants. Again, this deviation from the standard methodology stems from the desire to ensure that not only do all participants consume the same amount of food, but that the nutritional and sensory properties of the food items consumed is also identical across all participants. Thus, the only variable differing between participants is the presence or absence of distraction during the meal. Because of the variation in the methodology employed, the extent to which the results of this experiment can be discussed in terms of sensory-specific satiety per se may be a topic of debate. Clearly, the methodology employed allows an assessment of a process akin to this. However, to avoid confusion, here the results are interpreted in terms of ‘food-specific satiety’.

A second aim of this experiment is to ascertain how long any potential effects of the distracter task last. This reason for this is two-fold. Firstly, studies of sensory-specific satiety typically assess pleasantness immediately upon meal termination and for varying durations thereafter, and effects have been observed up to two hours after eating cessation (Weenen et al., 2005; see section 10.2.3.). Thus, notwithstanding the deviations from the generic sensory-specific satiety paradigm mentioned above, it is important that this experiment represents an accurate analogue of such studies. Therefore, the duration of the effects is investigated. Secondly, because previous investigations of the relationship between distraction and eating behaviour have restricted the observation of the effects of a distracter to within the period of distraction itself, the possibility that distraction also influences satiety and eating behaviour after the distraction has been removed has not been explored. However, this possibility is potentially very important. Evidence that this is the case would have implications for the way in which the effects of distraction are viewed. By extending the duration of time over which food-specific and general satiety ratings are obtained, this previously overlooked possibility can be explored. Therefore, in this experiment, measures of general and food-specific satiety are assessed before, and at three time-points after consuming a fixed quantity of food.

12.2. METHOD

12.2.1. Participants

Eighty-four female undergraduate students at Loughborough University were recruited via email (mean age = 21.24, *SD* = 2.54). All were paid five pounds (Sterling) for their participation.

12.2.2. Design and group classifications

The experiment consisted of an independent samples design. Participants were randomly assigned to a ‘distraction’ or a ‘no-distraction’ condition.

12.2.3. Subjective measures and questionnaires

Measures of general satiety (hunger, fullness, and desire to eat) were obtained using the same rating scales as in previous experiments. 100 mm visual-analogue rating scales were also used to obtain the food-specific measures. Specifically, the participants were asked to rate “How pleasant is the taste of the food in your mouth?” (end anchors “very unpleasant” and “very pleasant”), “How intense is the taste of the food in your mouth?” (end anchors “very weak” and “very strong”), and “How strong is your desire to eat more of this food right now?” (end anchors “not at all strong” and “extremely strong”). Measures of dietary behaviour (restraint, disinhibition, dieting status) and tendency to engage in proactive disinhibition were again obtained using the same questionnaires used previously.

12.2.4. Foods and distracter task

As in Experiment 4, during the main eating episode participants ate five Jaffa Cakes McVities, London, UK; 48 kcal / 8g each). The game, ‘Pong’, was again used to

distract half of the participants while they ate. In order to provide ratings for the assessment of food-specific satiety, participants were also required to taste and rate both the 'eaten' food and two other 'uneaten' foods. The uneaten foods were bacon-flavoured corn snacks ('Frazzles'; Walkers Snack Foods Ltd., UK; 470kcal / 1975kJ per 100g) and mandarin fruit segments (Tesco Stores Ltd., Cheshunt, UK; 74kcal / 315kJ per 100g). For each assessment participants ate one bacon-flavoured corn snack (approx 3g / 14kcal), one segment of mandarin fruit (approx 8g / 6kcal), and a one-quarter portion of a single Jaffa Cake sample (approx 2g / 12kcal). A 200 ml glass of water was also provided for participants to clean their palates between samples (N.B., at all other times, the glass of water was removed).

12.3. PROCEDURE

Participants were tested between 2 p.m. and 6 p.m. in individual cubicles in the Ingestive Behaviour Laboratory at Loughborough University, having consumed no food during the three hour period prior to arrival. On arrival, all participants provided ratings of their general feelings of hunger, fullness, and desire to eat. They were then presented with a tray containing the three food samples. Participants were instructed to eat each sample and to complete a set of ratings (pleasantness, intensity, and desire to eat) after each one. The bacon-flavoured snack was always consumed first, followed by the mandarin fruit segment, and finally the Jaffa Cake sample. Participants were instructed to take a sip of water to clean their palate after tasting each sample.

After completing these ratings, the procedure for the five-minute eating episode was explained. This was identical to Experiment 4. Half of the participants ate while sitting in silence. The other half ate while playing 'Pong'. At the end of the eating episode, all of the participants completed a second set of general satiety ratings (hunger, fullness, desire to eat) followed by a second assessment of the pleasantness, intensity, and desire to eat the three food samples. When they had finished, they were left alone to sit in silence. This procedure was then repeated five and ten minutes after the end of the eating episode.

Finally, the participants completed the DEBQ-restraint scale, the TFEQ-disinhibition scale, and questions assessing dieting status and proactive use of the task¹¹. At this point a measure of height (cm) and weight (kg) was also taken from those participants who consented ($n = 79$). The participants were then paid, debriefed, and thanked for their assistance with the experiment.

12.3.1. Data analysis

In this experiment, sets of ratings were issued before, and then immediately, five- and ten-minutes after the eating episode. Respectively, these time points are referred to as t_{base} , $t_{0\text{min}}$, $t_{5\text{min}}$, and $t_{10\text{min}}$. For each of the general and food-specific ratings, change scores were calculated based on the difference between baseline ratings (t_{base}) and those taken after the eating episode ($t_{0\text{min}}$, $t_{5\text{min}}$, and $t_{10\text{min}}$). In this way, for each type of rating and for each participant, three scores were derived that reflect how the ratings changed after eating relative to baseline.

To analyse changes in the general measures of satiety (hunger, fullness, and desire to eat), each set of change scores was submitted to a mixed model ANOVA. ‘Distraction’ (no distraction / distraction) and ‘time’ (change at $t_{0\text{min}}$, $t_{5\text{min}}$, and $t_{10\text{min}}$) were included as a between- and a within-subjects factor, respectively.

To assess evidence for food-specific satiety, the ratings associated with the eaten food were compared with the mean of the ratings relating to the two uneaten foods. ‘Food type’ (eaten / uneaten) was entered along with ‘time’ and ‘distraction’ in a set of three-way ANOVAs that explore changes in pleasantness, intensity, and desire to eat.

At each time point, linear regression analyses were also conducted to assess the extent to which changes in ‘general’ and ‘food-specific’ satiety could be predicted by the interaction between distraction group and dietary behaviour. For the general

¹¹ N.B. The small number of participants who reported dieting ($n = 8$) and ‘using’ the task ($n = 7$) precludes the inclusion of these variables as factors in the analysis.

measures of satiety (hunger, fullness, and desire to eat), the change scores calculated at each time point were entered into the regression models. For the food-specific measures (pleasantness, intensity, and desire to eat), a single score of food-specific satiety was derived at each time point by subtracting the change score associated with the uneaten foods from the change score associated with the eaten food. These scores were then entered into regression models.

12.4. RESULTS

12.4.1. Group characteristics

Table 11 shows the mean (*SD*) BMI, DEBQ-restraint and TFEQ-disinhibition scores, and initial ratings of hunger, fullness, and desire to eat associated with the distracted and the non-distracted groups separately. A comparison across groups revealed no significant differences in any of these measures (all $p > 0.05$).

	Group	
	Distraction <i>n</i> = 42	No-distraction <i>n</i> = 42
BMI	22.86 (2.74)	22.77 (2.67)
DEBQ-restraint	2.66 (0.89)	2.86 (0.76)
TFEQ-disinhibition	7.64 (3.10)	7.90 (3.40)
Initial hunger	64.00 (22.58)	60.55 (18.52)
Initial fullness	20.98 (17.61)	24.95 (13.67)
Initial desire to eat	64.24 (24.79)	62.79 (17.55)

Table 11. Mean (SD) BMI, DEBQ-restraint, and TFEQ-disinhibition scores, and mean (SD) initial hunger, fullness, and desire to eat ratings (mm), for the distraction and the no-distraction group in Experiment 5.

For each of the three foods, Table 12 shows the mean (*SD*) baseline ratings of pleasantness, intensity, and desire to eat. Again, across groups no significant differences were found in any of these ratings (all $p > 0.05$).

	Group	
	Distraction <i>n</i> = 42	No-distraction <i>n</i> = 42
<i>Bacon corn snack</i>		
Pleasantness	73.50 (18.09)	72.19 (22.66)
Intensity	69.83 (21.27)	71.36 (21.30)
Desire to eat	66.64 (23.85)	63.31 (25.47)
<i>Mandarin fruit segment</i>		
Pleasantness	73.39 (21.35)	75.31 (19.78)
Intensity	57.52 (17.47)	57.83 (18.69)
Desire to eat	55.12 (28.81)	60.43 (26.22)
<i>Jaffa Cake</i>		
Pleasantness	69.33 (22.04)	74.90 (23.24)
Intensity	62.26 (18.44)	68.17 (17.35)
Desire to eat	55.69 (26.96)	59.93 (27.59)

Table 12. Mean (*SD*) ratings (*mm*) of pleasantness, intensity, and desire to eat each of the three food samples, at each time point in Experiment 5. Values for the distraction and no-distraction groups are provided separately.

12.4.2. Effect of distraction on changes in hunger, fullness, and desire to eat

Relative to baseline, Figure 11 shows the change in hunger (panel a), fullness (panel b), and desire to eat (panel c), at the three time points after the 5-minute eating episode. Means (*SD*) from the no-distraction and the distraction group are presented as open circles and closed squares, respectively.

12.4.2.1. Change in hunger and fullness

Changes in hunger differed significantly across time ($F[2,164] = 12.79, p < 0.001$) and the effect of time on the change in fullness narrowly missed significance ($F[2,164] = 2.89, p = 0.059$). The main effect of distraction failed to reach significance (hunger; $F[1,82] = 0.32, p = 0.58$, fullness; $F[1,82] = 0.30, p = 0.59$; see Figure 11, panels a & b). Likewise, the interactions between distraction and time were not significant (hunger; $F[2,164] = 1.46, p = 0.24$, fullness; $F[2,164] = 0.079, p = 0.92$).

12.4.2.2. Change in desire to eat

The reduction in desire to eat attenuated over time ($F[2,164] = 3.49, p = 0.033$) (see Figure 11, panel c). The data also show that non-distracted participants experienced a significantly greater overall reduction than did the distracted participants ($F[1,82] = 4.32, p = 0.041$), and that the effects of time and distraction appear to operate independently ($F[2,164] = 1.25, p = 0.29$).

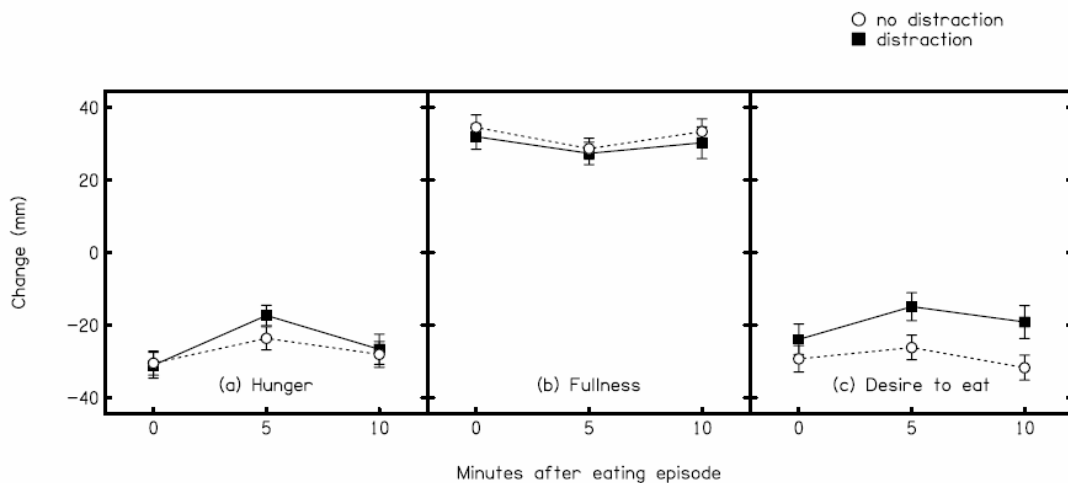


Figure 11. Mean (\pm SEM) change in hunger (panel a), fullness (panel b), and desire to eat (panel c), 0, 5, and 10 minutes after the eating episode in Experiment 5. The no-distraction group is represented by the open circles. The distraction group is represented by the closed squares.

12.4.3. Effect of distraction on food-specific satiety

12.4.3.1. Change in pleasantness

At each time point, Figure 12 shows the change in pleasantness of the uneaten (panels a and b) and the eaten (panel c) foods. The greatest change in pleasantness occurred in the eaten food ($F[1,82] = 39.45, p < 0.001$). Neither the main effect of time ($F[2,164] = 2.95, p = 0.055$) or distraction condition reached significance ($F[1,82] = 0.32, p = 0.25$).

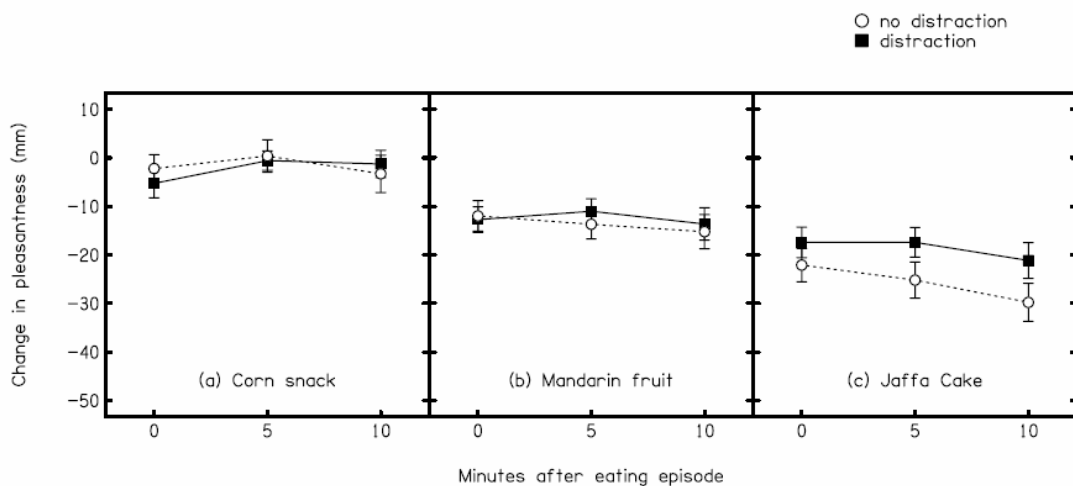


Figure 12. Mean (\pm SEM) change in pleasantness for the bacon-flavoured corn snack (panel a), mandarin fruit segment (panel b), and Jaffa Cake (panel c), at each of the three time points (0, 5, and 10-minutes post-intake) in Experiment 5. The no-distraction group is represented by the open circles. The distraction group is represented by the closed squares.

This pattern of results is consistent with evidence for sensory-specific satiety. However, the critical interaction between food type and distraction condition failed to reach significance ($F[1,82] = 2.85, p = 0.095$). Figure 12 (panel c) shows that non-distracted participants reported a greater decline in the pleasantness of the eaten

food than did distracted participants. In contrast, for the uneaten foods (panels a and b), both groups reported a similar change in pleasantness.

12.4.3.2. Change in intensity

Figure 13 shows the changes in intensity that occurred in the eaten food (panel c) and the two uneaten foods (panels a and b).

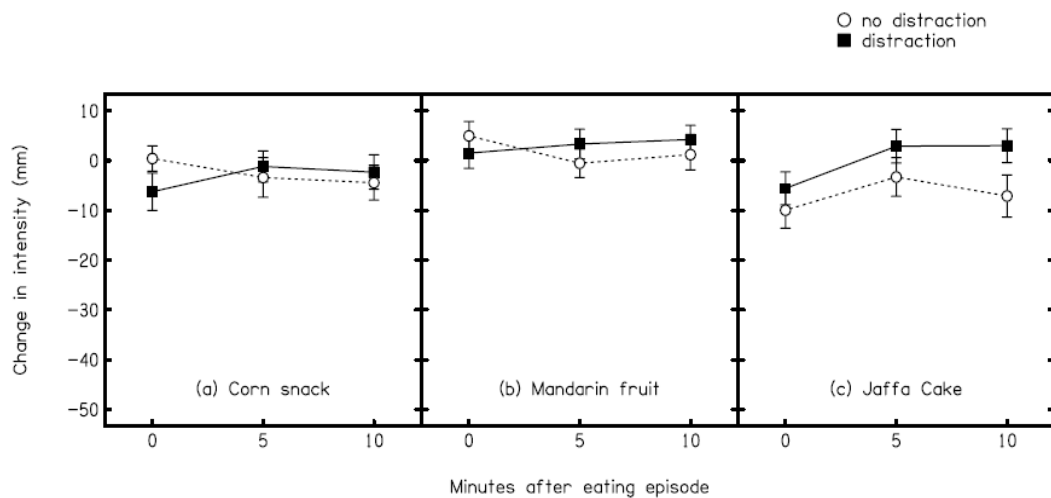


Figure 13. Mean (\pm SEM) change in intensity for the bacon-flavoured corn snack (panel a), mandarin fruit segment (panel b), and Jaffa Cake (panel c), 0, 5, and 10 minutes after the eating episode in Experiment 5. The no-distraction group is represented by the open circles. The distraction group is represented by the closed squares.

The change in intensity differed across time ($F[2,162] = 3.11, p = 0.047$). However, little evidence for a clear trend in the data was found. In both groups, the intensity of the two uneaten foods did not differ greatly from baseline. With respect to the eaten food, a different pattern, as indicated by a significant interaction between food-type and time ($F[2,164] = 6.86, p = 0.002$) was observed. Generally, the distracted group experienced a modest increase in the intensity of the eaten food over time. At the end of the experiment their ratings were close to baseline. In the no distraction group ratings remained generally lower than baseline throughout.

However, with respect to this difference, the interaction between distraction and food-type failed to reach significance ($F[1,82] = 1.65, p = 0.20$), as did the main effect of distraction ($F[1,82] = 1.44, p = 0.23$), and the main effect of food type ($F[1,82] = 1.54, p = 0.22$).

12.4.3.3. Change in desire to eat

The changes in desire to eat were not dissimilar to the changes in pleasantness. Figure 14 shows that participants experienced a slightly greater decline in desire to eat the eaten food (panel c) compared with the uneaten foods (panels a and b). Consistent with this observation, food-type emerged as a significant predictor in the analysis of changes in desire to eat ($F[1,82]= 51.46, p < 0.001$).

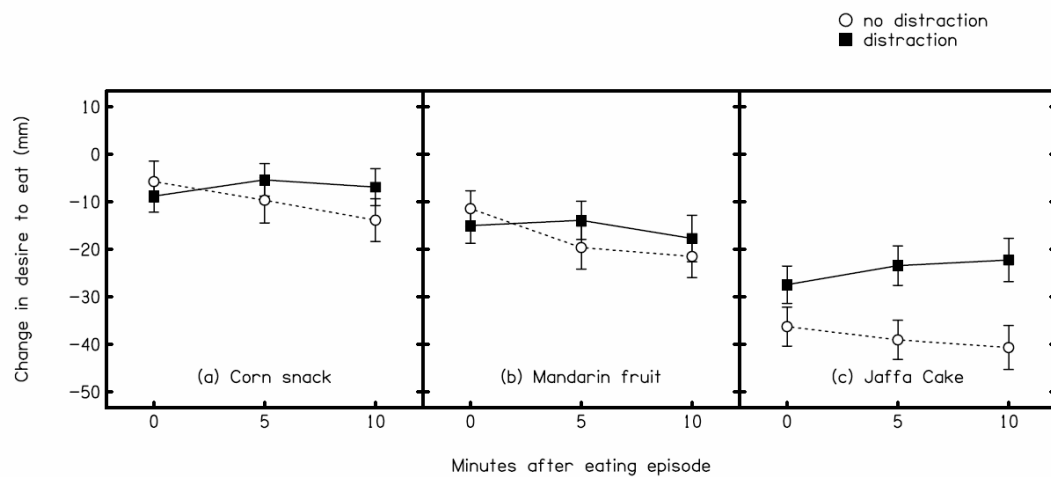


Figure 14. Mean (\pm SEM) change in desire to eat the bacon-flavoured corn snack (panel a), mandarin fruit segment (panel b), and Jaffa Cake (panel c), at each time point (0, 5 and 10-minutes post-intake) in Experiment 5. The no-distraction group is represented by the open circles. The distraction group is represented by the closed squares.

In terms of the effects of distraction, panels a and b show that both distracted and non-distracted participants experienced the same modest changes in desire to eat the

non-eaten foods. In contrast, a relatively marked reduction was observed with respect to the eaten food, but only in non-distracted participants. This food-specific effect of distraction was confirmed by a significant interaction between food type and distraction ($F[1,82] = 5.77, p = 0.019$). Further t -tests confirmed that the decline in desire-to-eat Jaffa Cakes was significantly greater in the no-distraction group at $t_{5\min}$ ($t[82] = -2.67, p = 0.018$) and at $t_{10\min}$ ($t[82] = -2.83, p = 0.012$). In addition, ANOVA also revealed a significant interaction between time and food type ($F[2,164] = 3.09, p = 0.048$) and time and distraction condition ($F[2,164] = 7.40, p = 0.001$). Both the main effect of distraction condition ($F[1,82] = 3.27, p = 0.074$) and time ($F[2,164] = 1.33, p = 0.27$) failed to reach significance.

12.4.4. Correlation between changes in pleasantness and desire to eat

In order to ascertain the extent to which changes in pleasantness and desire to eat were related, at each time point, and in each group separately, these measures were correlated. This revealed that in both the distracted and the non-distracted group, immediately, 5-, and 10-minutes after the meal terminated the change in pleasantness correlated significantly with the change in desire to eat (all $p < 0.001$, r values in the range 0.357 – 0.616).

12.4.5. Relationship with DEBQ and TFEQ scores

A set of regression analyses were used to determine whether the effects of distraction are more or less evident in those individuals who score highly on the measures of restrained and disinhibited eating. Accordingly, for each general (changes in hunger, fullness, and desire to eat) and each food-specific measure (changes in pleasantness, intensity, and desire to eat), the extent to which variance can be explained by an interaction between either of the two assessments of dietary behaviour and the effects of distraction was explored. Since there were six measures in total (3 general and 3 food-specific), three time points ($t_{0\min}$, $t_{5\min}$, and $t_{10\min}$), and two assessments of behaviour (restraint and disinhibition), 36 separate regression analyses ($6 * 3 * 2 = 36$) were conducted.

For the measures of general satiety, all interaction terms failed to reach significance (p values in the range 0.055 – 0.970). For the food-specific measures, all interactions terms failed to reach significance (p values in the range 0.061 – 0.970), with the exception of one - ten minutes after the eating episode the difference in the change in desire to eat between the eaten and uneaten foods was predicted by an interaction between the TFEQ-disinhibition score and distraction group ($t = -2.35$, $b = -4.123$, $s.e. = 1.756$, $p = 0.021$). Based on the number of separate tests performed, this isolated case is easily attributable to chance.

12.5. DISCUSSION

Consistent with Experiment 4, irrespective of everyday dietary behaviour (DEBQ-restraint and TFEQ-disinhibition scores), participants experience a greater reduction in their ‘general’ desire to eat when they eat without distraction. However, contrary to the results of Experiment 4, differences in hunger and fullness failed to approach significance. The reason why this aspect of Experiment 4 failed to be replicated is unclear. Procedurally, it may be relevant that participants completed fewer types of ratings in Experiment 4. This may have increased the potential for participants to conflate the variety of potential responses (general and food-specific) that were otherwise recorded in this experiment.

Due to the methodological constraints on the design of this experiment, a complete replication incorporating the methods typically used in studies of sensory-specific satiety was not possible. Therefore, caution should be used when interpreting these results. Rather than providing evidence for sensory-specific satiety per se, these results may be better accepted if discussed in terms of a process akin to this. Hence, the term ‘food-specific satiety’ is used here. Similarities between the two processes are evident. For example, sensory-specific satiety effects have been found to generalise from an eaten food to an uneaten food that has a similar flavour (Johnson & Vickers, 1993). Here, evidence of a similar effect was also found. Specifically, ratings of the mandarin fruit segment declined more than those of the other uneaten

food (bacon-flavoured corn snack) indicating that there was some generalisation between the mandarin and Jaffa Cakes, which both have an ‘orangey’ flavour.

With respect to ratings of pleasantness, the reduction reported by the distracted and the non-distracted groups did not differ significantly. In contrast, with ratings of desire to eat, a significant difference was observed. Both groups experienced a greater decline in their desire to eat the ‘eaten’ relative to the ‘uneaten’ foods. However, a comparison across groups revealed that this food-specific satiety was represented much more clearly in individuals who were not distracted during eating. Furthermore, this effect appears to be present at least up to 10 minutes after the distraction task has terminated. Indeed, at this time, differences between distracted and non-distracted participants are larger than immediately (where no significant difference was observed) and 5-minutes after the end of the eating episode. The reason why no significant difference was observed immediately after eating cessation is unclear. Notwithstanding this, since the effects of distraction have not previously been reported outside of the eating bout, the finding that a difference exists 10-minutes post-intake is important.

The extent to which between-group differences in desire to eat the ‘eaten’ food can be considered to be a form of sensory-specific satiety is unclear. This is because the definition of sensory-specific satiety embodies changes in pleasantness, rather than desire to eat. In this regard, it is noteworthy that the changes in desire to eat that occurred in each group did correlate significantly with the changes in pleasantness, highlighting the correspondence between the two. This is relevant to a discussion on the difficulty in distinguishing between ‘liking’ and ‘wanting’ (Berridge, 1996; see section 10.2.1.). While separate brain mechanisms for each of these processes have been identified (Berridge, 1996), evidence from studies using subjective assessments of liking and wanting suggest that individuals find it difficult to distinguish between the two (e.g., Hetherington, 1993). Indeed, Rolls and McDermott (1991) found that ratings of pleasantness and desire to eat declined to a similar extent following a meal (see also Guinard & Brun, 1998). Therefore, the finding that changes in pleasantness correlate with changes in desire to eat suggests that individuals may be drawing on the same information to complete these different assessments. Thus, declining desire to eat could be considered to be a

proxy for declining pleasantness, consistent with what would be predicted by the process of sensory-specific satiety.

If the effects observed here can be taken as preliminary evidence that distraction may weaken the development of sensory-specific satiety, and that these effects extend beyond the eating episode, then this is relevant to researchers with an interest in meal size. Since energy intake is the function of both the number and the energy content of eating occurrences, one possibility is that distraction may reduce the time interval between meals. Consistent with this idea, observations of everyday dietary behaviour suggest that meal frequency is higher when meals are consumed during distraction (Stroebele & De Castro, 2004b).

12.6. SUMMARY AND RATIONALE FOR EXPERIMENT 6

The results of this experiment suggest that a process akin to sensory-specific satiety may be attenuated when eating while distracted. Specifically, elevated desire to eat may be implicated as a mechanism which serves to prolong an eating bout when distracted or reduce the time interval between meals. However, it is unclear why the distracted group exhibited an elevated desire-to-eat Jaffa Cakes, relative to the non-distracted groups, both five- and ten-minutes post-intake, but not immediately upon eating cessation. One way in which to explore this finding further is through an analysis of the microstructure of the eating episode. Therefore, the aim of Experiment 6 is to ascertain how satiety changes *during* a meal eaten when distracted compared to when not distracted. In addition, a measure of salivation is also incorporated in an attempt to examine the nature of the process underlying elevated subjectively-rated desire to eat.

CHAPTER 13: EXPERIMENT 6

13.1. INTRODUCTION

This experiment aims to explore the microstructure of eating behaviour, both when distracted and when not distracted. The microstructure of ‘normal’ human eating behaviour has been extensively studied for a number of years. Studies have tended to concentrate on aspects of eating behaviour, such as meal size, meal duration, eating rate, bite size, and bite frequency. Central to such work has been the use of the ‘universal eating monitor’ (UEM) to determine eating rate. This instrument was developed by Kissileff, Klingsberg, and Van Itallie (1980) and consists of a covert weighing scale that measures the amount of food eaten versus the duration of the meal. The graphical illustration of this relationship is referred to as a ‘cumulative food-intake curve’ and can be described mathematically (Kissileff, Thornton, & Becker, 1982).

Subjective satiety during a meal has also been assessed using 100 mm visual analogue scales administered at set intervals throughout the eating episode. For example, in research exploring the ‘appetizer effect’, Yeomans and colleagues have used UEMs to administer meals to participants and recorded the number of grams of food eaten. In a typical experiment, the eating bout is interrupted after a set period of time has passed (e.g., two minutes, Yeomans, 1996) or a specific weight of food has been consumed (e.g., 50g, Yeomans & Gray, 1997; Yeomans, Gray, & Conyers, 1998; Yeomans, Gray, Mitchell, & True, 1997), and participants are instructed to complete rating scales measuring hunger, fullness, and food pleasantness before continuing with their meal. Similarly, investigations with eating-disordered participants have used methods whereby rating scales are completed during a meal to assess the possibility of a link between bulimia and satiety-related disturbances (for a review see Guss & Kissileff, 2000). The visual representation of these subjective parameters has also been used to develop ‘curves’ which represent of how satiety develops over the course of a meal. (e.g., Westerterp-Plantenga et al., 1990; for a review see Westerterp-Plantenga, 2000).

Evidence suggests that desire to eat during a meal tends to decline in a linear fashion (e.g., Westerterp-Plantenga, Duijsens, & Ten Hoor, 1997). The results of Experiment 4 and 5 suggest that this decline in desire to eat is attenuated when eating while distracted. However, the simple comparison of pre- and post-intake ratings gives little indication of exactly how desire to eat changes *during* the meal. Therefore, greater insight into the influence of distraction may be gained through an analysis of the microstructure of eating behaviour when distracted.

In Experiment 5, the change in desire-to-eat Jaffa Cakes experienced immediately upon meal termination did not differ between the distracted and non-distracted groups. However, at five- and ten-minutes post-intake the distracted group experienced significantly elevated desire to eat compared to the non-distracted group. The reason for the lack of difference immediately after the eating episode is unclear. However, at least two possibilities exist and these are illustrated in panels a and b of Figure 15.

The first possibility is that when distracted, desire to eat declines in a similarly linear fashion to that characteristic of normal eating behaviour, albeit it at a slightly attenuated rate (see Figure 15, panel a). Therefore, at the end of the meal both groups have experienced a similar change in desire to eat, reflected in similar ratings given immediately upon meal termination. The second possibility is that any awareness of changes in desire to eat is undermined when distracted. Therefore, desire to eat remains relatively unchanged across the course of the meal. However, following meal termination, when a measure of desire to eat has to be obtained, a reduction is reported, possibly driven by demand characteristics regarding the expected magnitude of change (e.g., Herman, Fitzgerald, & Polivy, 2003; Kramer, Rock, & Engell, 1992), or by a sudden feeling of satiety (Figure 15, panel b). Therefore, when distracted, desire to eat *during* the meal may either decline to a similar extent to that observed in a non-distracted participants, or it may remain relatively unchanged until after the meal has terminated.

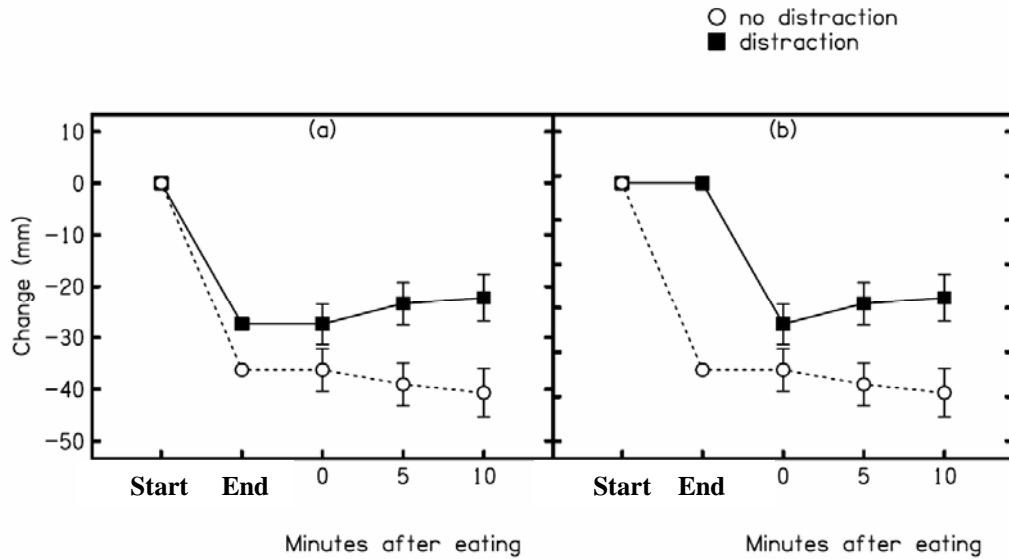


Figure 15. A representation of the possible ways in which desire to eat ratings may change during a meal eaten while distracted (solid lines), compared to when non-distracted (dotted lines). ‘Start’ and ‘End’ represent hypothetical data that reflect desire to eat before and after intake. The data at stages 0, 5, and 10 represent the actual data (mean \pm SEM) from Experiment 5 taken immediately, 5- and 10-minutes post-intake¹².

The reason why a difference was observed between distracted and non-distracted groups five- and ten-minutes post-intake is similarly unclear. One possibility is that because the distracted group experience less of a reduction in desire to eat during the meal, the rebound in desire to eat to baseline level occurs faster. Implicit in this explanation is the idea that given a longer period of time, the same rebound will be exhibited by the non-distracted group and the difference between the groups will again fail to be significant. In order to explore whether the desire to eat of the non-distracted group begins to rebound with increasing time, in this experiment, ratings of satiety were obtained up to 15 minutes post-intake.

A secondary aim of this experiment is to obtain a more objective measure of desire to eat, alongside the subjective ratings of general satiety (hunger, fullness, and

¹² ‘End’ reflects desire to eat upon meal termination *before* a rating is immediately obtained at ‘0 minutes’.

desire to eat) and food-specific satiety (pleasantness, intensity, desire to eat). In order to achieve this, measures of salivation are taken at the same time points as the ratings (at baseline, immediately, 5-, 10- and 15-minutes post-intake). Measuring salivation provides an additional means of examining hedonic-related shifts in the sensory properties of food stimuli. Cephalic phase salivation has been used as a psycho-physiologic measure of appetite since values tend to be higher in hungry compared to satiated individuals and are related to palatability (e.g., Wooley & Wooley, 1981). Furthermore, following repeated exposure to the same food cue, this salivary response tends to decrease along with reductions in subjective liking (e.g., Epstein et al., 1995). This process, known as salivary habituation (see section 10.3.1.), is believed to represent a process that is functionally similar to, and may underlie the expression of, sensory-specific satiety (Hetherington & Rolls, 1996). Importantly, habituation has been shown to be undermined by the presence of a distracter (Corcoran & Houston, 1977; Epstein et al., 1992; 1997; 2005; see section 10.3.1.1.). Therefore, by taking a measure of salivation, an assessment of the correspondence between subjective and objective measures is permitted. Moreover, the possibility that elevated desire to eat ratings represent an attenuation of the habituation process can be explored.

13.2. METHOD

13.2.1. Participants

Seventy female undergraduate students at Loughborough University were recruited via email (mean age = 21.58, *SD* = 2.89). All were paid five pounds (Sterling) for their participation.

13.2.2. Design and group classifications

As in the previous experiments, the design employed was an independent samples design and participants were randomly allocated to either a ‘distraction’ or a ‘no-distraction’ group.

13.2.3. Food and distracter task

As in Experiments 4 and 5, participants were required to eat five Jaffa Cakes (McVities, London, UK; 48 kcal / 8g each), at the rate of one every 60 seconds. The game ‘Pong’, available on the Atari games console, was again used as the distracter task.

13.2.4. Subjective measures and questionnaires

Ratings of general satiety (hunger, fullness, and desire to eat) and food-specific satiety (pleasantness, intensity, and desire-to-eat Jaffa Cakes) were obtained at various points throughout the experiment. In all cases, ratings were obtained using the same 100 mm visual-analogue rating scales used previously and participants were instructed to complete the scales as quickly as possible and “not to think too hard. Just go with your instantaneous response”. Consistent with the experiments preceding, an assessment of participants’ dietary predilections (DEBQ-restraint, TFEQ-disinhibitor, dieting status, and proactive task-use) were also obtained.

13.2.5. Salivation measure

Salivation was measured five times during the experiment (pre-intake, and then again immediately, 5-, 10-, and 15-minutes post-intake). For all measures, participants were asked to place a pre-weighed cotton wool roll under their tongue for 60-seconds and to keep their mouths closed for the full duration of the measure, avoiding any chewing motions. A stop-clock was provided so that participants

could begin the procedure when they were ready and terminate it after the duration allocated for saliva collection (60 seconds) had passed. During each measure, a piece of Jaffa Cake (one-quarter) was left in view the participants. The participants were informed that they would have to eat the piece of Jaffa Cake upon completing the saliva sample, and that while providing the sample they should focus on, and imagine eating, the piece of Jaffa Cake. Following each sample, the cotton wool rolls were immediately weighed and the difference in weight (pre- to post-sample) recorded.

13.3. PROCEDURE

Participants were tested between 11 a.m. and 6 p.m., having abstained from eating for at least three hours, in individual cubicles in the Ingestive Behaviour Laboratory, Loughborough University. Upon arrival, participants were randomly allocated to either the distraction or the no-distraction condition. After informed consent was gained, participants rated their hunger, fullness, and desire to eat. The procedure for the salivation measure was then explained. Following oral confirmation that they understood, participants were then presented with a plate holding one-quarter of a Jaffa Cake and were left alone to provide the first saliva sample. They were also told that once they had completed the measure, they should eat the piece of Jaffa Cake and then complete the ratings of pleasantness, intensity, and desire to eat, which were presented on a piece of paper placed faced down on their table.

The procedure for the main eating episode was then explained. As in previous experiments, participants were required to eat five Jaffa Cakes - one each time an auditory tone signalled the end of a 60-second period. In this experiment, the auditory tone also signalled that participants must complete a set of rating scales, as quickly as possible, before eating the next Jaffa Cake. Specifically, at the end of every 60-second period, participants rated their hunger, fullness, desire-to-eat Jaffa Cakes, and the pleasantness of the taste of the food. Thus, during the eating episode, participants ate five Jaffa Cakes and completed a set of ratings on five separate

occasions. Half of the participants completed this procedure while sitting in silence. The other half completed it while playing ‘Pong’.

After the eating episode had terminated, the procedure for obtaining a saliva sample was repeated, following which the piece of Jaffa Cake sample was consumed and ratings of pleasantness, intensity, and desire-to-eat Jaffa Cake were completed. Participants were then left alone for 15 minutes. During this time, at 5-minute intervals, they were asked to rate their general satiety (hunger, fullness, and desire to eat), provide a salivation measure (in the presence of the food), eat the food sample, and then complete ratings of food-specific satiety (pleasantness, intensity, and desire-to-eat Jaffa Cakes).

At the end of the experiment, participants completed the DEBQ-restraint scale, TFEQ-disinhibition scale, and questions assessing current dieting behaviour and tendency to engage proactively with the task¹³. Before being debriefed, paid, and thanked for their participation, if consent was obtained, a measure of height (cm) and weight (kg) was taken. Five participants declined to be weighed; two in the no-distraction group and three in the distraction group.

13.4. RESULTS

13.4.1. Group characteristics

Table 13 shows the mean (*SD*) DEBQ-restraint scores, TFEQ-disinhibition scores, and BMI, along with baseline ratings of hunger, fullness, and desire to eat, for the distracted and non-distracted groups. Participants in the two groups did not differ significantly in their scores on the DEBQ-restraint scale ($t[67] = 0.54, p = 0.558$), the TFEQ-disinhibition scale ($t[66] = 0.42, p = 0.678$), or in their BMI ($t[66] = -1.62, p = 0.111$).

¹³ N.B. No more than 9 participants reported either dieting or proactively using the task. Consequently, these variables are not included as factors in the data analysis.

	Group	
	Distraction <i>n</i> = 35	No-distraction <i>n</i> = 35
BMI	23.09 (3.09)	21.93 (2.87)
DEBQ-restraint	2.73 (0.82)	2.83 (0.76)
TFEQ-disinhibition	7.09 (3.71)	7.43 (3.14)
Initial hunger	61.97 (2.90)	60.26 (3.07)
Initial fullness	24.11 (3.34)	25.77 (3.60)
Initial desire to eat	66.00 (3.57)	66.26 (3.05)

Table 13. Mean (SD) BMI, DEBQ-restraint, and TFEQ-disinhibition scores, and initial ratings (mm) of hunger, fullness, and desire to eat, for the distraction and no-distraction groups in Experiment 6.

Baseline ratings of hunger ($t[67] = -0.41, p = 0.686$), fullness ($t[67] = 0.34, p = 0.737$), and desire to eat ($t[66] = 0.05, p = 0.956$) also did not differ significantly between groups. Table 14 shows the mean (SD) initial ratings of pleasantness, intensity, and desire-to-eat Jaffa Cakes and baseline salivation. No significant differences were observed between distracted and non-distracted participants in any of these initial ratings (pleasantness, $t[58] = 1.53, p = 0.131$; intensity, $t[67] = -0.14, p = 0.885$; desire-to-eat Jaffa Cakes, $t[55] = 1.34, p = 0.187$), or in the baseline measure of salivation ($t[67] = -0.75, p = 0.456$).

	Group	
	Distraction <i>n</i> = 35	No-distraction <i>n</i> = 35
Initial pleasantness	73.37 (3.68)	80.11 (2.41)
Initial intensity	75.46 (2.76)	74.91 (2.55)
Initial desire to eat	70.71 (4.18)	77.23 (2.52)
Initial salivation	0.784 (0.55)	0.683 (0.58)

Table 14. Mean (SD) initial ratings (mm) of pleasantness, intensity, and desire-to-eat Jaffa Cakes, and baseline measure of salivation (g), for the distraction and no-distraction groups in Experiment 6.

13.4.2. Effects of distraction on within-meal ratings

At five points during the meal, ratings of hunger, fullness, desire-to-eat Jaffa Cakes, and pleasantness were obtained. At each time point, a change score was derived by subtracting the rating given at that time (t_1 , t_2 , t_3 , t_4 , or t_5) from that obtained at baseline (t_{base}). These change scores were then analysed using repeated measures ANOVA with ‘time’ (t_1 , t_2 , etc) as the within-subjects factor and ‘distraction group’ as the between-subjects factor.

13.4.2.1. Hunger and fullness

Figure 16 shows the decrease in hunger (panel a) and increase in fullness (panel b) that occurred in each group during the meal. Ratings of both hunger ($F[4,272] = 33.46$, $p < 0.001$) and fullness ($F[4,272] = 21.87$, $p < 0.001$) changed significantly over time. The effect of distraction was not significant for the changes in either hunger ($F[1,68] = 0.461$, $p = 0.499$) or fullness ($F[1,68] = 0.371$, $p = 0.545$). As can be seen in Figure 16, panel b, the increase in fullness from baseline tended to be greater in the distraction group, however the relative change *during* the meal was

smaller in this group. The results of the analysis did reveal a significant interaction between time and distraction group for the change in fullness ($F[4,272] = 4.38, p = 0.002$). However, this interaction was not significant when applied to the change in hunger ($F[4,272] = 1.23, p = 0.297$).

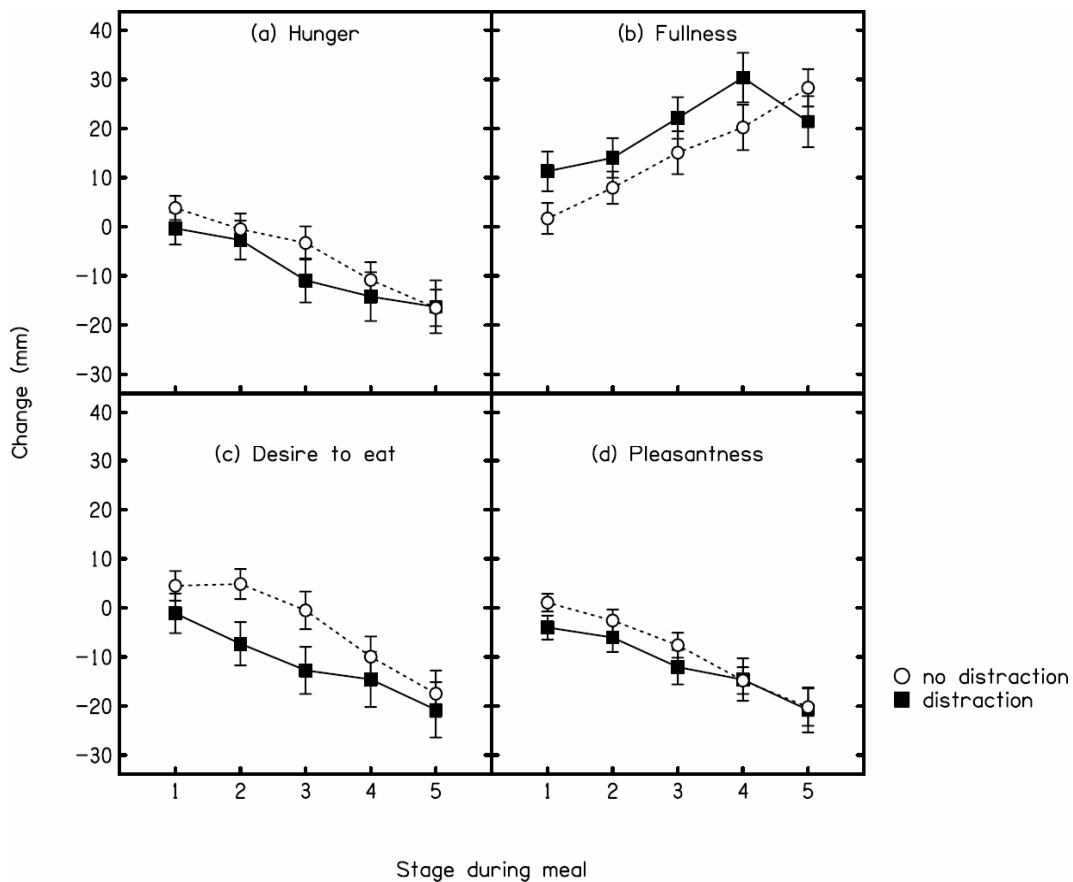


Figure 16. Mean (\pm SEM) change in rated (mm) hunger (panel a), fullness (panel b), desire-to-eat Jaffa Cakes (panel c), and pleasantness (panel d) reported at each of the five stages of the meal. The open circles represent the non-distracted group and the closed squares represent the distracted group.

13.4.2.2. Desire to eat and pleasantness

Panel c of Figure 16 shows the change in desire to eat that was observed across the five-minute eating episode in each of the two groups. Panel d shows the change in

pleasantness that occurred over the same time. In general, both desire to eat and pleasantness declined over time ($F[4,272] = 32.64, p < 0.001$ and $F[4,272] = 36.14, p < 0.001$, respectively). No significant difference was observed between groups in the magnitude of change in either desire to eat ($F[1,68] = 1.796, p = 0.185$) or pleasantness ($F[1,68] = 0.463, p = 0.498$). The interaction between distraction group and time also failed to reach significance for either measure (desire to eat, $F[4,272] = 2.130, p = 0.077$; pleasantness, $F[4,272] = 0.844, p = 0.498$).

13.4.3. Effects of distraction on post-intake ratings

Ratings of general satiety (hunger, fullness, desire to eat) were obtained before (t_{base}) and 5- ($t_{5\text{min}}$), 10- ($t_{10\text{min}}$), and 15-minutes ($t_{15\text{min}}$) post-intake. Ratings of food-specific satiety (pleasantness, intensity, desire-to-eat Jaffa Cakes) were obtained at these times, and in addition, a rating was taken immediately post-intake ($t_{0\text{min}}$). At each time point post-intake, a change score was derived by subtracting the rating obtained at that time ($t_{0\text{min}}, t_{5\text{min}}, t_{10\text{min}}, t_{15\text{min}}$) from that obtained pre-intake (t_{base}). As with the change scores derived during the meal, these change scores were analysed using a repeated measures ANOVA with ‘time’ ($t_{5\text{min}}$ etc) as the within-subjects factor and ‘distraction group’ as the between-subjects factor.

13.4.3.1. Hunger, fullness, and desire to eat

Figure 17 shows the change in hunger (panel a), fullness (panel b), and desire to eat (panel c) experienced from baseline to 5- ($t_{5\text{min}}$), 10- ($t_{10\text{min}}$) and 15-minutes ($t_{15\text{min}}$) after the eating episode. Over time, hunger and desire to eat declined ($F[2,136] = 4.18, p = 0.017$, and $F[2,136] = 10.03, p < 0.001$, respectively) while fullness increased ($F[2,136] = 3.24, p = 0.042$). The main effect of distraction group was not significant ($F[1,68] = 0.040, p = 0.842$) nor was the interaction between time and distraction group ($F[2,136] = 0.205, p = 0.815$).

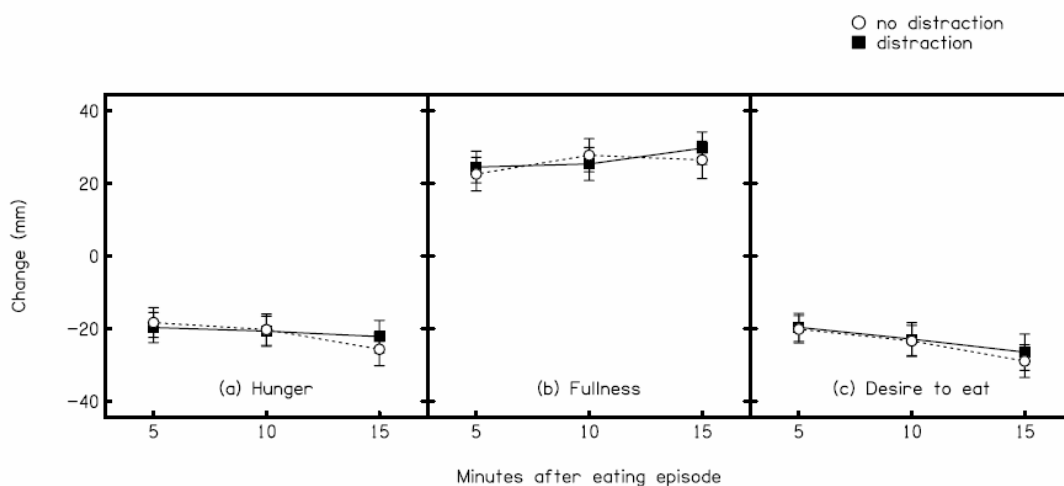


Figure 17. Mean (\pm SEM) change in hunger (panel a), fullness (panel b), and desire to eat (panel c), 5, 10, and 15 minutes after the eating episode in Experiment 6. The no-distraction group is represented by the open circles. The distraction group is represented by the closed squares.

Panel a and b of Figure 17 suggest that the change in hunger and fullness tended to interact with distraction group. However, the results of the ANOVA failed to confirm that distraction group had a significant effect on the changes in either measure (hunger, $F[1,68] = 0.010$, $p = 0.922$; fullness, $F[1,68] = 0.022$, $p = 0.883$), or that time and distraction group interacted significantly (hunger, $F[2,136] = 1.09$, $p = 0.339$; fullness, $F[2,136] = 1.315$, $p = 0.272$).

13.4.3.2. Pleasantness, intensity, and desire-to-eat Jaffa Cakes

Figure 18 shows the change in rated pleasantness (panel a), intensity (panel b), and desire-to-eat Jaffa Cakes (panel c) across time, for each group separately. Ratings of pleasantness and desire to eat tended to decline over time ($F[3,204] = 4.41$, $p = 0.005$, and $F[3,204] = 0.411$, $p = 0.007$, respectively). In relation to intensity, no clear pattern of change across time was observed ($F[3,204] = 1.153$, $p = 0.329$).

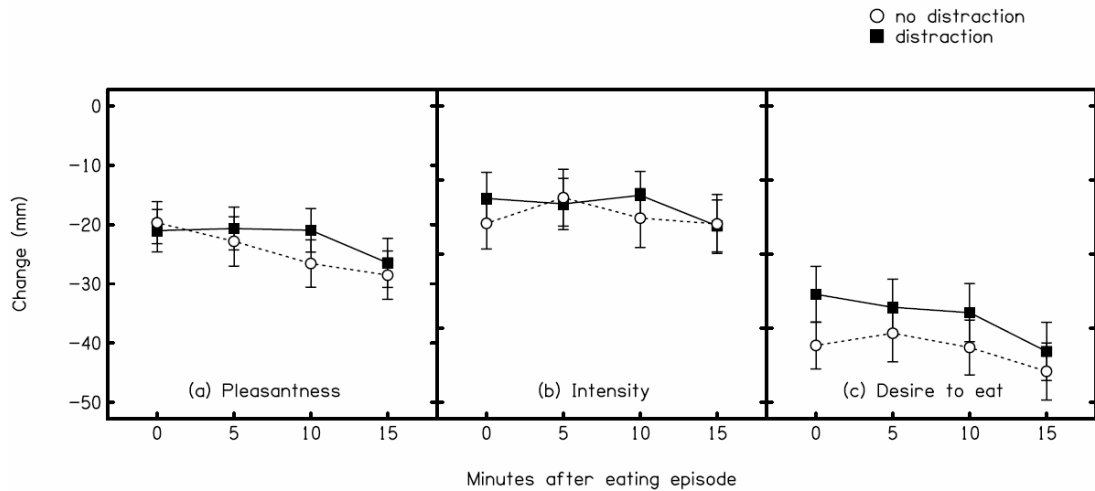


Figure 18. Mean (\pm SEM) change in pleasantness (panel a), intensity (panel b), and desire to eat (panel c), 0, 5, 10, and 15 minutes after the eating episode in Experiment 6. The no-distracted group is represented by the open circles. The distraction group is represented by the closed squares.

The distracted and the non-distracted group did not differ significantly in the reduction in pleasantness ($F[1,68] = 0.196, p = 0.660$), intensity ($F[1,68] = 0.083, p = 0.774$), or desire to eat ($F[1,68] = 0.852, p = 0.359$) reported. Likewise, the interaction between time and distraction group was not significant for either the change in pleasantness ($F[3,204] = 0.919, p = 0.433$), intensity ($F[3,204] = 0.726, p = 0.537$), or desire to eat ($F[3,204] = 0.495, p = 0.686$).

13.4.4. Effects of distraction on salivation

Change in salivation was calculated by subtracting the amount of saliva collected at baseline (t_{base}) from that collected immediately ($t_{0\text{min}}$), 5- ($t_{5\text{min}}$), 10- ($t_{10\text{min}}$) and 15- minutes ($t_{15\text{min}}$) post-intake. These difference scores were then analysed using repeated measures ANOVA with 'time' ($t_{0\text{min}}$, $t_{5\text{min}}$, $t_{10\text{min}}$, and $t_{15\text{min}}$) as the within-subjects factor and 'distraction group' as the between-subjects factor. Figure 19 shows the change in salivation in the distracted and non-distracted groups.

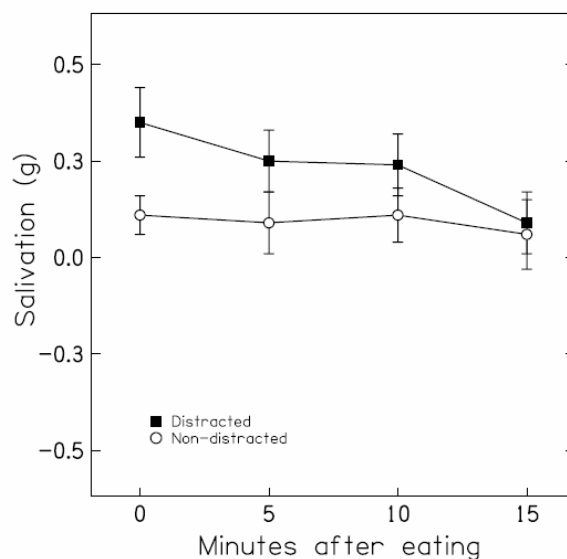


Figure 19. Mean (+/- SEM) change in salivation (g) from baseline to immediately-, 5, 10, and 15 minutes post-intake in Experiment 6. The no-distraction group is represented by the open circles. The distraction group is represented by the closed squares.

As can be seen in Figure 19, the distracted group experienced a greater increase in salivation, compared to baseline, than did the non-distracted group and this continued across the course of the experiment. The main effect of time was significant ($F[3,204] = 3.88, p = 0.010$). However, the results of the ANOVA revealed that the effect of distraction group failed to reach significance ($F[1,68] = 2.27, p = 0.137$) and no interaction between distraction group and time of saliva sample was found ($F[3,204] = 1.63, p = 0.185$).

13.4.5. Relationship with DEBQ and TFEQ scores

Consistent with Experiments 4 and 5, a secondary aim of this experiment was to determine whether the effects on satiety of engaging with the task while eating are more or less evident in those individuals with high scores on the measures of dietary behaviour (i.e., restrained and disinhibited eating). Accordingly, regression analyses

were used to determine whether the change in satiety ratings is predicted by an interaction between these dietary measures and distraction group.

An assessment of this interaction for each of the ratings (hunger, fullness, desire to eat, pleasantness) taken at each of the time points (1, 2, 3, 4, 5) *during* the meal would have resulted in 40 comparisons (4 ratings * 5 time points * 2 dietary measures). Therefore, the overall change from baseline to the final rating ($t_{\text{base}} - t_5$) was calculated. This resulted in only eight comparisons being made (4 ratings * 1 change * 2 dietary measures). On this basis, neither DEBQ-restraint nor TFEQ-disinhibition scores were found to significantly interact with distraction group to predict the observed changes in hunger, fullness, desire to eat, or pleasantness (p values in the range 0.07 – 0.92).

Similarly, for the food-specific ratings, the change in pleasantness, intensity, and desire to eat the Jaffa Cakes that occurred from pre- (t_{base}) to 15-minutes ($t_{15\text{min}}$) post-intake was not predicted by the interaction between distraction and either of the two dietary measures (p values in the range 0.08 – 0.98). The one exception was the interaction between the change in intensity and TFEQ-disinhibition scores ($t = 2.13$, $b = 4.12$, $s.e. = 1.94$, $p = 0.037$).

Regression analysis was also used to assess the extent to which changes in salivation could be accounted for by the interaction between distraction group and dietary measures. This yielded eight comparisons (4 time points * 2 dietary measures). None of the interactions reached significance (p values in the range 0.062 – 0.967).

13.5. DISCUSSION

The aim of this experiment was to ascertain how satiety changes during a meal eaten when distracted compared to when not distracted. Using a methodology similar to that used previously (e.g., Yeomans, 1996), no significant differences in the microstructure of appetite were observed between distracted and non-distracted participants. Similarly, post-intake ratings of general satiety (hunger, fullness,

desire to eat) did not differ significantly across the two distraction groups, nor did the changes in the food-specific ratings (specifically pleasantness and desire-to-eat Jaffa Cakes), or salivation. Thus, in contrast to the results from Experiments 4 and 5, eating while distracted was not found to be related to an attenuation of any measure of general- or food-specific-satiety. Consistent with these previous results, these changes were not influenced by dietary behaviour (DEBQ-restraint and TFEQ-disinhibition).

In order to understand the effects of distraction on eating behaviour, it is important to ascertain how the presence of distracting stimuli undermines the ability to successfully regulate food intake. In Experiments 1 and 2, the relationship between attention and intake was assessed by measuring performance on a task carried out while eating. The advantage of this methodology is that it offers a tool by which attention can be objectively, albeit indirectly, assessed. As such, it provides an alternative method of measuring attention that overcomes some of the problems associated with subjective reports. Unfortunately, due to the introspective and subjective nature of appetite, such methods can not be used when measuring distraction-related differences in satiety. Therefore, one possibility is that the failure to replicate the findings of Experiments 4 and 5 is related to the precise methodology employed. Specifically, despite the instruction to give no thought to the ratings and to complete them as quickly as possible, the simple act of completing the ratings scales, or the knowledge that this activity had to be performed, may have served to focus the participant's attention on their appetite, thus making changes in satiety very salient in both groups. As a result, the distracter task is unlikely to have been successful in undermining attention to dietary control. An alternative explanation is that this experiment lacked power, as the number of participants tested was smaller than that of Experiments 4 and 5 (which had an additional 14 and 18 participants, respectively). However, a *post-hoc* power calculation fails to identify this as a possible explanation for the lack of statistically significant results. Therefore, it is concluded that, under these circumstances, the attempt to manipulate attention using the game 'Pong' was unsuccessful.

One way in which the effects of distraction on changing appetite during a meal could be explored in the future is through the use of brain imaging techniques to

measure event-related potentials. These are neural signals, measured through the scalp, of which the location and magnitude gives an indication of brain functioning without having to rely on introspective accounts. Hetherington, Regan, and Pirie (1997) have shown that changes in brain potentials reflecting sensory and attentional processing are related to declining desire to eat (both measured pre- and post-intake). Thus, changes in subjectively rated appetite can be predicted by changes in objectively measured neuronal activity. The use of such a technique would obviate the need to rely on subjective reports of satiety in an attempt to discover whether distraction attenuates the rate at which sensory-specific satiety (or a process akin to this) develops. In relation to the aims of Part I of the thesis, such techniques may also prove useful in identifying how attention is allocated during a meal. For example, using a dichotic listening task, the brain activation that occurs during divided and focussed attention (see section 3.2.) has been studied (Jancke, Specht, Shah, & Hugdahl, 2003). The pre-SMA (presupplementary motor area) area of the brain - argued to be a 'computing centre' (e.g., Shima & Tanji, 1998) that prepares and controls complex movements and cognitions - is more strongly activated during divided than focused attention conditions. Furthermore, the pre-SMA area is less active when executing tasks that are automatic, and is more active when executing tasks that involve processing conflicts (e.g., the Stroop task; see section 3.4.1.) and which require additional cognitive computations (e.g., Peterson et al., 2002). In the case of eating while distracted, the extent to which attention is divided between the distracter task and dietary control, and consequently how much processing conflict occurs, will be related to how much attention this latter process requires. Based on the research cited above (Jancke et al., 2003), those participants who allocate greater amounts of attention to dietary control while performing the task may be identifiable by increased activity in the pre-SMA area of the brain.

13.6. SUMMARY AND RATIONALE FOR EXPERIMENT 7

Overall, the results of this experiment fail to offer any new insights into the potential effects of distraction on the regulation of eating behaviour. One reason for this, and a potential limitation of the methodology used in this study, relates to the problems associated with assessing developing satiety *during* a meal. While

advances in brain imaging techniques will undoubtedly benefit research in this area, useful insights into the ways in which distraction may lead to increased meal size may still be gained from other subjective methods taken after a meal. In this regard, in addition to assessing subjective changes in general- and food-specific-satiety, an exploration of the reasons given for meal termination may also be valuable. This is because such an approach allows for an assessment of the extent to which food-specific satiety is important in meal termination. In turn, this may provide further support (or otherwise) for the possibility that eating while distracted results from an attenuation of this process. Based on the work of Hetherington (1996) and Poothullil (2002), the aim of the final experiment is to explore the possibility that eating while distracted is associated with different reasons for ending an *ad libitum* meal compared to when eating while not distracted.

CHAPTER 14: EXPERIMENT 7

14.1. INTRODUCTION

Declining pleasantness is believed to be an important factor involved in meal termination (Hetherington, 1996) and may lead to eating cessation before stomach fullness has been reached. Support for this proposition comes from studies that have shown that food intake can be reinitiated after a meal has ended by the presentation of a new, different food (Rolls et al., 1984; see section 10.2.3.). Furthermore, Poothullil (2002) found no difference in the amount of cereal eaten when participants were instructed to eat until they felt satisfied, or when they were instructed to eat until the pleasantness of the food subsided. Conversely, intake was much greater when instructed to eat until stomach fullness was reached, or while watching television. Therefore, these results suggest that cessation of ‘normal’ food intake may be governed by sensory-specific satiety, or a process akin to this, while cessation when distracted is less influenced by declining pleasantness and may be more likely to be motivated by stomach fullness.

Hetherington (1996) used a retrospective ranking procedure to assess reasons for meal termination (see section 10.2.3.1.) and found that hedonic-related reasons (e.g., the food has stopped tasting good) were cited most often as the motivation behind the termination of an eating episode. Here, this methodology is employed to assess the reasons given for meal termination by distracted and non-distracted participants following free access to Jaffa Cakes. Based on the findings of Poothullil (2002), it is predicted that distracted participants will eat more than non-distracted participants, and that stomach fullness will be cited as the main reason for meal termination in this group. Conversely, in the non-distracted group, hedonic shifts (i.e., declining pleasantness) will be cited as being more influential in determining eating cessation.

14.2. METHOD

14.2.1. Participants

Seventy-four female undergraduate students at Loughborough University were recruited via email (mean age = 20.64, $SD = 2.45$). All were paid five pounds (Sterling) for their participation.

14.2.2. Design and group classifications

An independent samples design was employed in this experiment. Participants were randomly allocated to a ‘distraction’ or a ‘no-distraction’ condition. For the purposes of data analysis, participants were also grouped according to what reason they gave for terminating their meal.

14.2.3. Subjective measures and questionnaires

Ratings of general appetite (hunger, fullness, desire to eat) were obtained using the same 100 mm visual-analogue scales used in the previous experiments. As in Experiment 4, ratings were taken both before and immediately after the eating episode. All participants were also asked to complete the restraint scale of the DEBQ, the disinhibition scale of the TFEQ, and questions assessing current dieting status and proactive use of the task. Those participants who ate while distracted were also asked to provide additional information about the task. Specifically, they were asked to rate, on a 100 mm VAS scale, how engaging, stressful, and challenging they found the game. Lines were anchored “not at all (engaging / stressful / challenging)” and “extremely (engaging / stressful / challenging)” on the left- and right-hand sides of the lines, respectively. The same anchors were also used on two ratings scales to measure how i) stressful and ii) challenging participants found the requirement to play the game *while* eating. These ratings were taken in order to assess the extent to which the distracter task is associated

with heightened physiological arousal, a factor that has been implicated in overeating (see section 2.5.2.1.).

14.2.4. Assessment of reason for meal termination

A questionnaire was administered to assess the reason given for meal termination. Five reasons were adapted from those used by Mook and Votaw (1992) and Hetherington (1996). These were:

- a) I was concerned about how many calories I was eating
- b) The food began to taste less pleasant
- c) I felt full
- d) I got tired of eating the food
- e) Other (please explain.....)

Two additional reasons were also included:

- f) I wanted to finish the experiment quickly
- g) I wanted to play the game without eating (distracted participants only)

These additional reasons were included in order to monitor whether participants had terminated their meal prematurely for reasons unrelated to their hunger or liking for the food. As in previous experiments, participants were asked to indicate the main reason why they finished eating (Mook & Votaw, 1992), and then to rank the reasons into order of importance (Hetherington, 1996; Mook & Votaw, 1992). In addition, in this experiment, participants were also asked to “Please rate how important each of the following reasons was in your decision to stop eating”. A separate 100 mm rating scale was presented for each reason with end anchors, “not at all important”, and “extremely important” on the left- and right-hand sides of the line, respectively.

14.2.5. Food and distracter task

Participants were presented with a small white plate holding 30 Jaffa Cakes (McVities, London, UK; 48 kcal / 8g each). As in Experiments 4, 5 and 6, the game 'Pong' was employed as the distracter task for half of the sample.

14.3. PROCEDURE

Participants were tested between 11 a.m. and 5 p.m. in individual cubicles in the Ingestive Behaviour Laboratory, at Loughborough University, having abstained from eating for at least three hours. On arrival, all participants rated their hunger, fullness, and desire to eat, following which they were presented with a plate containing 30 Jaffa Cakes. They were instructed that they were free to eat as much or as little of the food as they desired, but that they must eat one Jaffa Cake every 60-seconds. Again, a PC emitted a beep at the end of every 60-second interval to signal to the participants to eat another Jaffa Cake. The participants were instructed that when they had eaten all that they wished to, they should press a button (which rang a bell in the laboratory) to inform the experimenter that they had finished. They were instructed that after having done so, they should continue playing the game or to remain sitting in silence, as appropriate, until the experimenter returned after a period of time had elapsed. This aim of this latter instruction was two-fold. It was hoped that it might reduce the possibility that participants would terminate their meal prematurely based on a desire to complete the experiment as quickly as possible and / or to play the game without eating. Thus, by making it clear that the experimenter would only return after a period of time had elapsed and that there would be an opportunity to play the game without eating, it was hoped that these possibilities would not influence the length of the eating bout. In reality, the experimenter returned as soon as the participants rang the bell to signal that they had finished eating, at which point any remaining food was removed and, if appropriate, the game was terminated.

Following termination of the meal, all participants completed the second set of hunger, fullness, and desire to eat ratings, along with the task evaluation

questionnaire (distracted group only). This was followed by the questionnaire assessing reason for meal termination. Participants were instructed to i) indicate the main reason for stopping eating from the list by circling the appropriate letter, ii) rank the reasons into order of importance by allocating each one a number (1 = most important), and then iii) complete the set of ratings indicating exactly how important each reason was. Having done this, the dietary questionnaires were then administered, along with the questions assessing current dieting behaviour and proactive disinhibition¹⁴. Measures of height (cm) and weight (kg) were then taken, and participants were thanked, paid, and fully debriefed. Two participants in the no-distraction group and one participant in the distraction group declined to give a measure of height and weight.

14.4. RESULTS

14.4.1. Group characteristics

The participants in the distraction and no-distraction groups did not differ significantly in their BMI ($t[67] = -0.12, p = 0.904$), or in their scores on the restraint scale of the DEBQ ($t[68] = 0.95, p = 0.344$), or the disinhibition scale of the TFEQ ($t[70] = 0.22, p = 0.829$). The groups also did not differ significantly in their baseline ratings of hunger ($t[63] = 0.82, p = 0.416$), fullness ($t[71] = -0.15, p = 0.882$), and desire to eat ($t[70] = -0.51, p = 0.610$). Table 15 shows the mean (*SD*) BMI, DEBQ-restraint and TFEQ-disinhibition scores, and baseline ratings of hunger, fullness, and desire to eat for the participants in the distraction and no-distraction groups, separately.

¹⁴ Only three participants reported dieting and five reported engaging proactively with the task. As a result, the analysis does not include these variables as factors.

	Group	
	Distraction <i>n</i> = 37	No-distraction <i>n</i> = 37
BMI	22.74 (3.13)	22.66 (2.58)
DEBQ-restraint	2.87 (0.76)	3.06 (0.98)
TFEQ-disinhibition	7.46 (3.44)	7.65 (4.04)
Initial hunger	56.03 (4.25)	60.22 (2.86)
Initial fullness	24.03 (3.26)	23.32 (3.40)
Initial desire to eat	64.41 (3.61)	61.95 (3.16)

Table 15. Mean (SD) BMI, DEBQ-restraint, and TFEQ-disinhibition scores, and baseline ratings (mm) of hunger, fullness, and desire to eat, for the distraction and no-distraction groups in Experiment 7.

14.4.2. Effects of distraction on reason for meal termination: analysis of ranks

Across all participants, the most popular reason given for meal termination was “the food began to taste less pleasant” (26%, *n* = 19). This was also the main reason cited by the no-distraction group (30%, *n* = 11), while in the distracted group “I felt full” was chosen most often (24%, *n* = 9). The three highest ranks for the distraction group were: “the food began to taste less pleasant” (mean = 2.56, *SD* = 1.30), “I got tired of eating the food” (mean = 2.81, *SD* = 1.39), and “I felt full” (mean = 3.05, *SD* = 1.65). The three highest ranks for the no-distraction group were: “the food began to taste less pleasant” (mean = 2.54, *SD* = 1.43), “I got tired of eating the food” (mean = 2.65, *SD* = 1.06), and “I was concerned about how many calories I was eating” (mean = 2.95, *SD* = 1.67).

Participants were divided into four groups based on whether they ranked i) concern, ii) fullness, iii) hedonics (‘less pleasant’ and ‘tired of eating’), or iv) some other reason, as being most important in their decision to stop eating. Figure 20 shows the

frequency with which each reason was chosen in the distracted and the non-distracted group. On this basis, both the distracted and the non-distracted participants cited hedonic-related reasons as being the most important in their decision to stop eating. However, analysis of the frequency with which each category of reason was chosen did not differ significantly between distracted and non-distracted groups ($\chi^2 [3, N = 74] = 2.570, p = 0.463$).

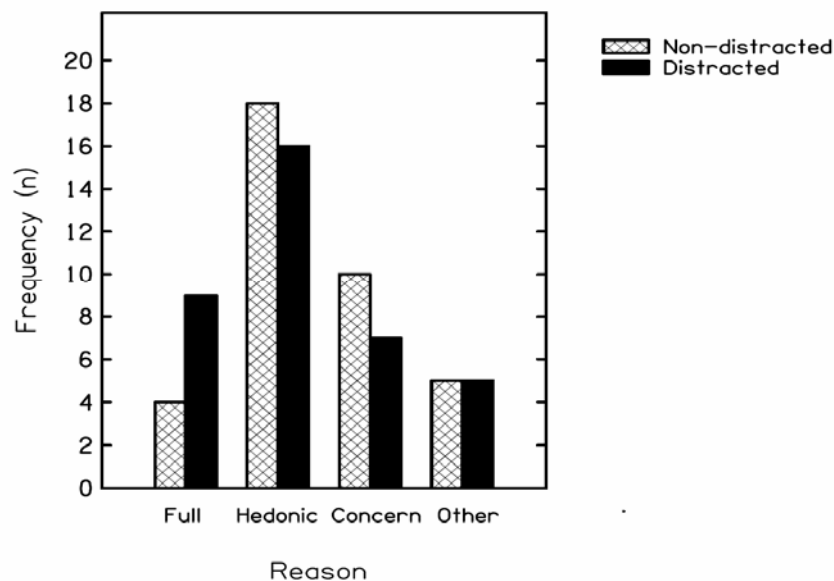


Figure 20. A bar chart to show the frequency (n) with which each reason was selected as the main reason for eating cessation in Experiment 7. The hashed bars represent the non-distracted group and the solid bars represent the distracted group.

14.4.3. Effect of distraction and reason for meal termination on amount eaten

Amount eaten was calculated by subtracting the number of Jaffa Cakes remaining on the plate from 30. A univariate ANOVA with ‘distraction group’ (distracted / non-distracted) and ‘reason’ (concern, fullness, hedonic, or other) as factors revealed a main effect of distraction group. Specifically, the participants in the distraction group ate significantly more of the Jaffa Cakes (mean = 7.38, $SD = 2.78$) than did the participants in the no-distraction group (mean = 5.22, $SD = 2.49$;

$F[1,66] = 70.72, p = 0.002$). Neither the main effect of reason ($F[3,66] = 2.31, p = 0.085$), nor the interaction between reason and distraction group reached significance ($F[3,66] = 1.35, p = 0.267$). Since the specific interaction of interest is that between distraction group and whether participants cited fullness or hedonic-related reasons as most important in meal termination, the analysis was repeated with only these two reasons included. Again, the interaction failed to reach significance ($F[1,43] = 0.221, p = 0.640$). Figure 21 illustrates the amount eaten by the distracted and non-distracted groups according to reason for meal termination.

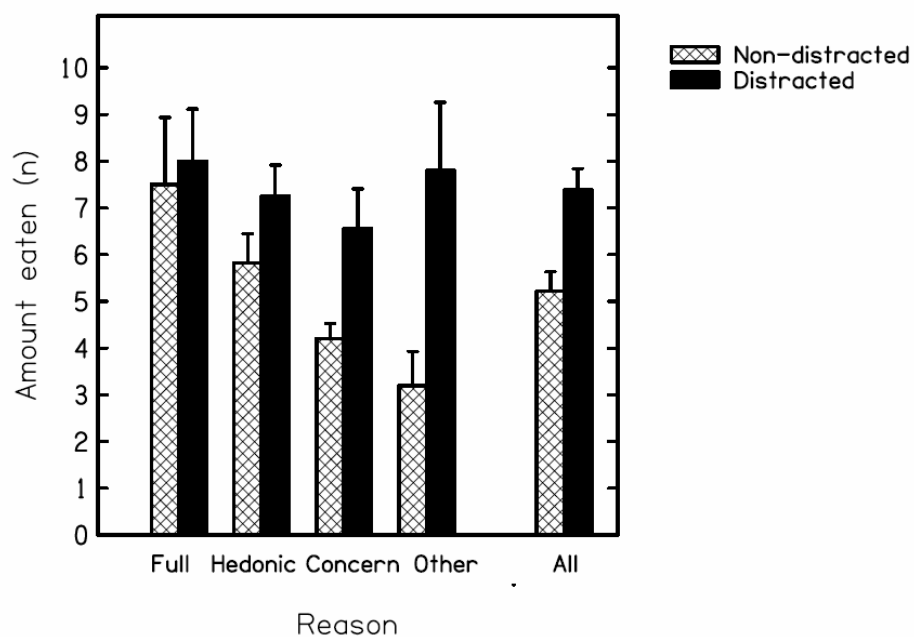


Figure 21. A bar chart to show the mean (+/- SEM) amount eaten according to the main reason cited for meal cessation, and total amount eaten in each group, in Experiment 7. The hashed bars represent the non-distracted group and the solid bars represent the distracted group.

14.4.4. Effects of distraction on reason for meal termination: analysis of ratings

The method of applying ranks is potentially problematic not only because it forces participants to discriminate between a number of potentially equally important reasons, but because it does not offer any indication as to the magnitude of the

difference in importance between each reason. Thus, in this experiment, participants were also asked to rate the importance of each reason. Table 16 shows the means (*SDs*).

It was decided *a priori* that the rated importance of each reason should be compared between the distracted and the non-distraction participants, using an independent samples *t*-test. The results of this analysis revealed only one significant difference; the rated importance of “fullness” was significantly higher in the distracted group compared to the non-distracted group ($t[71] = -2.07, p = 0.042$). The rated importance of all other reasons did not differ significantly between groups (all $p > 0.05$).

	Group	
	Distraction <i>n</i> = 37	No-distraction <i>n</i> = 37
concern about calories	42.5 (31.8)	55.8 (34.7)
food tastes less pleasant	71.3 (21.4)	65.8 (30.0)
to finish experiment	22.2 (21.1)	20.1 (19.1)
felt full	66.7 (25.3)	53.9 (27.9)
tired of eating the food	69.0 (25.3)	60.1 (26.1)
to play game	45.41 (30.70)	~
other	18.8 (35.0)	23.1 (38.8)

Table 16. Mean (SD) rated importance (mm) of reasons for meal termination in Experiment 7. Separate values are shown for the distracted and non-distracted groups.

14.4.5. Relationship between importance of each reason and amount eaten

A second assessment of the relationship between amount eaten and reason for meal cessation was calculated by correlating both the rated and ranked importance of each reason with the amount eaten.

14.4.5.1. Rated importance and amount eaten

Across all participants, “concern” was found to be negatively related to amount eaten ($r = -0.343$, $p = 0.003$), while a positive relationship was observed between amount eaten and “fullness” ($r = 0.361$, $p < 0.001$). The same analysis in each group separately revealed that amount eaten was positively related to “fullness” ($r = 0.437$, $p < 0.001$) and negatively related to “other” ($r = -0.664$, $p = 0.013$) in the no-distraction group. The relationship between “concern” and amount eaten failed to reach significance ($r = -0.299$, $p = 0.072$). Similarly, in the distracted group, none of the relationships between amount eaten and rated importance of each reason reached significance (r values in the range 0.090 – 0.476, all $p > 0.05$).

14.4.5.2. Ranked importance and amount eaten

Consistent with the relationships reported above, across all participants larger meal size was associated with lower ranked importance of “concern” ($r = 0.343$, $p = 0.003$) and with higher ranked importance of “fullness” ($r = -0.352$, $p = 0.002$)¹⁵. The same relationships were observed in the no-distraction group (concern: $r = 0.338$, $p = 0.040$; fullness: $r = -0.514$, $p < 0.001$), while in the distraction group, none of the correlations between ranked importance and amount eaten reached significance (r values in the range 0.021 – 0.333, all $p > 0.05$).

¹⁵ The direction of the correlation (positive or negative) differs depending on whether ranked or rated importance is analysed. This is because greater importance is indicated by lower ranks (i.e., most important = 1) but by higher ratings (i.e., most important = 100).

14.4.6. Correlation between ranked and rated importance

In order to gauge the level of correspondence between the ranking and rating procedures, the mean rank for each reason was correlated with the mean rating. In all cases, the correlation was highly significant (r values in the range $-0.625 - -0.879$, all $p < 0.001$).

14.4.7. Task evaluation and amount eaten

Those participants who ate while distracted were additionally asked to complete a number of rating scales assessing their experience of the task. The means (SDs) of these ratings are shown in Table 17.

	Distracted Group ($n = 37$)
Engaging	60.76 (23.2)
Stress – task	41.78 (24.6)
Stress – task and eating	59.27 (24.2)
Challenging – task	47.19 (20.1)
Challenging – task and eating	65.19 (20.6)

Table 17. Mean (SD) ratings (mm) of how engaging participants found the task, and how stressful and challenging participants found both the task itself, and the requirement to eat while performing the task in Experiment 7. Separate values are shown for the distracted and non-distracted groups.

In order to assess whether increased arousal (inferred from ratings of engagement, stress, and how challenging the task was) is related to amount eaten, correlational analyses were conducted. Based on this analysis, increased food intake was not found to be related to how engaging participants found the task ($r = 0.047$, $p = 0.78$). It was also unrelated to how stressful or challenging participants found the

task, both generally ($r = 0.047, p = 0.78$, and $r = 0.089, p = 0.60$) and when required to perform the task while eating ($r = 0.017, p = 0.92$, and $r = -0.025, p = 0.89$).

14.4.8. Relationship with DEBQ and TFEQ scores

As in previous experiments, a set of regression analyses were used to determine whether those individuals who score highly on measures of restrained and disinhibited eating are more susceptible to the effects of distraction. On this basis, amount eaten failed to be predicted by the interaction between distraction and DEBQ-restraint ($t = 1.39, b = 0.99, s.e. = 0.44, p = 0.17$) or TFEQ-disinhibition scores ($t = 1.24, b = 0.21, s.e. = 0.17, p = 0.22$).

14.5. DISCUSSION

Previously, changes in both general (Experiment 4 & 5) and food-specific (Experiment 5) desire to eat have been found to be less attenuated when eating while distracted. Here, using the same distracter task, distracted participants ate significantly more than non-distracted participants, irrespective of their dietary behaviour (restraint and disinhibition). This finding is important as it confirms the status of the game 'Pong' as a method of distraction that can lead to increased food intake (see section 2.5.2.). Taken together with the results of Experiment 4 and 5, it also provides indirect evidence that distraction may lead to overeating by undermining the extent to which desire to eat declines.

Inspection of the average top three ranked reasons for meal cessation revealed that both groups ranked hedonic-related reasons the highest and, between groups, the frequency with which each reason was cited did not differ. However, in line with the predictions based on Poothullil (2002), distracted participants rated fullness as being of significantly more importance than did non-distracted participants. This suggests that declining pleasantness is important in both groups. However, in the distraction group, this may only be the case after a greater amount of food has been consumed.

Amount eaten did not differ significantly with regard to reason for meal termination. However, some evidence for a logical trend was apparent in the non-distracted group. This is supported by the results of the correlational analysis which found that the meal size of the non-distracted group is related to how much importance participants place on the reasons ‘concern’ and ‘fullness’; the more important that concern is, the smaller the meal size. Conversely, the more important that fullness is, the larger the meal size. The fact that no such trend was apparent when ranked or rated importance was correlated with intake in the distracted group may indicate that their choice of reason simply reflects a *post hoc* decision that is unrelated to actual eating behaviour. This may be because an appreciation of the factors involved in meal termination is unavailable to direct introspection when distracted.

The correspondence observed between the importance allocated to each reason when asked to rank versus rate the reasons suggests that these measures are reliable. However, the extent to which the use of such methodologies allows for the underlying reason for meal termination to be identified is a source of much controversy and debate. One possibility is that responses are driven by the desire to give an appropriate or socially desirable response (see section 16.3.). In relation to this, ‘fullness’ may be chosen as the main reason for meal termination as a result of beliefs regarding what factors *ought* to be important (see Mook & Votaw, 1992). The extent to which this may be the case in the results reported here is unclear. If participants were relying on such beliefs, both groups might be equally expected to cite fullness as the main reason for meal termination. This was not the case.

14.6. SUMMARY

The results of this experiment are in line with previous research that has shown that eating while distracted is associated with larger meal size (e.g., Boon et al., 2002; see section 2.5.2.2.). Furthermore, consistent with the prediction that when distracted eating cessation is likely to occur at a point close to when stomach fullness is reached (Poothullil, 2002), distracted participants rated fullness as being

of significantly more importance in their decision to stop eating than did non-distracted participants. However, no conclusive evidence was found to suggest that meal termination is governed by separable processes when eating while distracted compared to when not distracted. Rather, consistent with the conclusion drawn following Experiment 5, declining pleasantness may be responsible for meal termination in both groups, but the rate at which this occurs may simply be attenuated when distracted. In the next chapter, the results from this experiment and those of Experiments 4, 5, and 6 are brought together in the context of a General Discussion in an attempt to provide an overview of the role of declining pleasantness in the regulation of eating behaviour under conditions of distraction.

CHAPTER 15: GENERAL DISCUSSION: EXPERIMENTS 4 - 7

15.1. INTRODUCTION

One of the factors that is involved in the regulation of eating behaviour is the extent to which the food being consumed is perceived as pleasant. Pleasantness is influenced by the energy needs of the consumer (Cabanac, 1971; see section 10.2.2.), and once eating has begun, tends to decline during the meal by a process known as sensory-specific satiety (Rolls, 1986; see section 10.2.3.). Because declining pleasantness is believed to be involved in satiety and meal termination (Hetherington, 1996; see section 10.2.3.1.), and salivary habituation (a process that is functionally similar to sensory-specific satiety) can be undermined by distraction (Epstein et al., 1992; see section 10.3.1.1.), one possibility is that overeating when distracted is related to an attenuation of this process. The aim of the experiments presented in Part II of the thesis was to investigate this possibility. In this chapter, the findings of these experiments are reviewed and the veracity of this possibility is discussed.

15.2. IS AN ATTENUATION OF DEVELOPING SATIETY INVOLVED IN OVEREATING WHEN DISTRACTED?

Part II of this thesis has attempted to explore whether an attenuation of the rate at which satiety develops, both general and food- (sensory) specific, is important in overeating when distracted. In order to do this, a number of different approaches have been employed. Experiment 4 consisted of a simple test whereby pre- and post-intake ratings of general satiety were compared between those who had and had not eaten while distracted. Experiment 5 extended this paradigm to investigate the time course of these effects and whether evidence of attenuated food-specific, as well as general satiety, is found when eating while distracted. Experiment 6 employed an alternative paradigm whereby developing satiety was assessed *during*

the meal. Finally, Experiment 7 investigated the possibility that eating while distracted is associated with differences in reasons for meal termination.

Overall, the findings of these experiments suggest that overeating while distracted is likely to be related to an attenuation of the rate at which satiety develops. Although the results of Experiment 4 suggest that this may be a general effect, when participants are asked to provide both general and food-specific ratings of satiety (Experiment 5), less evidence that this is the case is observed. Rather, when less opportunity is available to conflate the range of possible responses, the effects of distraction appear to be more evident when comparing the change in food-specific ratings. Unfortunately, the results of Experiment 6 were unable to offer any insight into how appetite changes (or not, as the case may be) during the actual eating bout. It is speculated that the failure to find any evidence of attenuated satiety may be a consequence of the requirement to rate appetite during the meal, which is likely to have resulted in the unintentional but unavoidable focus of attention on satiety. If so, the results of Experiment 6 do, at least, succeed in confirming the fundamental role of attention in the regulation of eating behaviour.

Here, it is hypothesised that an attenuation of the rate at which food-specific satiety develops may be responsible for prolonging the eating bout when distracted. Consistent with this, when given *ad libitum* access to food in Experiment 7, both distracted and non-distracted participants ranked hedonic shifts (declining pleasantness of taste and pleasure of eating) as being influential in eating cessation. However, in the distracted group, this occurred after a longer duration of time had elapsed and a larger amount of food had been consumed. Studies of sensory-specific satiety have shown that meals tend to be terminated before stomach fullness is reached (see section 10.2.3.). This is because the presentation of a new food can re-instate food intake after a meal has terminated, an effect that would be unlikely to occur if the stomach was full. Indeed, across a four-course meal, food intake is greater at each course if it consists of a new food (Rolls et al., 1984). This idea is similar to that of alliesthesia, which predicts that when in a state of energy repletion, the likelihood that a food will be perceived as pleasant and will be ingested is low. The fact that meals tend to be terminated before stomach fullness is reached suggests that this may be an important factor involved in the successful regulation

of eating behaviour (Rolls, 1996) and continually eating meals that terminate only when stomach fullness is achieved may result in positive energy balance (Poothullil, 2002). Consistent with this, in Experiment 7, the distracted group placed comparably greater importance on feelings of fullness than did the non-distracted group. This suggests that when the rate at which food-specific satiety develops is attenuated, hedonic shifts in the sensory properties of the food may not influence intake until closer to the point at which stomach fullness is reached.

The process of habituation also represents one way in which food intake may be inhibited. The evolutionary value of habituation has frequently been the subject of conjecture. In relation to attention, habituation allows us to easily turn attention away from familiar and stable stimuli and towards novel and changing stimuli. In this way, it is likely to be advantageous as it allows us to function within a highly stimulating environment that may otherwise become too taxing. In relation to eating behaviour, habituation may represent a safeguard against overconsumption, reducing the desire for a food despite continuing opportunity to eat. However, when distracted, this protection may be lost. Salivary habituation studies have shown that salivary reactivity is sensitive to distraction, with habituation to a repeatedly presented taste occurring at a slower rate when distracted compared to when not distracted (e.g., Epstein et al., 1992). Habituation is considered to be functionally similar to sensory-specific satiety (Hetherington & Rolls, 1996). Although at first glance the two appear different - habituation occurs following mere exposure to taste stimuli, while sensory-specific satiety involves actual ingestion of food (typically to satiety) - the finding that both may be undermined by distraction is important as it strengthens the argument that the two are transposable processes.

As the name suggests, sensory-specific satiety refers to the changing affective properties of the food. As such, it is sensory in nature. However, an alternative suggestion is that sensory-specific satiety actually reflects a cognitive process, akin to boredom. Thus, declining pleasantness may represent a reduction in the attractiveness of the idea of eating the food, rather than a real decline in the pleasantness of the taste. Rolls (1986) has suggested that the development of satiety may involve a cognitive process that assesses that enough of a food has been eaten. The role of cognitions has also recently been acknowledged in the expression of

other processes previously considered to be implicit (Brunstrom, Higgs, & Mitchell, 2005; see section 17.3.1.). Some research has attempted to tease apart the difference between the pleasantness gained from eating a food (influenced by palatability) from the pleasantness gained from the eating experience (influenced by hunger/satiety) following Rogers's (1990) call for the need to define a palatability construct. However, these ratings have been found to be highly correlated (Hetherington, 1993; Rolls & McDermott, 1991) implying that people have difficulty distinguishing between the two (see section 10.2.1.). This issue highlights an important problem associated with using subjective measures to assess changes in appetite – that it is unclear exactly what information participants are relying on in order to make their ratings. This issue is discussed in more detail in section 16.2.1.

15.3. THE ROLE OF DIETARY BEHAVIOUR

Previously, overeating when distracted has been reported to be more likely to occur in those individuals who score highly on measures of restrained and/or disinhibited eating (e.g., Ward & Mann, 2000; Westenhoefer et al., 1994). Consistent with this, in Experiments 1 and 2, amount eaten was found to differ significantly across groups. In Experiments 4 - 7, no reliable evidence was found to suggest that either amount eaten or changes in self-reported satiety could be predicted by an interaction between the effects of distraction and scores on the restraint scale of the Dutch Eating Behaviour Questionnaire (Van Strien et al., 1986), or the disinhibition scale of the Three Factor Eating Questionnaire (Stunkard & Messick, 1985). This suggests that the effects of distraction may be ubiquitous, affecting all participants alike.

One reason for the lack of consistency in the extent to which self-report dietary measures predict overeating when distracted may be related to the reliability of such methods (see section 16.3.). Two alternative explanations relate to 1) the way in which dietary behaviour measures are analysed, and 2) the type of behaviour the particular distracter task allows. These possibilities are discussed in the sections that follow.

15.3.1. Effects of method of data analysis

The most common method of assessing differences between restrained and unrestrained eaters involves artificially dichotomising the continuous variables of restraint and disinhibition, using median splits, in order to produce groups of ‘high restrained’ and ‘low restrained’ eaters (or ‘high disinhibition’ and ‘low disinhibition’ groups). This method has been used, almost exclusively, to investigate the effects of distraction (e.g., Boon et al., 1997; 2002; Mann & Ward, 2004; Ward & Mann, 2000) and was used in Experiments 1 and 2 reported in this thesis. Across all fields in psychology, such an approach is common. For example, in a review of all articles published between January 1998 and December 2000 in the *Journal of Personality and Social Psychology*, *Journal of Consulting and Clinical Psychology*, and *Journal of Counselling Psychology*, MacCallum, Zhang, Preacher, and Rucker (2002) found that 110 (11.5%) of the 958 articles published contained at least one instance of dichotomisation. The apparent customariness of such procedures is highlighted by the finding that only 20 per cent of the articles offered any justification for the use of this method.

Despite the apparent widespread acceptance of such methods, many methodologists have criticised the use of median splits to dichotomise continuous variables (e.g., Cohen, 1990; Donner & Eliasziw, 1994; Irwin & McClelland, 2003; Wright, 2003). One reason for this is that those values closest to the median are most likely to end up on one or other side of the median purely by chance (Hibscher & Herman, 1977) and those scores close to the median are counted as being equally ‘high’ or ‘low’ to the more extreme values in each category (Irwin, 2001). Furthermore, caution should be applied when comparing results across experiments, since relying on a data dependent split (i.e., at the median) is likely to produce groups that are not comparable with one another¹⁶. It is also argued that the result of artificially grouping participants together in this way is a loss of information about individual

¹⁶ The median splits in Experiments 1 & 2 occurred at the same point and were similar to those based on normative data (Gorman & Allison, 1995; Wardle, 1987) and used in previous experiments with both English (Haynes et al., 2003) and German (Westenhoefer et al., 1994) populations. This is advantageous since it increases the comparability between studies.

differences and a loss of effect size and power. Although proponents of this approach often offer this as a justification for the use of this procedure (because lower power will lead to effects being detected only at levels that are more conservative and are therefore more impressive), Wright (2003) cautions against using median splits, and advises the use of regression procedures, as opposed to ANOVA, which are considered to be mathematically equivalent (Cohen, 1968).

In line with this, a number of researchers have begun to explore the effects of restrained and disinhibited eating using regression analysis that does not require dichotomisation of these continuous variables (e.g., Ouwens et al., 2003; Van Strien et al., 2000). Similarly, in Experiments 4 – 7, this approach was used exclusively. Compared to previous studies of distraction, and the results of Experiments 1 and 2, no significant effects of restraint or disinhibition status were observed in Experiments 4 – 7 using this approach. Therefore, one possibility is that the discrepancy in the findings of these and previous studies of distraction is related to the differences in the way in which the data are analysed.

15.3.2. The role of proactive (dis)inhibition

A further factor that might be relevant in a discussion of why restraint-related effects were observed in Experiments 1 and 2, but were absent in the experiments reported thereafter, is related to the particular distracter task used. In Experiments 4 – 7, the task was highly engrossing, albeit very simple. Kemps et al. (in press) have found that restraint-related impairments in performance are only observed on tasks of moderate complexity. Therefore, the relatively undemanding nature of ‘Pong’ (and the word search task in Experiment 3) may have rendered it incapable of inducing restraint-related differences. This may be because, in this context, both restrained and unrestrained eaters are passively distracted from monitoring their intake and related satiety signals. On the other hand, less engrossing and/or more complex tasks might offer greater opportunity for different levels of engagement. For example, in Ward and Mann’s (2000) study, in addition to a reaction-time task that all participants completed, the participants in the high cognitive load condition were asked to watch and memorise a series of art slides. This type of task does not

offer the same element of enjoyment as ‘Pong’ and is not likely to hold the participant’s attention for the full duration of the eating episode. Because of this, participants are likely to differ to a greater extent in the amount of attention that they allocate to the task, and the extent to which they are able to engage in proactive strategies (see section 9.2.). In this regard, it is worth noting that very few participants in these experiments reported engaging in a strategy that can be described as proactive (dis)inhibition.

15.4. SUMMARY

Taken together, the results of Experiments 4 – 7 suggest that the development of food-specific satiety is attenuated when distracted and that this attenuation may be responsible for the increase in meal size that tends to occur when eating while distracted. In each of the experiments presented in this part of the thesis, the decision to employ the particular paradigms used arose from the need to control for the influence of potentially confounding factors and to increase the generalisability of the findings across experiments, with the aim of building a more succinct picture of the phenomenon under study. The main limitation of the methodology used is that only comments related to the relationship between ‘Jaffa Cake-specific satiety’ and distraction can be made. However, there seems to be little reason why this relationship would not generalises to other foods. Indeed, the demonstration of this effect with a single food represents an important first step towards understanding the effects of distraction on eating behaviour. In future, it might be useful to go on to look at the effects of distraction on sensory-specific satiety within a paradigm that is more akin to that generically used. The next chapter considers additional methodological issues and the potential limitations that are pertinent to this research.

CHAPTER 16: METHODOLOGICAL ISSUES

16.1. INTRODUCTION

The previous chapter discussed the results of Experiments 4 - 7 in detail. Before further broadening the discussion of Parts I and II in the General Discussion (chapter 17), this chapter reviews the methodological issues that merit further consideration. Specifically, issues related to the use of subjective methods to assess appetite and dietary behaviour are set out. These factors represent likely sources of 'noise' – nuisance variables that obfuscate real underlying effects by increasing error in the data. This is then followed by a discussion of the potential limitations of this research, along with possible directions for future research.

16.2. PROBLEMS ASSOCIATED WITH SUBJECTIVE MEASURES OF APPETITE

Research with human participants relies on subjective reports and/or objective measures of intake as indices of appetite. In Experiments 4, 5 and 6, the likelihood that the groups would differ in the amount eaten was inferred from differences in subjectively assessed appetite. Subjective ratings of appetite have been shown to have good test-retest reliability when obtained within a few hours (Flint, Raben, Blundell, & Astrup, 2000) or even when ratings of hunger across a week are compared with the average of those obtained on each day (Womble, Wadden, Chandler, & Martin, 2003). However, controversy exists over the extent to which hunger ratings can be considered reliable proxy measures for actual intake (Herman et al., 1999). For example, in a study conducted by Mattes (1990), male and female participants recorded their hunger and food intake every waking hour for seven consecutive days. The data was analysed in a variety of ways including scrutiny of the correlation between hunger ratings and computed energy intake, and hunger ratings and the number of eating occurrences, on weekdays and weekends separately. No significant correlations were observed between hunger and energy

intake in any individual participant, and a significant association between hunger and eating frequency was observed in only a minority. Thus, Mattes concludes that hunger ratings may not be a valid index of energy intake, particularly when computed from food records. Evidence both in favour (e.g., Rolls et al., 1988) and against (e.g., De Castro & Elmore, 1988; De Graff, 1993) this argument have been cited, suggesting that the nature of any relationship is highly variable. Therefore, caution should be taken when inferring the likelihood of a particular behaviour based on subjective ratings. In this regard, it may be considered advantageous to include a measure of intake in all studies that infer amount eaten from rated appetite.

16.2.1. Between-participant differences in interpretation

One potential reason for this divergence may be related to the way in which participants interpret what the rating scales are asking. Yeomans and Symes (1999) found that without explicit instruction, individuals differ in how they interpret the meaning of different terms. Fifty male participants were asked to rate both the pleasantness and the palatability of a food, both before and after *ad libitum* intake. The researchers found that there were two distinct ways in which the term 'palatability' was interpreted. Almost three quarters of the participants responded to the question assessing this factor in a manner synonymous with 'pleasantness'. That is, ratings of both palatability and pleasantness declined to the same extent from pre- to post-intake. However, approximately one quarter of the participants responded as though the two terms described different variables. In these cases, while pleasantness tended to fall across the duration of the meal, palatability remained relatively constant. This study highlights not only the potentially imprecise nature of subjective ratings, but also the importance of giving clear instructions to participants as to what the ratings refer. Similarly, Moskowitz and Krieger (1995) found that consumers differed in what sensory inputs they deemed to be most important when assessing overall liking. While some consider flavour/taste to be most important, others are more likely to make judgements of liking based on texture. However, generic ratings of 'liking' or 'pleasantness' do not allow these differences to be unpicked.

Booth (1987) has argued that hunger, desire to eat, pleasantness etc, reflect the same general variable, but that individuals interpret them as seemingly different psychological aspects of appetite. Thus, when participants rate each variable differently, it is unclear exactly what information they are drawing on to make these distinct judgements. Booth (1981) has suggested that participants may use hunger ratings as a way of indicating their disposition to eat or how much they wish to eat, both of which are influenced by a range of factors. Similarly, Mela (2000) and Kramer et al. (1992) have suggested that these ratings may reflect the appropriateness of eating a certain food in a certain situation. Indeed, as Compeau, Grewal, and Monroe (1998) have stated, such affective responses are "...a feeling state that occurs in response to a specific stimulus...with a potential range of cognitive effort". This implies that subjective ratings are likely to vary depending on the context in which the evaluation takes place and the cognitions of the individual. In line with this, Herman et al. (2003) have shown that the hunger ratings of both restrained and unrestrained eaters can be influenced by the reported hunger (high or low) of a confederate (see section 2.5.2.4.). Therefore, affective responses such as 'hunger' should not necessarily be viewed as a constant variable that is interpreted by all individuals in a similar way. Rather, an "individuals appetitive (or any other) behaviour at [a] given moment is a cognitive performance that combines perceived sensory, somatic and social features of the situation into the observed verbal and physical expression of hunger" (Booth, 1994, p.197).

16.2.2. Cognitive biases

In relation to the results obtained in the experiments presented in Part II, it is possible that the ratings of the participants who ate in silence were more influenced by cognitive factors than were those of their distracted counterparts. Thus, declining desire to eat may have reflected feelings of boredom associated with the eating situation. Or, by virtue of the fact that the non-distracted participants were able to allocate more attention to the food, this group may have been more susceptible to cognitions related to how healthy the food was and/or concerns related to caloric intake. A further possibility is that this group were more aware of giving ratings that

they deemed appropriate (i.e., declining across the meal) than were those who ate while distracted. Thus, the difference between distracted and non-distracted participants may not be attributable to an attenuation of the rate at which satiety develops when distracted. Rather, it may be related to an over-exaggeration of this rate when not distracted. Although this is a possibility, if desire to eat was in fact higher in the non-distracted group than they reported, this group would have been expected to have consumed a greater amount of food in Experiment 6 than they did. In actual fact, in Experiment 6 the non-distracted group ate, on average, almost an identical amount to the non-distracted participants in Experiments 4 and 5 (5.2 Jaffa Cakes versus 5, respectively). As Herman et al. (2003) have shown, although participants can falsely report how they feel to be in line with that of a confederate, actual intake tends to reflect real underlying hunger.

In relation to the influence of cognition, Mook and Votaw (1992) have also found that the inclusion or omission of particular alternatives can change the frequency with which certain responses are chosen. Using a questionnaire to assess reasons for meal termination (see section 10.2.3.1.), the authors found that the frequency with which the response “I felt full” was chosen was increased by 22 per cent by the explicit inclusion of this as an alternative (as opposed to simply providing the “other” option under which fullness could be reported). The authors suggest this may be because the explicit inclusion of this option as a possibility primes participants to believe that it must be important. Therefore, under certain circumstances, participants may respond in a manner in which they think they *ought* to be responding, as opposed to giving responses that reliably reflect their underlying opinions, thoughts, feelings etc.

16.2.3. Alternative approaches

Despite the potential drawbacks of relying on subjective introspection that may or may not be an accurate reflection of underlying motivational processes, rating scales continue to be widely used. This is because they represent the most economical and unobtrusive method of gaining an insight into how an individual feels. In addition, even when a neural basis for a phenomenon exists, for example

with sensory-specific satiety (Rolls, 2004; 2005), use of subjective measures remains popular. Indeed, even the strongest proponents of the view that sensory-specific satiety is governed by neuronal activity in identifiable areas of the brain have left open the possibility of cognitive involvement (e.g., Hetherington & Rolls, 1996; Rolls, 1990). Therefore, subjective measures should be viewed as a valuable source of information that is complimentary to, not competitive with, physiological data.

Recently, new scales have been developed that overcome some of the measurement-related problems that plague traditional scales (e.g., under use of end-points; see Cardello, Schutz, Leshner, & Merrill, 2005) and more discursive approaches to studying eating behaviour have been proposed that have the advantage of being able to unpick, for example, how food preferences are conceptualised. Wiggins (2001; 2002; 2004) advocates that positive and negative attitudes towards food can be based on both cognitive and affective factors. For example, cognitive factors may include beliefs regarding how healthy a particular food is, or how convenient it is to prepare. Affective factors refer to the hedonic tone associated with eating, either directly from the ingestion of the food, or from the pleasure derived from sharing a meal with friends. In either case, the range of influences is vast and Wiggins (2001; 2002; 2004) argues that discursive approaches may represent a useful tool for understanding on what basis preferences are constructed. The extent to which such an approach may be incorporated into the study of distraction per se is more complicated, since any reference to eating behaviour during the meal is likely to undermine the effects of the distracter task. However, the potential of such approaches to provide useful retrospective insights into the effects of eating while distracted warrants investigation.

16.3. RELIABILITY OF DIETARY BEHAVIOUR MEASURES

In Experiments 3 and 7, food intake was found to be unrelated to the interaction between either restraint or disinhibition scores and how attention was directed. Similarly, in Experiments 4 – 6, the effects of distraction on changes in satiety were independent of these measures of dietary behaviour. The discrepancy between these

findings, and what might be predicted based on the findings of other research (e.g., Ward & Mann, 2000), highlights the complexity of the relationship between the dietary predilections of an individual and how these influence behaviour in a range of situations. In line with this, Stice, Fisher, and Lowe (2004) have shown that widely used dietary restraint scales (DEBQ; TFEQ; Revised Restraint Scale) may not actually be reliable measures of short-term food restriction, either in the laboratory or in the real-world.

One reason for the complexity of this relationship may be related to the reliability of such measures of dietary behaviour. For example, responses on questionnaires assessing generic eating behaviour (i.e., what one *usually* does) are likely to be influenced by recent behaviour. Higgs (2002; 2005) has shown that amount eaten is influenced by the saliency of the previous meal. Similarly, restraint scores may be influenced by recent experience, such that they may be (uncharacteristically) high when assessed the day after an evening spent over-indulging at a restaurant. However, day-to-day fluctuations in scores on these scales are unlikely to represent a form of systematic bias.

Self-report measures of dietary behaviour may also be inaccurate due to the influence of social desirability effects. The impact of social desirability on the validity of questionnaire results has been acknowledged in psychology for over 50 years (Edwards, 1953). Informal conversations with participants tested in the Ingestive Behaviour Laboratory at Loughborough University has raised the suggestion that, at least for a sub-set of participants, the responses given to the questionnaires assessing dietary behaviour may be influenced by a desire to appear to have 'socially acceptable' eating habits. Some evidence suggests that those individuals who have a greater wish to appear more socially desirable tend to report lower restraint (Allison, Kalinsky, & Gorman, 1992; Johnson, Lake, & Mahan, 1983) and less concern for body-weight or engagement in unhealthy dieting behaviours (Klesges et al., 2004). Social desirability is also likely to be related to underreporting of the tendency to overeat, as assessed by the TFEQ-disinhibition scale. This is because behaviours measured by this scale, such as the intake of unhealthy or high-fat foods (Fricker, Baelde, Igoin-Apfelbaum, Huet, & Apfelbaum, 1992; Scagliusi, Polacow, Artioli, Benatti, & Lancha, Jr., 2003) and

eating when emotional or depressed (Kretsch, Fong, & Green, 1999) tend to suffer from underreporting, most often by highly-disinhibited individuals (Lara, Scott, & Lean, 2004). Indeed, underreporting is rife, both in terms of reported body-weight (Jeffrey, 1996; Morgan & Jeffrey, 1999) and food intake, with estimates of intake often around 20 per cent below actual intake (see De Castro, 2000), and even at levels that would be expected to result in death by starvation (Klesges, Eck, & Ray, 1995).

The extent to which the reliability of the measures of dietary behaviour reported in this thesis are influenced by factors such as social desirability is unclear. However, in future, it may be useful to assess dietary behaviour via methods that obviate the lack of anonymity that is associated with completing pen and paper measures of dietary behaviour that have to be handed back to the experimenter, since this may be a contributory factor in social desirability effects. In this regard, it is encouraging that recent studies comparing computerised (Booth-Kewley, Larson, & Miyoshi, 2005, in press) and web-based questionnaires (Huang, 2005, in press) with pen and paper versions confirm that the latter are associated with more response bias and less truthful answers.

16.4. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

This thesis has attempted to provide a first step towards understanding the nature of the mechanisms that may underlie overeating when distracted. The results presented offer a convincing argument for the importance of attention in the regulation of eating behaviour. However, this research is not without its limitations. These, along with possible directions for future research, are discussed in the sections that follow.

16.4.1. Design

In this research, a between-subjects design was used exclusively. This decision stemmed from a concern regarding demand characteristics. As it stands, participants were unaware of the purpose of the experiments. However, had the participants

been required to take part in two ostensibly identical test sessions, differing only in the presence or absence of a concurrent task, it is, without doubt, extremely likely that the participants would have deduced the aim of the experiments and that their subsequent behaviour may have been biased by this. Indeed, other research investigating the effects of distraction has also tended to use between-subjects designs (e.g., Boon et al., 1997; 2002; Mann & Ward, 2004; Ward & Mann, 2000), most likely as a result of similar concerns. Therefore, in light of the aims of this research, a between-subjects design is considered most appropriate.

However, aspects of the research may benefit from replication using within-subjects designs. The advantage of such an approach is that it allows baseline measures of the variable(s) under study to be obtained, before any experimental manipulation takes place. In relation to the research presented here, a baseline measure of intake would have permitted a comparison between the amount eaten under distraction and non-distraction conditions, and the extent to which participants have ‘overeaten’ to be ascertained. As mentioned previously (see section 8.5.), it would also have enabled a greater insight into the extent to which engagement in a proactive strategy is associated with the desired outcome. Therefore, an obvious first step for future research may be to explore the relationship between attention and intake within the same individual. In this regard, an interesting study may be to use measures of concurrent task performance, such as those employed in Experiments 1 and 2, to identify the extent to which within-subject changes in attention accompany bouts of overeating.

16.4.2. Influence of stress

As outlined in section 2.5.2.1, stress has been associated with increased food intake, most commonly in dietary restrained women (Greeno & Wing, 1994). The number of studies that have explored this phenomenon, and the range of stress-inducing stimuli that have been used, reflect the assumption that emotional arousal is causally related to bouts of overeating. With regard to the effects of distraction, one possibility is that participants eat more when distracted because the distracter task is stress-inducing, rather than because it consumes valuable cognitive resources,

otherwise required to maintain dietary control. A potential limitation of this thesis is that more attention has not been given to exploring this possibility further. However, evidence taken from a number of sources suggests that the likelihood that the results of the present set of experiments are attributable to stress, as opposed to distraction, is limited.

The RVIP task used in Experiments 1 and 2 is designed to measure sustained attention. Consequently, it may be considered to be arousing and / or stressful. Despite this, in Experiment 2, no evidence was found to suggest that stress was related to amount eaten. In fact, higher perceived task difficulty was related to smaller, not larger, meal size, the opposite of what might be predicted if task difficulty is taken as a measure of arousal (Greeno & Wing, 1994). Similar findings were observed when the distracter task consisted of a word search (Experiment 3) and a computer game (Experiments 4 – 7); on all occasions amount eaten was not related to any measure of stress or arousal. In fact, when subjective ratings of the level of stress associated with each task (RVIP, word search, and Pong) were obtained, these ratings rarely exceeded neutral on the rating scales. This is consistent with previous research (e.g., Ward & Mann, 2000) and implies that the distracter tasks used were, in fact, not particularly stressful. Furthermore, if heightened stress or arousal is responsible for the attenuated satiety ratings (Experiments 4 & 5) and increased intake (Experiments 7) observed when playing the game ‘Pong’, then the same effects would be expected to have occurred in Experiment 6 when the same distracter task was used. However, this was not the case. This suggests that the effects on developing satiety are related to how attention is allocated (the aspect of Experiment 6 that failed to be manipulated successfully). Indeed, the tasks used in Experiments 3 - 7 were expressly chosen to minimise any potential confounding effects of stress and arousal. Specifically, both the word search task and ‘Pong’ are neither particularly stressful, nor particularly exciting. In addition, in Experiment 3, participants were afforded the freedom to choose if and when they engaged with the word search task, and the possibility that individuals will voluntarily choose to cause themselves stress would seem unlikely. Furthermore, in Experiments 4 - 7, the instruction that participants could re-set the game at any time was included to minimise the possibility that participants would feel any anxiety related to their performance.

Although the concept of stress-induced overeating is well accepted, mounting evidence suggests that this assumption may be unreliable. Studies that have employed alternative designs to the commonly used ‘ice-cream taste-tests’ have not always succeeded in finding evidence for stress-induced eating (e.g., Shapiro & Anderson, 2005). One reason for this may be that, as suggested in section 2.5.2.1., the documented effects of stress on eating behaviour are in actual fact a consequence of distraction. Consistent with this hypothesis, E. Dove (personal communication, 9th September 2005) has found that participants attending a weight-reduction clinic report being distracted during bouts of overeating when stressed. Thus, rather than stress being involved in distraction-related overeating, distraction may be the important mediating factor in what has been regarded as stress-induced overeating. Indeed, Lowe and Kral (in press) have recently advocated that it “no longer appears tenable...to suggest that stress increases the intake of restrained eaters...or that negative emotional arousal that is usually produced by stressors is a necessary part of this relationship”. Rather, the authors support the proposition that increased intake induced by non-stressful cognitive manipulations (i.e., distraction) are unlikely to be mediated by stress.

Notwithstanding all of the above, because the tasks used in this research were not very powerful, acute stressors, the likelihood that they could be capable of causing an increase in cortisol (the physiological stress response that has been linked with overeating; Tataranni et al., 1996) is slim. Even if they could raise cortisol levels, the effects would be likely to occur much slower, after around 15 minutes or more of engagement with the task (N. Bruce, personal communication, 8th September 2005). This is consistent with previous research that has found that not all recently experienced ‘stressful’ events are associated with cortisol release, and that effects do not tend to peak until 20-40 minutes after the start of the stressor (Brandenberger, Follenius, Wittersheim, & Salame, 1980; Holl, Fehm, Voigt, & Teller, 1984). Since differences were observed between distracted and non-distracted groups before this time, the possibility that the effects of cortisol are responsible for these results is questionable.

In future, one way in which the effects of stress may be investigated is through the use of multiple-task procedures. Research into focused and divided attention has shown that under dual-task conditions, performance on one or both tasks is impaired, and the extent of the impairment is related to the degree of similarity between the two tasks (see section 3.2.2.). Overeating while distracted has been conceptualised in this thesis to occur as a result of insufficient availability of cognitive resource under dual-task conditions. However, if overeating occurs as result of stress, then it should occur under all stressful conditions, irrespective of any differences in the amount of available cognitive resource. In order to ascertain whether the effects of a distracter task are related to cognitive interference or to stress, it may be possible to compare performance on two tasks that are very stressful but which differ in modality of input or required response, with two that are equally stressful but which are very similar in input or response modality. In each case, performance on the two task occurs concurrently with food intake. If distraction influences eating regulation through heightened stress and arousal, the effects should be similar under both conditions. Rather, if the effects of distraction are related to cognitive interference, then greater effects should be observed under the ‘similar’ compared to ‘different’ task condition.

16.4.3. Clinical significance

In this research, conclusions regarding the effects of distraction on the regulation of eating behaviour have been drawn. However, a potential limitation of this research is the extent to which these results can be interpreted as evidence for the effects of distraction per se. This is because for each hypothesis investigated, only one type of distracter was employed. For example, playing ‘Pong’ appears to be associated with an attenuation of the rate at which satiety develops, and greater food intake. However, it is unclear whether this is related to general effects of allocating attention to a concurrent task, or to more specific effects of ‘Pong’. This latter possibility would seem unlikely, since the documented effects of a range of distracter tasks appear to be consistent (e.g., Bellisle et al., 2004; Boon et al., 2002; Mann & Ward, 2004; Ward & Mann, 2000; see sections 2.5.2.2. & 2.5.2.3.). However, in future, it may be worthwhile to see if the findings reported here are

replicated when different distracter tasks are used. This would allow for more firm conclusion regarding the effects of distraction, rather than the effects of one ostensible distracter task, to be drawn. In particular, it might be useful to attempt to replicate these findings using distracters that are closer to those typically encountered in real-life (De Castro, 2000). For example, watching television represents a more familiar form of distraction and one which has been reported to be associated with increased intake (e.g., Coon et al., 2001). Careful selection of the material to viewed can also minimise any potentially confounding effects of heightened stress or arousal (see section 2.5.2.1.). In addition, aspects of the design, such as allowing participants to choose the food that they eat is likely to increase the ecological reliability of the behaviours observed.

16.5. SUMMARY

The study of ingestive behaviour relies heavily on the scrutiny of processes that are, by their introspective nature, only open to assessment by subjective methods. As with any research relying on such assessments, an awareness of the potential influences that can affect responding is important. The issues reviewed in this chapter highlight the general problems that are associated with the use of such methodologies. The recognition of these issues is important when interpreting the data gathered via subjective methods, presented in this thesis and elsewhere. This chapter has also outlined the potential limitations associated with this research. Future research may benefit from exploring these issues further in order to build a more reliable picture of the phenomenon under study.

CHAPTER 17: DISCUSSION AND CONCLUSIONS

17.1. INTRODUCTION

The aim of this thesis is to identify the nature of the potential process(es) involved in the occurrence of overeating when eating while distracted. This research has been presented as two distinct lines of investigation. The first explores the relationship between how attention is allocated and the effect on subsequent intake in groups of individuals differing in their current dietary behaviour and / or their self-reported use of proactive strategies. The second explores the more general effects of attention on the operation of those sensory-specific processes thought to be involved in the regulation of eating behaviour. Based on this research, it is concluded that overeating may be most likely to arise when constraints on attention result in an attenuation of the rate at which changes in satiety and hedonic shifts in the sensory properties of a food occur. However, subsumed within this are individual differences relating to the effects of distraction on the ability to maintain cognitive control on eating behaviour, and the tendency to engage in strategic allocation of attention. This chapter reviews the results of the research that give rise to this conclusion, and the resulting current perspective. Links are then drawn between the conclusions of this research and other pertinent research areas.

17.2. OVERVIEW OF MAIN FINDINGS

In each of the experiments reported, the basic experimental paradigm involved an assessment of the effects of distraction, either between different groups of similarly distracted participants (Experiments 1 & 2), or between distracted and non-distracted participants (Experiments 3 - 7). The effects of this manipulation on a number of dependent measures were investigated. These included the total amount of food consumed (Experiments 1, 2, 3, & 7), performance on a concurrent task (Experiments 1 & 2), use of a proactive strategy (Experiments 2 & 3), changes in

satiety, both general and sensory-specific (Experiments 4 - 6), and reasons for meal termination (Experiment 7).

In Experiment 1, dieters and four groups of non-dieting participants (low restraint/low disinhibition, low restraint/high disinhibition, high restraint/low disinhibition, high restraint/high disinhibition) were asked to perform a vigilance task (the Rapid Visual Information Processing task) while eating, for as long as they wished. Performance on the RVIP task was taken as an indirect, objective measure of attention to dietary control. Using this methodology, both amount eaten and performance were found to differ across the five groups. Specifically, in line with previous observations of the eating behaviour of these groups, the current dieters and the high restraint/high disinhibition group ate the most food. Furthermore, the large food intake of the dieters was coupled with significantly better performance, compared to the non-dieting groups, as the meal progressed, providing some evidence to suggest that increased intake is associated with decreased attention to dietary control (inferred from good performance on the task). The possibility that this group might be engaging in what has been referred to here as 'proactive disinhibition' - the tendency to strategically allocate more attention to the task in order to permit overeating - was suggested following the observation that the high restraint/high disinhibition group, who ate a comparable amount of food to the dieters, did not exhibit the same pattern of elevated performance.

The veracity of this possibility was confirmed in Experiments 2 and 3. Using both a similar (Experiment 2) and a novel (Experiment 3) procedure to that used in Experiment 1, self-reported 'use' of the task was found to be common, particularly in dieters. In each experiment respectively, 30 per cent and 26 per cent of participants reported actively focusing their attention on the task in order to avoid cognisance of the food. Importantly, in Experiment 2, use of this strategy was found to be related to the objective measure of attention, confirming the reliability of these reports. Furthermore, non-dieting task-users ate significantly more food than the non-dieting non-task-users.

Although this strategy was initially hypothesised to aid overeating, the observation that the dieting task-users ate *less* than the dieting non-task-users raised the

possibility that under certain circumstances individuals may also focus on the task in order to avoid the temptation to eat. In Experiment 3, when asked to indicate why they focused on the task, the majority of task-users confirmed that this was the case. However, the extent to which this strategy was successful is difficult to establish. Task-users and non-task-users did not differ in their intake. However, this may reflect either the fact that the task-users were successful in restraining their intake (as otherwise they would have eaten more than the non-task-users), or that conversely they were unsuccessful and proactive use of the task failed to result in the consumption of less food than the non-task-users. A potential weakness of this design is that no baseline measure of intake was taken. Such a measure would have permitted the amount eaten when attempting to avoid the temptation to eat to be compared against the amount eaten when no such opportunity was available, and a chance for these competing hypothesis to be unpicked.

Taken together, the results of Part I of this thesis confirm the relationship between attention and amount eaten, and highlight how attention can be influenced by dietary behaviour and the use of proactive strategies. Based on this, the aim of Part II was to explore the nature of the underlying mechanism by investigating the effects of distraction on changes in general and food-specific satiety. Experiment 4 established that after consumption of a fixed portion of food, those who had eaten while distracted experienced smaller changes in fullness and desire to eat, compared to those who had eaten without distraction. The attenuation of the extent to which desire to eat changes while distracted was confirmed in Experiment 5 and was exhibited not only in terms of a general desire to eat (i.e., any food), but also specifically for the food being eaten (i.e., Jaffa Cakes). Furthermore, these food-specific effects were present both 5- and 10-minutes after the meal terminated. Experiment 6 failed to offer any insight into the microstructure of a meal eaten while distracted, although the results do confirm that distraction undermines attention to satiety by showing that these differences abate when attention is drawn to these signals. Finally, the assumption that playing the game 'Pong' would be sufficient to lead to increased food intake was confirmed in Experiment 7. Furthermore, some evidence was found to suggest that this may reflect the attenuated rate at which declining pleasantness occurs, with meals terminated closer to the point at which stomach fullness is reached. Taken together, the results from

Part II suggest that the mechanism that may be undermined when eating while distracted is related to extent to which food-specific satiety (i.e., declining pleasantness, desire to eat etc) develops under such circumstances.

17.3. CURRENT PERSPECTIVE

As outlined in section 3.6.4, the construct of attention as a limited capacity resource has enjoyed much favour in the dietary restraint literature. This is because it represents a workable framework within which differences in cognitive performance between dieting, restrained, and unrestrained eaters can be usefully viewed. More recently, this framework has been applied to research investigating overeating in the hope that it may also prove useful in conceptualising the process(es) involved (e.g., Boon et al., 2002). Overall, the findings presented in both Part I and Part II of this thesis have shown that attention to a concurrent task influences eating regulation, both in terms of an objective assessment of amount eaten, and subjective measures of general and food-specific satiety. Therefore, these results are in line with the notion that the successful regulation of eating behaviour is governed by a limited capacity resource. The findings suggest that this may be because an awareness of shifts in the hedonic properties of food, which signal developing satiety and when to terminate a meal, is reliant on the availability of sufficient cognitive resource. When the availability of this resource is limited, as is the case when a demanding concurrent task competes for attention, these signals are undermined and thus overeating can occur. This conclusion is important since it brings together the research from what have been two seemingly distinct areas of the literature (cognitive impairments versus overeating/‘disinhibition’) and encapsulates them within the same theoretical framework. As a result, it offers a convincing case on which to base an argument that other factors undermining eating behaviour, such as extreme mood states or social facilitation effects, can be usefully explained by models of limited cognitive resource.

The extent to which the changes in, what in this thesis have been termed ‘food-specific satiety’, reflect sensory-specific satiety or habituation (or indeed both) is unclear. A number of the findings are characteristic of what would be predicted if

sensory-specific satiety was the phenomenon in question. In particular, in Experiment 5, pleasantness and desire to eat the ‘eaten’ food declined to a greater extent, relative to the uneaten foods. Furthermore, these effects persisted over time and some evidence of a generalisation effect to a similar flavoured food was observed. In terms of the effects of distraction, the decline in desire to eat differed between groups and this too persisted over time. However, contrary to the evidence required to confirm that sensory-specific satiety per se is undermined when distracted, the decline in pleasantness did not differ between distracted and non-distracted groups. Therefore, although distracted participants experience less attenuation of their food-specific desire to eat, this does not appear to reflect attenuated sensory-specific satiety in the formal sense of the term. It may, however, reflect a reduction in the extent to which habituation has occurred. Salivary habituation to a repeated food cue has been shown to be significantly attenuated by the presence of distracting stimuli (e.g., Epstein et al., 2005; see section 10.3.1.1.). However, the separable processes of habituation and sensory-specific satiety are difficult to tease apart and habituation is often cited as a potential mechanism underlying the expression of sensory-specific satiety (Hetherington & Rolls, 1996). As such, the extent to which elevated desire to eat and increased intake when distracted can be considered to occur as a result of decreased habituation requires further investigation.

17.3.1. The role of cognition in ‘primitive’ responses

Sensory-specific satiety is often conceptualised as a primitive response. However, the results presented in this thesis suggest that this process may be more complex and that a cognitive element may be involved in the regulation of food intake and the development of satiety. This is in line with the findings of Hetherington and Rolls (1988) and Rolls et al. (1992) who showed that sensory-specific satiety develops to differing extents in both anorexic and bulimic patients depending on the food (high / low calorie) that they are asked to consume (see section 10.3.2.). It is also consistent with the findings of studies of salivary habituation that have shown that the level of attenuation of this response is positively related to the level of cognitive load (Epstein et al., 1997; see section 10.3.1.1.). Indeed, as discussed in

section 10.3.2., notwithstanding the identification of a neural basis of sensory-specific satiety, many researchers acknowledge the likelihood of the important role played by cognition. In this regard, it is surprising that more research has not sought to understand how the two interact.

The possibility that what is often considered to be a simple, sensory process can be influenced by more cognitive processes fits in with recent work in the area of dietary learning (for a review see Brunstrom, 2005). Specifically, the idea that forms of dietary learning (e.g., flavour-flavour learning, flavour-nutrient learning) represent primitive, implicit processes has been challenged. ‘Flavour-flavour learning’ refers to the process whereby the repeated presentation of a neutral flavour (the conditioned stimulus; CS) in close proximity with an already liked flavour (the unconditioned stimulus; US) leads to preference for the previously neutral flavour to increase. Variations on this paradigm include ‘flavour-picture learning’ in which the valence of novel visual stimuli can be increased or decreased through repeated presentation with a liked or disliked flavour, respectively. Over a series of studies, the possibility that the operation of this type of learning is governed solely by exposure to the sensory representation of the evaluative stimuli has not been confirmed. Rather, in studies using a chocolate reward as the unconditioned stimulus, no evidence for learning has been found in dietary restrained females (Brunstrom, Downes, & Higgs, 2001). Furthermore, learning appears to be related to the amount of attention that is allocated to the CS-US relationship during the conditioning phase (Brunstrom & Higgs, 2002). Since interfering thoughts are known to influence attention (see section 3.4.1.), it has been suggested that the impairments in restrained eaters may be related to negative beliefs and attitudes regarding the US consuming valuable cognitive resource. The finding that restrained eaters show the greatest increase in liking for flavours or pictures that are paired *less* often with a chocolate reward would appear to support this proposition (Brunstrom, Higgs, & Mitchell, 2005). Similar work has also been conducted showing that flavour-nutrient learning may also be influenced by beliefs regarding the CS (Brunstrom & Mitchell, under review). Therefore, it is not implausible to suggest that other processes that have until now been regarded as ‘primitive’ may also be highly susceptible to the influence of cognitions.

17.3.2. The logical proposition framework and the study of attention

This research has focused on attempting to understand the relationship between attention and subsequent eating behaviour. However, studying attention can be problematic. The results of Experiment 1 and 2 suggest that performance is impaired when attention is allocated to dietary control. This conclusion is superseded by the assumption that if no impairment is observed, then no attention has been allocated to dietary control. However, as argued by Botella (2000), one of the problems associated with studying selective attention is the difficulty associated with proving that irrelevant stimuli has not been processed. To do so relies on a null result. Such a result, however, is often associated with doubt that the lack of effect is related to insufficient sample size or to the particular manipulation used. This may be why research has tended to focus on the conditions under which individuals are poor at efficient selective attention, rather than the converse. However, an important aspect of the research presented in Part I of this thesis is that it provides evidence to support the idea that a lack of degraded performance does not necessarily indicate a lack of interference.

The logical proposition framework (see Figure 22) assumes that ‘If P then Q’, where ‘P’ refers to the efficient selective attention and ‘Q’ refers to no evidence for interference, and provides a useful illustration of the ways in which conclusions regarding the efficiency of attention are drawn. For example, based on these propositionally logical conclusions, if performance on a task is degraded by the presence of interfering stimuli (i.e., ‘Q’ is not true), one can conclude with confidence that the irrelevant information has been extracted and processed (i.e., ‘P’ is not true). This mode of logic is referred to as *modus tollendo tollens* (see Figure 22, column a). Conversely, if no such impairment is observed (‘Q’), then one might logically conclude that the irrelevant information has not been extracted or processed (‘P’). However, this would be a fallacious response, and is known as *affirmation of the consequent* (see Figure 22, column b). This is because although ‘P’ and ‘Q’ are related, there are also alternative explanations. In this regard, a better way to illustrate this is shown in column c of Figure 22.

P: The selection is efficient with regard to the irrelevant stimuli Q: The responses are indifferent to the irrelevant stimuli		
(a) Modus Tollendo Tollens	(b) Affirmation of the Consequent	(c) Alternative Explanations
$P \longrightarrow Q$ Q^- <hr style="border-top: 1px dashed black;"/> P^-	$P \longrightarrow Q$ Q <hr style="border-top: 1px dashed black;"/> P	$P \longrightarrow Q \text{ or } X$ P <hr style="border-top: 1px dashed black;"/> $Q \text{ or } X$

Figure 22. Diagram of the logical mode ‘Modus Tollendo Tollens’, the fallacious mode ‘Affirmation of the consequent’, and an alternative mode. Adapted from Botella (2000). Based on the proposition that ‘If p then q’, from which logically follows, ‘If q, then p’ and ‘If not q, then not p’.

One such alternative explanation relates not to whether the irrelevant information is extracted or not, but rather assuming that it is, the extent to which the individual can control its influence. In this regard, the finding that the relationship between performance and interference is not straightforward, but can be mediated by the extent to which an individual is able to strategically control their attention, illustrates this point. In this thesis, the strategic use of concurrent tasks characterises what is referred to as ‘proactive (dis)inhibition’, and is reported to be used to avoid cognisance of the food (that is, irrelevant information). Thus, in this case, irrelevant stimuli is extracted but it is the participant’s use of a proactive cognitive strategy that results in significantly less impairment compared to those who do not use such a strategy. Importantly, therefore, this thesis lends support to the argument that a null result may not necessarily reflect the absence of any influence of the irrelevant information, as is so often fallaciously concluded.

17.4. CONCLUSION AND FINAL REMARK

For many years, research has been preoccupied with the increasingly important need to understand the mechanisms that are involved in food choice and which govern the volume of food that is consumed. To date, the finding that food intake increases during meals eaten when distracted has been extensively documented. Despite this, little research has attempted to identify the nature of the potential mechanisms underlying this phenomenon. The aim of the research presented in this thesis was to address this theoretical weakness. By doing so, cognitive distraction has been identified as a powerful factor involved in the regulation of human eating behaviour and the way in which attention influences eating regulation has been specified. Specifically, this thesis has advanced knowledge in two particular areas. Firstly, in identifying that disinhibition (and inhibition) may involve the proactive allocation of attention, the assumption that eating regulation is a passive process has been challenged. Secondly, understanding of this phenomenon has been further expanded by the recognition that overeating when distracted may involve an attenuation of the rate at which shifts in the hedonic properties of a food occur, a possibility that has not been explored previously. Both of these findings offer a novel theoretical perspective on the nature of the processes involved in overeating. To move forward, research may now focus on exploring why distraction undermines recognition of the changing sensory properties of a food, and understanding the cognitive activity behind the strategic use of concurrent tasks in more detail. Future research may benefit from confirmation of the operation of these phenomena outside of the laboratory. Only once the interaction between the physiological, psychological, and environmental factors that influence food intake is understood will any success in the battle against obesity be won.

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APPENDIX A

The restraint scale of the Dutch Eating Behaviour Questionnaire (Van Strien et al., 1986).

When you have put on weight do you eat less than you usually do?	not relevant	never	seldom	sometimes	often	very often
Do you try to eat less at mealtimes than you would like to eat?		never	seldom	sometimes	often	very often
How often do you refuse food or drink offered to you because you are concerned about your weight?		never	seldom	sometimes	often	very often
Do you watch exactly what you eat?		never	seldom	sometimes	often	very often
Do you deliberately eat foods that are slimming?		never	seldom	sometimes	often	very often
When you have eaten too much, do you eat less than usual the following day?		never	seldom	sometimes	often	very often
Do you deliberately eat less in order not to become heavier?		never	seldom	sometimes	often	very often
How often do you try not to eat between meals because you are watching your weight?	not relevant	never	seldom	sometimes	often	very often
How often in the evenings do you try not to eat because you are watching your weight?	not relevant	never	seldom	sometimes	often	very often
Do you take your weight into account with what you eat?		never	seldom	sometimes	often	very often

APPENDIX B

The disinhibition scale of the Three Factor Eating Questionnaire (Stunkard & Messick, 1985).

1. When I smell a sizzling steak or see a juicy piece of meat, *or some other favourite food*, I find it very difficult to keep from eating, even if I have just finished a meal.
2. I usually eat too much at social occasions, like parties and picnics.
3. Sometimes things just taste so good that I keep on eating even when I am no longer hungry.
4. When I feel anxious I find myself eating.
5. Since my weight goes up and down I have gone on reducing diets more than once.
6. When I am with someone who is overeating I usually overeat too.
7. Sometimes when I start eating, I just can't seem to stop.
8. It is not difficult for me to leave something on my plate.
9. When I feel blue I often overeat.
10. My weight has hardly changed at all in the last ten years (*except for natural growth*).
11. When I feel lonely, I console myself by eating.
12. Without even thinking about it, I take a long time to eat.
13. While on a diet, if I eat a food that is not allowed I often then splurge and eat other high calorie foods.

14. Do you eat sensibly in front of others and splurge alone?

- | | | | |
|--------------|---------------|--------------|---------------|
| 1. | 2. | 3. | 4. |
| Never | Rarely | Often | Always |

15. Do you go on eating binges though you are not hungry?

- | | | | |
|--------------|---------------|------------------|-----------------------------|
| 1. | 2. | 3. | 4. |
| Never | Rarely | Sometimes | At least once a week |

16. To what extent does this statement describe your eating behavior?

"I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow."

- | | | | |
|--------------------|-----------------------|--------------------------|-------------------------------|
| 1. | 2. | 3. | 4. |
| Not like me | Little like me | Pretty good | Describes me perfectly |
| | | description of me | |

N.B. The text in italics was added by the experiment in order to further clarify the meaning of the question.

For items, 1-7, 9, 11, and 13, a score of 1 is allocated to all ‘true responses.

For items 8, 10, and 12, a score of 1 is allocated to all ‘false’ responses.

For items 14, 15, and 16, response options 1 and 2 score zero, while a score of 1 is allocated to response options 3 and 4.

APPENDIX C

HOW TO COMPLETE A RATING SCALE

Please read the following instructions carefully.

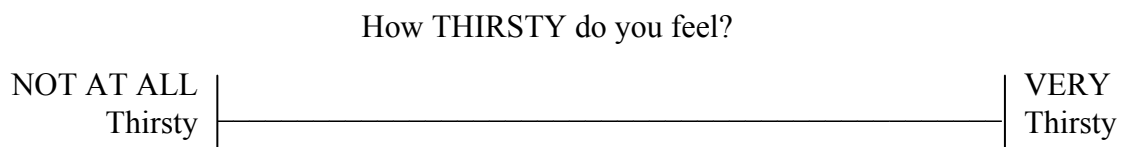
A rating scale consists of a line with two end-anchor points. The line represents a continuum of possibilities between these two statements. Above the line is a question.

When making a rating you should:

1. Read and think about the question.
2. Read and think about BOTH anchor points.
3. Think of the line as a continuum of possibilities between the anchor points.
4. Place a single vertical line on the rating scale. This should intersect the line at the point that relates your answer to the appropriate corresponding position on the line.

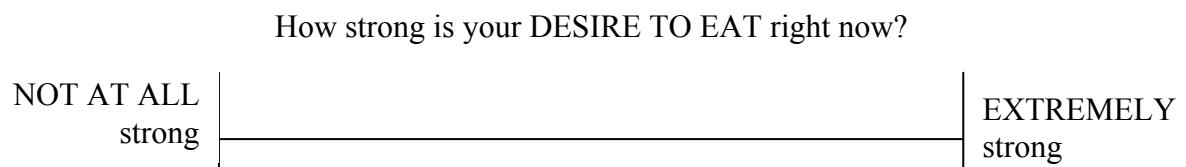
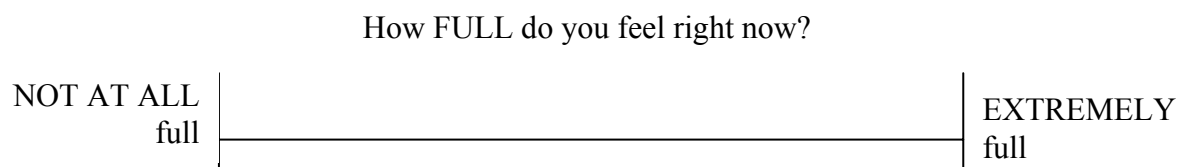
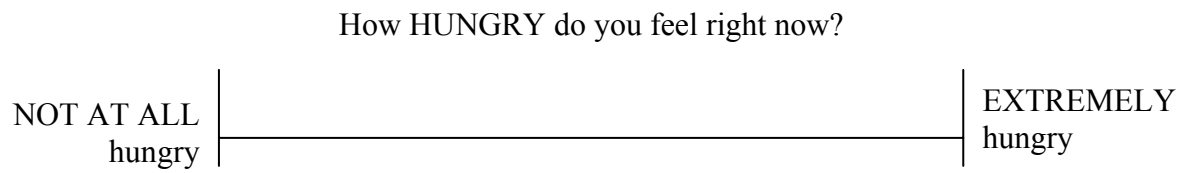
If you do not understand the question or labels then you must ask the experimenter for assistance.

Example:



APPENDIX D

Examples of the VAS rating scales used.



APPENDIX E

The word search task used in Experiment 3. The 20 target words are underlined. Target words were written either forwards or backwards, going either up or down, and in either a straight or diagonal line.

s a j u s x f g f x q o f e c s b x z y t y r u v
z r q q l j k n z l q f s r n l w w z n j d x p y
g c i j z o k i h t s w c o v v i w o h a v i i g
o h g k u r x l t y w h o k g s v m a a s t r a d
t e u q o r c c s t b k l o t s e s b r o w i n g
r r q t e k l y q i e j g n z d f c k i l l o w b
m y z y a m s c u r c v i i g t t l d i n f f v q
f e n c i n g v a l h x k x p k b e q o i g i x r
c z k u z s g h s l u g e n q m m d k n s n z y g
d v b a b i a y h d b o n a h j b y l c m d g t e
g n i x o b e f r h f e l u g p x p r i i c a r r
g a q w c k c u r i y d i q s k s a p u c r g q l
y n o j c k b o h u p x u w k x w w j t o g c z y
f r i o o o g q a z v n i j a d n c f l h q v w o
q r h v w n a d e u a m g g t m p q i x v t q i d
k i i l l i r c y l z c a d i b c p g h e z l r j
u a i c a d k u g b a i c l n k q z n n x x a x o
c n n i v r j b n f g w t x g s q b n l c v t x c
g a o m j i l l i t j u x m o j v i z n s n d q w
d t s m t d u r k a x v r r y s s t f s u h f b t
i m o t f i k c i v z m f p m s n e m p k f s g p
g a n u c m f j h h b a q y d c y q l k m s j d x
y l d p a w z w w q d p r p d z o c m s g m i i c
e u q l v f q z t v q r u s n r y v j q y o f e l
f f q u y x g b x v g e s i j j y p s v d e s x x