Episodic Memory and Food Choice

By

Eric Robinson

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ABSTRACT

This thesis examined the relationship between episodic memory of past eating experience and food choice. Studies in Chapter 2 show that recalling an episodic memory of enjoying eating vegetables increases predicted enjoyment of eating vegetables in the future and increases amount chosen. In Chapter 3 it is reported that increasing remembered enjoyment of a food results in a greater amount of that food chosen. In Chapter 4, after a disappointing experience with a food, liking was examined one day or one week later. Liking was reduced at one day, but not one week, suggesting that episodic memory influences liking when an experience has occurred recently. A second study showed that a disappointing experience influenced liking at one week, for only novel foods, suggesting that early experiences with food may be particularly important in shaping liking. The final chapter examined how episodic memory for enjoyment of an eating experience is formed. The final moments of a food item and most enjoyable item in a multi item meal predicted remembered enjoyment, although these effects were moderated by dietary restraint. It is argued episodic memory influences food choice and that manipulations to alter memory may provide a novel approach to influencing food choice.

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DISSEMINATION

The contents of this thesis have been presented at conferences for The British Feeding and Drinking Group (2009-2011), The Society for the Study of Ingestive Behaviour (2010), The Cognitive Section of the British Psychological Society (2010) and The Experimental Psychology Society (2010). Experimental work in peer reviewed publication form:

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Studies 4 and 5 from Chapter 3 are reported in:

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Studies 6 and 7 from Chapter 4 are reported in:

Robinson, E., Blisset, J., & Higgs, S. (2011). How good will the future be? Episodic and semantic memory influences on hedonic predictions and beliefs. *In prep for Journal of Experimental Psychology: General.*

Studies 8 and 9 from Chapter 5 are reported in:

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CHAPTER 1: GENERAL INTRODUCTION

1.1 Studying eating behaviour

The emergence of an international obesity problem and greater awareness of the importance of diet and weight status in wellbeing (Kopelman, 2007; Steinmetz & Potter, 1996) have led to increased interest in the factors that influence eating behaviour in both the media and academic study. There is likely to be significant health and economic benefits of greater understanding of the processes underlying eating behaviour (McCormick & Stone, 2007). These direct applications aside, eating behaviour also provides an interesting model with which to study human behaviour more broadly. The aim of this thesis is to add to the existing empirical research into the processes underlying eating behaviour, with an emphasis on examining how memory for past eating experiences informs food choice.

1.2 'Physiological' and 'external' influences

A significant proportion of research on eating behaviour has focused on physiological factors. A common notion is that we eat due to physiological need, such as hunger acting as a signal that we 'need more energy' or that our stomach is empty (Assanand, Pinel & Lehman, 1998). A number of early theoretical approaches to eating behaviour were somewhat similar, focusing on what can be viewed as physiological 'set-point' approaches; whereby hunger is experienced due to a signal originating from our digestive system, due to some form of depletion. For example, Cannon & Washburn (1912) suggested hunger is a signal to motivate eating, once the volume of food in the stomach has past a set point. Similarly, Mayer (1955) proposed a glucostatic theory of eating,

whereby hunger is signalled when glycogen stores are close to being used up and energy is depleted.

In line with this, brain regions involved in homeostatic like processes, such as the hypothalamus have been outlined to be extremely important in the regulation and control of eating behaviour (Elmquist, Elias & Saper, 1999; Meister, 2000). Early lesion studies that linked adiposity to impaired hypothalamic function in animal models suggested its likely importance (Hetherington & Ranson, 1942) and more recent work has continued to provide strong evidence for the role of physiological regulation of eating behaviours. In particular, the discovery of leptin and the inhibitory role it plays on food intake through its interaction with the hypothalamus has underlined the importance of an underlying physiological feedback system (Gautron & Elmquist, 2011; Mesiter, 2000). Acting as a marker of adiposity or 'energy need', imbalances of leptin levels have been shown to result in alteration to food intake (Friedman, 1998; Gautron & Elmquist, 2011).

Set point approaches are supported by findings that introduction of a high or low calorie diets can result in marked weight gain and loss, but once the diet is removed, individuals tend to return to their original weight status as a function of compensatory eating (Rosenbaum, Kissilef, Mayer, Hirsh & Leibel, 2010; Jequier, 2002). Indeed, the importance of physiological regulation is likely to explain 'yo-yo dieting', whereby individuals can lose weight due to caloric restriction, but overtime weight is regained, presumably because of physiological regulation (Rosenbaum et al. 2010).

Conversely, other recent research has started to outline a number of 'external' or 'environmental' factors that have been suggested to be influential on eating behaviours. The terminology 'external' influence has generally applied to aspects of the environment that change eating behaviour like food intake and choice (see Wansink, 2004). For example, portion and food packaging sizing have been shown to impact on energy intake (Rolls, Roe, Kral, Meengs & Wall, 2004;Wansink & Sobal, 2007), and atmospheric factors such as lighting and background music have also been suggested to change eating behaviour (Wansink; 2004; Milliman, 1986; North & Hargreaves, 1996).

Experimental studies also indicate that watching television whilst eating increases food intake (Blass, Anderson, Kirkorian, Pempek, Price & Koleini, 2006), which may have cumulative effects that increase weight gain and risk of obesity (Dietz & Gortmaker, 1985; Robinson, 2001). One explanation for these findings is that an aspect of our external environment (television) serves as a distraction from the amount of food being consumed, which results in over-eating.

The external social environment also appears to be of importance. Social facilitation of eating (the tendency to eat considerably more when in the company of others) is a robust phenomenon that has been reported across different meal types and contexts (De Castro, Brewer, Elmore & Orozco, 1990; De Castro & Brewer, 1992; Redd & De Castro, 1994). Furthermore, social modelling is a pervasive influence on eating behaviour. Participants commonly match the intake of a dining companion (normally a confederate of the researcher) (Herman, Roth & Polivy, 2003). These matching effects have also been shown to be moderated by social context and perceived similarity between eaters (Hermans,

Engels, Larsen & Herman, 2009; Hermans, Larsen, Herman & Engel, 2008). Moreover, social modelling effects have been shown to in some cases to over-ride physiological signals of hunger, since food deprived participants who been starved of food for 24 hours have been reported to eat only small amounts in the presence of others who are eating very little (Herman, Polivy, Kauffman & Roth, 2003).

The dichotomy behind terms such as 'physiological' and 'external' influences is arbitrary, as all actions require a nervous system and by default will have an underlying physiological basis. In line with this, some authors have argued that models and approaches incorporating both theoretical stances will be most fruitful if we are to further understand eating behaviour (de Castro & Plunkett, 2002; Speakman, 2004). What unites these different influences on eating behaviour is that both types of signal (whether physiological and 'internal', or environmental and 'external') are needed to be detected by the brain and then translated into a complex eating behaviour (Booth, 1994; 2008). For example, whether it is the detection of information from the stomach concerning increased food volume, or the detection of a visual cue from our environment that others around us are no longer eating, the brain is of course the crucial component in processing this information and bringing a period of food intake to an end.

1.3 Cognition

The importance of what can be conceptualised as 'higher level cognition' have been studied less frequently in relation to eating behaviour. Yet, sensory information coming from both the external and internal environment is likely to be processed or 'filtered' by brain regions responsible for high level cognition and processes (Booth, 2008). These

processes, such as conscious thought, memory and attention, originate in areas of brain such as the cerebral cortex. Thus, such mental processes or 'cognition', that can occur both before, during and after eating experiences are also likely to be important in explaining what, when and how much we eat (Booth, 1994; 2008). Moreover, a body of evidence showing the importance of cognition in eating behaviour has started to emerge and supports this premise.

1.4 Learning food likes and dislikes

As liking for food is thought to be a strong determinant of choice (de Graaf, Kramer, Meiselman, Lesher, Baker Fulco, Hirsh & Warber, 2005; Dinehart, Hayes, Bartoshuk, Lanier & Duff, 2006; Mustonen, Nissa, Houtilanien, Miettinen & Tuorilla, 2007), how we learn likes and dislikes is of obvious importance. Before discussing literature that suggests we posses some inherited influences on eating behaviour, the crucial role that learning and memory plays in eating behaviour will be outlined.

Although there is evidence that many food preferences are acquired, it is also the case that we are born with some innate taste preferences (Rozin & Zellner, 1985; Steiner, 1977). It has been observed that humans have an innate liking for sweet tastes and innate disliking for bitter tasting foods (Cowart, 1981; Rozin & Vollmecke, 1986). These preferences are proposed to be adaptive consequences of naturally occurring sweet tasting foods being rich in calorific content and the association between toxins and bitter taste (Steiner, 1977; Scott & Verhagen, 2000). Inherited genetic differences have also been suggested to have some capacity in explaining the wide variety in food intake and taste preference observed across populations (de Castro, 1993; Dinehart, Hayes, Bartoshuk, Lanier & Duffy, 2006).

The relative importance of genetic versus learnt influences on eating behaviour is debated. For instance, it has been suggested that learnt cultural and environmental influences may play a more significant role in shaping food preference and intake (Rozin & Vollmecke, 1986). Indeed, such conclusions have some backing in early twin studies that failed to find strong genetic influences on food selection (Krondl, Coleman, Wade & Miller, 1983; Rozin & Millman, 1987). More recent studies have found more evidence of genetic influences on food preferences (Breen, Plomin & Wardle, 2006; Keskitalo, Silventoinen, Tuorila, Perola, Pietiläinen, Rissanen & Kaprio, 2008). Although effects are modest, with a considerable amount of variance (well over 50% in Breen, Plomin & Wardle, 2006) attributed to our environment, suggesting the environment we learn in is also of high importance. Although there is some debate, these more recent results suggest that genetics and our environment are both likely to play important factors. In line with this, the interaction between gene and environment may be of significance in explaining eating behaviours and this premise has started to receive attention in the field (Campbell, Mill, Uher & Schmidt, 2010). I next discuss mechanisms by which individuals are likely to learn about food likes and dislikes from their environment.

There is evidence that early childhood experiences with flavours shapes later preference and liking. Mennella and Beauchamp (2002) reported that variations in the flavour of baby feeding formula influenced acceptance and liking for similarly flavoured foods several years later. Babies fed on sour flavoured formula showed a preference for apple juice in comparison to other babies, suggesting that exposure is important in the development of liking. 'Mere' exposure to flavours through repeated tasting of foods can increase

familiarity and acceptance (Birch, McPhee, Shoba, Pirok & Steinberg, 1987; Wardle, Herrera, Cooke & Gibson, 2003). In line with this, a recent large scale intervention study by Lakkakula**,** Geaghan, Zanovec, Pierce and Tuuri (2010) showed that repeated lunch time exposure to a variety of vegetables in US school children increased liking for the vegetables post intervention.

There is strong evidence that associative learning or 'conditioning' is of importance in the development of food liking. The classic Pavolvian conditioning experiments showed that learned associations can be made by repeatedly pairing a neutral stimulus with a response (Pavlov, 1927). It is thought that similar learning takes place when we ingest foods. In relation to food, associative learning is when an ingestion experience results in a specific cue in our environment (normally a sensory characteristic of the ingested food) to be learnt to be associated with a specific consequence of ingesting that food. Two examples of such associative learning are flavour-nutrient learning; the pairing of a novel flavour with the post ingestive consequences it has on our body, and flavour-flavour learning; the pairing of a novel flavour with a non novel flavour we already like or dislike (Gibson & Brunstrom, 2007).

Flavour nutrient learning has received particular attention (Sclafani, Rozin & Kalat, 1971). This effect has been shown in a number of studies by Birch and colleagues. For example, Birch, McPhee, Steinberg and Sullivan (1990) altered the caloric density of a novel flavoured drink and gave children repeated exposures of either a low or high calorie dense version. After several conditioning trials participants consuming the higher caloric dense drink showed a stronger liking of the flavour, which is likely to be due to a learnt

association between the flavour and post-ingestive reward of the energy dense food (Capaldi, 1996; Birch et al. 1990). Learnt post-ingestive consequences of food items are also proposed to play an important role in meal size and termination; commonly referred to as 'learned satiety' (Booth, 1985; Booth Lee & McAleavey, 1976).

Experiments by Gibson and Desmond (1999) and Gibson and Wardle (2001) provide further support for learning based on the post-ingestive qualities of food and suggest how such learning could moderate future food choices. Gibson and Desmond (1990) report a study in which over a two-week period participants were instructed to eat chocolate twice a day. In a 'hungry condition' participants ate the chocolate in a designated time slot that resulted in them being hungry prior to eating. In a 'satiated condition' participants instead ate the chocolate shortly after eating a meal, which resulted in these participants only consuming chocolate whilst fully satiated. One finding of the study was that consuming chocolate when hungry resulted in increased chocolate craving and intake after the training period, when hungry. Additionally, consuming the chocolate when satiated reduced cravings markedly, suggesting that the hunger state in which a energy rich food such as chocolate is eaten determines appetite for the food in the future (Gibson & Desmond, 1999).

A further similar study by Gibson and Wardle (2001) showed that repeated consumption of a low calorie dried fruit bar whilst hungry reduced later craving to eat the bar whilst hungry. Presumably because participants had learnt that the fruit bar was energy low and unlikely to diminish hunger. These finding appear to provide further support to the role of

post-ingestive consequences on learning and also imply that the nutritional state in which we eat foods will also modulate dietary learning.

A further learning mechanism that is thought to play a role in determining food preference is social learning. Individuals in a variety of species have a tendency to avoid approaching novel food stuffs (commonly referred to as food neophobia) and it is thought that this is adaptive as it reduces the likelihood of consuming toxins (Rozin, 1986; Galef, 1996). However, approach and subsequent acceptance of novel food types can be greatly enhanced through the process of social learning. Newly born rats tend to imitate the food selection of older rats in the near vicinity (Galef, 1992) and prefer flavours that they smell on other rats; suggesting the food is safe to eat (Galef, Whiskin, & Belavska, 1997). Thornton (2008) reported a controlled experimental study showing this effect in the wild. Watching a conspecific eating a novel food greatly increased the likelihood of meerkats later approaching and consuming the novel food. It appears that animals can learn whether foods are suitable to eat vicariously (Galef, 1996; Thornton, 2008).

A similar social learning process is thought to occur in humans, whereby watching another person eating a novel food increases the likelihood of choosing to eat the food (Harper & Saunders, 1975; Birch, 1980; Hendy & Raudenbush, 2000). A more recent study building on this work, by Addessi, Galloway, Visalberghi and Birch (2005) further supports the social learning hypothesis. Acceptance of a novel food (coloured semolina), was observed in children aged 2-5 years old; the time period in which neophobia is thought most pronounced. Children were offered semolina in the presence or absence of another person eating semolina. A further dimension of the experiment was that the other eater (the

'model') ate either the same or different coloured semolina to each child. Therefore, if social learning is of importance, it would be hypothesised that acceptance should be particularly pronounced when the food item being eaten by the model was the same as the food made available to the child. Results showed that acceptance of the semolina was greatest when the model was present and eating the same coloured food. This supports the social learning hypothesis as the effect was specific to the viewed food colour, suggesting that children were not merely increasing intake due to desires to affiliate or impress the model (Addessi et al. 2005).

These studies provide strong evidence for an important role of learning and memory in guiding eating behaviours. Although these studies use participants from 'normal' populations, the increasing awareness of the importance of learning and memory in eating behaviour has resulted in related theoretical interest and application to clinical populations. Jansen (1998) suggested a learning model of binge eating, whereby exposure to contexts associated with binge episodes results in a strong autonomic response (or 'craving') to repeat another binge episode. This model has been supported by findings from cue reactivity in restrained eaters and similar models of addiction (see Jansen, 1998; Federoff et al. 1997; Federoff et al. 2003). Jansen reported promising data from pilot interventions attempting to form new associations between binging cues and subsequent outcomes. In these studies binge eaters were encouraged to extinguish previously formed memory associations between the conditioned stimuli (such as the context in which an episode normally occurs) and the behavioural outcome (binging) through repeated exposure to binge 'cues' followed by no subsequent binging (Jansen, 1998).

Expectations

Cognitive expectations have also been shown to have marked effects on ingestive behaviour (Cardello & Sawyer, 1992; Turoilla, Deliza & Macfie, 1996). For example, Cardello and Sawyer (2002) showed how leading participants to believe that a pomegranate juice drink was particularly pleasant, resulted in greater liking for the product when it was consumed. A recent novel study by Yeomans, Chambers, Blumenthall and Blake (2008) highlights how expectations interact with eating experience. In a series of studies the authors report that liking of a novel food (smoked salmon ice cream) could either result in acceptance or strong dislike, depending on how the food had been labelled. This study showed that if labelling results in a marked contrast between expectations and actual sensory qualities, this can result in a negative taste response to the food (Yeomans et al. 2008; Lee, Frederick & Ariely, 2006).

Expectations about how 'filling' an ingested food will be (expected satiety) also influence eating behaviour via effects on portion size selection. Brunstrom and colleagues have shown that expected satiety predicts a large amount of variance in self-selected portion sizes (Brunstrom, Collingwood & Rogers, 2010). Furthermore, the same group have shown that directly manipulating beliefs about the satiating effects of a food impact on self reported hunger and fullness after consumption (Brunstrom, Brown, Hinton, Rogers & Faye, 2011).

Attitudes

Attitudes towards food, such as health concerns can predict food choice (Stafleu, de Graaf, van Staveren & Schroots, 1992; Conner & Armitage, 2003). Zandstra, de Graff and Van Staveren (2001) found that people who scored high on a general health interest questionnaire tended to consume less fat and more fruit and vegetables than participants expressing little interest in health. Furthermore, in a direct experimental test of these findings, Roininen and Tuorilla (1999) found that individuals with positive attitudes towards healthy eating were more likely to choose an apple than chocolate bar as a 'reward' for participation in a study.

A further attitudinal dimension that has been shown to influence eating behaviour is dietary restraint. Herman & Polivy (1980) introduced the term dietary restraint to describe individuals who commonly use self-imposed cognitive controls to suppress food intake and weight gain. A well replicated effect observed in relation to dietary restraint is that if attempts to restrain intake are thwarted then over-eating and binge like behaviour can occur. The most well known experimental effect is the pre-load effect, whereby participants are instructed to consume a high calorie food (a milkshake for example) and then asked to participate in a taste test of another high calorie food. Restrained eaters have been reported to consume significantly greater amounts of the taste test foods than non-restrained eaters after the preload and this has been argued to be because the pre-load breaches the restrained eater's dieting boundary and disinhibits cognitive control, (Polivy & Herman, 1984; Herman & Polivy, 1980; Polivy, Heatherton & Herman, 1988. See Lowe, 1995 for an alternative interpretation).

A number of studies also suggest that restrained eaters differ from unrestrained eaters outside of the laboratory in their everyday food choices. Moreira, De Almeida and Sampaio (2005) found restrained females tend to avoid energy dense foods like pastries, sugars and starchy foods when making everyday food choices. Furthermore, Tepper, Trail and Shaffer (1996) found a tendency for restrained eaters to consume fewer full fat dairy products, fats, oils and red meats than non restrained eaters. These and other findings suggest there is good evidence that cognitive constructs such as attitudes and beliefs inform food choice and intake. Although see Stice, Fisher and Lowe (2004) for further discussion.

Attention

Attention is another cognitive process that is suggested to influence eating behaviour. Attention to food stimuli is heightened by hunger (Channon & Hayward, 1990; Lavy & van den Hout, 1993) and this is a useful adaptation that may promote food intake. However, there is also some thought that increased attention and sensitivity to food cues paired with today's 'obesogenic environment' may promote overeating, (Berridge, 2009; Polivy, Herman & Coelho, 2008). We are exposed to highly palatable but unhealthy foods that are becoming increasingly advertised and visible. Work by Castellanos, Charboneay, Dietrich, Park, Bradley, Mogg (2009) implicates attentional bias in overeating. In this study, Castellanos et al. showed that eye fixation and viewing duration is enhanced towards food related pictures in obese individuals in comparison to normal weight controls.

A subsequent study by Nijs, Ingmar, Franken & Muris (2010) supports this premise. Based on their findings the authors concluded that the obese individuals in their study appeared to have an automatic processing bias towards food stimuli. Yet, disentangling a causal relationship between overeating and attentional biases is difficult. More concrete findings are required to confirm that attentional biases may be a cause of overeating. In support of this premise recent manipulations aimed to reduce or increase attention towards food have been shown to have effects on subsequent food intake (Wansink & Payne, 2009; Seage & Lee, 2010) and attentional bias has been shown to predict weight gain (Yokum, Ng & Stice, 2011).

1.5 Memory

There is strong evidence that cognitive factors are of importance in explaining eating behaviours such as food choice, intake and liking for foods. However, an important cognitive system that is likely to underlie and explain all of the aforementioned cognitive influences on eating behaviour is memory. Memory generally refers to the systems that enable prior experience and information associated with that experience to be processed and retrieved for the use of guiding present and/or future behaviour (Eysenck, 2001).

A growing literature suggests that memory is key to the development and regulation of eating behaviours, such as food preferences, eating patterns and regulation of intake (Rozin & Vollmekce, 1986; Rozin & Zellner, 1985; Gibson & Brunstrom, 2006). Indeed, memory is likely to be a key underlying mechanism behind the role that other cognitive influences have on eating behaviour. The expectations we develop concerning the hedonic experience or satiety that foods provide are thought to be learnt through experience (Rozin, 1986; Gibson & Brunstrom, 2006) and therefore are reliant on memory systems. Food

likes and dislikes are strongly influenced by the learned association between food flavours and positive or negative postingestive consequences (Gibson & Brunstrom, 2006; Sclafani, 1997). Similarly, increased attention to food cues when in a state of craving or hunger is likely to be the product of learnt associations between the ability of food to satisfy such needs.

Although the discussed literature on memory, learning and eating behaviour are likely to show diverse memory mechanisms and processes at work, the specific role that 'episodic memory' plays in eating behaviour has started to receive attention.

1.6 Episodic memory and eating behaviour

Episodic memory is defined as memory for specific past episodes or events that we have experienced (Wheeler, Stuss & Tulving, 1977). Episodic memories act as short records of sensory and affective qualities of past events and tend to be represented in the form of visual imagery. A key defining feature is that they are recollectively experienced when retrieved, enabling us to think about our personal experience of the event/memory in question (Conway, 2009; Tulving, 1985; 2002).

The relationship between episodic memory and appetite regulation was brought to attention with striking data from lesion studies reported first by Hebben, Corkin, Eichenbaum, and Shedlack (1985) and then later in a controlled experiment by Rozin, Dow, Moscovitch and Rajaram (1998). In Rozin et al. (1998) the patients studied suffered from profound amnesia and could not recall events that had taken place as recent as 2 minutes earlier. On several occasions the researchers served the two amnesic patients a

lunchtime meal and then 10 to 30 minutes later would serve another identical meal and again would serve a third identical meal 10 to 30 minutes after the second, unless a patient stopped eating or rejected a meal. Although matched controls tended to consume most of the first lunchtime meal they rejected the offer of a second identical meal. Conversely, the amnesic patients appeared to be unaware of the previously eaten (and identical) meals and continued to consume the majority of the second and third meals. One amnesic patient (R.H) consumed in excess of 1000 calories in two of the three sessions. Rozin and colleagues concluded that such findings show the importance of memory for recent eating experiences is likely to have strong bearing on decisions to start or finish eating a meal.

Yet, as the brain trauma that resulted in the two patients' amnesia was not controlled, there is the possibility that these findings may be due to other consequences of the trauma unrelated to memory. For example, Higgs, Williamson, Rotshtein & Humphreys (2008) provides one potential alternative explanation that the damage may have disrupted systems regulating the reward value of food. Such disruption could result in the amnesic patients over eating not because of failings in memory, but because of the food possessing an increased reward value in comparison to the control participants used in the experiment. However, Higgs et al. (2008) later replicated the effect of multiple meal eating in another group of amnesic patients and also showed that their sensory specific satiety was intact. Therefore, the observed multiple meal eating reported in Higgs et al. (2008) is highly unlikely to be explained by differences in sensory specific satiety between amnesic patients and controls.

Experimental research with neurologically intact participants has further underlined the likely influence episodic memories of recent eating experiences have on food intake. Across two studies Higgs (2002; 2008) showed that cueing participants to recall a recently eaten meal reduces the amount of food eaten (which was measured covertly). Interestingly, no such effect was observed when participants were cued to recall a meal eaten the previous day, which implies a reduction in intake is likely to be because of the recall of a recent memory. Higgs suggests that in these studies it would appear that previous meal information was being accessed through memory retrieval and then used to moderate food intake (Higgs, 2008).

These data provide evidence of a potentially important role for episodic memory in informing eating behaviour. Yet, a further study manipulating memory provides even more compelling evidence. Although the memory cueing effects reported by Higgs (2002, 2008) are suggestive that memory of recent intake is likely to guide intake, the experimental manipulation could be described as somewhat artificial. It is rare to explicitly recall a lunchtime meal prior to starting an afternoon snack. However, manipulating memory encoding of a recent meal and then examining how this may affect later intake (without cueing explicit recall) would provide a strong counter to any such arguments. Higgs & Woodward (2009) report such an experiment.

Participants either consumed a laboratory lunch whilst watching television or in its absence. The rationale behind this manipulation was for the television viewing to divert attention away from the food and for this disruption of attention to interrupt the encoding/formation of memory for the meal. In line with the existing literature the authors

hypothesised that this would result in an increase of food eaten in the later session and results confirmed this (Higgs & Woodward, 2009). Subsequent replication has confirmed the pattern of results (Oldham-Cooper, Hardman, Nicoll, Rogers, & Brunstrom, 2011). Furthermore, a corollary to this would be that enhancing memory of a recent eating experience should have the opposite effect and reduce intake. In support of this, recent data from the same laboratory examining the effects of enhancing attention towards a lunchtime meal appears to reduce afternoon intake (Higgs & Donohoe, 2011).

If episodic memory does play a significant role in regulating eating behaviour then perhaps one of the most stringent tests of this hypothesis would be to observe behavioural effects on eating behaviour as a result of acquiring a memory for a fictitious eating experience. Research utilising the false memory paradigm has attempted to show this effect. In such experiments participants are led to believe, through subtle suggestion or doctored information, that they had witnessed or were part of a specific event such as getting lost in the supermarket as a child, which did not actually occur (Loftus & Pickrell, 1995). Through implanting a positive childhood memory of enjoying eating asparagus, Laney, Bowman-Fowler, Nelson, Bernstein and Loftus (2008) found that acceptance of the new memory resulted in a greater reported liking and desire to eat asparagus. This effect was also observed 2 weeks after the original manipulation, with participants being more likely to choose to eat asparagus in a follow up session (Laney et al. 2008). Interestingly, these effects were specific to asparagus.

Additionally, Bernstein and Loftus (2009) reported that the acquisition of a negative false food memory results in a lower consumption and avoidance of the food. In this study

participants were led to believe that they had an aversive experience with egg salad when they were younger. Four months later participants attended a second session disguised as a food and beverage tasting study. Participants consumed significantly fewer egg salad sandwiches due to the memory manipulation. However, some caution should be taken in the interpretation of such findings as demand characteristics are typically high in false memory studies. Yet, the behavioural effects observed weeks and months later do appear to be in line with the studies reported by Higgs (2002; 2008; 2009), suggesting that episodic memory of previous eating experiences inform eating behaviour.

The discussed literature underlines the significance of memory in a variety of eating behaviours, including the regulation of dietary intake (Rozin et al., 1998; Higgs, 2005) and acquisition of flavour and taste preferences (Rozin & Zellner, 1988; Gibson & Brunstrom, 2005). Rozin & Vollmecke (1986) suggest that liking and enjoyment is likely to be the strongest predictor of variance in food preference within cultures and more recent data showing enjoyment predicts food choice adds support to this (de Graaf et al. 2005; Dinehart et al. 2006; Mustonen et al. 2007). However, how individuals come to form judgements of liking for food items, or predictions of how enjoyable food items will be has surprisingly received very little attention in the eating behaviour literature (Rode, Rozin & Durlach, 2007). The following sections examine how memory is likely to be key in explaining how enjoyment predicts food choice.

1.7 The relationship between experience, memory and choice

Kahneman (1994) and Kahneman, Walker and Sarin (1997) proposes that the relationship between experienced, remembered and expected enjoyment is complex. Kahneman argues

that how much an individual likes an experience and how enjoyable they believe it will be is based on past experience, but only in part. As our knowledge concerning past experiences are normally reliant on memory, when individuals make judgements concerning how much they like a food item, or enjoyed eating it previously, they are doing so using a form of 'proxy' measure in the form of memory (Kahneman, 1994). This idea of memory only being a 'proxy' has been underlined by the work of cognitive psychologists that has shown that memory and actual 'online' experience share similarities, but importantly are distinct (these differences will be discussed in further detail shortly). Therefore, a simplified model of this relationship is as follows;

Experienced enjoyment ⟶ *Remembered Enjoyment* ⟶ *Expected Enjoyment*

Thus, in the case of judging whether or not a food item will be enjoyable, the judgement is only in part based on actual experience. It is remembered enjoyment that shapes expected enjoyment over and above experienced enjoyment because people normally rely on memory when making judgements concerning enjoyment (Kahneman, 1994; Wirtz, Kruger, Napa-Scollon, & Diener, 2003). Support for this idea has been provided from research in other areas of psychology that have demonstrated that memory influences predictions of how enjoyable an experience will be.

The relationship between experienced, remembered and expected enjoyment has received a significant amount of attention of late (Schachter, Addis & Buckner, 2007; Gilbert & Wilson, 2007). When individuals think about how enjoyable an event will be (i.e. how enjoyable will eating that packet of crisps be?) they are partaking in what has been called

‘mental time travel’ (Schachter et al. 2007) or ‘prospection’ (Gilbert & Wilson, 2007). It is proposed that to imagine how enjoyable an event will be, individuals create simulations or mental previews of the future event. Based on the feelings that the mental stimulation evokes (e.g. will this be a positive or negative experience?), individuals then choose to experience the previewed event or not (Gilbert, Gill & Wilson, 2002). How these mental simulations are constructed is of interest. There is increasing evidence that they are strongly reliant on memory for similar past experiences.

In a study reported by Morewedge, Gilbert and Wilson (2007) researchers approached participants prior to an American football game and asked them to predict how enjoyable the game would be. Prior to making the predictions, the researchers either cued participants to recall ‘any’ previous football match they had attended or to recall several football matches. When recalling only one football match, the participants tended to produce extremely positive forecasts of enjoyment for the football match they would shortly watch. However, after recalling several football matches, the forecasts of enjoyment were more conservative. More conservative predictions of enjoyment as a result of multiple memory recalls was suggested to be because the participants were using the differing affective valence of the multiple memories to shape their mental ‘preview’ of enjoyment.

Conversely, it was argued that in the ‘any’ recall condition participants were basing their predictions on the memory that sprung to mind first, which happened to be an extremely positive one (Morewedge et al., 2007). These findings were also replicated when participants were asked to predict how enjoyable a negative experience would be.

Commuters at a train station were asked to predict how bad missing their train would be. Those participants that had been instructed to recall several occasions on which they had missed a train produced less extreme predictions than commuters who were not explicitly asked to recall any memory prior to prediction.

A study by Wirtz et al. (2003) supports the premise that memory guides expected enjoyment. Participants were contacted at random intervals during their spring break vacation and asked to rate their current enjoyment of the holiday using handheld data recording devices. Two weeks after the vacation, participants returned to the laboratory and rated how enjoyable they thought the vacation was and finally rated their desire to repeat the experience. Path analysis revealed that it was remembered enjoyment of the holiday and not actual experienced enjoyment of the holiday that accounted for a significantly large amount of variance in future intentions. Another study involved manipulating participants' remembered enjoyment of an experimental session that involved talking about safe sex (Hodges, Klaaren & Heatle, 2000). The authors reported that increasing participants' remembered enjoyment of the session by implying that other had found the session rewarding resulted in an increase in reported intentions of returning for a later session (Hodges et al. 2000).

Schachter and Addis (2007) argue that one of the key functions of episodic memory may be to construct mental previews or 'simulations' and similar notions have been forwarded by other laboratories in recent times (Tulving, 2002; Conway, 2009).Consistent with the idea that memory and future thinking are intrinsically linked, Schachter and Addis (2007) report cognitive and neurological data showing substantial overlap between recalling

episodic memories and mental previewing. Observations from neurological patients further support this premise. Individuals that have suffered from episodic-like amnesia have also reported a failing in the ability to mentally preview and simulate future alternatives. For example, Tulving (2002), reports a patient (KC) that suffered from complete loss of episodic memory (due to severe trauma) and that was also completely unable to think about and imagine what future experiences he may encounter would be like.

It would therefore appear that there is a strong body of evidence that underlines the significant role memory plays in decision making. To decide whether an experience will be pleasant we have to anticipate how enjoyable that experience will be, and such anticipation or 'simulation' is strongly based on our memory of similar past experiences. Theoretically this should also be likely to be the case with food choice. As enjoyment strongly predicts food choice, individuals are choosing to eat foods they predict they will find enjoyable. In turn, they are likely to be basing these choices on how enjoyable they remember the food to have been. Indeed, anecdotes of why an individual avoids brussel sprouts are normally accompanied by vivid details from a memory of them tasting foul during a Christmas dinner! (Manning, 2009).

Memory is Distinct from Experience

A question that is raised by these considerations of the role that memory plays in decision making is whether we need to directly study memory? Online enjoyment ratings of food (measurements of enjoyment as the individual eats the food) have been shown to be a predictor of future choice (Mustonen et al. 2007; Dinehart, 2006). Yet, although online enjoyment and remembered enjoyment of experiences are likely to be related (Kahneman,

2004; Ariely & Carmon, 2000), a large body of research shows us that actual experience and memory for that experience are distinct and often different; so much so that it has been questioned whether a fully accurate memory for an event can actually exist (Mazzoni, 2002).

The idea that memories are not perfect records of actual events is not a new one. Over eighty years ago, Bartlett's identification of the inaccuracies of memory in his infamous 'War of the Ghosts' study (Bartlett, 1932) underlined the distinction between actuality and recollection of the past. An overwhelming amount of evidence has since shown that memory fades over time and by its nature only stores a limited amount of information concerning past events (Ebbinghaus, 1885; Hyman & Loftus, 2008). Memory is also thought to be a reconstructive process that can be prone to naturally occurring biases (Bartlett, 1932), distortions (Loftus, 1992) and forgetting (Ebbinghaus, 1885). Moreover, individuals can acquire completely false memories of events that never took place (Loftus & Pickrell, 1994).

A variety of systematic factors have been shown to act on memory to create discrepancies. McDonald and Hirt (1997) report a series of studies that show how expectation influences memory. The researchers examined how memory for a fictional student's academic achievement (in the form of grades) could be biased by expectations of whether the student improved over time. When led to believe the student would improve, participants remembered the initial grades to be lower than they were. This effect presumably occurred in order to confirm their expectations of academic improvement (Mcdonald & Hirt, 1997).

Biased memory retrieval has also been reported extensively. Kunda and Sanitioso (1989) manipulated some participants to believe that introversion made academic success more likely and others that extraversion was important in academic success. Participants subsequent memories of extroverted or introverted behaviour depended on whether they had been informed the personality trait was related to academic success.

There is also good reason to believe that episodic memory is often discrepant from actual experience. Parts of past experiences fade and become harder to retrieve from memory, leaving us with a limited number of easily retrievable memories of the experience (Conway, 2009; Robinson & Clore, 2002). An analogy of this is attempting to make sense of a jigsaw picture with only a small proportion of the individual pieces. Because we have to reconstruct past events with limited information these constructions from memory can become inaccurate.

Wirtz et al. (2003) showed that remembered enjoyment of a holiday that had occurred 2 weeks earlier was discrepant from actual experienced enjoyment, as participants tended to recall the holiday as being more enjoyable than it actually was. Such discrepancies in remembered enjoyment can also occur in much shorter time frames between experienced enjoyment and remembered enjoyment. Research by Ariely and Zauberman (2000) indicates that even when judgements of overall enjoyment are made minutes after the end of an experience there can be discrepancies between experienced enjoyment and remembered enjoyment.

Although the existing literature is small there is some evidence that similar episodic memory discrepancies occur in relation to eating experiences. Armstrong, MacDonald, Booth, Platts, Knibb and Booth (2000) show that memory for past eating experiences diminishes rapidly with time. These authors reported that as time passed, the number of foods that were correctly remembered to have eaten declined and false memory intrusions occurred, with participants becoming confused between the usual contents of their diet and what was actually eaten. Moreover, Jezior, Lesher and Popper (1990) carried out a large scale study examining whether retrospective ratings of US army rations were representative of actual enjoyment ratings made shortly after consuming the meal. The two types of ratings were correlated, yet retrospective ratings tended to be lower than ratings made shortly afterwards. In addition, discrepancies between actual and ratings made in retrospect were much larger when the food eaten was disliked.

Discrepancy between online and memory for the sensory characteristics of foods have also been reported. Laureati, Pagliarini, Mojet and Koster (2011) have previously reported results suggesting that participants were poor at recognising previously consumed samples of biscuits and fruit juice. Mojet and Koster (2005) show that although participants have good recognition for some samples of food they have tasted previously, memory for perceived fat content was poor (Mojet & Koster, 2005). In support of these findings, a study by Laureati et al. (2008) tested absolute (is this the sample you ate?) and relative (is this different to the food you ate?) memory of foods consumed in a lab setting 24 hours previously and found across both measures memory for a sweet dessert to be very poor.

Finally, in a currently unpublished research report, Zandstra, Hauer and Weegels (2010) reported a discrepancy between actual liking and remembered liking. Participants consumed a composite meal and then made retrospective ratings at differing time intervals. The data suggested that remembered enjoyment was discrepant from actual enjoyment at both two days and one week after the original meal. Although there are a limited number of studies examining episodic memory for past eating experience they do convey that, as is the case with other types of experience, discrepancies occur between actual and remembered experience. There is therefore good reason to study remembered enjoyment of eating experiences rather than purely experienced enjoyment, as it is memory that is more predictive of future behaviour (Kahneman, 1997; Wirtz et al. 2003).

The Relationship between experienced and remembered enjoyment

To understand the relationship between experienced and remembered enjoyment it is important to examine how memories of enjoyment are formed. A rational approach would be some form of averaging heuristic, whereby each part of an experience is weighted into its overall evaluation. Yet, research implies that this strategy is not common. Instead, there is growing consensus that people rely on a limited number of characteristics of an experience when making global evaluations of enjoyment. Why this is the case is unclear, although there is some suggestion that for ease and speed of processing, sampling a select number of snap shots is adaptive (Ariely & Carmon, 2000). It has been suggested that the hedonic profile of an experience; how the intensity of an experience changes over its course, is important factor that influence remembered enjoyment. Ariely (1998) reported that sequences that have a steady improvement in hedonic experience over time are

remembered as less painful than the exact same sequence but in reverse (steady decline in hedonic experience over time).

The final few moments of an experience have been shown to also have a disproportionately large influence on remembered enjoyment (Kahneman et al. 1993). In an influential study, participants were exposed to two unpleasant experiences. In one they immersed their hand in cold water (14 degrees Celsius) for 60 seconds and in the second they immersed their hand in 14 degree Celsius water for 60 seconds but kept their hand n the water for a further 30 seconds with the temperature being slightly raised (15 degrees Celsius). The final 30 seconds in the second condition were still rated as painful, but slightly less painful than the initial 60 seconds. The addition of the slightly less painful 30 seconds produced a less aversive memory of the overall trial (in comparison to the other trial). Participants were then asked to choose which of the two trials they would repeat. Although the second trial resulted in experiencing more pain overall than the first, participants tended to choose to repeat it because they were reliant on their (unrepresentative) memory when simulating how painful repeating the experience would be (Kahneman et al. 1993).

A follow up study that involved a large scale randomised trial by Redlemeier, Katz and Kahneman (2003) revealed that the addition of a less painful end to an experience can have long lasting behavioural effects. The researchers randomly assigned patients undergoing colonoscopy to one of two conditions. In the first condition, participants experienced the usual procedure for colonoscopy and in the second condition participants had a short interval added to the end of their procedure in which the tip of the surgical instrument was

left in the rectum. This manipulation was used in order to ensure the final few moments of the experience were less painful. As hypothesised, the group that had experienced a slightly less painful final few moments of the experience rated the overall experience as being less painful than the control group. Additionally, in comparison to the control group the less painful ending group ranked the procedure as less painful than a number of other unpleasant experiences. Patients who received the procedure with the less painful ending were also more likely to return for a repeat colonoscopy several years later (Redlemeier et al. 2003).Thus, the final few moments of the procedure had a disproportionately large influence on participant memory and future behaviour.

There is also a small amount of evidence that the first few moments of an experience (a 'primacy effect') can influence overall memory. Weinstein and Roediger (2010) provide evidence of a retrospective bias in test performance. When questions were ordered so that the easiest were at the start of a test, participants remembered they had answered more questions correctly overall in the test. In addition, Montgomery and Unnava (2009) showed that 2 weeks after listening to a CD, participants were more willing to pay a large amount of money for that CD if the most enjoyable tracks came early in the experience rather than at the end of the experience.

The 'peak' intensity (the least or most liked moment) of an experience has also been shown to have a disproportionately large effect on memory. Redelmeier and Kahneman (1996) recorded patient online experience of pain during colonoscopy and lithotripsy surgery and then asked patients to recall remembered pain one month and one year after the surgery. Analysis indicated that patient memory for overall experienced pain was

disproportionately influenced by the most painful moment in the experience at both one month and one year after the surgery. This 'peak' effect has also been replicated in studies examining memories of positive affect experiences. Rozin and Goldberg (2004) measured participant online enjoyment whilst listening to pieces of music and then examined remembered enjoyment. Peak intensity (the most enjoyable moment in the experience) was shown to have a disproportionately strong bearing on overall remembered enjoyment.

The relationship between actual and remembered enjoyment also appears to be reliant on perception of the cohesiveness of an experience. Ariely and Zauberman (2000) argue that if we perceive an experience to be composed or divided into multiple parts we are more likely to average across these parts when making global retrospective ratings. These claims are supported by a series of studies by Ariely and Zauberman (2003). Participants experienced either an improving or declining sequence over time and were then asked to make a retrospective overall judgement. However, an experimental manipulation was used to create regular partitions, resulting in the experience to be perceived as being divided into 3 or 4 separate parts for some participants. When the sequences were perceived as divided, participants were less reliant on the trend of the profile and more likely to average across the separate sections. Although one might predict that this would result in a far more accurate calculation of overall remembered enjoyment, the authors also report that the individual sections are still evaluated in a Gestalt manner. Thus, although participants average across evaluations of 3 or 4 separate sections of the experience, these individual sections are still likely to be influenced by the trend of the profile, peak or final few moments within the section (Ariely & Zauberman, 2003).

The effect of partitioning on overall memory may be of particular importance when considering how individuals form memories of previous eating experiences. Although a number of eating events can be classified as singular or separate experiences (e.g. a packet of crisps or bowl of soup) many involve multiple components, such as the traditional 3 course meal or a composite meal with distinct sub sections on one plate (e.g. meat, carbohydrates, vegetables).

The concept of 'duration neglect'; the tendency to give relatively little weighting to the duration of an experience when evaluating how aversive or painful it was, has also received attention in the literature. Frederickson and Kahneman (1993) suggest that because retrospective evaluations are so strongly determined by 'snapshots' of key moments (i.e. end or peak effects) individuals appear to make memory evaluations almost devoid of duration. Such strong claims have received objection, but there is now some consensus that because of the strong effects of certain moments of an experience, duration is often weighted disproportionately small in memory (Ariely, Lowenstein & Kahneman, 2000). Taken together this literature reinforces the difference between experienced and remembered enjoyment and starts to raise some interesting questions about how memories of past eating experience are formed.

Until now, only one study has examined how individuals form memories for how enjoyable food items or meals are. Rode, Rozin and Durlach (2007) report three studies and conclude that they could not find any evidence of recency, end or peak effects acting on memory. Despite this, the there were a number of methodological and associated problems that may have affected results (which will be addressed in detail in the

introduction to Chapter 5) and the paper largely consisted of a number of null findings. The researchers did not take into account individual differences likely to mediate eating behaviour and most of the research was field based and lacked experimental control. The relationship between experienced and remembered enjoyment of eating experiences is still relatively unknown and worthy of investigation for two main reasons: the available literature suggests that episodic memory may be important in food choice and there is little research examining how individuals form episodic memory for enjoyment of an eating experience.

1.8 Thesis aims

This thesis consists of four experimental chapters. The literature to date shows that learning and memory processes play an important role in regulating aspects of eating behaviour. Of late, a particular interest in episodic memory has emerged and it has been shown to be implicated in the regulation of food intake (Higgs; 2002; Higgs 2008). Yet, the relationship between episodic memory and food choice has received little attention. Based on the observation that enjoyment is a strong predictor of food choice (Rozin, 1986) and choice behaviours are reliant on episodic memory (and not actual experience) of past similar experiences (Gilbert & Wilson, 2007), the relationship is likely to be an important one. This thesis starts to address some of the questions concerning experienced enjoyment, remembered enjoyment and food choice.

Chapter 2 investigates the relationship between memories of past eating experience and food choices for a specific type of food. Accumulating literature underlines that there is good reason to believe that, as with many behaviours, when individuals are considering

food choices they may use episodic memories of past experiences to forecast how enjoyable eating the food would be. Three studies are designed to examine individuals' memories of past enjoyment for a food and whether cueing explicit recall of such memories impacts on expected enjoyment and food choice.

Chapter 3 examines whether remembered enjoyment of a previous eating experience can be manipulated and whether such changes have behavioural consequences. If episodic memory for enjoyment is an important factor in food choice then it would be expected that manipulations to increase or decrease remembered enjoyment should alter future food choice. Two studies reported in Chapter 3 examine the effects of episodic memory on food choice (after having manipulated remembered enjoyment) without cueing explicit recall of a memory.

Chapter 4 reports a further test of the hypothesis that episodic memory informs food choice and also examines whether the effect of episodic memory on food choice differs as a function of time. A test of whether episodic memory is likely to influence food choice would be to examine whether a negative experience with a food influences beliefs about how much one likes to eat that food. Furthermore, whether such an effect would last hours, days or weeks is another intriguing question. Two studies reported in Chapter 4 test these propositions.

Finally, Chapter 5 examines how individuals form memories of past eating experiences. Evidence suggests that Gestalt characteristics such as the first few moments, final few moments and most intense moments of an experience shape overall memory for that

experience. Until now only one paper has examined how individuals form hedonic food memories (Rode et al. 2007). Yet, as discussed, these studies suffered from methodological issues. These methodological problems are addressed and two studies that examined the relationship between experienced and remembered enjoyment are reported.

In summary, the main aim of this thesis is to examine the relationship between episodic memory and food choice. Additional aims are to investigate; how individuals form episodic memories for enjoyment of food and under what conditions episodic memory may be particularly important in shaping behaviour.

CHAPTER 2: THE RELATIONSHIP BETWEEN EPISODIC MEMORY OF EATING EXPERIENCE AND FOOD CHOICE

2.1 INTRODUCTION

The studies presented in this chapter investigated the relationship between episodic memory and food choice for a specific food type (vegetables). As episodic memory is thought to have an influence on decision making (Gilbert & Wilson, 2007) and has been shown to be an important influence on food intake (Higgs, 2005), the studies in Chapter 2 were designed to examine the effects of recall of episodic memory on food choice. If episodic memory influences food choice, several hypotheses can be made. It can be hypothesised that the hedonic content of episodic memory for eating vegetables may be associated with intake of vegetables; individuals with more positive memories of eating vegetables should be more likely to choose to eat vegetables on a regular basis. A further hypothesis is that recalling a positive episodic memory of eating a food may influence individual's food choices in relation to that food.

Study 1 examined hedonic content (or 'remembered enjoyment') of episodic memory for eating vegetables and how this relates to usual intake. Study 2 examined the effect of recalling episodic memories on predicted enjoyment of eating the food and whether this leads individuals to believe they would be more likely to choose to eat the food in the future. Study 3 directly examined whether recall of a memory of eating vegetables altered food choice.

To investigate the influence of episodic memory on food choice the first study was designed to examine hedonic memories of eating vegetables. Epidemiological research has demonstrated the potential health protective effects of vegetables. There is evidence that individuals who consume a greater amount of vegetables than the national average consumption have reduced risk of developing cancer (Steinmetz & Potter, 1996), cardiovascular diseases (Ness & Powles, 1997), ischemic stroke (Kaumudi, Joshipura, Ascherio & Manson, 1999) and hypertension (Van Duyn & Pivonka, 2000), compared with individuals consuming less than the national average. Furthermore, due to their relatively low caloric content, substitution of vegetables into the diet should also have benefits in weight control (Rolls et al. 2005).

Such findings have resulted in the government releasing a public health recommendation to consume at least 5 portions of fruit and vegetables a day; 3 of which should be derived from vegetables (D.o.H, 2009). However, intake of vegetables in the UK is variable, with a significant proportion of individuals failing to consume the recommended amounts (Ministry of Agriculture, Fishers & Food, 1999; D.o.H, 2009). Similar patterns have also been identified internationally (Thompson, Demark-Wahnefried, Taylor, McCelland, Starles & Havas, 1999). It therefore appears that understanding food choice in relation to vegetable intake could be beneficial.

Enjoyment of vegetables has also previously been shown to predict intake. For example, Dinehart et al. (2006) found that enjoyment of sampled vegetables in the laboratory predicted average number of consumed vegetables per day. In reviewing the literature examining predictors of vegetable intake, Pollard, Greenwood, Kirk and Cade (2001) also

report higher liking of vegetables consistently indicates higher consumption. Finally, focus group interviews reported by Brug, Lechner and Vries (1995) suggest that individuals value liking and enjoyment as essential prerequisites in their choices regarding vegetable consumption.

When we make decisions, we rely on our memory for how enjoyable an experience was rather than 'actual' enjoyment (Kahneman, 1994). Thus, when studies show that self reported enjoyment predicts intake of vegetables, it is likely that it is memory for enjoyment of vegetables that is the underlying determinant. Hence, it was decided that examining the relationship between remembered enjoyment of past eating experience and food choice using vegetables was an appropriate approach for the three studies reported in the present chapter.

2.2 STUDY 1: EATING VEGETABLES: HEDONIC CONTENT OF EPISODIC MEMORIES

2.2.1 Introduction

To investigate the hedonic content of episodic memories of vegetable consumption, the present study examined remembered enjoyment of individual's memories of past eating experience with vegetables. Participants were asked to recall an instance in which they had eaten a serving of vegetables (free recall) and then asked rate how enjoyable the experience was. It was hypothesised that individuals would be able to recall instances of vegetable eating as it has been previously noted that individuals have access to many episodic memories of past experience (Conway, 2009; Robinson & Clore, 2002).

There is evidence suggesting that episodic memory retrieval can be biased. For example, it has been shown that individuals are likely to recall atypical experiences (Morewedge et al. 2005). Morewedge et al. (2003) reported that when asked to recall any occasion in which they missed a train, participants tended to recall an occasion that was strikingly similar (in hedonic content) to participants who were asked to recall the worst ever occasion in which they missed a train. The interpretation of these findings was that individuals are more likely to recall an atypical memory of a past experience (i.e. the best or worst experiences) as these experiences are more memorable. Therefore, to further understand the content of episodic memories of eating vegetables, participants in the present study also recalled the worst and best ever servings of vegetables. These measures were included to examine how the hedonic content of any previous memory may be related to worst or best ever experiences.

Based on the notion that memory is important in decision making, it was hypothesised that habitual intake of vegetables may be related to the hedonic content of vegetable eating memories. For example, individuals with more positive memories of eating vegetables may be more likely to consume vegetables as they would use such memories when forecasting how enjoyable eating a serving would be (Wirtz et al. 2005; Morewedge et al. 2003). Therefore, a measure of usual vegetable intake was included in the present study.

To provide an estimate of usual vegetable consumption a dietary recall measure was developed. Food frequency questionnaires (FFQ) are often used in estimations of food choice (Bingham et al. 1997). Although FFQs are widely used they possess flaws. It has been proposed that such measures can be prone to reporting errors (Fowke et al., 2005). Kristal, Peters and Potters (2005) argue that when completing FFQs individuals may report beliefs concerning their usual diet rather than a systematic assessment of what has actually been consumed. This may be particularly relevant as FFQs commonly ask participants to estimate usual consumption of foods over a year long period, meaning that some error is almost unavoidable (Armstrong et al., 2000).

Thus, in order to provide a more accurate account of dietary behaviour, some researchers have utilised 24 hour dietary recall measures. Although 24 hour recalls are also retrospective, research indicates that recall over this time period tends to be more accurate, with few recall errors than recall over longer periods (Armstrong et al. 2000). For the present study, a simple 24 hour recall measure was devised ('Episodic Recall Measure').

2.2.2 Method

Participants

Fifty four participants were recruited using the University of Birmingham's online research participation scheme, whereby psychology students participate in exchange for course credit. The study was advertised as a 'questionnaire based study on food' and on recruitment participants were instructed not to eat one hour prior to the study. Participants gave informed signed consent and the study protocol was approved by the University of Birmingham Research Ethics Committee. All subsequent studies were also approved by the same committee. The sample consisted of 38 females and 16 males with an average age of 22.0 years (s.d = 2.9).

Episodic Recall Measure

Participants were asked (starting from waking) to recall all eating episodes for the previous day. The instructions were as follows; *"In this section you are asked to remember each eating episode (each time you ate) yesterday, from waking up to going to sleep. An eating episode includes any food eaten, which includes small snacks and main meals. You are instructed to try and mentally re-visit each eating episode in order, by starting with waking up and working your way through the day and provide as much detail as possible. Please include all food items consumed during each episode. Under the heading 'Portion size' please estimate the amount of each food eaten in the episode."*

Participants were then provided with 6 boxes in which to enter information concerning eating episodes during the previous day. The prompts were as follows; *"What time did you eat? Where did you eat? What did you eat? Portion size".* We instructed participants to

recall all types of food eaten to ensure that any meals containing vegetables were not excluded from the recall. To assess intake of vegetables, each time a participant recalled eating a portion of vegetables, this was classed as one portion.

The Three-Factor Eating Questionnaire (TFEQ)

To assess cognitive restraint of the sample, the cognitive restraint scale of the Three Factor Eating Questionnaire (TFEQ) was used (Stunkard & Messick, 1985). The restraint scale of TFEQ is a commonly used questionnaire scale that uses 21 true/false responses to assess the extent to which individuals consciously attempt to limit the number of calories in their diet (i.e. "I enjoy eating too much to spoil it by counting calories or watching my weight'). The scale results in a score between 0-21 (higher score denoting higher restraint) and has been shown to possess good validity, internal consistency and test–retest reliability; 0.90 (Stunkard & Messick, 1985). As previous studies have shown highly restrained samples to consume different food items to normal levels of restraint (Moreira et al. 2005), the measure was included to assess the samples degree of restraint.

Procedure

Participants were greeted and shown to a testing cubicle. After gaining informed consent and completing demographic measures for gender and age, participants were provided with questionnaire pack 1 and left to complete it alone. Questionnaire pack 1 consisted of the vegetable memory recall questions. Question 1; participants were asked *to "describe an instance in which you ate a serving of vegetables and rate how much you liked eating the vegetable serving"* on a 10cm visual analogue scale (V.A.S), anchors, from left to right: strongly disliked and strongly liked. Question two; participants then completed a

filler question – *"describe an instance in which you ate a serving of pasta, rice or potato and rate how much you liked the serving"* using the same scale as in question 1. The filler question was included to reduce the effect of responses to question 1 influencing questions 3 and 4. For questions 3 and questions 4 participants were instructed to describe *"the most enjoyable"* and *"least enjoyable"* instances in which they ate a serving of vegetables and rate for liking (using the same scale as in Question 1 and 2). To control for any order effects question 3 and question 4 were counterbalanced.

After completing questionnaire pack 1, the experimenter returned and gave participants the Episodic Recall measure and cognitive restraint scale of the TFEQ to complete. On completion, the experimenter then measured weight and height to calculate BMI; [weight (kg) divided by height (metres)^2]. Weight was measured using a set of digital electronic scales (accurate to 0.1 kg) and height was measured using a stadiometer. Participants were then thanked for their time and debriefed concerning the aims of the research. As the main aims of the study were not covert (the hedonic content of memory for past eating experience), participants were not asked to guess the aims of the study.

Scoring Visual Analogue Scales (V.A.S)

As in all other studies in this thesis, visual analogue ratings were obtained by measuring the distance in cm from the left extremity of the line to where the participants had marked their response with an 'x' (resulting in a score ranging from 0.0 – 10.0)

2.2.3 Analysis

To examine differences between the hedonic content of the three vegetable memories recalled, paired sample t-tests were used. The relationships between rated enjoyment when asked to recall any vegetable serving and enjoyment of the most enjoyable, least enjoyable vegetable experiences and filler question (carbohydrate) was assessed using Pearson correlation coefficients.

2.2.4 Results

Sample characteristics

BMI for the sample was within the normal range, with a mean = 22.9 and s.d. = 3.1. Restraint scores (mean = 9.0, s.d = 5.8) were within normal range (previous studies suggest that a score between 8 and 12 on the TFEQ are normal for university students; (McLean & Barr, 2003). Participants consumed , on average, 2.2 portions of vegetables during the previous day (s.d = 1.3).

Type of recalled vegetable memories

46 participants (85%) recalled the context in which their eating experience occurred (e.g. 'I ate them for dinner last night'). Forty three participants (80%) provided information that was event specific (e.g. 'It was at dinner last night in my front room') and forty five participants (83%) named the vegetable they ate.

Hedonic content of recalled memories

When asked to recall a previous vegetable experience (free recall), participants recalled a positive experience (mean enjoyment = 8.4cm, s.d = 1.3), with all participants exhibiting

an enjoyment rating above the midpoint of the 0-10cm line scale (range = 5.9 to 10.0cm). For *most enjoyable* and *least enjoyable* vegetable experiences, participants recalled a very pleasant experience (mean enjoyment = 9.2cm, s.d = 1.1) and an unpleasant experience (mean enjoyment = 1.3cm, s.d = 1.2). Rated hedonic content of the freely recalled previous serving of vegetables was significantly lower than that of the most enjoyable [$t(49) = 5.34$ $p < 0.001$] and higher than least enjoyable experience [$t(49) = 33.2$ $p < 0.001$]. As expected, most enjoyable and least enjoyable experiences also significantly differed [$t(49) = 26.3$ $p < 0.001$].

There was a significant positive relationship between the enjoyment rating of the freely recalled vegetable eating memory and vegetable consumption, $r = 0.27$, $p < 0.05$.

Pearson's correlation coefficient indicated that the hedonic content of the freely recalled vegetable experience was strongly related to best ever experience [$r(50) = 0.60$, $p < 0.01$]. However, no correlation was found between hedonic content of the freely recalled vegetable experience and hedonic content of the least enjoyable serving of vegetables [$r(50) = -0.18$, $p = 0.21$] or recalled serving of carbohydrate [$r(50) = 0.05$, $p = 0.71$].

2.2.5 Discussion

When asked to recall best and worst experiences of eating vegetables, as expected, participants tended to recall pleasant and unpleasant memories. However, when first asked to freely recall any previous occasion in which they had eaten vegetables, our sample tended to recall an extremely positive experience. Additionally, the hedonic content of the

freely recalled memory was related to intake, whereby individuals with positive hedonic memories tended to consume more vegetables.

That our overall sample recalled extremely positive memories was unexpected, as population studies indicate that vegetables are a food group that tend to be avoided and consumed infrequently, especially in this age group (see also Department of Health, 2009; Moreira et al. 2005). In support of this, on average the 50 participants sampled in the present study consumed only 2 portions of vegetables a day, which is below the national recommendation. The strong correlation between hedonic content of the freely recalled memory and 'best ever' experience (but no significant association of worst ever experience, or the filler question, with the freely recalled memory) is further suggestive that participants were retrieving markedly positive experiences from memory.

Based on the assumption that enjoyment influences food choice (Rozin & Vollmecke, 1986) and memory for past experiences is important in decision making (Gilbert & Wilson, 2007), one might hypothesise that higher consumption of vegetables would be associated with more pleasant memories. The significant relationship between intake and hedonic content of vegetables in the present study confirmed this. Yet, the finding that intake was still low across the sample, even though mean hedonic rating of recalled memory was high, suggests other factors are influencing food choice.

One suggestion as to why some participants recalled these positive memories, but consume few vegetables, may be that they are not solely using these episodic memories when thinking about how enjoyable a serving of vegetables will be. Although we know episodic

memory is important in decision making (Morewedge et al. 2005), other processes and factors are likely to be implicated. For example, individuals may also rely on more general semantic knowledge concerning foods (Robinson & Clore, 2002) or other implicit forms of memory (Szpunar, 2010). Theoretically, such forms of information may differ to that of episodic memory and also influence expected enjoyment.

Due to the known relationship between memory and decision making and the content of the memories recalled in the present study, an interesting hypothesis is that if these positive episodic memories of eating vegetables can be 'boosted' through making them more salient then we might expect to see an increase in food intake. Indeed, if remembered enjoyment of past eating experiences is important in shaping food choice, then it would be predicted that recalling and making particularly positive memories salient should influence predicted enjoyment and choice behaviour.

2.3 STUDY 2: THE EFFECT OF RECALLING EPISODIC FOOD MEMORIES ON PREDICTED ENJOYMENT

2.3.1 Introduction

The results of Study 1 raised the question of what effect recalling a previous occasion in which one enjoyed eating a portion of vegetables would have on food choice. A number of empirical studies suggest that if an individual remembers an experience to have been enjoyable they are more likely to repeat the experience in the future (Kahneman et al. 1993; Redelmeier & Kahneman, 2003). It is suggested this occurs because the content of the memory is factored into mental simulations of how enjoyable repeating the event would be (Gilbert & Wilson, 2007). Therefore, to test the hypothesis that episodic memories of past eating experience influence forecasts of enjoyment, the present study used a similar memory cueing paradigm as previously used by Higgs (2002) and Morewedge et al. (2005).

Morewedge et al. (2005) suggest that episodic memories shape forecasts of enjoyment. In a series of studies participants were cued to describe a memory of a previous experience (e.g. watching a football match) rate how enjoyable the experience was and then forecast how enjoyable they think a similar event would be in the near future (a football match they were waiting to watch). The authors argued that the affective content of the recalled memories influenced the affective content of the forecasts such that recall of more conservative memories of past enjoyment led to similarly conservative forecasts.

Using a similar memory cueing paradigm, Higgs (2002) reported a study which suggests shows evidence for the role that episodic memory processes play in regulating food intake. In these studies participants are cued to recall a memory of the last meal they have eaten and instructed to write as much as possible about the meal. Intake is then compared to control groups and the effect of making the memory for past experience salient decreases food intake (Higgs, 2002; Higgs, 2005). It is hypothesised that if memory for recent eating experiences informs caloric intake then recalling such a memory prior to an eating episode should influence amount eaten.

There have been a limited number of studies showing that cognitive manipulations can have significant influence on eating behaviour. For example, Federoff, Polivy and Herman (1997) instructed participants to think about pizza for ten minutes, before measuring desire to eat pizza and providing participants with fresh pizza to eat ad libitum. Thinking about pizza increased desire to eat and intake of pizza relative to the control condition (Federoff et al. 1997). These data were explained with a cue reactivity account, whereby exposure to intake related thoughts triggered a learned association between the food and intake which caused craving and desire to consume the food. One further explanation is that participants may have retrieved positive memories of eating pizza and used these when deciding whether eating pizza during the session would be desirable. However, this suggestion is speculative as the nature of the studies makes any process based interpretations difficult. Yet the more general finding that a purely cognitive manipulation can alter desirability and intake of food is in line with the present rationale.

The present study examined whether the recall of positive past experiences of eating a vegetable serving would influence forecast of enjoyment of eating the vegetable and likelihood of choosing it. It was hypothesised that the recall of a positive memory would result in individuals using the affective content of the recently retrieved memory when imagining how enjoyable eating the food would be. It was hypothesised this would result in a greater predicted enjoyment and increased likelihood of choice.

To test these hypotheses, participants were asked to recall an occasion when they had eaten broccoli and then rate predicted enjoyment for a variety of foods (including broccoli, other vegetables and non vegetables). Participants were led to believe that they would be required to return for a later session and asked how likely they would be to choose several meals and vegetable side servings for that session. Broccoli was chosen as the food item of interest because it was commonly recalled in the Study 1 and recalled memories were positive. A detailed cover story was used to disguise the aims of the study, which was outlined to participants when they signed up for the study using the online research portal and corroborated with filler questions during the study.

Three control conditions were used. To control for general task demands, the first control group recalled their journey to the session. To control for the effects of recalling an eating memory, another group recalled eating a different food to that recalled by the experimental group (crisps). To investigate the importance of recalling a personal memory, a final group visualised someone else enjoying eating broccoli as previous research suggests that thinking another person enjoyed a food can have effects on liking (Barthomeuf, Rousset & Droit-Volet, 2009).

2.3.2 Method

Participants

Ninety five participants were recruited using the University of Birmingham's online experiment scheme. The study was advertised as 'A study of food, cognition and personality' and participants were instructed not to eat for two hours prior to the study to ensure they would not arrive satiated. The sample consisted of 66 females and 29 males, mean age = 22.0 (s.d. = 3.7). Participants gave informed signed consent and the study protocol was approved by the University of Birmingham Research Ethics Committee.

Experimental Groups

Participants were assigned randomly to one of four conditions prior to the session:

1) Broccoli recall group (n=25): Participants in this group were asked write about an occasion when they ate broccoli and include when they ate it, where, how it tasted and how enjoyable it was.

2) Journey recall group (n=23): Participants wrote about their journey to campus on the day of the experiment. Prompts included how long the journey took, what they saw and what they did.

3) Chips recall group (n=23): Participants in this control group wrote about a previous occasion in which they ate a food item dissimilar to broccoli (potato crisps). The same prompts were used as in the 'broccoli recall' group.

4) Broccoli visualisation group (n=24): Participants in this group were instructed to read and visualise a 9 line narrative of a person enjoying eating broccoli with a meal.

Measures

Likelihood of choice: Participants were informed that *"you may be required to return for a later lunch session and select a meal to eat and an accompanying portion of vegetables."* Participants were then provided with a list of main meals (breaded fish, roast chicken, lasagne, jacket potato with beans, cottage pie, quiche) and a list of 5 vegetable servings (broccoli, cauliflower, carrots, green beans, peas sweet corn) and asked to *"please indicate how likely it is you would choose the follow food items by placing an X at the appropriate point"* on a 10 cm V.A.S (anchors: not at all, on the left, and very, on the right).

Predicted enjoyment: Participants were asked *"If you were to eat the following meal accompaniments, how enjoyable do you think each one would be right now?"* Marking an X at the appropriate place on a 10 cm V.A.S (anchors: not enjoyable, on the left, and very enjoyable, on the right). Items included broccoli, four other vegetables (salad, carrots, peas, sweet corn) and three other food items (garlic bread, jacket potato, potato wedges).

Procedure

Sessions took place on weekdays at lunchtime. On meeting the experimenter, participants were informed that the study would involve completing questionnaires and that they may be asked to return at a later date. Participants were then seated alone in the laboratory. After answering questions on demographics, rating baseline hunger (10 cm visual analogue line rating scale (V.A.S) with "Not at all" and "Extremely" as end anchors) and

completing 10 likert scaled personality filler questions (e.g. 'I enjoy a challenge in life' on a five-point likert scale with anchors from left to right; strongly disagree and strongly agree), participants completed their experimental manipulation.

Participants in each condition then rated their enjoyment of the recalled experience (10cm V.A.S, anchors: strongly disliked, on the left and strongly liked, on the right) and the 'broccoli visualisation' control group were asked to rate 'how much they thought the person enjoyed eating the broccoli' using the same scale. The experimenter then returned and immediately asked participants to complete the likelihood of choice, and predicted enjoyment measures. Participants then completed the restraint scale of the TFEQ (Stunkard & Messick, 1985) and weight and height were then measured using electronic digital scales and a stadiometer to calculate BMI (kg/metres^2). Finally, participants were asked what they thought the aims of the study were, thanked for their time and debriefed.

2.3.3 Analysis

ANOVA was used in order to examine whether the groups were balanced for baseline hunger, age, restraint and BMI. ANOVA was also used in order to examine whether the experimental groups differed in their rated enjoyment of the recalled memory or description.

Two sets of ANOVAs were run to examine the effect of the experimental manipulations on predicted enjoyment and likelihood of choice. In the first, predicted enjoyment of broccoli, other vegetables and non vegetables served as the outcome variables. In the second, likelihood of choosing broccoli, other vegetables and non vegetables served as the

outcome variables. The four experimental conditions served as between group factors. If a significant effect of group was observed, between group comparisons were made using least square difference method and only significant differences between experimental conditions are reported.

2.3.4 Results

Sample characteristics

BMI for the sample (mean = 24.1, s.d = 4.3) and restraint scores (mean = 7.3, s.d = 4.5) were both within normal range. Baseline hunger rating was 5.0 (s.d = 2.3), suggesting that our pre-study requirement was adhered to and participants were not satiated on arrival. One participant's BMI information was not recorded and is excluded from BMI analysis.

Group characteristics

ANOVA indicated that groups did not differ on baseline hunger [$F(3,91) = 1.57$, $p = 0.20$], restraint score [$F(3,91) = 1.05$, $p = 0.38$], BMI [$F(3,91) = 1.01$, $p = 0.38$] or age [$F(3,91) = 0.49$, $p = 0.70$]. See Table 2.1

Table 2.1

Participant characteristics by condition for Study 2

	Age	Hunger	BMI	Restraint
Broccoli recall	22.8 (5.1)	6.0 (2.5)	23.1 (2.7)	7.5 (3.9)
Chips recall	21.9 (2.3)	4.6 (2.8)	24.4 (4.3)	8.6 (5.1)
Journey recall	21.7 (2.8)	4.6 (2.5)	25.2 (4.9)	7.0 (4.6)
Broccoli visualisation	21.7 (3.8)	5.0 (2.6)	23.9 (4.9)	6.3 (4.2)

Table values: Values refer to means. *Hunger ratings in cm 0-10 visual analogue scale, anchors; 'not at all hungry' and 'extremely hungry' (standard deviations in brackets).Age in years. Restraint score = 0-21 score on questionnaire.*

Type of recalled vegetable memories

25 participants (100%) recalled the context in which they ate broccoli. 24 participants (96%) recalled how it tasted and 21 (84%) recalled how the broccoli was served.

Experimental Manipulation Rated Enjoyment

The 'broccoli recall' condition (mean = 6.59cm, s.d = 2.55), 'chips recall' condition (mean = 6.78cm, s.d = 2.34), 'journey to campus' recall condition (mean = 5.70cm, s.d = 1.54) and 'broccoli visualisation' condition (mean = 6.77cm, s.d = 2.14) did not differ in ratings for enjoyment of recalled/visualised experience [$F(3,91) = 1.29$, $p = 0.28$].

Predicted Enjoyment

Broccoli: ANOVA revealed a significant effect of group on predicted enjoyment of eating broccoli [$F(3,91) = 4.90$, $p < 0.01$]. Predicted enjoyment was significantly higher in the

'broccoli recall' condition than in the 'journey recall' condition [$p < 0.01$], 'chips recall' condition [$p=0.02$] and 'broccoli visualisation' condition [$p < 0.01$] (Table 2.2).

Other food items: There was no significant effect of group on predicted enjoyment of other vegetables [$F(3,91) = 2.01$, $p = 0.12$] or non vegetable food items [$F(3,91) = 1.34$, $p = 0.27$]. See Table 2.2.

Table 2.2

Predicted enjoyment of food items by condition in Study 2

Experimental condition	Broccoli	Other vegetables	Non vegetable food items
Broccoli recall	7.2 (1.9)	6.5 (1.7)	7.0 (1.8)
Journey recall	5.1 (2.6)*	5.7 (1.5)	6.4 (2.1)
Chips recall	5.4 (2.2)*	5.7 (1.5)	6.9 (1.9)
Broccoli visualisation	4.4 (2.7)*	5.7 (1.8)	6.5 (2.0)

Values refer to means. Ratings = 0 – 10 cm visual analogue scale (anchors from left to right 'not at all enjoyable' and 'extremely enjoyable'). Note: Standard deviations are presented in brackets. * indicates score is significantly different from broccoli recall group

Likelihood of Choosing

Broccoli: ANOVA revealed a significant effect of group [$F(3,91) = 3.65$, $p < 0.05$]. Likelihood of choosing broccoli was significantly higher in the 'broccoli recall' condition than the ''journey recall' control condition [$p < 0.05$] and 'broccoli visualisation' control condition [$p < 0.01$]. Although in the expected direction, the 'chips recall' condition was not significantly higher than the 'broccoli recall' control condition [$p=0.25$]. See Table 2.3.

Other food items: ANOVA revealed a significant effect of group on likelihood of choosing other vegetables [$F(3,91) = 5.21$, $p < 0.01$]. Likelihood of choosing other vegetables was significantly higher in the 'broccoli recall' condition in comparison to 'journey recall' condition [$p < 0.01$], 'chips recall' condition [$p < 0.01$] and 'broccoli visualisation ' condition [$p = 0.01$]. There was no significant effect of group on likelihood of choosing non vegetable food items [$F(3,91) = 0.90$, $p = 0.44$]. See Table 2.3.

Table 2.3

Likelihood of choice of food items by condition for Study 2

Experimental condition	Broccoli	Other vegetables	Non vegetable food items
Broccoli recall	8.2 (1.7)	7.4 (1.1)	5.5 (1.4)
Journey recall	7.2 (2.9)	6.2 (1.3)*	5.2 (1.2)
Chips recall	6.5 (3.1)*	5.9 (1.3)*	5.1 (1.6)
Broccoli visualisation	5.6 (3.2)*	5.9 (1.9)*	4.9 (1.6)

Values refer to means. Ratings = 0 – 10 cm visual analogue scale (anchors from left to right 'not at all enjoyable' and 'extremely enjoyable'). Note: Standard deviations are presented in brackets. * indicates score is significantly different from broccoli recall group.

2.3.5 Discussion

After recalling a positive memory of eating broccoli participants predicted that they would find broccoli more enjoyable to eat and would also be more likely to choose it as a meal accompaniment than control conditions. Broccoli recallers also reported that they would be more likely to choose other vegetables as a meal accompaniment. Similarly, a trend was observed in the expected direction for predicted enjoyment of other vegetables, although it was not significantly different to controls. The recall of eating broccoli had no effect on predicted enjoyment or likelihood of choosing non vegetable food items.

These findings are in line with previous literature that has shown episodic memory to be important in influencing how enjoyable individuals believe a similar future event will be (Morewedge et al. 2005). In one study reported by Morewedge et al. (2005), when participants recalled extremely negative memories of missing a train, their forecasted affective experience of missing a train in the near future were similarly negative. Here, when participants recalled a positive memory of eating broccoli, their predicted enjoyment and likelihood of choosing broccoli increased similarly.

The finding that the observed effects were food group specific adds further support to the notion that individuals were using the content of the recalled memory to guide forecasts of enjoyment (Kahneman, 1997; Morewedge et al. 2005). Recalling eating another food (crisps) did not have any effect on predicted enjoyment or likelihood of choice and recalling a broccoli memory did not increase predicted enjoyment or choice of non vegetable items. Groups were also well matched for BMI, age restraint, hunger, as well as hedonic content of recalled memory. Demand characteristics also appear to be an unlikely explanation for the observed results. On completion of the study, each participant was asked for their thoughts on the aim of the study and no participants correctly identified the aims. In addition, one of the control groups controlled for exposure to positive thoughts concerning eating broccoli.

The observed effect of increased likelihood of choosing broccoli also crossed over to other vegetables. This may be because the recall of the episodic memory served as a more general reminder of how enjoyable vegetables often are and participants used this information accordingly when making ratings. If this were the case then we would also

expect to see a significant increase in predicted enjoyment of other vegetables. In the present study, a similar trend was observed but the effect was not significant.

The data reported here are similar to research reported by Higgs (2002; 2008) which links episodic memory to the regulation of eating behaviour. Across several studies Higgs provides evidence that episodic memories inform dietary intake. In a similar vein, the findings of the present studies appear to suggest that episodic memories may also play some role in informing food choice. Although the present study is suggestive that recall of a memory of enjoying eating a food results in a greater likelihood of choosing that food, the accuracy of the self report method of measuring likelihood of choice could questioned.

Intentions and actual future behaviour are sometimes discrepant and although individuals often think they 'know themselves' (in terms of how they will behave in the future), this sometimes is not the case (Wilson & Dunn, 2004). Thus, a limitation of the present study is that actual choice behaviour was not measured. Although participants believed they would be more likely to choose broccoli in the future, there is a possibility that this belief was erroneous. A study that involved a similar cueing paradigm followed by a covert measurement of food choice would provide a more direct test of the possible influence of recalling an episodic memory on food choice.

STUDY 3: THE EFFECT OF RECALLING EPISODIC FOOD MEMORIES ON FOOD CHOICE

2.4.1 Introduction

The results from Study 2 indicated that recalling a memory of enjoying eating broccoli resulted in participants believing that they would find broccoli more enjoyable to eat (than controls). Recall also resulted in participants reporting themselves as being more likely to choose broccoli as a meal accompaniment as part of a meal. Although these data appear to be in line with other empirical data that suggest episodic memory of past experiences is an important informant of future behaviour (Redelmeier & Kahneman, 2003; Wirtz et al. 2003), participants only self reported how likely they would be to choose the recalled food in the future. Thus, the present study attempted to address this question by examining whether the recall of eating a serving of vegetables resulted in participants choosing a greater amount of the recalled vegetable as part of a meal.

Participants attended two sessions and a cover story was used. In the first session, participants studied a word list and then completed the experimental manipulation. As part of the study cover story they were led to believe that in the second session they would be required to recall the information from the word list as the study 'examined the affect eating has on memory retention'. In line with this cover story, shortly after reading the word list and completing the experimental manipulation, participants were shown to a buffet and asked to select some food to take away with them for lunch. As carrots are a commonly consumed vegetable in the UK and piloting suggested that participants could recall positive eating memories, carrots were used as the recalled food in Study 3. The

effect of recall on food choice was examined by measuring the amount of carrot sticks that participants chose from the buffet. To examine whether the effect also crossed over to other food types, non vegetable food items (quiche, sandwiches, crisps, pastries, cocktail sausages) and another vegetable (celery) was also in the buffet.

Some minor changes were made to the design of Study 2. As a few participants recalled aversive experiences with broccoli in Study 2 (one participant recalled eating the food whilst ill for example), participants were asked to recall an enjoyable occasion in which they had eaten carrots in order to ensure the experimental group were recalling positive memories with the food. A potential explanation of the findings of Study 2 is some form of halo effect, whereby recalling eating a healthy food (broccoli) primes healthy food choice or makes individuals health conscious. Thus, in the present study, the control condition for whether the effect of recall is food group specific were asked to recall an occasion in which they enjoyed eating a healthy food (fruit), rather than recalling eating crisps (as in Study 2).

2.4.2 Method

Participants

Sixty four participants were recruited using the University of Birmingham's online experiment scheme. The study was advertised as ‘A study of how eating affects memory’ and instructions were included not to have eaten two hours prior to the study to ensure participants would not arrive satiated. The sample consisted of 51 females and 13 males (mean age 19.3 yrs old, s.d =1.3). Two participants guessed the aims of the study and 2 participants did not return to complete the second session and were removed from

analyses. Participants gave informed signed consent and the study protocol was approved by the University of Birmingham Research Ethics Committee.

Experimental groups: Participants were randomly assigned to one of four conditions groups prior to the session:

1) 'Carrot recall' group (n=15): Participants in this group were asked to write about an occasion when they enjoyed eating carrots and include when they ate it, where, how they tasted and how enjoyable they were.

2) 'Journey recall' group (n=14): Participants wrote about their journey to campus on the day of the experiment. Prompts included how long the journey took, what they saw and what they did.

3) '*Fruit recall' group (n=15):* Participants in this control group wrote about a previous occasion in which they enjoyed eating a piece of fruit. The same prompts were used as in the 'carrot recall' group.

4) '*Carrot visualisation' group (n=16):* Participants in this group were instructed to read and visualise a 9 line narrative of a person enjoying eating carrots with a meal.

Procedure

Sessions took place at lunchtime. On arrival, participants completed demographic questions and rated hunger (10 cm visual analogue line rating scale (V.A.S) with "Not at

all" and "Extremely" as end anchors). Participants were informed that the study would involve two parts. In the first part they would be required to study a word list and some written information. Participants were then provided with the word list (24 food-related; i.e. 'bread', 'plate' and 24 object words 'pen', 'car') and given two minutes to study it. They then completed their experimental condition. On completion, they were informed that the second session would test memory for words from the word list and the information from the written task and that they were required to take away a lunch to consume in between the two sessions. Participants were then taken to the buffet, provided with a container to take away food, instructed to take as much as they liked and left alone to choose. In line with the cover story, two hours later participants completed the word list recall test, followed by the restraint scale of the TFEQ (Stunkard & Messick, 1985).Height and weight were then measured and participants were asked to guess the study aims and were debriefed.

Lunch buffet

The buffet consisted of carrot sticks (80g, 22kcals), cocktail sausages (65g, 173kcals), tortilla chips (20g, 93kcals), savoury pastries (100g, 324kcals), celery sticks (85g, 16kcals), chicken sandwiches (70g, 129kcals) and quiche (200g, 410kcals) (all food from Sainsbury's U.K.). The arrangement of the buffet was the same for all participants and participants were free to choose from each plate as much food as they wished. After participants made their selections the experimenter determined the amounts that had been chosen by calculating the change in weight of the food plates.

2.4.3 Analysis

ANOVA was used in order to examine whether the groups were balanced for baseline hunger, restraint, age and BMI. ANOVA was also used in order to examine whether the experimental groups differed in their rated enjoyment of the recalled memory or description.

ANOVA was also used to examine the effect the experimental manipulations had on amount of each food selected. If a significant effect of group was observed, pairwise comparisons were made using least square difference method and only significant differences between individual experimental conditions are reported.

2.4.4 Results

Sample characteristics

BMI for the sample (mean = 23.2, s.d = 3.5) and restraint scores (mean = 7.6, s.d = 5.3) were both within normal range. Baseline hunger rating (0-10cm) was mean = 6.5 (s.d = 1.9), suggesting that our pre-study requirement worked and participants were fairly hungry on arrival.

Group characteristics

ANOVA indicated that groups did not differ on baseline hunger [$F(3,57) = 0.72$, $p = 0.55$], restraint score [$F(3,57) = 0.14$, $p = 0.93$], age [$F(3,57) = 0.21$, $p = 0.89$] or BMI [$F(3,57) = 0.86$, $p = 0.47$]. See Table 2.4

Table 2.4

Participant characteristics by condition for Study 3

	Age	Hunger	BMI	Restraint
Carrot recall	19.1 (1.2)	7.2 (1.2)	22.1 (2.4)	6.6 (4.7)
Chips recall	19.3 (1.3)	7.3 (1.3)	24.0 (5.6)	7.9 (6.9)
Journey recall	19.3 (0.8)	6.2 (1.5)	24.0 (2.8)	8.0 (5.6)
Carrot visualisation	19.1 (0.8)	5.9 (2.5)	23.4 (3.7)	8.1 (5.0)

Table values: Values refer to means. *Hunger ratings (0-10cm visual analogue scales), anchors; 'not at all hungry' and 'extremely hungry' (standard deviations in brackets).Age in years. Restraint = 0-21 questionnaire score.*

Type of recalled memories

12 participants (80%) recalled the context in which they ate carrots. 15 participants recalled how it tasted (100%) and 13 recalled how the carrots were served (87%).

Experimental Manipulation Rated Enjoyment

There was a significant effect of group for rated enjoyment [$F(3,57) = 14.00$, $p < 0.001$]. The 'carrot recall' (mean = 7.49cm, s.d = 1.23), 'fruit recall' (mean = 8.18cm, s.d = 1.02), and 'carrot visualisation' groups (mean = 8.38cm, s.d = 1.46) rated their recalled experience/visualisation significantly more positively ($p<0.05$) than the 'journey to campus recall' group (mean = 5.01cm, s.d = 2.37). There were no other group differences.

Choice

Participants in the 'carrot recall' condition selected a significantly larger portion of carrots [$F(3,50) = 3.2$, $p=0.03$] than participants in the 'journey recall' [$p = 0.01$], 'fruit recall' [p

= 0.03] and 'carrot visualisation' groups [p = 0.03]. No other between group differences were observed for carrot choice. Additionally, there was no effect of group for any of the other 6 food items (*p* values relate to post-hoc tests). See Table 2.5 for grams of food selected by experimental group.

Table 2.5

Mean Grams of food chosen by condition for Study 3

Condition	*Carrot recall*	*Fruit recall*	*Journey recall*	*Carrot visualisation*	*Between group differences analysis (df = 3,50)*
Carrot sticks	25.9 (14.0)	13.0 (9.2)*	16.2 (7.9)*	15.6 (15.7)*	F=3.21, p =0.03
Cocktail sausage	19.0 (17.7)	23.2 (14.9)	23.5 (12.3)	18.0 (15.7)	F=0.52, p=0.67
Tortilla chips	5.4 (3.9)	5.6 (3.7)	6.6 (5.1)	6.6 (3.9)	F=0.34, p = 0.80
Celery sticks	7.9 (10.2)	4.3 (7.2)	9.8 (9.6)	5.4 (6.5)	F = 1.20, p = 0.33
Chicken sandwich	34.1 (23.3)	37.2 (37.0)	36.0 (27.3)	23.8 (23.0)	F = 0.70, p = 0.51
Cheese pastry	24.2 (15.7)	27.1 (23.0)	27.3 (16.4)	24.0 (11.6)	F = 0.19, p = 0.90
Quiche	31.7 (34.2)	30.9 (24.6)	41.9 (30.7)	31.3 (29.5)	F = 1.30, p = 0.29

Note: Values refer to means. Standard deviations are presented in brackets. * *indicates amount is significantly different to carrot recall group*

Post-hoc it was decided to examine frequency of choice of the food item of interest (carrots). In the carrot recall condition 100% (15/15) of participants selected carrots, fruit recall condition 86% (12/14) selected carrots, journey recall condition 80% (12/15) selected carrots and in the carrot visualisation condition 69% (11/15) selected carrots. In line with the mean grams chosen data, descriptive statistics suggest frequency of carrot choice was highest in the carrot recall group compared to controls. However, a chi square analysis indicated there was no significant association between condition and choice of

carrots; x^2 (3) = 5.6, p = 0.12. This non significant effect may have occurred due to a ceiling effect, as control groups tended to have a high frequency of carrot selection (e.g. 86% of participants in the fruit recall control condition chose carrots). Indeed, due to the nature of the design of this study (not forcing participants to make a choice between consuming or not consuming carrots), when comparing frequency of choice of a food that most participants are already choosing (albeit in small amounts), observing a statistically significant result will be difficult .

2.4.5 Discussion

After recalling a positive memory of eating carrots participants chose a significantly greater amount of carrots from a buffet for a lunch time meal than controls. However, this effect did not cross over to another vegetable (celery sticks). Mere visualisation of someone else enjoying eating carrots, recall of a neutral event or of eating another healthy food did not affect choice. The lack of effect of the visualisation task on food choice suggests that merely being reminded that eating carrots is enjoyable is not sufficient to affect choice and that an important factor is recall of a personal event. Furthermore, the lack of effect of recalling eating a healthy food on food choice suggests that the results are unlikely to be explained by participants becoming more health conscious in food choice due to recalling eating a healthy food.

Demand characteristics are also unlikely to explain results. Participants were left alone to select their take away lunch and only two of sixty four participants correctly identified that we were interested in the food choices made by participants. The results of the present study support the findings from Study 2 that recalling a positive episodic memory of an

eating experience influences rated desirability of eating that food in the future. In line with Morewedge et al. (2005), an explanation of the effect of recall on food choice is that the episodic memory served to 'remind' participants how enjoyable eating carrots can be and participants then used this information when deciding whether or not they would enjoy eating carrots as part of their lunch. These findings further support the notion that the content of episodic memory for past eating experiences is likely to be important in influencing food choice.

An alternative explanation for the present results is that episodic memory recall affected food choice more indirectly, through setting up an expectancy for the participants that they are the kind of person who likes eating vegetables, and this affected their subsequent choices. Setting up an imagined expectation that participants are reluctant to disconfirm could lead to behaviour consistent with that expectation or could have encouraged participants to believe they like eating vegetables and therefore act accordingly to maintain a consistent self-perception (Bem, 1967). Teasing apart such influences would be difficult, but regardless of exact mechanism, the recall of an episodic memory of eating vegetables appears to result in a change to food choice and might have useful application.

2.5 CHAPTER 2: GENERAL DISCUSSION

Chapter 2 was designed to examine the relationship between episodic memory and food choice with regards to vegetable consumption. In Study 1, although participants reported that they habitually consumed few vegetables, when asked to recall an episodic memory of eating vegetables, participants recalled extremely positive experiences. Furthermore, the more positive a memory that was recalled, the higher individuals vegetable intake tended to be, which is suggestive that remembered enjoyment of eating vegetables may be of importance in determining food choice.

Thus, based on current thought that the content of episodic memory is important in shaping decision making, in Study 2 it was examined whether the recall of a positive memory of eating a vegetable (broccoli) would result in a greater predicted enjoyment of eating that vegetable. The results appeared to confirm this and also suggested that the recall may also affect choice, as participants reported themselves as being more likely to choose broccoli as part of a meal in the future. These effects also appeared as though they it may cross over to other types of vegetable (albeit less strongly), as participants reported themselves as being more likely to choose other vegetables.

In Study 3 the effect of recall on actual food choice was examined and it was found that after recalling an enjoyable serving of carrots, participants chose significantly more carrot sticks as part of a lunch time buffet. However, the effect did not cross over to celery, as the experimental groups did not differ in the amount of celery sticks chosen from the buffet. It may be that a cross over is more likely to be observed if an individual perceives the

vegetables to be similar in taste or appearance. The foods used in Study 3 where no cross over occurred; celery and carrot are fairly unique in both appearance and presumably taste. Whereas, in Study 2, a number of vegetables in which a cross over effect occurred with broccoli are similar in appearance; peas, salad or taste, i.e. cauliflower. Further examination of this would be of interest, as it may provide greater insight into how episodic memory informs behaviour.

In Study 1, participants tended to recall positive memories of eating broccoli. However, habitual vegetable intake was low across the sample. To some extent, this may seem contradictory and may raise a question of why habitual intake is so low, considering that individuals have positive memories? One suggestion may be that these are not the only forms of memory that individuals rely on to inform food choice. For example, it may be that individuals also rely on implicit theories about liking for vegetables which are divorced from episodic experience (Robinson & Clore, 2002a; 2002b). Such theories/beliefs could be affected by other factors, such as a belief that the healthier a food is, the less enjoyable it will be (Raghunathan, Walker & Hoyer, 2006).

Episodic memory is likely to serve alongside a myriad of other factors that have been shown to influence food choice, which in some cases may reduce how strongly hedonic content of episodic memories influence food choice. In the case of vegetables, their lack of energy density may make individuals avoid consumption when hungry, even if one does possess positive hedonic memories (Brunstrom & Rogers, 2009). Therefore, the hedonic content of episodic memory for previous eating experiences is likely to act alongside other factors.

In conclusion, the findings of Studies 1, 2 and 3 suggest that the notion from other areas of psychology that episodic memories inform decision making may also apply to food choice. Although the findings from this chapter are suggestive of this, further supporting research is required. For example, if manipulation of an episodic memory to produce a more positive memory of enjoyment resulted in a change to food choice (without having to explicitly recall the memory), this would provide stronger evidence of the role that episodic memory naturally plays in food choice. The following chapter addressed this question.

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CHAPTER 3: MANIPULATING REMEMBERED ENJOYMENT OF EATING EXPERIENCES

3.1 INTRODUCTION

A stringent test of the relationship between episodic memory and food choice would be to experimentally manipulate remembered enjoyment of a past eating experience and examine subsequent effects on food choice. Based on the proposed relationship between remembered enjoyment and food choice, the main hypothesis would be that increasing remembered enjoyment of a food item should result in an increased likelihood of choosing to eat the food in the future.

The studies reported in the present chapter tested this hypothesis. A small amount of evidence suggesting that changing memory may influence choice behaviour is first reviewed and then manipulations of remembered enjoyment are discussed. Next, the studies in the present chapter examine whether remembered enjoyment of an eating experience can be altered (Study 4) and whether a manipulation to increase remembered enjoyment would also increase food choice (Study 5). Such findings would further support the notion that remembered enjoyment is important in explaining food choice and may also have practical application.

Research linking memory alteration to behavioural change

There is limited literature on the effect of altering memory on future behaviour. As discussed in the general introduction to this thesis, Redelmeier and Kahneman (2003) utilised the end effect bias and suggested that this resulted in participants being more likely

to return for repeat surgery over a 6-year period. However, there are methodological weaknesses to the study which may exaggerate the effect that the altered memory has on future behaviour. After surgery, participants rated their memory for experienced pain and also ranked the surgery alongside several other common surgical procedures for experienced discomfort. It is possible that the memory ratings and ranking may be more responsible than actual memory of the experience for the increase in repeat surgery. For example, some participants could have been using their memories of evaluating the procedure when deciding that repeat surgery would not be too painful. Thus, a study manipulating memory but not including a manipulation check prior to measurement of behavioural change is needed to confirm Redelmeier and Kahneman's (2003) conclusions. Study 4 will address this issue.

Another study that is of relevance to the studies reported in this chapter is a study by Laney et al. (2009) that involved implanting participants with a false memory of having enjoyed eating asparagus as a child. The participants then rated how much they would pay for asparagus in an imaginary shop and how likely they would be to choose asparagus in a follow up study and these measures were disguised among other measures. Aside from the fact that the study relied on self report rather than measuring actual behaviour it is questionable whether memory was successfully manipulated. In false memory paradigms only a minority of participants are classed as having 'accepted' the false memory and it is rare for these participants to report a completely new memory. Instead, their classification as having 'accepted' the memory is based on them increasing their belief that the false event took place. Hence, it is possible that the effect is not due to the content of an

acquired memory, but due to some kind of change in belief about disliking the 'implanted' food or demand characteristics.

A reliable manipulation of remembered enjoyment

To test the effect on food choice of altering remembered enjoyment a reliable manipulation of remembered enjoyment is required. Remembered enjoyment can be changed due to a pre-experience, online experience or post experience manipulation. For example, Klaaren et al. (1994) report data that pre-event expectations about an experience can distort later memory. In an experimental study, the authors report that leading some participants to believe that a session would be particularly enjoyable resulted in these participants remembering the experience as being more enjoyable than it actually was (Klaaren et al. 1994). The authors explanation of these findings was that individuals often use expectations to guide memory and do so by reinterpreting parts of experiences to 'fit in' to existing expectations (Klaaren et al. 1994).

Yet, using a pre-experience manipulation possesses weaknesses and other studies have failed to find that pre-experience expectations influence remembered enjoyment of the experience (Wirtz et al. 2003; Terry, Niven, Brodie, Jones & Prowse, 2007). Terry et al. (2007) measured expectations concerning experienced pain in future medical surgery and found no effect of expectations on memory. In addition, using a pre-experience manipulation is also problematic as it is likely to influence online enjoyment. For example, Wilson, Lisle, Kraft and Wetzel (1989) showed that leading participants to believe that a series of cartoons would be funny resulted in participants finding the cartoons more humorous than controls (self report and facial expression data confirmed this). Thus,

determining whether effects are observed because of changes to remembered or solely online enjoyment is difficult.

An alternative approach would be to manipulate the experience online, such as manipulating the order or quality of food to produce a more pleasant memory. However, this approach also possesses some weakness and it may be difficult to ensure participants have positive or negative experiences at predefined moments. A similar manipulation to that used by Redelmeier and Kahneman (2003) could be utilised, whereby an additional moment of pleasure or discomfort is added to the end of an experience, to utilise the end effect bias. Yet, adding additional pleasant food to the end of the meal would be likely to raise online enjoyment and therefore make it difficult to attribute whether it is online or remembered enjoyment that is responsible for any effect. Similar concerns in relation to the 'peak effect' finding can be raised. Manipulating one group of participants to have an extremely positive most liked moment in the meal is likely to result in an increase in online enjoyment as well as remembered enjoyment.

One further reason that online manipulations may be problematic is because the order in which food is eaten shapes online enjoyment (Kamenetzy, 1959). For example, contrast effects can occur, whereby eating particularly pleasant food at the beginning of a meal can result in food later in the meal being rated as more unpleasant than if the order were to be reversed (Kamenetzy, 1959). Hence, adding a particularly pleasant moment ('peak') or manipulating a time in the meal to be particularly pleasant is likely to affect online enjoyment of preceding items. Such effects are particularly problematic in between group

designs, as balance for online enjoyment is key to ensuring between group differences are attributable solely to differences in memory.

An alternative option is to manipulate memory post-experience (Hodges et al. 2000; Braun, 1999). A strength of manipulating memory post-experience is that there is no effect on online experience. Moreover, it is well known that that memory is very malleable immediately after an event. For example, Elizabeth Loftus and colleagues have shown consistently that exposing individuals to erroneous information concerning a recently witnessed event can alter the memory representation of that event (Loftus, Miller & Burns, 1978). Similarly, Braun (1999) reported that exposure to positive advertisement concerning a recently viewed product resulted in participants remembering the product to have been of higher quality.

Another well replicated finding from the memory literature is that recall enhances memory (Abbot, 1909). For example, providing word lists and then asking some participants to rehearse the list in between learning and testing phase results in a greater recall rate of the rehearsed words at testing (Spitzer, 1939). This effect is well known to educators and used as a study method for exams. Rehearsal is likely to improve later recall through strengthening the representation of the information in memory, making the information easier to recall (Anderson, Fincham & Dougless, 1999).

Research has also shown that specific moments of an experience have disproportionately large influence on overall evaluations of past experiences and such effects occur because of the ‘strength’ of those parts of experience in memory representation (Unnava &

Montgomery, 2009). Data reported by Unnava and Montgomery (2009) suggests that the most intense moments of an experience have such large influence because they 'stand out' as unique. Thus, when recalling the experience, these moments are readily retrieved and so are used to make the overall evaluation. This view is in line with current thought concerning episodic memory; the overwhelming majority of moments from an experience fade in memory with time, leaving only a limited select number of moments in memory which remain due to encoding strength (Conway, 2009).

Collectively, what the data reviewed above suggest is that manipulating a part of an experience to be memorable should result in it being more accessible in memory and therefore weighted more strongly in evaluations of later remembered enjoyment. Thus, to examine the effects on food choice of changing remembered enjoyment, in Study 4 remembered enjoyment was manipulated by having participants rehearse what aspects of the meal they found enjoyable shortly after consuming it. As rehearsal makes information more memorable and thus easier to retrieve (Anderson et al. 1999), it was hypothesised that rehearsing the enjoyable parts of a meal immediately after consumption would make these moments more salient in memory, which would result in an increase in remembered enjoyment. This approach is further qualified by the finding that most moments of an experience fade rapidly from memory (Conway, 2009) and rehearsal would reduce fading of the rehearsed moments, leaving individuals more reliant on the positive parts of the meal when evaluating enjoyment.

3.2 STUDY 4: MANIPULATING REMEMBERED ENJOYMENT OF A MEAL

3.2.1 Introduction

Study 4 was designed to examine if a feasible manipulation of remembered enjoyment could be devised. The post event rehearsal manipulation (as discussed in chapter introduction) was utilised. To test whether the rehearsal manipulation could increase remembered enjoyment, participants in the present study attended two sessions. A cover story was used to disguise the aims of the study. In the first session, participants were served a lunch time meal and completed the experimental manipulation, before returning for a second session to rate remembered enjoyment of the meal.

Participants were asked (immediately after consumption) to write down what they found enjoyable about a multi item meal and then rate remembered enjoyment of the meal 24 hours later in the second session. To reduce any demand characteristics, there were three control group writing tasks. The first control condition controlled for the effect of thinking about the enjoyable aspects of a recent experience by writing down what they found enjoyable about their journey to campus. The second controlled for any effect of thinking about the enjoyable aspects of another recently eaten meal by writing down what they found enjoyable about a meal eaten the previous day. The final condition controlled for thinking back about eating the lunch time meal, without concentrating on the enjoyable aspects (thus controlling for any other general rehearsal).

3.2.2 Method

Participants

Fifty nine psychology undergraduates (47 females and 11 males; mean age = 20.2 S.D = 3.8) participated in exchange for course credit. The experiment was advertised as a two part study on 'Social emotions, mood and food'. The study protocol was approved by the University of Birmingham Research Ethics Committee.

Experimental groups

Participants were assigned to one of four conditions and given three minutes to complete their writing exercise:

a) *Enjoyable aspects of meal rehearsal (experimental), n = 14*: participants in this group were asked to 'write down your thoughts on the enjoyable aspects of the meal, providing as much detail as possible'.
b) *Other recent experience rehearsal (control), n =15:* participants in this group were asked to 'write down your thoughts on the enjoyable aspects of your journey to campus today, providing as much detail as possible'.
c) *Other recent meal rehearsal (control), n =15:* participants in this group were asked to 'write down your thoughts on the enjoyable aspects of a meal you ate yesterday, providing as much detail as possible'.
d) *Neutral meal rehearsal (control), n =13*: participants in this group were asked to 'think back to when you were eating the meal and answer the following questions, 1) list the meal ingredients, 2) how long did it take to eat the meal? 3) which utensils did you eat with?'

Meal

All participants were served a microwavable Heinz Weight Watchers Tomato & Basil Chicken ready meal (249 kcals). The meal consisted of chicken fillets in a sauce with tomato, courgette, pepper, basil and potato wedges.

Measures

Personality questionnaire: This measure included 10 five-point-likert scaled (strongly disagree – strongly agree) personality questions; e.g. 'I enjoy a challenge in life'. It was included to corroborate the cover story and distract attention from the study aims.

Online meal questionnaire: This questionnaire included the online enjoyment measure for the meal; 'the meal is pleasant'; five-point-likert scale (strongly disagree-strongly agree). To corroborate the cover story the questionnaire then asked participants to rate how 'relaxed', 'sad', 'awake', 'nervous' and 'stressed' they were using the same rating scales.

Mock mood questionnaire: To further corroborate the cover story, in the second session participants completed ratings for how awake, nervous, excited and stressed they felt by circling 'not at all', 'quite' or 'very' for each item.

Remembered enjoyment measures: Participants were asked to complete three visual analogue measures by marking lines with an X (10cm line). 1) 'Compared to an average lunch, yesterday's lunch was'; anchors (from left to right) – not at all enjoyable and extremely enjoyable. 2) 'I would enjoy eating the meal again'; anchors – not at all likely and extremely likely. 3) 'I would recommend the meal to a friend'; anchors – not at all

likely and extremely likely. The measures of remembered enjoyment used a different scale to the online measure of enjoyment (V.A.S rather than likert) to reduce the possibility of participants basing their remembered enjoyment ratings on their online ratings, rather than their memory of the actual experience.

Procedure

Sessions took place on weekdays at lunchtime. Participants were informed that the study would involve eating a lunch time meal and returning the following day at the same time. Participants were then seated alone in the laboratory. After answering questions on demographics, and rating baseline hunger ('how hungry are your right now?' V.A.S, 10cm, anchors; not at all and extremely), participants were provided with the mock personality questionnaire. On completion, the lunchtime meal was served on a white plate (diameter 25 cm). Participants were provided with a knife and fork to eat the meal.

After two minutes, the experimenter returned and asked participants to stop and complete the online meal questionnaire. Participants informed the experimenter when they had completed the questionnaire and were left alone to finish the meal. On completion, the experimenter returned and took away the plate and utensils. Participants were then randomly assigned to the experimental conditions. After completing their condition, participants left the laboratory. Twenty four hours later participants returned for the second session.

A gap of twenty four hours was chosen as was convenient for subsequent testing sessions. After rating their hunger (same scale as used in session 1), participants were provided with

the mock mood questionnaire, followed by the remembered enjoyment measures. The restraint scale of the TFEQ was completed before weight and height were measured using electronic digital scales and a stadiometer to calculate BMI (kg/metres²). Finally, participants were asked what they thought the aims of the study were, thanked for their time and debriefed.

3.2.3 Analysis

To examine if groups did not significantly differ for baseline hunger, BMI, age and restraint, ANOVA was used. The three remembered enjoyment questions were highly correlated (0.77, 0.76, 0.75) and loaded onto one factor, so were collapsed to form one measure of remembered enjoyment. To examine between group differences for online and remembered enjoyment, MANOVA was used as online and remembered enjoyment ratings were strongly correlated. If a significant effect of group was observed, LSD t-tests were used to examine between group differences.

3.2.4 Results

Sample Characteristics

One participant came close to guessing the aims of the study ('I think it might be how memory affects eating behaviour') and one participant had finished the meal before being given the online meal questionnaire, so both were removed from analysis. The average restraint score for the sample was mean = 6.8 (s.d = 5.0) and BMI = 23.3, (s.d =4.4). ANOVA indicated that groups did not differ significantly for BMI [$F(3,52) = 1.20$, $p = 0.33$], hunger [$F(3,52) = 0.2$, $p = 0.99$], age [$F(3,52) = 0.77$, $p = 0.52$] and restraint [$F(3,52) = 1.40$, $p = 0.26$]. See Table 3.1.

Table 3.1

Participant characteristics by condition for Study 4

	Age	Hunger	BMI	Restraint
Enjoyable aspects of meal	19.3 (0.7)	6.6 (2.2)	24.8 (1.9)	6.7 (5.8)
Other recent experience	20.6 (3.5)	6.5 (1.9)	22.0 (6.9)	9.0 (3.7)
Other meal rehearsal	19.8 (1.9)	6.5 (1.3)	23.7 (3.8)	6.1 (5.5)
Neutral meal rehearsal	21.1 (5.5)	6.6 (1.6)	23.3 (3.2)	5.4 (5.2)

Table values: Values refer to means. *Hunger ratings (0-10cm visual analogue scale), anchors; 'not at all hungry' and 'extremely hungry' (standard deviations in brackets).Age in years. Restraint = 0-21 questionnaire score.*

Online and remembered enjoyment

Using Roy's largest root, MANOVA indicated a significant effect of group on the outcome variables [$\Theta = 0.25$, $F(3, 52) = 4.4$, $p < 0.01$). Univariate analysis indicated no effect of group on online enjoyment [$F(3,52) = 0.19$, $p = 0.91$] See Table 3.2. A significant effect of group was observed on remembered enjoyment [$F(3,52) = 2.90$, $p<0.05$]. Pairwise comparisons indicated that the experimental group (*enjoyable aspects of meal rehearsal*) had a significantly higher remembered enjoyment than all three control groups; other recent experience rehearsal group ($p<0.05$), other meal rehearsal group ($p<0.05$) and neutral meal rehearsal group ($p<0.05$). No other between group differences were observed for remembered enjoyment (see Table 3.2).

Table 3.2

Online and remembered enjoyment of meal by condition for Study 4

	Online enjoyment *(1-5 likert scale)*	**Remembered enjoyment** *(0-10 cm V.A.S)*
Enjoyable aspects of meal (n=14)	4.2 (0.6)	7.0 (1.2)
Other recent experience (n=15)	4.0 (0.9)	5.2 (2.2)*
Other meal rehearsal (n=15	4.1 (0.8)	5.3 (2.3)*
Neutral meal rehearsal (n =13)	4.1 (0.8)	5.4 (1.8)*

*Note: Values refer to means. Standard deviations are presented in brackets * indicates score is significantly different from enjoyable aspects of meal group. Anchors of both scales 'not at all enjoyable' and 'extremely enjoyable'*

3.2.5 Discussion

After rehearsing the enjoyable aspects of a recently eaten meal, participants in the 'enjoyable aspects of meal rehearsal' condition had a significantly higher remembered enjoyment of the experience than control groups, twenty four hours later. These findings are particularly striking as a measurement of enjoyment taken during the meal showed that all groups were closely matched for online enjoyment. The results suggest that rehearsal of the enjoyable parts of a recent meal results in a marked effect on later remembered enjoyment, with individuals possessing a more positive representation of the experience in memory.

The control groups used in the present study make it seem unlikely that demand characteristics can explain the observed effects. One control condition instructed participants to rehearse the enjoyable parts of another recently eaten meal, suggesting the effect is unlikely to be due to demand characteristics of having thought positively about any eating experience. In addition, the final control group rehearsed neutral aspects of the meal. The finding that thinking about 'neutral' aspects of the meal did not result in a change to remembered enjoyment suggests that it is specifically rehearsing the enjoyable moments that is responsible for the effect and not a simple exposure effect. The detailed cover story used resulted in only one participant coming close to guessing the aims of the study, which further suggests a change to memory may account for our results.

The findings that the manipulation resulted in an increase for remembered enjoyment are in line with other research that has shown post event manipulations can alter affective memory for a past experience (Hodges et al. 2000; Braun, 1999). If remembered enjoyment does play a significant role in food choice, then an increase in remembered enjoyment would be expected to result in an individual being more likely to choose that food in the future. Now that a suitable manipulation to change remembered enjoyment had been developed, next a study is reported that was designed to examine whether this change to remembered enjoyment would impact on food choice.

3.3 STUDY 5: THE EFFECTS OF MANIPULATING REMEMBERED ENJOYMENT ON FOOD CHOICE

3.3.1 Introduction

Study 5 attempted to build upon the findings of Study 4. The finding that the post event rehearsal manipulation resulted in a marked increase in remembered enjoyment was utilised in Study 5. The same manipulation was used to increase remembered enjoyment of a food item. A cover story was also used to examine if increasing remembered enjoyment resulted in a change to food choice. Food choice was examined the following day by instructing participants to choose lunch from a buffet selection, which included the food item that had been manipulated in memory. If remembered enjoyment is a determinant of food choice, then it was hypothesised that participants would choose a significantly greater amount of the food, due to the increase in remembered enjoyment.

The food item used in the present study was a vegetable quiche, which was chosen as it is a multi-component food item (enabling enjoyable aspects to be rehearsed) and was fairly well liked in a pilot study. To distract participants from the true aims of the study, participants were led to believe they were participating in study examining how lunch intake affects mood. During the first session participants were informed they needed to complete a questionnaire to examine if they were suitable for the study and were asked to sample some foods (including the vegetable quiche) that may be involved in the second session the following day. The experimental manipulation of rehearsing the enjoyable aspects of the vegetable quiche was then completed and was hidden within a 'feedback questionnaire'.

A control group for exposure to general rehearsal of the recently eaten quiche completed the same procedure. Here participants were instructed to think back to eating the quiche and list the ingredients they ate and how long it took them to eat the quiche. It was decided to only use the general rehearsal control group as in the previous study (Study 4) no differences were observed between control groups. In the second session, participants were asked to select some lunch from a buffet (which included the quiche) to eat as part of the 'mood' study. At the end of the study, a manipulation check was used to examine if remembered enjoyment for the quiche consumed in the first session had been altered in the experimental group. We hypothesised that the manipulation would result in an increase in quiche selected from the buffet as a consequence of the change to remembered enjoyment.

3.3.2 Method

Participants

Thirty seven psychology undergraduates (32 females and 5 males; mean age = 20.1years, s.d = 2.8; mean BMI = 22.6, s.d = 3.9) participated in exchange for course credit. The mean restraint score was 6.5 (s.d = 4.9). The experiment was advertised as a two-part study on 'Social emotions, mood and food'. The study protocol was approved by the University of Birmingham Research Ethics Committee.

Experimental groups

Participants were assigned to one of two conditions:

a) Enjoyable aspects of meal rehearsal (experimental), n = 16: for the final question in the mock test food questionnaire, participants in this group were asked to '*Please write down your thoughts on what was enjoyable about the Mediterranean Quiche.'*

b) *Neutral meal rehearsal (control), n =16*: for the final question in the mock test food questionnaire, participants in this group were asked to *'Think back to eating the Mediterranean Quiche. Please write down the ingredients in it and how long it took you to eat it.'*

Test Foods

In session 1, all participants were served three test foods to eat. They rated enjoyment for the foods and were informed that the foods may be used in the second session. The foods were: 2 mini cheese and onion pastries, 2 mini sausages and a serving of feta, red pepper and spinach quiche. All foods were sourced from Sainsbury's, UK. In session 2, all participants were required to choose lunch from a buffet. The buffet foods were served on individual plates. The plates were approximately half full as though to appear as if earlier participants had chosen foods from them and we had not restocked or measured the amount taken.

There were 6 foods in the buffet; 6 x mini cheese and onion pastries (69.1 grams, 343kcals per 100g), 16 x mini sausages (97.8 grams, 295kcals per 100g), 6 x slices of feta, red pepper and spinach quiche (150 grams, 222kcals per 100g), 4 x roast chicken and stuffing sandwich quarters (78.8 grams, 150kcals per 100g), 16 x carrot sticks (79.3 grams, calories, 26kcals per 100g) and 14 x tortilla chips (25.8 grams, 495kcals per 100g).

Measures

Mock suitability measure (Need for Cognition questionnaire; Cacioppo & Petty, 1982): This measure includes 18 five-point likert scaled (strongly disagree – strongly agree) personality questions concerning the degree to which individuals enjoy and actively engage in thinking. It was described as a screening questionnaire in the first session that we were using for suitability for participation in the 'mood' study the next day in the second session. We included this personality measure to corroborate the cover story and distract attention away from the aims of the study.

Test food rating questionnaire: This questionnaire asked participants to eat and rate each of the three test foods that were provided in the first session. Participants were asked to eat and then rate each individual item; cheese and onion pastries, sausages and quiche on separate 10cm V.A.S (i.e. *How enjoyable was the sausage?*); anchors (from left to right) – *'not at all enjoyable'* and *'extremely enjoyable.'*

Memory manipulation 'Test food' questionnaire: Here participants were asked three questions about the recently sampled test foods: Q1 and Q2: *'I have eaten Cocktail Sausages before'* and *'Cheese and onion pastries are fairly common'*, both 5 point likert scaled response formats; strongly disagree to strongly agree. Q3 varied dependent on experimental condition (*see experimental groups*). Q3 permitted for five lines of writing space.

Manipulation check questions: Participants were asked here to think back to test foods in the previous session and rate how enjoyable they were using the same scales as in the test food rating questionnaire.

Procedure

Sessions took place on weekdays at lunchtime. Participants were informed by the experimenter that a study was being run to examine how food intake and mood interact and that the first session was to check that participants were suitable to take part. They were assured that most participants were likely to be able to take part in the second session that would involve eating a lunch time meal. Participants were then seated alone in the laboratory. After answering questions on demographics, and rating baseline hunger ('*how hungry are your right now?*' 10cm V.A.S, anchors from left to right; *'not at all'* and *'extremely'*), participants were provided with the *mock suitability measure*. On completion of the scales, the experimenter returned with the three test foods and left participants alone with the foods and *test food rating questionnaire* to eat and rate the three test foods.

After participants had eaten and rated the three test foods, the experimenter returned to remove the plates and questionnaire. Shortly afterwards, the experimenter returned and provided participants with the *memory manipulation test food questionnaire*, which included the experimental manipulations. Participants were left for three minutes to complete the questions. On completion, the experimenter informed participants that their score on the mock suitability measure was fine and that they should return the following day at the same time.

Participants arrived for the second session twenty four hours later and were seated alone in the laboratory. To further corroborate the study cover, participants completed an 18 item self esteem scale (Rosenberg, 1964) and then completed ratings of how awake, nervous, hungry, excited and stressed they felt by circling 'not at all', 'quite' or 'very' for each item. Participants were then asked to eat some lunch before completing further mood ratings. Participants were then taken to a kitchen area, where the buffet was located. After being informed to choose whatever they wanted and provided with a plate, the experimenter then informed participants that they should take the food back to the laboratory to eat.

To corroborate the cover story, participants were then informed that the second set of mood ratings would be left in laboratory and that it was important that they completed them as soon as they finished eating. The experimenter was not present during food selection or eating. After eating their chosen lunch from the buffet and completing the mood ratings, participants were provided with the cognitive restraint scale (Stunkard & Messick, 1985), before being asked to guess the aims of the study and debriefed. The *manipulation check questions* were then administered. Weight and height were measured using electronic digital scales and a stadiometer to calculate BMI (kg/metres). The experimenter then calculated the amount of each food item selected from the buffet and noted down if any food items chosen were not consumed.

3.3.3 Analysis

Independent sample t-tests were used to examine if groups were matched for hunger prior to food selections, BMI, restraint, age and online liking for the test foods sampled in

session 1. To examine whether the manipulation had an effect on food choice, independent sample t-tests were used to examine between group differences for choice and intake of the 6 test foods. Similarly, independent sample t-tests were used to examine between group differences on remembered enjoyment of the food items that was measured in the manipulation check.

3.3.4 Results

Sample Characteristics

No participants came close to guessing the aims of the study. One participant failed to return for the second session and two participants included rehearsal of negative aspects of the quiche in the experimental condition and so they were removed from analyses.

T-tests indicated that the two groups did not significantly differ for age [$t(32) = 0.73$, $p = 0.47$], hunger [$t(32) = 0.59$, $p = 0.56$], BMI [$t(32) = 1.02$, $p = 0.32$] and restraint [$t(32) = 0.07$, $p = 0.95$].

Experimental condition (values refer to means); age in years = 19.7, s.d = 2.5, BMI = 22.0, s.d = 3.2, restraint, score of 0-21= 6.4, s.d = 4.0, hunger, 0-10cm line scale = 7.1cm, s.d = 1.3. Control condition; age = 20.5, s.d = 3.1, BMI = 23.1, s.d = 3.4, restraint = 6.5, s.d = 5.8, hunger = 6.8, s.d = 1.4.

Online enjoyment

The two groups did not significantly differ for online enjoyment of the quiche and two other test foods in session 1. See Table 3.3.

Manipulation check

Analysis indicated that participants in the experimental group had a significantly higher remembered enjoyment for the Mediterranean quiche in comparison to controls suggesting that the manipulation was effective. See Table 3.3.

Table 3.3

Online and remembered enjoyment of food items by condition for Study 5

	Experimental condition (n= 17)	**Control condition** (n=17)	**T-test results** (df = 32)
Quiche online enjoyment	*5.2(2.6)*	*4.5 (2.6)*	*t = 0.85, p = 0.40*
Sausage online enjoyment	*6.4 (1.9)*	*5.8 (2.5)*	*t = 0.81, p = 0.42*
Pastry online enjoyment	*5.1 (2.7)*	*5.6 (1.3)*	*t = 0.63, p = 0.53*
Quiche remembered enjoyment	*5.8 (2.7)**	*3.9 (2.6)**	*t = 2.0, p < 0.05**
Sausage remembered enjoyment	*6.3 (1.5)*	*5.9 (2.5)*	*t= 0.53, p = 0.60*
Pastry remembered enjoyment	*5.2 (2.9)*	*5.5 (1.8)*	*t= 0.25, p = 0.80*

*Note: Values refer to means. Standard deviations are presented in brackets. * indicates score is significantly different from experimental group. Table values: Enjoyment ratings, 0-10cm scale, anchors; 'not at all enjoyable' and 'extremely enjoyable'.*

Food choice and intake

Analysis indicated that participants in the experimental group chose significantly more quiche than participants in the control group. No differences were observed for the other 5

buffet foods. In addition, as all participants finished all of the lunch they chose, intake data is exactly the same to that of food choice. See Table 3.4.

Table 3.4

Amount chosen and consumed of foods by condition (grams) for Study 5

	Experimental condition (n= 17)	**Control condition** (n=17)	**T-test results** (df = 32)
Quiche	*37.7 (21.9)**	*19. 7 (23.6)**	*t= 2.31, p <0.05**
Pastry	*16.8 (15.1)*	*11.0 (9.5)*	*t = 1.34, p =0.19*
Sausage	*19.2 (10.9)*	*16.2 (10.7)*	*t = 0.81, p = 0.43*
Sandwich	*24.3 (16.4)*	*28.9 (15.8)*	*t = 0.84, p = 0.41*
Tortilla chips	*5.3 (5.2)*	*6.0 (3.8)*	*t = 0.42, p = 0.68*
Carrot sticks	*14.3 (6.5)*	*18.9 (12.4)*	*t = 1.37, p = 0.18*

*Values refer to means. * indicates score is significantly different from experimental group*

Frequency of choice

Post-hoc it was decided to examine frequency of choice of the food item of interest (vegetable quiche). In the experimental condition 87% (15/17) participants selected quiche and in the control condition 44% (8/18) participants selected the quiche. In line with the mean grams chosen data, descriptive statistics suggest frequency of quiche choice was

highest in the experimental condition compared to control. A chi square analysis confirmed this, indicated there was a significant association between condition and choice of quiche; x^2 (1) = 6.6, p = 0.01.

3.3.5 Discussion

Although there was no difference between the groups for online enjoyment, after thinking about the enjoyable aspects of a recently eaten food item participants chose and ate a significantly larger amount of that food as part of a lunchtime meal than controls twenty four hours later. In line with the findings of the Study 4, a manipulation check after the lunchtime meal indicated that participants who had rehearsed the enjoyable aspects of the food item remembered it to be significantly more enjoyable (in the previous session) than controls.

It is unlikely that the observed effects are due to simple demand characteristics. The effect was found to be food type specific; the two groups were well balanced for intake and remembered enjoyment of other food items that were not subject to the experimental manipulation. This suggests that our manipulation did not just prime participants to like any food that they had previously eaten in our laboratory and that the manipulation was only affecting the food item of interest. The elaborate cover story used is also of importance, as it made the true aims of the study well hidden, again reducing any impact of possible demand characteristics. Finally, the study has a further strength as it was designed to lead participants to believe that we were not interested in food choices and this manipulation appeared to work, as participants were not aware of the study aims when later questioned.

In line with previous research that has linked memory and future behaviour (Redelmeir & Kahneman, 2003), the results indicate that remembered enjoyment can be an important determinant of food choice and in the present study it appeared to be of more importance than online enjoyment. These findings are also of interest as they indicate that manipulations of remembered enjoyment may have practical application. The strength of the effect on food choice observed in the present study is also worthy of note, as the experimental manipulation resulted in participants consuming close to twice the amount that the control group ate.

3.4 CHAPTER 3: GENERAL DISCUSSION

In Study 4, after thinking about the enjoyable aspects of eating a food shortly after consumption, participants remembered the food to be significantly more enjoyable than controls. These findings suggest that remembered enjoyment for a food can be changed. In Study 5 the same manipulation was used to examine if the change to remembered enjoyment affected food choice. As hypothesised, the increase in remembered enjoyment was associated with a greater amount of that food being chosen and eaten. This finding is consistent with the idea that episodic memory of remembered enjoyment plays an important role in food choice.

The exact processes behind the effects observed in the present study are hard to confidently pin down. It is proposed that writing about the enjoyable aspects of the meal strengthened consolidation of those episodic elements, resulting in those parts of the experience having greater weighting in later memory evaluation. The finding that the majority of episodic elements of experiences normally fade rapidly with time (unless rehearsed) supports this premise (Conway, 2009). Moreover, this interpretation is in line with consolidation theory, which suggests that a post experience window exists whereby hormonal and cognitive influences may alter memory representation (Muller & Pilzecker, 1900; McGaugh, 2000).

Alternatively, the manipulation may also result in reinterpretation of moments from the recent experience, whereby individuals re-evaluate parts of the experience more positively, which results in a change to episodic memory. Regardless of exact mechanism by which

episodic memory is changed, the effect on food choice in Study 5 and changes to remembered enjoyment across both studies suggests that altering memory is likely to have behavioural consequences on food choice. Further work tracing how the manipulation exactly distorts episodic memory would be of interest.

The strength of the effect observed on memory and food choice is also of note since the experimental group choose close to twice the amount of the control group. This suggests that the manipulation may be of practical use to increase food liking and intake. Although we did observe an interesting effect on food choice (presumably because the change in episodic memory resulted in participants expecting the quiche to be more enjoyable than controls), how long such effects might last is a question that remains unclear. Does a positive or negative experience with a food alter expected enjoyment of that food days or weeks afterwards? In the following chapter, further studies are reported which were designed to address this question.

CHAPTER 4: EFFECTS OF A DISAPPOINTING EATING EXPERIENCE ON FUTURE FOOD LIKING

4.1 INTRODUCTION

The findings from Chapters 2 and 3 suggest that episodic memory may be an important determinant of food choice. If episodic memory guides decisions about food, then a particularly positive or negative experience with a food should result in an individual altering their appraisals of how much they like the food (as they would be relying on their memory of the negative experience). Study 6 in this thesis provides a final test of the hypothesis that episodic memory informs food choice by giving participants a disappointing experience with a food and then examining whether this affected their imagined liking of the food in the future. The study also examines how long such an effect may last. Study 7 was designed to investigate whether the effects of a disappointing food experience on food choice can have longer lasting consequences on liking (up to a week afterwards).

4.2 STUDY 6: THE EFFECT OF A DISAPPOINTING EXPERIENCE ON FOOD LIKING

4.2.1 Introduction

Episodic memory is proposed to be of particular importance to short term goal directed behaviour (Conway, 2009). Data suggests that when asked to make affective judgements, individuals tend to rely on one of two different types of information stemming from different memory systems – 'experiential'/episodic information and 'semantic' information (Robinson & Clore, 2002a; 2002b; 2007). Robinson and Clore (2002a) suggest that episodic information tends to be used to make affective evaluations in recent time frames (i.e. last few days), rather than wider time frames (last few weeks), due to accessibility. When asked how happy one was yesterday, one can recall memories of yesterday quite easily to make the evaluation. If asked how happy one was a month ago, this process is far more difficult. This is likely to be because episodic memory fades quickly and becomes more difficult to access over time (Tulving, 1985; Conway, 2009). Thus, it is proposed that when episodic memory is no longer accessible, individuals are likely to be more reliant on semantic or general beliefs to make decisions (Robinson & Clore, 2002a; 2002b; 2007).

As forecasts of predicted enjoyment and choice behaviour are reliant on memory systems, then we might expect to see similar patterns of behaviour when making decisions about food. In the context of food choice, if episodic memory is important one would hypothesise that a recent negative experience with a food would result in individuals using such information to inform food choice in the near future (as episodic memory is

accessible). If the present study were to find evidence of this it would be further strong evidence for a role for episodic memory in food choice. However, as this time period extends, individuals may become more reliant on semantic knowledge concerning the food and be less likely to use episodic memory for the recent experience. Whether the recent experience may 'update' semantic knowledge and still have some effect on food choice is unclear, but as semantic knowledge is thought to be fairly rigid and not easily changeable, such updating may not always occur (Swann & Schroeder, 1995).

Study 6 was designed to address these questions. Participants attended three sessions under the guise of participating in three separate studies. In the first session, participants were asked to consume and rate their enjoyment of five snack food items (these items were chosen as they were shown to be of low quality in a pilot study). Prior to this, participants had also rated 'general liking' for a long list of food items (which included the 5 foods above). Using the individual participant's general liking and online enjoyment rating of the five foods, the snack food that was the most disappointing was selected. Hidden within a cover study, participants then rated liking of the disappointing food, either at one day or one week after the first session. Two control conditions were included, in which participants rated liking of a food at one day or one week, but did not have a disappointing experience.

It was hypothesised that there would be no difference between the two control conditions. The main hypothesis was that there would be a fall in liking for the one day condition, as participants would be using the episodic memory of the disappointing experience to inform liking. It was also tentatively hypothesised this fall in liking would not be observed for the

one week experimental condition, as participants would no longer rely on the episodic memory and switch to semantic memory.

4.2.2 Method

Participants

Eighty six students participated in exchange for course credit (69 females and 17 males, mean age = 20.6 yrs old, s.d =3.4). Participants were asked not eat for one hour prior to the study to ensure similar levels of hunger. Participants gave informed signed consent and the protocol was approved by the University of Birmingham Research Ethics Committee.

Outline

Participants attended three sessions. Cover stories were used to give the impression that the sessions were unrelated. In the first session, participants rated how much they liked five snack foods to give a measure of baseline liking. They then ate and rated samples of those foods to give a measure of online liking. For each participant, the snack food that produced the most disappointing experience (defined as an online rating lower than baseline liking) was selected as the target food (the *'Disappointing Food'*). Participants returned for two sessions at one day and one week later. In one of these sessions (*Later Liking Session*) participants completed a measure of liking for the *Disappointing Food*. In the other session (*Questionnaire Session*) they completed a questionnaire measuring dietary restraint and had their BMI measured. Thus, experimental participants rated liking for a food they had had a disappointing experience with, either one day previously, or one week previously. Two control groups followed the same procedure, but consumed different foods to the experimental participants at the first session. Hence, they rated the

same foods as the experimental participants in the *Later Liking Session* but had not previously had a disappointing experience with these foods at Session 1. Sessions took place between 10am and 12pm and 2pm and 5pm on weekdays. The first session for all participants was the *'Food Tasting Session'*. The order in which participants completed the next two sessions was dependent on condition.

Conditions

1) One day (experimental): Participants in this group consumed and rated five snack foods (in order); a jaffa cake, three pieces of toffee popcorn, a piece of shortbread, a piece of white chocolate and a chocolate chip cookie. One day later they completed the *Later Liking Session* in which they completed a measure of liking for the '*Disappointing Food*'. To disguise the study aims, this measure was hidden among a number of other questions. One week later participants completed the *Questionnaire Session*.

2) One week (experimental): Participants consumed and rated the same foods as the one day experimental group. They then completed the *Questionnaire Session* one day later and the *Later Liking Session* one week later.

Control Conditions

The two control groups followed the same procedure as the two experimental groups but consumed different snack foods during session 1 (in order); a digestive biscuit, piece of milk chocolate, a fig roll, a 'jammy dodger' biscuit and a cereal bar. Thus, control participants did not consume the food they would rate for later liking.

Session 1 (Food Tasting Session):

Participants were informed that the study was examining personality and food liking. Demographic questions were completed before rating baseline hunger (‘*how hungry are your right now?’* on a 10cm V.A.S, with anchors; ‘not at all’ and ‘extremely’). Participants then rated baseline liking; *‘how much you enjoy eating the following foods?’* on separate 10cm V.AS (anchors from left to right; ‘not at all enjoyable’ and ‘extremely enjoyable’). To corroborate the cover story participants completed 10 five-point personality questions (e.g. ‘I am confident in life’; anchors - strongly disagree to strongly agree).

The experimenter presented the five foods on individual plates and provided participants with a rating questionnaire. Participants were instructed ‘*In the next section you are required to eat each food item and then rate how much you enjoyed it before moving onto the next item. Please eat the foods in the order shown below’;* Again participants made ratings on a 10cm V.A.S, with anchors from left to right (not at all enjoyable and extremely enjoyable), see ‘*Conditions*’ for order in which food was eaten.

Target Foods

Disappointment was calculated by subtracting online liking of each snack food from its baseline liking score. The item producing the largest negative mismatch was selected as the *Disappointing Food*. For example, if a participant had a baseline liking of white chocolate as 8.0 and their online liking of the white chocolate they consumed was 6.0, they would have a mismatch of -2 and, if this was the largest mismatch of all 5 food items, white chocolate would be selected as the disappointing food. The disappointing foods did not differ by condition: one day condition, cookie n=6, shortbread n=8, toffee popcorn

n=3, jaffa cake n=5; one week condition, cookie n=8, shortbread n= 5, toffee popcorn n=2, jaffa cake n=3, white chocolate n=4.

The target foods rated by control participants were matched to the foods selected for the experimental group, i.e. if the disappointing food for participant 5 in the condition: *one day (experimental)* was white chocolate, participant 5 in the condition: *one day (control)* also rated white chocolate.

Later Liking Session:

Participants were informed that they would be completing a study examining consumer food attitudes. They rated hunger, before completing 9 attitude questions using five-point likert scaled response formats (e.g. *'I don't like cheap products'*; anchors - strongly disagree and strongly agree). Participants were then asked imagine entering a newly opened food store. To corroborate the cover story, five questions asked how tempted participants thought they would be by hypothetical special offer price reductions.

Participants were then instructed to imagine being offered several foods in the supermarket and rate their liking for the foods; '*You are now shown to a free food sampling area. You see the following foods and drinks. How enjoyable do you think the following would be to eat?* Using the same 10cm V.A.S as in the first session (anchors from left to right; 'not at all enjoyable' and 'extremely enjoyable'), participants rated liking for 6 foods. The second food item was the *'Disappointing Food'*, which was specific for each participant. The other five were a glass of orange juice, cheddar cheese, a doughnut, a piece of sausage and a glass of grape juice.

Participants were then asked to guess the study aims. Finally, to examine whether the one day and one week experimental participants had an accurate memory of their experience with the *Disappointing Food,* they were asked to *'think back to the first session, how enjoyable were the foods you ate?'* on 10cm V.A.S (anchors from left to right; 'not at all enjoyable' and 'extremely enjoyable').

Questionnaire session:

Participants were informed that they were taking part in a questionnaire validation study. First, participants completed the cognitive restraint scale of the TFEQ (Stunkard & Messick, 1985), to check that the groups were matched for restraint Participants also completed a Need for Cognition scale; a measure comprising of 18 five-point likert questions that measure individual's enjoyment of thought and problem solving (Cacioppo & Petty, 1982). This measure was included to corroborate the cover story. At the end of the final session, weight and height were measured to calculate BMI (kg/metres^2) and participants were thanked for their time, before being debriefed.

4.2.3 Analysis

ANOVA was used to check that the groups were matched for baseline liking, hunger at the *Later Liking session*, BMI, age and cognitive restraint. A t-test was used to test whether the experimental groups had a similarly disappointing experience with their *Disappointing Food*. To assess whether participants liking scores changed over time, the change in liking was computed for each participant, by subtracting the later liking score (measured at one day or one week) from the baseline liking score and analysed by ANOVA.

4.2.4 Results

Sample Characteristics

No participants guessed the study aims. Mean BMI = 20.5, s.d. = 3.3. The groups did not differ for mean baseline liking of the target food [$F(3,82) = 0.50$, $p = 0.69$], hunger at the later liking session[$F(3,82) = 1.99$, $p = 0.12$], age [$F(3,52) = 0.77$, $p = 0.52$] , restraint score [$F(3,82) = 2.16$, $p = 0.10$] and BMI [$F(3,82) = 0.78$, $p = 0.51$]. See Table 4.1

Online Enjoyment of Disappointing Food

The two experimental groups did not significantly differ in the extent of their disappointing experiences with the target food [$t(42) = 1.2$, $p = 0.23$] (Table 4.2).

Change in Liking of Target Food

There was a significant effect of group on change in liking [$F(3,82) = 3.80$, $p < 0.05$]. Participants in the one day (experimental) group had a significantly greater change in liking of the target food ($p<0.05$) than one week (experimental), one day (control) and one week (control) and this change in liking was significantly different from 0 [one sample t-test: $t(21) = 4.6$, $p <0.05$]. No other significant between group differences were observed Table 4.2.

Table 4.1

Participant characteristics by condition for Study 6

	Hunger	Age	BMI	Restraint
One day (experimental), n = 22	4.3 (2.8)	19.4 (1.9)	22.4 (2.5)	6.8 (5.1)
One week (experimental), n = 22	5.5 (2.3)	19.9 (1.4)	22.1 (2.8)	6.0 (4.5)
One day (control), n = 21	3.8 (2.0)	21.5 (3.4)	23.2 (2.8)	9.4 (6.2)
One day (control), n = 21	4.8 (2.6)	22.4 (4.7)	23.3 (4.0)	5.9 (5.1)

Table values, *Values refer to means**:** Hunger ratings (0-10cm line scale), anchors; 'not at all hungry' and 'extremely hungry' (standard deviations in brackets).Age in years. Restraint = 0-21 questionnaire score.*

Table 4.2

Target food liking ratings by condition for Study 6

	Baseline liking (0-10cm score)	Mismatch between online liking and baseline (0-10cm score)	Change in liking (0-10cm score)
One day (experimental), n = 22	7.7 (2.1)	-2.5 (1.7)	-1.8 (1.8)
One week (experimental), n = 22	7.8 (2.0)	-2.0 (1.2)	-0.5 (2.0)*
One day (control), n = 21	7.2 (1.8)	N/A	- 0.1 (1.9)*
One day (control), n = 21	7.3 (2.0)	N/A	- 0.6 (1.2)*

Values refer to means. All values in cm.*indicates significant difference at $p < 0.05$ to one day (experimental) group (standard deviations in brackets). *Table values: liking ratings, 0-10cm scale, anchors; 'not at all enjoyable' and 'extremely enjoyable'.*

Memory Accuracy

One explanation for why the one day (experimental) group differed in change in liking to the one week (experimental) group is that over a week remembered liking of the disappointing food became inaccurate. Thus, we compared the experimental groups on their memory accuracy by subtracting online liking from remembered liking. The one day (experimental) and one week (experimental) did not differ on this score (mean accuracy score one day = 0.34cm, s.d. = 1.2; one week = 0.76cm, s.d. = 1.6, $t(42) = 1.0$, $p = 0.32$).

Food Eaten & Change in Liking

According to participant self report data, a small number of participants had consumed their 'disappointing' food (this was only evident for participants that had been assigned to chocolate chip cookie) in between session 1 and the later liking session in the one week experimental condition. Conceivably, these consumption experiences may have been responsible for the lack of an observed fall in liking in this condition. ANOVA was computed to examine whether fall in liking varied across disappointing foods (for participants in the one week experimental condition). Results indicated that test foods did not significantly differ in fall in liking [$F(4,17) = 0.23$, $p = 0.92$], indicating that the null effect one week after a disappointing experience was unlikely to be due to a small number of participants consuming a chocolate chip cookie in between sessions.

4.2.5 Discussion

One day after a disappointing experience with a food, participants exhibited a significant fall in a measure of liking of the food in comparison to controls who did not consume the food. In addition, these participants showed a significantly larger fall than another group

that followed the exact same procedure, but instead rated liking at one week after the disappointing experience. The other main finding of note was that fall in liking did not differ between controls at one week and the group which had disappointing experience and rated liking at one week.

Collectively these findings support the notion that episodic memory is likely to be of importance when making decisions about how much one likes a food and will enjoy eating it (if an example of an experience has occurred recently). The results suggest that one day after a disappointing experience, individuals were using their memory of the recent experience when rating liking for the food. One week after the experience participants appeared to be no longer relying on their memory of the experience. This suggests that episodic memory may be of particular importance when a recent experience with the food has occurred, although over longer time frames individuals may rely on different information to inform liking. These data are also in line with suggestions that the episodic memory system may guide shorter term goal orientated behaviour (Conway, 2009; Higgs, 2002).

The use of two control groups provides support for this interpretation. The lack of difference in fall in liking between the two control groups suggests that the disappointing consumption experience with the food that appears to be of importance. Furthermore, the finding that no difference was observed between our two control groups that rated liking at one day and one week suggests that the difference observed between our two experimental groups is unlikely to be due to demand characteristics or order effects. The difference between the two experimental groups is proposed to be due to the two accessing different

information from memory; participants at one day after the experience using the recent experience to guide liking and participants at one week were not.

As our groups were well balanced for key variables of interest the observed between group differences are likely to be due to our experimental manipulation of time between disappointing experience and rated liking. However, one potential explanation for why the one day experimental group may differ from one week could be that they are still using the same episodic memory, but differ in how enjoyable they remember the food to have been. For example, over the course of a week, remembered enjoyment of the food may have increased. We compared these two groups on how accurate their remembered enjoyment for the food was and found no difference, which suggests such an explanation can be discounted.

An intriguing question is why individuals no longer relied on their disappointing experience with the food type when rating liking one week later. If episodic memory really is the key system involved in future forecasting, then one might hypothesise that participants reverted to a more memorable experience with the food type. Alternatively, semantic memory may have been important at one week. Thus, it may be that once episodic memory becomes less accessible, individuals switch to more semantic generalised beliefs about experience in question, to guide rated liking. If this is the case, in the present study, one negative experience with the food was not sufficient to update these beliefs about food enjoyment.

Further examination of the conditions under which episodic memory of food may update beliefs about liking in the long term would be of interest. There is evidence to suggest that early life experiences with foods may be particularly important in the acquisition of likes and dislikes (Skinner et al. 1992; Rollins, Lokin & Birch, 2010), which suggests early episodic experiences with food may be especially important in shaping beliefs about liking. In support of this, once individuals have developed self knowledge, (i.e. how much one likes or dislikes a stimulus), it is thought to be fairly rigid to long term changes via experience (Swann & Schroeder, 1995; Epstein, 1973). This may explain why we did not observe a fall in liking for participants that rated liking one week after their disappointing experience in the present study. Study 7 was therefore designed to examine whether changes to liking could be observed one week after a disappointing experience.

4.3 STUDY 7: THE EFFECT OF A DISAPPOINTING EXPERIENCE ON FOOD LIKING AS A FUNCTION OF FOOD FAMILIARITY

4.3.1 Introduction

The data from Study 6 suggest that a single disappointing experience with a food did not influence food choice at one week, presumably because episodic memory was no longer being used and participants switched to using semantic knowledge (Robinson & Clore, 2002; 2002b). If participants did switch to semantic knowledge, it would appear that the disappointing experience did not result in them updating their semantic knowledge about liking (as liking was similar to controls who did not have a disappointing experience). This raises an interesting question of under what conditions can episodic memory have longer lasting consequences on liking. It is likely that semantic memory/knowledge for liking of a food are based at least in part on our previous encounters, thus one function of episodic memory may be to update semantic memory (Klein, Cosmides, Gangi, Jackson & Tooby, 2009). As generalised beliefs are thought to be rigid and rarely updated (Swann & Schroeder, 1995; Robinson & Clore, 2002a), it may be that episodic memory of an eating experience may only serve to update semantic knowledge under certain conditions. One such condition may be if a person has had too few experiences to develop rigid semantic knowledge about their liking for an experience.

In Study 7 it was examined if a disappointing experience with a food can influence beliefs about liking of that food one week later, with either a familiar or novel target food. If a food is relatively novel individuals will have had little opportunity to form semantic knowledge concerning liking. It was hypothesised that due to this, novel foods may be

more prone to changes in liking as a result of a disappointing experience. Conversely, semantic knowledge for liking of familiar foods would already be developed and therefore more resistant to change when measured a week later. A similar paradigm was used as in Study 6, although liking was only measured only one week after a disappointing experience and participants either had a disappointing experience with a novel food or a familiar food. Liking was not measured one day after consumption as the aim of study 7 was to examine the long term effects episodic memory could have on food liking, through updating semantic knowledge/memory.

4.3.2 Method

Participants

Forty eight students participated in exchange for course credit (45 females and 3 males, mean age = 19.7 yrs old, s.d. =1.6, mean BMI = 22.1, s.d. = 2.6). The study was advertised as examining 'Taste preferences and personality'. Participants were instructed not to eat in the hour before the study to ensure similar levels of hunger across conditions. Sessions took place between 10am and 12pm and 1pm and 5pm on weekdays. Participants gave informed signed consent and the study protocol was approved by the University of Birmingham Research Ethics Committee.

Study Overview

Participants attended two sessions, a week apart. In the first session participants rated baseline liking for a list of foods, which included 5 novel and 5 familiar foods. Dependent on condition, participants then consumed either 5 novel foods or 5 familiar foods (from the list they rated baseline liking for). Low quality versions of foods were selected in order to

produce a disappointing experience (see Study 6 for reference to 'disappointing'). One week later participants returned and rated liking using the same list, as in the first session. The food which produced the most disappointing experience in session 1 was selected as a participants target food. Thus, change in liking due to a disappointing experience could be observed for the target food from session 1 to session 2 and whether food familiarity (i.e. whether the food consumed was novel or familiar) moderated any change in liking could be examined.

Experimental Groups

Familiar Food Group: Participants sampled five commonly consumed snack foods at the first session. These were the same foods as used for Study 6. A pilot study indicated that these foods were commonly consumed, thus they were selected as relatively 'Familiar' foods.

Novel Food Group: Participants sampled five unfamiliar snack foods at the first session (one tablet of chilli chocolate, half an amaretti biscuit, half a lemon cookie, half a chocolate tea cake and two dried apricots). A pilot study indicated that these foods are not frequently consumed by the study population, thus they were defined as 'Novel' foods.

Session 1

Session 1 was advertised as a study on personality and food preferences. Demographic questions were completed before rating baseline hunger and baseline liking for 10 food items (same scales as used Study 6). The foods were: dried apricot, toffee popcorn, jaffa cakes, lemon cookies, chocolate with chilli, shortbread, chocolate chip cookies, amaretti

biscuits and chocolate tea cakes and were rated in the order above. Participants then rated how often they ate each of the foods by ticking one of 9 boxes (anchors; 'never' and 'once a day'), resulting in a frequency of consumption score of 1-9. The experimenter then returned with five test foods on individual plates and provided participants with a rating questionnaire as in Study 6.

Target & control foods

The disappointing food was selected in the same way as described for Study 6.

To examine whether there was any change in general liking for novel and familiar foods across the two sessions in the absence of disappointing experience with those foods, participants in the experimental groups served as controls for each other. For example, if the disappointing food for participant one in the 'familiar food group' was milk chocolate, the fall in general liking for milk chocolate of participant one from the 'novel food group' served as the control. Thus, we could examine the extent to which general liking of a familiar food differed at session 2 to session 1 for a group of participants that did not have a disappointing experience with the familiar food (participants from the 'novel food group'). We could also examine the extent to which general liking of a novel food differed from session 1 to session 2 for a group of participants that did not have a disappointing experience with a novel food (participants from the 'familiar food group').

Session 2

To corroborate the cover study, at the start of the second session participants completed 10 personality questions (e.g. 'I never give up in life', 10cm V.A.S, anchors; 'disagree' and 'agree'), before rating their hunger (same scale as session 1). Participants then completed

liking for the 10 food items, using the same measure as in session 1. The cognitive restraint scale was then completed and participants were then asked to *'think back to the first session, how enjoyable were the foods you ate?'* on 10cm V.A.S (anchors from left to right; 'not at all enjoyable' and 'extremely enjoyable') for the five food items consumed in the first session; this was to examine whether the two groups had similar memory accuracy for the disappointing food (see Study 6 for explanation). Weight and height were measured before participants were asked to guess the aims of the study, debriefed and thanked for their time.

4.3.3 Analysis

T-tests examined if the groups differed in BMI, age, restraint and hunger at session 2 and whether the experimental groups had a similarly disappointing experience with the target food. Familiarity scores were compared for the novel and familiar foods. Change in liking was computed for each participant: baseline liking rating (rated in session 1) subtracted from liking rated in the second session (a week later). A 2x2 repeated measures ANOVA was used to examine change in liking across the four groups; *'Novel food - disappointing experience', 'Novel food – control' , 'Familiar food – disappointing experience', 'Familiar food – control.*

4.3.4 Results

One participant guessed the study aims and was removed. Seven participants did not have a disappointing experience with any of the foods they ate in session 1 and were also removed.

Participants in the novel and familiar groups did not differ in BMI [t(38) = 0.3, p = 0.98] restraint [t(38) = 1.0, p = 0.31], age [t(38) = 0.1, p = 0.96] and hunger [t(38) = 0.97, p = 0.34]. Novel group (mean values); BMI = 22.0, s.d = 3.2, hunger (0-10cm) = 5.8 , s.d = 2.6, age = 19.6, s.d = 2.1, restrain (0-21 score) = 7.6, s.d = 5.7. Familiar group (mean values); BMI = 22.1, s.d = 1.8, hunger (0-10cm)= 6.4, s.d = 1.7, age = 19.7, s.d = 1.3, restraint (0-21 score) = 9.4, s.d = 5.6.

The experimental group did not differ in how disappointing their experience was with their target foods [t(38) = 0.16, p = 0.95]. As expected, participants in the novel food group scored significantly lower on the frequency of consumption measure; 2.9 (s.d. = 1.5) than the familiar food group; 6.3 (s.d. = 1.9), [t(38) = 6.61, p < 0.01].

Baseline liking at session 1 differed between the familiar and novel food groups and was higher for the familiar than the novel food [t(38) = 5.1, p < 0.01] (See Table 4.3).

Change in liking of Target Food

There was no main effect of *Food Type (novel/familiar)* [F(1, 38) = 1.0, p = 0.33] but a main effect of *Eating Experience (disappointing/control)* [F(1, 38) = 9.53, p <0.01] and a significant interaction between Food Type and Eating Experience on change in liking of the target food [F(1, 38) = 7.64, p < 0.01]. The group '*Novel food – disappointing experience'* showed a significantly greater fall in liking than the three other groups; novel food no experience (t(38) = 2.34 , p < 0.05); familiar food disappointing experience (t(38) = 2.26 , p < 0.05) and familiar food no experience (t(38) = 3.79, p < 0.05). There were no other between group differences. This change in liking observed for the novel food

disappointing experience group was significantly different from 0 [one sample t-test: t (18) = 4.8, p <0.05].See Table 4.3

Table 4.3

Target food liking ratings by condition for Study 7

	Baseline liking (0-10cm score)	Mismatch between online liking and baseline (0-10cm score)	Change in liking (0-10cm score)
Novel food - disappointing experience, n = 19	6.4 (1.8)	-2.3 (1.3)	-1.80 (1.6)
Novel food - no experience	5.4 (3.0)	-	-0.64 (1.6)*
Familiar food - disappointing experience, n = 21	8.6 (1.0)*	- 2.2 (1.7)	-0.72 (1.3)*
Familiar food - no experience	8.3 (1.4)*	-	-0.25 (0.8)*

Values refer to means in cm's.*indicates significant difference at p < 0.05 to 'novel food disappointing experience' on measure. *Table values: liking ratings, 0-10cm scale, anchors; 'not at all enjoyable' and 'extremely enjoyable'*

As the novel and familiar groups differed in their baseline liking we tested whether this could account for the difference in change in liking between the novel and familiar group. Across the two experimental groups correlation showed that frequency of consumption (i.e. degree of food novelty) was significantly associated with change in liking (r(38) = 0.33, p <0.05), but baseline liking was not associated with change in liking (r(38) = 0.25, p = 0.12). Regression analyses produced similar results, whereby baseline liking did not even approach significance for predicting fall in liking ($\beta = 0.08$ p = 0.68). Thus, the fall in liking observed for the novel food group (but not for the familiar food group) is likely to

have been caused by participants' degree of previous consumption experience with the food and not initial difference in baseline liking.

Memory accuracy

The novel and familiar food groups did not differ in their accuracy for how much they enjoyed the *Disappointing Food* at session 1 (mean accuracy score novel food = 0.85cm, s.d. = 1.5; familiar food = 0.34cm, s.d. = 2.0, [$t(38) = 0.89$, $p = 0.38$]. This analysis was included as it may have been feasible that the two groups might differ in their remembered liking of their disappointing experiences (see Study 6).

Food Eaten & Change in Liking

As in Study 6, self report data indicated that a small number of participants had consumed their 'disappointing' food (only the chocolate chip cookie) in between session 1 and the later liking session in the familiar food condition. Conceivably, these consumption experiences may have been responsible for the lack of an observed fall in liking in this condition. ANOVA was computed to examine whether fall in liking varied across disappointing foods (for participants in the familiar food condition). Results indicated that no test foods differed significantly in fall in liking [$F(3,17) = 0.66$, $p = 0.59$], indicating that the null effect one week after a disappointing experience was unlikely to be due to a small number of participants consuming a chocolate chip cookie in between sessions.

4.3.5 Discussion

In line with the findings of Study 6, after a disappointing experience with a familiar food, participants liking of the food a week later was no different to that of a control group.

However, when the target food was novel, participants showed a significantly greater fall in liking than controls and the familiar food group. The two groups were well balanced for key variables and both had similarly disappointing experiences with their food. Thus, this change in liking due to a disappointing experience is likely to be associated with how much previous consumption experience participants had with the foods in question. Analysis suggested that although a minority of participants consumed their disappointing food in between sessions, this did not appear to be responsible for the observed pattern of results. In addition, the familiar and novel food conditions did not differ in their accuracy of remembered liking of the disappointing experience.

These findings are in line with the hypothesis that once individuals have developed self knowledge, (i.e. how much one likes or dislikes a stimulus), such self beliefs thought to be fairly rigid to change via experience (Swann & Schroeder, 1995). In support of this there is evidence that early life experiences with foods may be particularly important in the acquisition of likes and dislikes (Skinner et al. 1992; Rollins, Lokin & Birch, 2010), which also suggests early episodic experiences with food may be especially important in shaping beliefs about liking. Similarly, in the present study, episodic memory of the disappointing experience only served to inform liking at one week when a food was novel.

4.4 CHAPTER 4: GENERAL DISCUSSION

In Study 6 it was shown that a disappointing experience with a familiar food led to reduced liking for that food the next day but did not affect liking for that food when participants were asked one week later. These data suggest that episodic memory for past experiences is most likely to inform future though when an example of the experience in question has occurred recently. Over longer time periods (a week), individuals appear to be less likely to rely on the experience to guide decision making when the food is familiar.

The finding that episodic memory of the disappointing experience did not influence liking at one week in Study 6 raises an interesting question of the long term importance of episodic memories. Study 7 suggested that episodic memory may affect liking over longer time periods (up to a week) if individuals have not had chance to form beliefs about their food likes through multiple experiences. Indeed, it is generally assumed that preferences and likes/dislikes are based upon a collection of past experiences, but whether some experiences may be more important than others in shaping consumer beliefs about liking has not been investigated.

Further examination of the boundaries under which episodic memory update general beliefs would be of interest. For example, how many disappointing experiences with a food would be needed to change liking in the long term? An interesting question stemming from this is how episodic memories of past experiences are integrated to form stable generalised beliefs about liking. In the context of eating, early experiences with foods are thought to be especially important in the development and maintenance of likes and

dislikes (Skinner, 2002). Thus, in line with our the data from Study 7, it may be that beliefs about liking are strongly based upon early experiences which then become resistant to updating via episodic memory.

Although the studies in this chapter have a number of strengths, including stringent control groups and detailed cover stories, as with all studies there are some weaknesses. The research only focused on the effect that disappointing experiences with food has on liking. Other research should examine other products that individuals have frequent experiences with. Furthermore, examining whether similar changes to liking would be observed as a result of experiences that were surprisingly pleasant, rather than disappointing, would also be informative. Work by Napoleone, Conliffe, Hayes, Kneeland, Sullivan and Duffy (2007) has shown that sweetening vegetables increases acceptance in young children, which may be suggestive that producing positive episodic memories of a food could influence beliefs about liking.

An alternative explanation of the findings of Study 6 and 7 could be that changes in liking are as a result of conditioning (whereby individuals learn associatively about whether a food produces a pleasant or unpleasant response) rather than episodic memory acting on evaluations of liking. Yet, successful demonstrations of conditioning with food normally involve a large number of trials (Brunstrom, Downes & Higgs, 2001; Brunstrom, Higgs & Mitchell, 2005). Moreover, it has been recognised that even in multiple trial conditioning studies, producing consistent effects of increased liking in humans has previously proven difficult (Brunstrom et al. 2001; Gibson & Brunstrom, 2005). Here participants sampled a small amount of the targets foods on a single occasion. In addition, to produce a

conditioned effect on single exposure, the experience would have to be extremely pleasant or aversive (Coil et al. 1978). However, the ratings of enjoyment for the target foods such this was not the case, as online liking was still above midpoint on the rating scale, suggesting it wasn't an aversive experience. For further discussion of conditioning in relation to the findings of this thesis, see General Discussion of thesis.

Overall the data in both studies are also consistent with the suggestion in earlier chapters, that altering remembered liking of foods may be a way of increasing food choice. This may be especially applicable to the introduction of novel food products to children, as positive episodic memories may contribute to general beliefs about liking for that food and thus facilitate consumption.

CHAPTER 5: THE RELATIONSHIP BETWEEN ONLINE AND REMEMBERED ENJOYMENT OF EATING EXPERIENCES

5.1 INTRODUCTION

The findings from earlier chapters suggest that examining how individuals form memories of past enjoyment for foods may be informative, as remembered enjoyment may be an important determinant of food choice. One paper has previously examined the relationship between online and remembered enjoyment of food (Rode et al. 2007). This paper is first considered before two studies are reported in Chapter 5 which investigated the relationship between online enjoyment (enjoyment as one eats a food) and remembered enjoyment of eating experiences.

As discussed in the General Introduction to this thesis, research on remembered pain suggests that the relationship between online and remembered enjoyment/discomfort is complex (Redelmeier & Kahneman, 1996), with specific parts of the experience having a disproportionately large influence on memory (Ariely & Carmon, 2000). The final few moments (end effect) and most intense moments (peak effect) have been shown consistently to shape memory for painful experiences (Redelmeier & Kahneman, 1996; Redelmeier et al. 2003).

As both the experience of pain and pleasure are affective experiences, it could be hypothesised that a similar pattern of results might be expected for experienced and remembered enjoyment of positive affect. To date, relatively little research has addressed this question. Although recent studies by Rozin and Goldberg (2004) and Montgomery and

Unnava (2009) suggest similar processes may occur, a set of studies investigating remembered enjoyment of eating experiences reported by Rode et al. (2007) found little evidence for end or peak effects.

Research specifically examining online and remembered enjoyment of past eating experience is limited. Rogozenski and Moskowitz (1980) report a study in which they examined evaluations of hypothetical meals. The researchers had participants make individual ratings of enjoyment for dishes (including starters, main courses and dessert) and then later combined these dishes to form overall meals and asked participants to rate overall preference. The starters (first dish of the meal) had the largest effect on overall preference and accounted for close to 50% of variance in preference.

Anderson and Norman (1964) also report similar data. Participants rated liking for a number of food items and then from these items, the researchers constructed meals for participants to rate. If meals were manipulated so that the most pleasant dishes were at the start (rather than in reverse order), participants tended to rate the meal as being more appealing. These results are not predicted by the end effect bias. From these results it may be hypothesised that the first few moments of meal or food item may be particularly important in shaping food memories rather than the last few moments. Yet, these studies are not thorough tests of the relationship between remembered and experienced enjoyment. No meals were actually consumed and the cognitive processes involved in making judgements about imaginary meals are unclear. It may be that participants are imagining eating the meals in the future and then rating preference.

Research indicates that although forecasted enjoyment is reliant on memory, there are distinctions between remembered and imagined enjoyment (Van Boven & Ashworth, 2007; Gilbert & Wilson, 2005). For example, research by Soman (2003) suggests that when imagining future events, individuals tend to prefer sequences that start positively rather than ending on a positive note. One explanation for this is a natural tendency to favour shorter term gratification over longer term gains (Soman, 2003). Thus, although the Rogozenski and Moskowitz (1980) and Anderson and Norman (1964) studies are of interest, they are not tests of the relationship between actual and remembered enjoyment of eating experiences.

One paper that has attempted to directly address the relationship between experienced and remembered enjoyment of eating experiences is Rode et al. (2007). Across three studies the authors report that:

"Unlike the evidence on aversive experiences, and positive experiences with music, we find no clear signs of recency (end) or peak effects. We also get no indications of the primacy effect which is a common finding in memory studies but has not been reported either in previous studies of remembered hedonic value." (page 28).

That no start, end or peak effects were found to influence remembered enjoyment is unexpected. But this failure to find any significant effects across the studies may be due to methodological issues. In Study 1 participants in a psychology lecture were given jelly beans to eat and rate for enjoyment and then asked to rate overall enjoyment an hour later. To analyse effects of start and end effects the researchers used naturally occurring

differences in online taste preference and then compared overall remembered enjoyment for participants that had a pleasant ending to the 'jelly bean meal' compared to an unpleasant ending. No significant differences were observed. In Study 2 participants were instructed to imagine eating a meal bite by bite and then recall how enjoyable the imagined meal was. Again, no effects of peak, end or start were observed in remembered enjoyment. In Study 3 participants ate Chinese dishes in a buffet restaurant and were instructed to eat them in such a manner that the profile of the experience could be manipulated using prior ratings. Again, no start, end or peak effects were observed in this final study.

Study 1 and Study 3 lacked experimental control. Both were undertaken outside of the laboratory. Study 1 was completed in a large lecture hall with over 100 participants being tested simultaneously, so it is difficult to know whether participants followed instructions or paid attention to the task. Study 3 was completed in a restaurant (under the observation of a researcher from an adjacent table).This study again involved large group testing and no online ratings of enjoyment were made, making interpretation difficult. Study 2 was conducted in the laboratory and appears to be more controlled. However, this study involved no actual eating experience. Instead participants imagined eating a meal and then recalled how enjoyable the imagined meal had been. Small sample sizes were also used in study 2 (n = 20) and study 3 (n = 20), which may be problematic, as pain literature that has shown memory effects typically require much larger sample sizes (Ariely & Zauberman, 2000; Kahneman et al. 1993; Redelmeier & Kahneman, 1996). Aside from these methodological problems, a further explanation of why no effects may have been observed across the three studies could be individual differences in eating behaviour.

Individuals who tend to restrain their food intake and monitor diet choices have been shown to behave differently to less restrained eaters across eating contexts (Herman & Polivy, 1983; Herman & Polivy, 1980). In addition, it has been reported that individual differences in cognitive restraint of food intake influences memory processes. Restrained eaters do not learn in a flavour-flavour conditioning paradigm or flavour nutrient learning paradigm (Brunstrom, Downes & Higgs 2001; Yeomans et al. 2010), possibly because restrained eaters' beliefs about foods interfere with learning (Brunstrom, Higgs & Mitchell, 2005). In addition, restrained eaters have been shown to display other cognitive and attentional biases in relation to food stimuli (Green, Rogers, Elliman & Gatenby, 1994). Hence, dietary restraint may also have some influence on how individuals remember past eating experiences and as Rode et al's (2007) sample was a largely female population (and thus high in dietary restraint) any effects may have been masked by highly restrained individuals.

Therefore, there is good reason to believe that further examination of the relationship between experienced and remembered enjoyment of eating experiences may be fruitful. Although suffering from some methodological weaknesses, the Rode et al. (2007) studies raised an interesting question and the following studies reported in this chapter build upon this work. Larger sample sizes, measurement of dietary restraint, greater experimental control and online recording of experience are used to further examine the factors that influence remembered enjoyment of food. A paradigm similar to that used in other studies on experienced and remembered enjoyment was adopted. Participants make continuous ratings of enjoyment of their eating experience and then return for a later session to rate overall enjoyment of the experience. This method allows for direct examination of how

each moment of the experience factors into overall remembered enjoyment. Furthermore, manipulation of the enjoyment of different parts of a meal, allows a direct test of whether a pleasant start or end to a meal experience influence memory.

However, there is some suggestion that making online ratings draws attention to the different moments of an experience and may encourage mental partitioning, which may influence the results (Ariely & Carmon, 2000). Yet, if this were to have an impact on memory, it would be likely to reduce any 'end' or 'peak' bias as such ratings would draw attention to all the different parts of an experience. Thus, it is unlikely that this paradigm would increase the likelihood of the occurrence of end, start or peak effects in memory evaluations (if anything, one might suggest it would reduce their likelihood). It was therefore decided that the use of online ratings was most appropriate for the research questions addressed in this chapter.

Study 8 examined if the 'end effect' bias observed for remembered pain also occurs for remembered enjoyment of a yoghurt dessert with a pleasant ending (fruit compote). Study 9 investigated which moments of a multi item meal shape remembered enjoyment of the meal. Across both studies these effects were examined as a function of low and high restraint, due to previous reports suggesting these two groups of individuals differ when learning about food (Brunstrom et al. 2001; 2005; Yeomans 2010).

5.2 STUDY 8: EXAMINING THE END EFFECT BIAS IN A SINGLE FOOD ITEM

5.2.1 Introduction

The present study tested for the end effect bias, whereby the final moments of a food item should theoretically have a disproportionately large influence on overall remembered enjoyment. To test this hypothesis, participants' attended two sessions. In the first, after lunch, participants consumed a yoghurt with a strawberry compote section (there were two sections; yoghurt and compote and order differed by condition) and then returned for the second session two hours later to rate overall remembered enjoyment of the yoghurt dessert. A two hour gap (rather than immediately after the experience) was selected to reduce the likelihood of participants remembering their initial online ratings.

The results of a pilot test indicated that participants enjoyed the compote section more than the yoghurt section. In session one, the order in which each participant ate the yoghurt was randomly selected. Half of the participants consumed the yoghurt section first, followed by the strawberry compote (pleasant ending) and the other half ate the strawberry compote section first followed by the yoghurt section (control). If the end effect bias occurs for remembered enjoyment of food, it was hypothesised that participants in the pleasant ending condition would have a significantly higher remembered enjoyment than the control group. Dietary restraint was also measured at the end of the study to examine whether it moderated an end effect bias.

5.2.2 Method

Participants

One hundred and four participants (undergraduate students from the University of Birmingham) were recruited in exchange for course credit (85 female & 19 male; mean age = 20.0 years, s.d = 2.2) or payment of £5. To disguise the aims of the study it was advertised as 'research examining mood and eating'. Participants gave informed signed consent and the study protocol was approved by the University of Birmingham Research Ethics Committee.

Test Food and Experimental Conditions

Participants ate a Sainsbury's tip & mix strawberry yoghurt dessert (175 g, 181 kcal). The dessert consisted of two separate components; a probiotic plain yoghurt and a strawberry compote. A pilot study indicated that the compote section was rated as more enjoyable than the plain yoghurt section. The dessert was served in a small opaque pot and participants were provided with a plastic spoon to eat with. In the 'pleasant ending' condition the pot was prepared so that the strawberry compote section was the bottom of the pot with the yoghurt on top. The order was reversed in the control condition; the pot was prepared so that the compote came first followed by the yoghurt.

Online Enjoyment Ratings

To measure online enjoyment of eating the dessert, participants rated their enjoyment of every other spoonful as they ate (i.e. 1st spoonful, followed by 3rd etc.). Participants were provided with a small booklet in which to make the ratings. Each page asked participants 'How enjoyable is spoon x?' and participants recorded their responses on a 10 cm V.A.S,

anchors from left to right ‘not at all enjoyable’ and ‘extremely enjoyable’. Instructions provided with the booklet informed participants to make their first rating after eating the first spoonful and then turn to the next page to rate the third spoonful and to continue in this manner until they had finished the dessert. Participants were informed to make a rating on the next available page of the booklet if they finished on an even number.

Procedure

Participants attended two sessions; the first was between 12 and 1.30pm and the second session was two hours after the end of the first session. On arrival, participants were seated in a testing cubicle and answered demographic questions and rated their mood. The following items; happy, hungry, tired, anxious and alert, were rated using a 10 cm V.A.S with “Not at all” and “Extremely” as end anchors e.g. “How happy do you feel right now?” (centred above the line scale).

Participants were then provided with a sandwich to eat as their lunch (Sainsbury’s UK Ham Sandwich 370kcal). After eating the sandwich, participants were provided with the dessert pot and rating booklet and left alone. When the rating task had been completed the researcher returned and provided participants with the same mood ratings as earlier in the session. The researcher asked participants not to eat in the two hour break between sessions.

At the beginning of the second test session the participant was asked to rate appetite and mood using the line rating scales described previously. Participants were then asked ‘Overall, how enjoyable was the yoghurt you ate in the earlier session?’ and indicated their

response using a tick box measure (9 boxes), with anchors from left to right; ‘not at all enjoyable’ and ‘extremely enjoyable’. The scale used to measure remembered enjoyment was different to that of the online measurements of enjoyment to reduce response bias. The cognitive restraint scale of the TFEQ (Stunkard & Mesick, 1985) was then completed. This scale has been shown to possess good validity, internal consistency and test–retest reliability (Stunkard & Messick, 1985). The scale consists of 21 multiple choice questions (e.g. ‘I eat anything I want, anytime I want’), resulting in a score ranging from 0-21.

Weight and height were then measured to calculate BMI (weight/height ^{2}). Finally, each participant was asked to guess the aims of the study, debriefed and thanked for their time. No participant guessed that the study examined memory.

5.2.3 Analysis

Participants were categorised as either ‘high’ or ‘low’ restraint according to their scores from the restraint scale of the TFEQ (Stunkard & Messick, 1985). Based on a median split of a larger database from our laboratory (n=412) participants were defined as being in the ‘high’ restraint group if they scored 7 or higher on the scale and as being in the ‘low’ restraint group if they scored 6 or below.

A 2X2 ANOVA (Factors: Condition & Restraint) was used to examine the interaction between restraint status and experimental condition on remembered enjoyment. A similar ANOVA design was used to examine any between group differences on baseline hunger, age and BMI. LSD Independent group t-tests were planned if a significant main effect or interaction was observed.

5.2.4 Results

Sample characteristics

Six participants were removed from analyses as they were classified as being clinically obese (because we were testing the hypotheses on a healthy weight sample). After removal of these participants, BMI was within normal range; mean = 22.9 (s.d = 2.6), and the mean restraint score (0-21 scale) was 7.0 (s.d = 5.0). There were 49 low restraint and 49 high restraint participants. 2*2 ANOVA indicated no effect of condition [$F(1,94) = 0.06$ $p = 0.92$], restraint [$F(1,94) = 1.5$, $p = 0.23$] or condition* restraint interaction [$F(1, 94) = 0.16$, $p = 0.69$] on baseline hunger. No effect of restraint on BMI was observed [$F(1,94) = 2.16$, $p = 0.15$], condition [$F(1,94) = 0.01$, $p = 0.96$] or condition*restraint interaction on BMI [$F(1,94) = 2.00$, $p = 0.16$]. No effect of condition [$F(1,94) = 0.30$, $p = 0.60$], restraint [$F(1,94) = 0.7$, $p = 0.41$] or condition* restraint interaction [$F(1,94) = 1.4$, $p = 0.23$] on age was observed. See Table 5.1

Remembered enjoyment

A 2*2 ANOVA indicated no effect of condition [$F(1,94) = 0.74$, $p = 0.39$] or restraint [$F(1,94) = 1.56$, $p = 0.22$] on remembered enjoyment. However, the condition*restraint interaction was significant [$F(1,94) = 4.11$, $p < 0.05$]. See figure 5.1. To investigate the interaction, pairwise comparisons were used to examine differences between the pleasant ending condition and control condition as a function of restraint.

Low Restraint

In participants with low restraint, the 'pleasant ending' group remembered the yoghurt to have been significantly more enjoyable than the control group [$t(47) = 2.28$, $p < 0.05$]. See

Table 5.2. To examine if the experimental manipulation worked, the pleasant ending and controls enjoyment of the last spoonful of yoghurt was compared. As expected, the 'pleasant ending' group enjoyed the last spoonful of the yoghurt significantly more than the control group [$t(47) = 2.80$, $p < 0.05$]. Groups were also compared for the most enjoyable spoon ('peak enjoyment') and average online enjoyment of the yoghurt, in order to ensure any differences in remembered enjoyment were likely to only be as a result of the end effect and not other differences in online experience. There were no differences between the two groups for average online enjoyment [$t(47) = 1.10$, $p = 0.28$] or 'peak' enjoyment [$t(47) = 1.10$, $p = 0.28$]. See Table 5.2.

Table 5.1

Mean participant characteristics by condition: low and high restraint for Study 8

		Hunger (0-10cm)	**BMI**	**Age**
LOW RESTRAINT	*Control condition (n=23)*	*5.3 (2.0)*	*22.9 (2.7)*	*19.3 (1.2)*
	Pleasant Ending condition (n=26)	*5.5 (3.0)*	*22.2 (2.6)*	*20.0 (1.9)*
HIGH RESTRAINT	*Control condition (n=24)*	*4.9 (2.4)*	*22.9 (3.1)*	*20.2 (2.9)*
	Pleasant Ending condition (n=25)	*4.7 (1.7)*	*23.8 (196)*	*19.9 (1.9)*

Table values: Values refer to means. *Hunger ratings (0-10cm scale), anchors; 'not at all hungry' and 'extremely hungry' (standard deviations in brackets).*

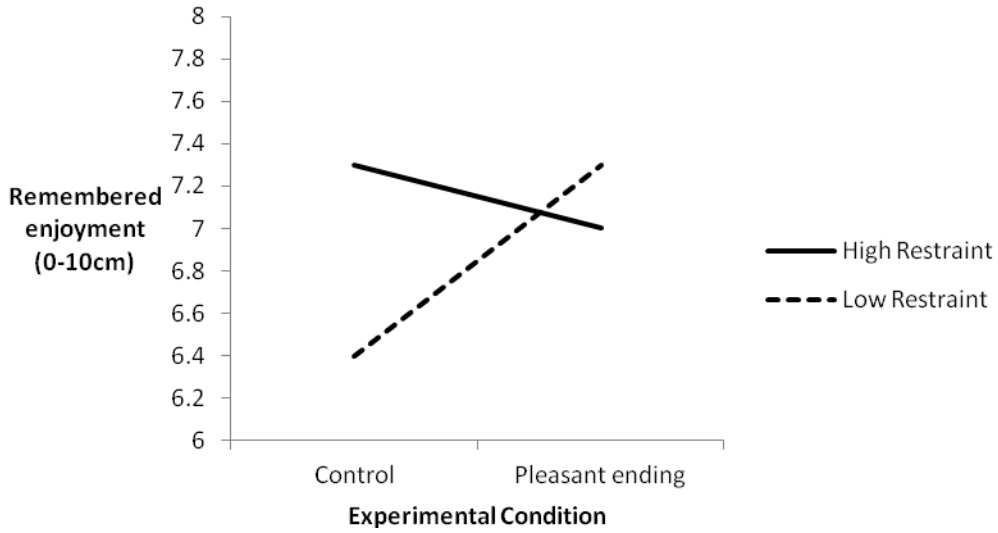
High Restraint

In participants with high restraint, the 'pleasant ending' group did not remember the yoghurt to have been significantly more enjoyable than the control group [$t(47) = 0.75$, p

=0.46]. There were also no differences between the two groups for average online enjoyment [t(47) = 0.22, p = 0.83], 'peak' enjoyment [t(47) = 0.18, p = 0.86]. In addition, the' pleasant ending' group did not differ for enjoyment of the last spoonful of the yoghurt compared to the control group [t(41) = 1.3, p =0.19], suggesting the experimental manipulation did not work in individuals with high restraint. See Table 5.2.

Figure 5.1

Interaction between restraint and condition on remembered enjoyment for Study 8



Remembered enjoyment values = 0-10cm line scale, mean values.

Table 5.2

Online and remembered enjoyment by condition: low and high restraint for Study 8

		Last Spoon enjoyment (0-10 cm)	**Average enjoyment** (0-10 cm)	**'Peak' enjoyment** (0-10 cm)	**Remembered enjoyment** (1-9 tick box)
LOW RESTRAINT	*Control condition (n=23)*	*5.3 (2.6)*	*6.2 (1.3)*	*7.8 (1.3)*	*6.4 (1.3)*
	Pleasant Ending condition (n=26)	*7.1 (1.9)**	*6.6 (1.4)*	*8.3 (1.3)*	*7.2 (0.9)**
HIGH RESTRAINT	*Control condition(n=24)*	*5.9 (1.7)*	*6.8 (1.2)*	*8.4 (1.2)*	*7.3 (1.1)*
	Pleasant Ending condition (n=25)	*6.7 (2.4)*	*6.9 (1.6)*	*8.3 (1.3)*	*7.0 (1.6)*

Table values: Values refer to means. *Enjoyment ratings (anchors; 'not at all enjoyable' and 'extremely enjoyable' (standard deviations in brackets). *indicates significant difference at p<0.05 between control and pleasant ending condition.*

Regression

As the final spoon manipulation did not produce two conditions with a difference in enjoyment of the final spoon of the yoghurt in the high restraint group of participants, the end effect bias cannot be examined by comparing remembered enjoyment in the 'pleasant ending' vs. control condition. However, regression analysis can be used to examine if final spoon enjoyment predicts remembered enjoyment for highly restrained participants. If an end effect bias does exist in highly restrained participants, we would expect the final spoon

to significantly predict remembered enjoyment. Entering both 'average online enjoyment' and 'final spoon' as predictors in two regression models, in line with the between group analysis, enjoyment of the final spoon predicted remembered enjoyment in the low restraint group ($\beta = 0.36$, $p < 0.05$). However, in the high restraint group the final spoon did not predict remembered enjoyment ($\beta = 0.11$, $p = 0.28$). This suggests that an end effect bias may not occur in highly restrained eaters.

5.2.5 Discussion

Participants scoring low in dietary restraint remembered a yoghurt dessert to have been significantly more enjoyable when the most enjoyable part of the dessert came at the end, rather than at the start, even though both groups were not different for average online enjoyment and other variables such as hunger and BMI. These data are consistent with the results of previous studies that have found that the final few moments of an experience can have a disproportionately large affect on memory for the overall experience (Kahneman et al. 1993; Rozin & Goldberg, 2004).

The experimental manipulation did not work for individuals that were defined as having high dietary restraint, as when the fruit compote section was at the end of the dessert it did not produce a significantly more enjoyable final moment of the dessert (compared to the control group). It is possible that the sweet strawberry compote was regarded as 'forbidden food' for restrained eaters and these beliefs about the food influenced their rated enjoyment (Kanarek et al. 1995). In support, dietary restraint has been reported to affect liking for dairy products with differing sucrose content (Frye et al. 1994). Therefore, as the manipulation worked in individuals with low dietary restraint, it is probably the elevated

levels of dietary restraint interfering with liking of the compote which are responsible for with the failed manipulation in the high restraint group.

This manipulation failure resulted in no difference between final spoon enjoyment for the pleasant ending vs. control condition, for highly restrained participants. However, regression analysis indicated that final spoon enjoyment did not predict remembered enjoyment in highly restrained participants, suggesting a lack of end effect bias in highly restrained eaters.

Unlike Rode et al's (2007) findings the present study suggests that key moments (the end) of a food item may have strong influence on overall remembered enjoyment (in individuals with low restraint at least). Although the present study found evidence for an end effect in a food item, whether other moments of an eating experience (peak, start, etc.) may influence remembered enjoyment was not examined and whether similar results would be obtained for a multi item meal was not examined. Study 9 attempted to address these questions.

5.3 STUDY 9: REMEMBERED ENJOYMENT OF A MULTI-ITEM MEAL

5.3.1 Introduction

The present study examined the relationship between experienced and remembered enjoyment of a multi-item meal. Participants consumed a 5 item lunch of buffet style foods and rated online enjoyment for each food. Two hours later participants' rated remembered enjoyment. Based on the existing literature related to remembered pain and the findings from Study 8, it was hypothesised that peak (the most enjoyable food item) and end (the final food item) would disproportionately influence remembered enjoyment. However, other research has also suggested that the beginning moments of the experience (Weinstein & Roediger, 2010) and the least enjoyable moments (Kahneman et al. 1997) of an experience can have large impact on memory. Thus, whether any of these Gestalt characteristics predicted remembered enjoyment was examined. The relationship between online and remembered enjoyment was also examined as a function of dietary restraint.

5.3.2 Method

Participants

Fifty undergraduate students from the School of Psychology, University of Birmingham were recruited in exchange for course credit (15 males, 35 females) with a mean age = 19.7 years (s.d = 2.3). To disguise the aims of the study it was advertised as 'research examining stress and eating habits', as with all studies in this thesis, the study was approved by the University of Birmingham ethics board.

Test Foods

As part of the lunch time meal participants ate and rated 5 food items; a portion of ham and cheese quiche (131 calories), 3 large carrot sticks (14 calories), 12 cheese snacks (85 calories), 2 mini sausage rolls (119 calories) and 4 salted pretzels (45 calories) (all foods from Sainsbury's UK). The amounts provided were based on the results of pilot study and ensured equal eating times for each of the 5 items (1 minute per item for eating and 5-10 seconds for rating). The five test foods were eaten in the same order by all participants: quiche, carrot sticks, cheese snacks, sausage rolls and pretzels.

Online Enjoyment Ratings

Participants were instructed to eat all of the first food item and then rate how enjoyable it was; e.g. 'How enjoyable was the quiche?' on a 10 cm V.A.S, anchors from left to right 'not at all enjoyable' and 'extremely enjoyable' and to continue in this manner until all 5 food items had been eaten and rated.

Procedure

Participants attended two sessions separated by an interval of 2 hours. The first session took place between 12pm and 2pm. On arrival, participants were seated in a small testing cubicle and left alone to complete a baseline hunger rating (as in Study 8) , demographic questions and 8 personality questions (e.g. 'I enjoy a challenge in life' on a five-point likert scale with anchors from left to right; strongly disagree and strongly agree) that were included as fillers to detract from the main purpose of the study. The experimenter then returned and placed the 5 food items (on separate plates) in the order in which they were to be eaten on the table from left to right. Participants were asked to read the instructions

provided with the rating questionnaire and were verbally reminded to eat the foods in the order shown on the questionnaire.

After eating the foods, participants were instructed to return for the second session, which was scheduled 2 hours later and asked not to eat in between. On arrival for the second session, participants completed the same 8 personality questions to further corroborate the study's cover story. Participants then completed 1 question concerning the 5-item meal eaten that had been eaten in the first session: 'overall the lunchtime meal in the earlier session was' (9 point tick box scale, anchors from left to right: 'not all enjoyable' and 'extremely enjoyable'). Participants then completed the dietary restraint scale (Stunkard & Messick, 1985), before being weighed and their height measured to calculate BMI. Participants were asked to guess the aims of the study, debriefed and thanked for their time. No participant guessed the aims of the study.

5.3.3 Analysis

T-tests were used to examine any differences between low and high restraint group for baseline hunger, BMI, age and enjoyment of all of the food items in the meal. Regression analysis was used to examine the relationship between online and remembered enjoyment of the multi item meal.

5.3.4 Results

Sample Characteristics

Six participants were removed from the analyses as 4 failed to return for the second session and 2 were classified as being clinically obese. The mean BMI was 23.4, (s.d. =

2.5) and the mean restraint score was 7.4 (s.d = 5.7).Twenty one participants were categorised as low in dietary restraint and 23 were categorised as high in dietary restraint. Restraint groups did not significantly differ in baseline hunger [t(42) = 0.43, p = 0.67]; low restraint group = 7.3 (s.d = 1.1) and high restraint group = 7.1 (s.d = 2.0) ,BMI [t(42) = 1.36, p = 0.18]; low restraint group = 22.9 (s.d = 2.5) and high restraint group = 23.9 (s.d = 2.5) or age [t(42) = 1.4, p = 0.16]; low restraint group = 20.1 (s.d = 3.0) and high restraint group = 19.1 (s.d =0.8).

Online Enjoyment

The food items were rated as enjoyable, mean item enjoyment ratings ranging from 5.1 (pretzels) to 6.7 (quiche) on a 0-10cm V.A.S. There were no significant differences between the high and low restraint groups for rated enjoyment of the 5 food items, least liked item, most liked item and average item enjoyment. See Table 5.3.

Table 5.3

Online enjoyment ratings of meal items by restraint group for Study 9

	Low Restraint n=21	**High Restraint n=23**	**T-test results df = 42**
Quiche (first item)	*6.4 (2.5)*	*6.4 (2.4)*	*t=0.10, p=0.95*
Carrot sticks	*5.4 (2.4)*	*5.6 (2.4)*	*t=0.68, p=0.50*
Cheese snacks	*6.4 (1.8)*	*6.7 (2.1)*	*t=0.83, p=0.38*
Sausage rolls	*5.9 (2.1)*	*6.2 (2.1)*	*t=1.10, p=0.26*
Pretzels (last item)	*5.4 (2.8)*	*5.1 (2.7)*	*t=0.68, p=0.50*
Most liked item	*8.0 (1.3)*	*8.2 (1.2)*	*t=1.10, p= 0.28*
Least liked item	*3.6 (2.1)*	*3.4 (2.0)*	*t=0.55, p=0.58*

Table values: Values refer to means. *Enjoyment ratings, 0-10cm scale, anchors; 'not at all enjoyable' and 'extremely enjoyable' (standard deviations in brackets).*

Remembered enjoyment

To examine the relationship between online enjoyment of the food items and overall remembered enjoyment of the meal a forced entry method regression model was planned. Based on the existing literature (discussed in the introduction) four predictor variables were included in the model; 'first item' (online enjoyment of the first food item), 'last item' (online enjoyment of the last food item), 'peak' (online enjoyment of the most liked item) and 'least liked item' (online enjoyment of the least liked item).

The overall model significantly predicted remembered enjoyment (Adjusted $R^2 = 0.34$, $p < 0.001$). Of the four predictors, first item ($\beta = 0.20$, $p = 0.31$), last item ($\beta = -0.08$, $p = 0.68$) and least liked item ($\beta = 0.25$, $p = 0.22$) did not predict remembered enjoyment. The most liked item ('peak) did significantly predict remembered enjoyment ($\beta = 0.39$, $p = 0.02$).

To examine if the relationship between online enjoyment of the most liked item ('peak') and remembered enjoyment was moderated by restraint, a further regression model testing this interaction was computed, with restraint group status entered as an additional predictor variable.

Results indicated a marginally significant interaction between peak enjoyment and restraint group ($\beta = 0.89$, $p = 0.06$) on remembered enjoyment. Although this interaction was only marginally significant, based on our a priori hypotheses that the relationship between online and remembered enjoyment would differ between the low restraint and high restraint groups, we computed separate regression models for the two groups to examine if the peak effect was observed in both restraint groups.

Low Restraint

The regression model significantly predicted remembered enjoyment of the meal for the low restraint group (Adjusted $R^2 = 0.67$, $p < 0.01$). However, of the four predictor variables, only enjoyment of the most liked item independently accounted for a significant amount of variance. First, last and least liked items of the meal did not significantly predict remembered enjoyment of the meal. None of the predictor variables had a high variance inflation factor, suggesting that multi-collinearity is unlikely to influence the interpretation of the reported findings. See Table 5.4.

Table 5.4

Regression model predictors for low and high restraint groups for Study 9

	Low restraint group n=21	**High restraint group n=23**
First item	β = 0.27 (p = 0.32)	β = -0.01 (p = 0.96)
Last item	β = -0.20 (p = 0.40)	β = -0.22 (p = 0.63)
Most like item	β = 0.69 (p <0.05)*	β = 0.18 (p = 0.86)
Least liked item	β = 0.18 (p = 0.62)	β = 0.25 (p = 0.59)

Table values: *beta coefficient and significance level for individual predictor variables.*
**indicates significant at p < 0.05*

High Restraint

The regression model did not significantly predict remembered enjoyment of the meal for the high restraint group (Adjusted $R^2 = 0.19$ p =0.44). Neither the most liked, first, last or the least liked item significantly predicted remembered enjoyment of the meal in the high restraint group. See Table 5.4. None of the predictor variables had a high variance inflation factor, suggesting that multi-collinearity is unlikely to influence the interpretation of the reported findings.

5.3.5 Discussion

For individuals low in dietary restraint, overall remembered enjoyment of the five item meal was predicted by online enjoyment for only one item; the most liked. First item, least liked and last item enjoyment did not significantly shape overall enjoyment. Conversely,

no peak effect was observed in individuals with high dietary restraint. Although low and high restraint groups did not differ in BMI, hunger or online enjoyment of any of the food items, none of the four predictor variables influenced remembered enjoyment of the overall meal for the high restraint group.

This finding that memory of the meal was dominated by the 'peak' moment in the experience is in line with previous research (Kahneman & Redelmeier, 1997). Although, unlike Study 8, no end effect bias was observed. It is unclear why this is the case, although it may be that peak intensity overrides the importance of other parts of the experience in the meal context. Alternatively, overall memory of an individual food item may differ from overall memory of a meal, as the meal is segmented into multiple distinct sub sections. For example, it has been reported that when an event is divided into component parts, evaluation of how enjoyable that event was is less influenced by the temporal profile of the event and more influenced by assessment of the individual segments (Ariely & Zauberman 2000).

The finding that no food items predicted remembered enjoyment for the highly restrained eaters is striking. It suggests that liking judgements of restrained eaters are being influenced by other cognitions that are divorced from the details of the meal experience. More detailed discussion of the differences between low and high restrained eaters follows in the following chapter general discussion.

5.4 CHAPTER 5 GENERAL DISCUSSION

Remembered enjoyment was higher for a yoghurt that had a pleasant ending than for a yoghurt that had a bland end for participants who scored low on dietary restraint (Study 8) Study 9 found that the most liked item ('peak effect') predicted remembered enjoyment of a multi-item meal, but again only for participants scoring low in dietary restraint. For both studies neither peak or end effects were observed for participants scoring high in dietary restraint. These data are consistent with the results of previous studies that have found that the final few moments of an experience and the peak level of enjoyment can have a disproportionately large affect on memory for the overall experience (Kahneman et al. 1993; Rozin & Goldberg, 2004).

There was no end effect on remembered enjoyment for high restraint participants in Study 8 as the 'pleasant ending' and control group participants did not differ in their online rating of the final spoon. Although further regression analysis indicated that final spoon enjoyment did not predict remembered enjoyment in highly restrained eaters, suggesting a lack of an end effect in this group of participants. Furthermore, remembered enjoyment of restrained eaters was not predicted by peak or end liking in Study 9. Collectively these findings indicate that highly restrained eaters memories for food enjoyment differ to individuals with low dietary restraint.

A previous suggestion as to why highly restrained eaters behave differently in learning paradigms is cognitive bias in the form of a preoccupation with food (Brunstrom et al. 2005). Diversion of attention whilst eating due to preoccupation with thoughts about food

may have resulted in distraction, which has been previously associated with an altered memory representation of eating experience (Higgs & Woodward, 2009).

An alternative explanation is that the lack of relationship between online enjoyment judgements and remembered enjoyment may suggest restrained eaters are likely to be being influenced by other cognitions. For example, restrained eaters may be more influenced by semantic knowledge and beliefs about foods that are divorced from the details of time and place, than episodic details related to a recent eating experience (Robinson & Clore 2002a; 2002b). Similarly, restrained eaters may also be factoring in beliefs about how acceptable the foods were in relation to dieting goals when evaluating enjoyable.

The studies reported in the present chapter provide evidence that moments of eating experiences have disproportionately large influence on overall remembered enjoyment. Unlike the Rode et al. (2007) studies we found evidence of peak and end effects, although it is difficult to ascertain exactly why this was the case. Our consideration of dietary restraint appears to be particularly important, but we also designed experiments with greater experimental control and used different methodologies, these factors may have contributed to the significant effects reported here and null findings of Rode et al. (2007).

Recent work suggests that the relative importance of the final few moments of an experience on memory may be based upon when the experience is recalled (Montgomery & Unnava 2009). Overall remembered enjoyment shortly after an experience was reported to be more reliant on the final few moments, whilst two weeks later the final few moments

were less important in shaping memory, presumably because they have faded from memory (Montgomery & Unnava, 2009). Yet, Redelmeier and Kahneman (2003) report long lasting behavioural effects over several months as a result of manipulating the final moments of a surgical procedure. Participants in the present study rated remembered enjoyment two hours later. The importance of the time interval between experience and recall would be worthy of further investigation, because it may be that the memory biases observed only exists for a limited time period after the experience.

These findings reported in the present chapter are important because, as the results of earlier chapters suggest, remembered enjoyment rather than actual enjoyment informs food choice. Further research of how memories of eating experiences are formed and how they change over time would enhance understanding of how individuals use memory to guide food choice. Zandstra (2010) report preliminary data that show remembered enjoyment of a meal changes over time. Further work examining what factors influence or distort episodic memory of a meal or eating experience would be of interest, as the findings from the present chapter may have some practical application. Providing a pleasant ending to a food item or one highly liked item in a meal could result in the formation of more pleasant memories and subsequently promote choice of these foods. The relevance of this and other chapters findings in relation to understanding food choice and application are now discussed in the final chapter of this thesis.

CHAPTER 6: GENERAL DISCUSSION OF THESIS

The overall aims of this thesis were to examine a) whether episodic memory is an important determinant of food choice, b) how individuals form episodic memories for enjoyment of food and c) under what conditions episodic memory may be particularly important in shaping behaviour. I will first discuss how this thesis has answered these theoretical questions (raised in aims a, b and c) by assessing each study in the order they are reported *('Overview of findings')*.

Next I will discuss the extent to which the findings presented in this thesis may have application for changing food liking and food choice *('Applied relevance'*). After discussing some general strengths and limitations of the work *('Strengths and limitations'*), I will briefly evaluate an alternative explanation for the observed findings in this thesis and then consider the process by which episodic memory may be impacting on enjoyment and choice of food *('Process considerations').* I will summarise and then finish with some concluding remarks ('*Concluding remarks and significance'*).

6.1 Overview of findings

In a preliminary test of the role episodic memory may play in food choice, Study 1 (Chapter 2) showed that habitual vegetable intake was associated with remembered enjoyment content of episodic memory for eating vegetables. Indeed, if episodic memory and remembered enjoyment are determinants of food choice then such a correlation would be hypothesised. A further finding of Study 1 was that although remembered enjoyment was associated with habitual intake, regardless of intake level, the majority of participants

recalled pleasant memories of vegetable consumption. Studies 2 and 3 examined whether cueing participants to recall these positive memories would result in changes to predicted enjoyment and choice of vegetables.

The original hypothesis linking episodic memory and food choice was based upon literature suggesting that individuals retrieve and then use the hedonic content of episodic memories to inform predicted enjoyment (Morwedge et al. 2005; Wilson & Gilbert 2007; Kahneman et al. 1994; Redelmeir & Kahneman, 2003). Thus, it was hypothesised that if episodic memory is of importance in food choice, recalling a memory in which one enjoyed eating a food (broccoli in the case of Study 2) should result in an increase in predicted enjoyment of eating that food. Study 2 directly tested this proposition and showed that recalling an enjoyable instance when one ate broccoli resulted in a significant increase in predicted enjoyment of eating broccoli. This in turn also increased participants self reported likelihood of choosing broccoli.

Study 3 examined whether the memory cueing paradigm would also result in a change to actual behaviour. Here a similar pattern of results was observed; recalling an enjoyable instance of eating vegetables (carrots) resulted in participants choosing more carrots as part of a lunch time meal. By showing that hedonic content of memory is related to habitual intake and that access to a positive memory resulted in an increase in predicted enjoyment and choice, Chapter 2 supports the notion that when making decisions about food, individuals may be guided by the hedonic content of episodic memories of similar past experiences (Gilbert & Wilson, 2007).

The two cueing studies reported in Chapter 2 suggest that episodic memory is implicated in food choice by showing that making an episodic memory more salient (through recall) impacts on food choice and more specifically, they suggest one condition under which episodic memory informs food choice; after explicit recall. A similar line of reasoning has been used in the cognitive psychology literature (Morewedge et al. 2005) and by Higgs (2002), linking episodic memory to food intake. Later studies were designed to further test whether episodic memory informs food choice and whether episodic memory would continue to serve as a determinant of food choice under conditions that did not involve cued recall.

The studies in Chapter 3 were designed to build on the work outlined in Chapter 2, by further examining whether episodic memory is likely to be important in food choice. In Study 4 a manipulation to alter remembered enjoyment of an eating experience was devised and tested. Here, experimental participants rehearsed what they found enjoyable in a meal, in order to change the consolidation of the meal memory. A day later this manipulation increased remembered enjoyment relative to a number of control groups. Hence, in Study 5 food choice could be examined in two groups of participants who differed in their remembered enjoyment. Participants who had been exposed to the experimental manipulation to increase remembered enjoyment of a vegetable quiche chose a greater amount of that quiche from a buffet the following day.

If episodic memory is an important determinant of food choice then we would expect a change in remembered enjoyment to result in a change in food choice. Study 5 examined this directly and confirmed that manipulating remembered enjoyment has a large effect on

food choice. Unlike the studies reported in Chapter 2, the findings from Study 5 also show that episodic memory is likely to influence food choice without explicit recall prior to choice. This underlines a different condition under which episodic memory can inform food choice, providing strong evidence for a role of episodic memory in food choice.

Chapter 4 attempted to add to the accumulating evidence of the earlier chapters. Here the relationship between episodic memory and food liking was investigated as a function of time. In the first study participants were given a disappointing experience with a food and asked to rate liking of that food a day or week later. Results showed that the disappointing experience led to a fall in liking one day afterwards, presumably because individuals were using their memory for the recent experience to inform liking judgements. This finding provides further evidence of a role for episodic memory in food choice and adds to the findings of Chapter 3, as the observed effects were achieved in a more naturalistic way (participants were not required exposed to a post experience manipulation to change memory).

An additional finding was that although the fall in liking was observed at one day, it was not observed at one week. Thus, at one week after the disappointing experience participants were unlikely to be using their memory of the recent experience to inform liking. This suggests a condition under which episodic memory may be particularly important in food choice; when an example experience of the food to be eaten has occurred recently, which is consistent with the idea that that episodic memory is primarily used for shorter term goal orientated behaviour (Conway, 2009).

Study 7 followed up the findings of Study 6 by examining whether episodic memory could have longer lasting effects on liking. Using a similar paradigm to Study 6, it was shown that episodic memory for a disappointing experience could have an effect on predicted liking at one week, but only for food that participants had not consumed frequently. These findings further support the notion that the content of episodic memory informs evaluations about how much an individual will enjoy eating a food. These findings also suggest that the first experiences with a food may be important in the acquisition of beliefs about food liking.

The studies reported in the final chapter were designed to investigate how individuals form memories of remembered enjoyment of eating experiences. Previous research suggests that remembered pain of a past episode is based upon key moments in the experience (Redelmeir & Kahneman 2003; Ariely & Carmon, 2000; Unnava & Montgomery, 2010). In particular, it is thought that the final few moments (end effect) and most intense moments (peak effect) of pain during an episode have an extremely large weighting in overall memory for that episode.

Study 8 of this thesis examined the end effect bias in remembered enjoyment of a food item (a yoghurt), by manipulating the order in which participants ate the yoghurt to ensure either a pleasant start or end. Measures of dietary restraint were also taken, as individuals with high dietary restraint have been shown to behave differently to low restraint eaters in ingestive learning/memory paradigms, such as flavour-flavour conditioning (Brunstrom, Downes & Higgs 2001). The end effect bias occurred in individuals with low dietary

restraint. No end effect was observed in individuals with high restraint, although the pleasant end manipulation did not work for this group of participants.

Study 9 examined remembered enjoyment for a multi item meal. For individuals with low restraint, the most enjoyable food item was the only significant predictor of memory, suggesting that remembered enjoyment of a meal is strongly based upon the best item. Conversely, this 'peak effect' was not observed in individuals with high restraint, nor did any other food items predict remembered enjoyment. In Study 9 both low and high restraint eaters appeared to ignore how enjoyable a large number of items were in their evaluations of overall enjoyment of the lunch. Collectively the findings in this chapter suggest that when individuals form memories of past eating experiences, remembered enjoyment is influenced by key moments such as the peak and end biases, although this tendency is moderated by dietary restraint. Why restrained eaters remembered enjoyment of an eating experience is different to unrestrained eaters and also appears to be influenced little by experienced enjoyment is an intriguing question.

Previous suggestions as to why highly restrained eaters behave differently have suggested that preoccupation or bias towards a food may interfere with the learning process (Brunstrom et al. 2001; Brunstrom et al. 2005). One such cognitive bias may be diversion of attention whilst eating or that restrained eaters may be preoccupied with other thoughts during eating, both of which could result in distraction which has been associated with an altered or inaccurate memory representation of eating experience (Higgs & Woodward, 2009). An alternative explanation that has not been previously considered is that differences between restrained and unrestrained eaters is caused by response styles to

measures of remembered enjoyment. Restrained eaters may have viewed the foods consumed as 'forbidden', which in turn may have interfered with their responses to the remembered enjoyment measures. Thus, responses to the question of 'how enjoyable was the food' now included dietary beliefs about whether they should or should not be eating the food and finding it enjoyable.

Teasing such possible influences apart would be difficult. However, if preoccupation with food is responsible for the different results, we might expect to see differences in item by item remembered enjoyment as well as overall remembered and impaired memory for other meal characteristics. Conversely, if it is a difference in response style and the two groups of participants are using different information to guide responses, then we might expect to see differences in response times. For example, restrained eaters may spend longer when answering questions concerning remembered enjoyment, as they also integrate dietary beliefs into their evaluations.

Further examination of why restrained eaters behave so differently would be of interest, as it would provide further insight into the relationship between memory and food choice in individuals who are thought to be particularly vulnerable to weight gain and over-eating (Polivy & Herman, 1985; Lowe, 1993; Van Strien et al. 2000). Another issue stemming from the findings of difference between low and high restraint eaters is whether restraint relates to the other findings in the earlier experimental chapters of this thesis. Issues surrounding this are discussed in the Strengths and Limitations section.

6.2 Applied relevance

The findings of this thesis raise an interesting question of whether there may be any potential for application to increase food liking and choice. The memory cueing studies in Chapter 2 suggest this may be the case. Cueing participants to recall an enjoyable memory of eating a vegetable resulted in a greater amount of that vegetable being selected as part of a lunch. Cues to promote recall of such memories in a canteen setting (prior to food selections) may be effective in increasing vegetable intake. Alternatively, instructing individuals that personal reminders may be an effective way of wanting to eat more vegetables may also be effective. The effectiveness of the former could be tested in a canteen or restaurant setting, using subtle cues to prompt recall of an episodic memory of enjoying eating a healthy food item on the menu and comparing increase in likelihood of choice to a control group.

Whether desirable effects on food choice would occur when individuals are consciously aware of the reasoning behind recalling such memories is unknown, as in the studies reported in Chapter 2 the aims of the study were hidden. Further examination of this would also be of interest. However, another potential application of the findings in this thesis would be to attempt to subtly change remembered enjoyment of foods. An idea with some similarity has been suggested previously, by Laney et al. (2009), who showed that implanting a false memory of having had an enjoyable first experience with a food had some effect on self reported intentions to eat the food in the future. Yet, the procedures required to implant false memories are time consuming and often do not result in participants acquiring the suggested false memory.

The post event rehearsal manipulation to increase remembered enjoyment reported in Studies 6 and 7 produced particularly strong effects on memory and food choice, in addition it was relatively easy to administer. However, as the manipulation requires participants to think about what aspects they found enjoyable, if a food is strongly disliked the manipulation might be weaker. Thus, further examination of whether the results reported here would also be applicable to lesser liked food would be needed, as presumably it is lesser liked foods that are in need of an increase in liking and acceptance. A similar design to that of the studies reported in Chapter 3 could be used, but with an inclusion of a further experimental factor of food palatability. Food palatability could be manipulated by changing the macronutrient composition of a meal (adding or reducing sugar, salt, fat etc.) or by using commercially available foods that varies in palatability. Whether the success of the manipulation to increase remembered enjoyment would be moderated by food palatability would then be assessed.

Studies 8 and 9 that showed the final and most enjoyable moments of eating experiences had disproportionately large influence on memory may also be useful in increasing remembered enjoyment of a food. Ensuring these moments are particularly enjoyable when eating a healthy food may be ways to increase liking for that food. In the pain literature, Redelmeier and Kahneman (2003) showed that adding a slightly less aversive moment to the end of a medical surgery increased rates of return for repeat surgery over several years. In addition, Finn (2010) have similarly shown that adding a short less taxing interval to a difficult learning experience increases future choice of that class. Thus, along with the findings of the studies in the final chapter, these studies suggest that providing pleasant peaks or ends to eating experiences may increase acceptance of a food.

Although this thesis has tested adult populations, application to increase remembered enjoyment of eating experiences may be particularly useful for children. Acquisition of food likes and dislikes is thought to take place during early childhood experiences (Skinner et al. 2002; Rollins, Loken & Birch, 2010), thus creating positive memories of foods early in development may be particularly important. False memory research also indicates that children are susceptible to misinformation and manipulations to change memory (Reyna, Holliday & Marche, 2006). Therefore, simple manipulations such as post event rehearsal or providing particularly enjoyable final and peak moments for healthy food options are worthy of further examination in younger populations.

Application of the end effect bias could be tested in young children. For example, using a similar paradigm to that of mere exposure type and flavour-flavour learning studies, but instead, repeatedly exposing children to a lesser liked food item modified to produce a particularly pleasant end. The end effect memory bias would suggest that participants receiving a particularly pleasant ending should acquire a more positive memory of their eating experiences with the food. Over time it would be predicted that such a manipulation should result in greater liking and intake of the food (compared to a control).

An important unanswered question is whether the potential applications of this work would have meaningful long lasting effects. The data from this thesis cannot answer this question directly. Further research is required to test the longevity of the effects. However, there is reason to believe that meaningful long lasting effects may occur. It is recognised that food choice is strongly influenced by hedonics, (de Graaf et al., 2005), so making

alterations to individuals' beliefs about the hedonic value of foods should have future consequences. Furthermore, simple cognitive manipulations in other fields have been acknowledged to show potential to cause longer term related change (Wilson, 2005). In line with this, Bernstein and Loftus (2009) have shown that implanting a false memory of having had an aversive experience with a food as a child, resulted in an avoidance of that food up to 6 months later. Nevertheless, research examining longer term consequences and how memory serves food choice over time is advised.

More generally the need to study longer term implications of memory manipulations and effects of learning is something that should be pursued in this field, as only a limited amount of literature has examined how learnt likes and dislikes change as a function of time (Skinner et al. 2002; Rollins, Loken & Birch, 2010). For example, although studies of flavour-nutrient conditioning and mere exposure show interesting results and increases in liking of initially disliked foods (at baseline), the literature remains relatively quiet concerning whether months or years later long term effects are observed. The findings of Study 6 in this thesis underline why this is important to study, as although a change in liking was observed in the short term (a day after the manipulation), liking appeared to revert back to baseline when measured over a longer time frame (a week after the manipulation).

A final question is how the findings of this thesis relate to recent work that suggests expected satiety appears to be more important than expected enjoyment/liking when making portion size selections (Brunstrom & Rogers, 2009; Brunstrom & Shakeshaft, 2009). In the studies in which effects on behaviour are reported in this thesis, participants

select foods from buffet plates. An important differentiation is that research linking expected satiety to choice concerns choice of portion sizing of a single food, not food choice between multiple items. Which food items we choose vs. how much we believe an ideal portion size of a single food would be are distinct. Thus, it may be the case that remembered enjoyment is particularly important in food choice (de Graaf et al. 2005) and not as important in portion sizing (Brunstrom & Rogers, 2009). In some contexts we might expect an interaction between the two, whereby enjoyment may have weighting in the choice of food and then expected satiety determines the amount of that food selected. Research examining the contributions of enjoyment and expected satiety specifically on food choice would be advised to further understand the relative importance of both variables on eating behaviour.

6.3. Strengths and limitations

The experimental work presented in this thesis has a number of strengths. The detailed cover stories and stringent control groups meant that the observed effects are unlikely to be explained by demand characteristics. Careful measurement of 'online experience' throughout the majority of studies has also helped to confidently tie down effects to differences in memory, rather than actual experience. Although the research has been carried out in laboratory settings, food choice tasks have been designed to mimic naturalistic settings. Yet, as with all experimental research, the issue of ecological validity remains. Previous research has shown that memory and decision making processes that are studied in the laboratory behave similarly when examined in more 'real world' settings (Redelmeir & Kahneman, 2003; Finn, 2010). Nevertheless, further studies testing outside

of the laboratory is advised; the suggested studies examining application of changing remembered enjoyment in the previous section would be ideal.

Restraint was selected as a key variable of interest for the final two studies of this thesis due to the unexpected finding reported by Rode et al. (2007) of no evidence for peak or end effects in memory for an eating experience. Close examination of the design of these studies was undertaken and a literature search regarding failed learning experiments was undertaken. Previous literature linking individual differences, in the form of restraint status appearing to cause failed dietary learning was considered to be potentially important (Brunstrom, Downes & Higgs, 2001; Brunstrom, Higgs & Mitchell, 2005). As the peak and end effect bias are such a consistently replicated finding in the pain literature, it was hypothesised that any end or peak effect in the data of Rode and colleagues may have been masked by high and low restraint eaters behaving differently (as the authors did not measure dietary restraint in the studies). Thus, the studies reported in the final chapter were designed to test the potential interactive effects of dietary restraint on the peak and end memory bias. The findings indicated that dietary restraint did moderate the peak and end biases and this may go some way to explain Rode et al.'s (2007) null findings. To some extent this raises a question of what implications this may have on the earlier experimental chapters of this thesis.

The broad aims of the thesis were to study the relationship between episodic memory and food choice. As restraint was considered only for the final studies, the earlier studies reported were not designed to test for restraint effects and therefore have insufficient sample size and power to be able to test any interactive effect. Ideally, future research

should examine whether both restraint groups use their memory for past experiences to guide food choice in a similar way. This may have particular importance to any applications derived from work linking memory and food choice, as restrained eaters may be within populations that are targeted. However, as dietary restraint is presumably learnt over time, younger samples would be unlikely to suffer from this limitation.

An interesting issue regarding the methods used in this thesis is measurement of food choice. Studies 3 and 5 were designed to assess amount of a food chosen from a buffet. However, a different way of examining food choice is to examine frequency of choice (i.e. how many participants chose a specific item or did not choose it). Post-hoc in both studies this second analysis was undertaken. In Study 3 the expected pattern of results was observed; a greater frequency of participants in the experimental condition selected carrots compared to controls. However, this did not reach significance. This may be due to a ceiling effect (see Study 3 results). In Study 5, the experimental group did select more of the food item of interest and analysis indicated this was a significant effect. Both approaches have merits, but for data where a ceiling effect for frequency of choice may exist, mean grams chosen seems a more appropriate test. Frequency of choice would be more appropriate choice if subsequent studies asked participants to make a choice between two different foods, whereby choice of one food infers rejection of another. In the present studies participants were not limited to selecting only one item.

A final limitation may be the sampling used in the present study. For all experiments, a largely female undergraduate sample was used. Whether this is representative of the general population may be questioned. In terms of some variables there are differences

between University and general populations (higher educational level tends to be associated with higher IQ for example; McCall, 1977). It is of importance to note that eating behaviour research suggests that gender may be an important variable, as males and females have been shown to differ in some studied eating behaviours. For example; males have been shown to be less likely to model the food intake of eating partners; Herman et al. 2005). Due to the extremely small number of males in our available population, gender effects cannot be examined in the present work.

However, it is likely that the relationship between memory and food choice is likely to hold for a large number of populations. Enjoyment of food has been shown to predict food choice across different populations (De Graaf et al. 2005; Aikman et al. 2006; Mustonen et al. 2007) and memory has been shown to inform future intentions and behaviour in non university populations (Redelmeir & Kahneman, 2003; Morwedge et al. 2005). Furthermore, to the knowledge of the author there is no published literature that has shown differences in affective memory or dietary learning as a function of gender. It therefore seems reasonable to assume remembered enjoyment may be an important determinant of food choice across other samples outside of the female undergraduate sample tested here.

6.4. Process considerations

It is important to be open to the possibility that other processes may provide a better explanation for observed findings. Here, an episodic memory account has been provided to account for the research in this thesis. It has been argued that individuals create representations of past eating experiences in the form of episodic memories and that these

memories inform food choice. Could an account that does not require a construct like episodic memory explain any of the results in this thesis?

For some experiments an alternative explanation that would not require episodic memory might be some form of conditioning - whereby individuals learn associatively (and perhaps without conscious awareness) that eating foods produces positive or negative responses, which then in turn influences behaviour. A number of findings in this thesis suggest this explanation seems unlikely to explain the main results of interest. Perhaps most importantly, in the studies that did involve consumption of food only one consumption experience with the food took place for participants, whereas successful demonstrations of conditioning with food normally involve a large number of trials (Brunstrom, Downes & Higgs, 2001; Brunstrom, Higgs & Mitchell, 2005). Moreover, it has been recognised that even in multiple trial conditioning studies, producing consistent effects of increased liking in humans has previously proven difficult (Brunstrom et al. 2001; Gibson & Brunstrom, 2005)

To produce a conditioned effect this single experience would have had to be extremely pleasant or extremely aversive (Coil et al. 1978). The ratings of enjoyment for the consumed foods in this thesis suggest that the foods were not extremely liked or disliked. For example, in Chapter 4 it was shown that a disappointing experience with a food resulted in a change to liking for the food a day later, but not a week later. A conditioning explanation for these results seems unlikely because the participants did not experience a large reduction in liking and still rated the disappointing food slightly above mid way on the rating scale; suggesting that the experience was far from aversive.

In Chapter 4 it was also shown that a change in liking occurred at one day but not one week, as a result of a disappointing experience with a food. As the food was served only once and not in between sessions, if it is a conditioned response at one day explaining the effect, it should theoretically remain at one week (although a different prediction would be that the conditioned response may have faded if the learnt response was relatively weak).Based on this and the method used that resulted in a single non-aversive consumption experience, it is therefore suggested that the interpretation that different memory is being used at one week to one day can explain these findings more adequately than a simple conditioning explanation. Furthermore, the findings are in line with other studies that suggest a switch from episodic to semantic memory to inform decision making at around one week (Robinson & Clore, 2002a; 200b).

In Chapter 2 it was shown that recalling a specific episodic memory of enjoying vegetables changes food choice. Perhaps more importantly a control group that were exposed to cues relating to eating and enjoying vegetables (without recalling a specific memory) did not exhibit any change in food choice, suggesting a conditioned response to eating vegetables seems an unlikely explanation here also. Finally, in Chapter 3 a sensitive manipulation to specifically alter the content of episodic memory was devised and this change to episodic memory resulted in changes to food choice. This finding provides particularly convincing evidence that episodic memory is an important underlying process.

Another consideration is whether the findings of this thesis can be explained through a cue reactivity account. Cue reactivity being a form of conditioned response that results in an

internal or external cue causing an increase in craving and/or intake of food. One might argue that the studies that involved cueing recall of memories of eating vegetables (in Chapter 2) could be explained by a cue reactivity account, as the experimental condition were exposed to thoughts about food through recalling memories of eating vegetables. However, this account seems an unlikely explanation as one control group were exposed to thoughts about personally eating a different food (crisps) and another control exposed to thinking about another person eating and enjoying vegetables. At the same time, it could be argued that a personal eating memory might produce a particularly strong 'cue', so for these studies, such an account cannot be completely discounted. Perhaps what is more important are the studies reported in Chapters 3 and 4, as they did not involve any explicit exposure to mental or environmental cues and still a change in food choice and liking occurred. Thus, collectively it seems unlikely that a cue-reactivity explanation can account for the main findings of this thesis.

The studies reported in this thesis provide evidence that episodic memory of past eating experiences inform food choice, which is in line with existing literature that has suggested episodic memory is important when imagining how enjoyable future experiences will be (Gilbert & Wilson, 2007). What still remains unclear is the exact process by which episodic memory informs food choice. A previously suggested hypothesis is that individuals retrieve a memory, inspect the hedonic content of the memory and then directly use this to guide predicted enjoyment (Gilbert & Wilson, 2007). Alternatively, it may be that episodic memory influences future behaviour more subtly, through altering beliefs (or 'semantic memory') and about how much one likes a type of experience, rather than being the direct cause of behavioural change itself (Bem, 1967).

Distinguishing between the two suggested processes would be of interest. For some time cognitive psychologists have argued for a dual system model of decision making, whereby individuals may use a quicker more heuristic information, (such as semantic memory to guide intentions) or a slower more effortful integration of information (such as the retrieval and inspection of an episodic memory to guide intentions), dependent on context and task (Kahneman, 1994). How would one go about answering such a question in relation to food choice? Reaction time paradigms in cognitive psychology have started to be developed and may be useful in distinguishing between semantic and episodic information retrieval (Robinson & Clore, 2002a; 2002b) and self report techniques have also been proposed to help to distinguish between the semantic vs. episodic content of future thought (Argembeau & Mathy, 2011).

The importance of memory and learning in eating behaviour now has empirical backing. Pinning down which memory systems drive different behaviours is a challenge that researchers interested in learning, memory and eating behaviour now face. For example, other areas of eating behaviour would benefit from understanding whether semantic or episodic memory is used primarily in decision making such as food choice and portion sizing, as the two types of information may produce different outcomes. For example, a commonly held belief is that 'healthy' food is less enjoyable than 'unhealthy food', (Raghunathan et al. 2006). Thus, if individuals rely on this belief when making food choice, they may be likely to avoid healthier food items. Conversely, if they were instead to access an episodic memory of having enjoyed a specific 'healthy' food item, one might predict an increase likelihood of choosing that healthy item.

If is the case that episodic memory has its effect on food choice through updating semantic memory / beliefs about foods, further work examining how past experiences shape semantic memory of food liking would be fruitful. Results from one study in Chapter 4 of this thesis suggest that early experiences may be important, but presumably individuals do, in some circumstances, update and change beliefs about food liking due to experiences that occur after this early period. One suggestion may be that episodic and semantic memory are closely related, whereby episodic memory 'feeds' into semantic memory and as episodic memory fades, in the long term, predictions about enjoyment are more likely to be advised by semantic memory (Klein et al. 2009). This idea suggests an important role for both episodic memory and semantic memory. Yet, how individuals integrate past experiences to form knowledge about how much they like a food and under what circumstances this may be changed are both questions that remain unanswered in literature at present.

6.5 Concluding remarks and significance

Across four experimental chapters, using a number of different paradigms, data in this thesis suggests that episodic memory is likely to play an important role in shaping food choice. There may also be application of these findings to promote liking and acceptance of foods, although further work is needed to fully understand how episodic memory of past eating experiences informs food choice and how this may be applied outside of the laboratory. The consistency of these findings reported here suggest that episodic memory is an important influence on eating behaviour and should therefore be studied further,

which adds to earlier suggestions made in the literature (Higgs, 2002; Rozin et al, 1998; Rode et al. 2007).

The findings from the final experimental chapter also suggest that episodic memory differs to actual experience. This further supports the notion that if we are to fully understand food choice and other aspects of eating behaviour, a focus should be made on memory processes, as it is with memory that we make many food related choices and decisions (Koster, 2009). Finally, the data presented in this thesis and conclusions drawn linking memory and food choice are presumably further reaching than earlier literature linking episodic memory and eating behaviour. Although memory has started to be linked to intake of foods (Higgs, 2002; Higgs, 2008) and expected satiety/portion sizing (Brunstrom et al. 2011), food choice is normally devoid of sensory contact with food and decisions concerning portion sizing and intake at a meal depend first on the foods chosen to consume.

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