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EATING BEHAVIOUR, AFFECT AND COGNITIVE FUNCTION

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Summary

The aim of this thesis was to examine the affective and cognitive disturbance associated with weight-loss dieting. We were particularly interested in how mood might interact with dietary restraint to produce cognitive deficit. Initially dieting was investigated in a community sample of overweight dieters. Affect was assessed by self-reported feelings of positive and negative mood (PANAS) and general psychological well-being (Ryff's PWB). Cognitive performance was assessed using a battery of computer administered tasks that measured speed to respond to a target stimulus; immediate memory recall; working memory capacity; vigilance (Bakan task); attentional distraction for food related stimuli (Stroop task); and, preference for food and body-shape related stimuli (Implicit Association Test). In replication of previous studies (e.g. Green, Rogers, Elliman, & Gatenby, 1994), dieting was found to be related to cognitive deficit. The same dieters were also found to be more neurotic and to have greater levels of affective disturbance compared to non-dieters. Contrary to expectation, restraint per se could not account for the dieter—non-dieter differences found. Further, differences in cognitive performance could not be explained as directly due to dieter—non-dieter differences in BMI, hunger, preoccupation, attentional bias or mood. Rather, it was the tendency to eat when emotional which best identified those dieters most vulnerable to cognitive *and* affective disturbance. Further investigation revealed that under conditions of high negative mood, tendency towards emotional eating was associated with an increase in preference for food related stimuli, and a decrease in attentional capacity. Accordingly, it was proposed that under dieting conditions, where opportunity for affective disturbance is increased, cognitive deficit is most likely to occur in the high emotional eater because they are highly sensitive to affective disturbance, and for them such disturbance results in preferential allocation of attentional resources to food and eating related cognitions. Further research is needed to fully examine the psychological profile of the individual with high tendency towards emotional eating. This issue is of particular importance given the additional finding that the tendency to consume when emotional is not context-bound but can also be observed in other behavioural domains, such as "emotional spending" on other consumer goods.

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Dedication

This thesis is dedicated to Jordan James (3 years) and Samuel Joseph (18 months):

you are my joy.

CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

Dieting offers the most accessible means of weight-loss and ultimately control over body weight and shape. In addition to the benefits of improved health, the achievement of weight-loss may serve to enhance feelings of self-respect and self-esteem in a culture where “thin” is highly valued. However, weight and shape may not be as malleable as our culture suggests (Mills, McCabe, & Polivy, 2000) and, due to the frustrations of restricted food intake, diets are often difficult to maintain. Indeed, most who have dieted regain their lost weight over time (Grodstein et al., 1996) and evidence suggests that many dieters eventually weigh even more than they did before dieting (Kirschenbaum, Stalonas, Zastowny, & Tomarken 1985; Murphy, Bruce, & Williamson, 1985). Accordingly it is perhaps unsurprising that dieting has been associated with mood swings (Tiggeman, 1994) and depression (Smoller, Wadden, & Stunkard, 1987). Further, a significant body of research has demonstrated dieting and high dietary restraint to be associated with impaired performance on selected tasks of cognitive function (e.g. Green & Rogers, 1995; Rogers & Green, 1993). Such findings have raised concerns that despite the positive aspects associated with weight-loss, dieting may have negative effects on both health and well-being (Brownell & Rodin, 1994).

In this thesis a series of studies is reported which examine the nature of the affective[1] and cognitive disruption that is proposed to occur during attempted weight-loss and weight control. We are particularly interested in how mood might interact with dietary restraint to produce cognitive deficit. In order to provide theoretical grounding for the studies to follow, this review examines how dietary restraint might influence cognitive performance, four possibilities are considered. First, restraint may have a direct effect on cognitive performance by a reduction in the ability to maintain attention. Second, restraint may bring about mood disruption that in turn has an effect on cognitive performance. Third, restraint may have psychological effects, such as preoccupations with and attentional bias towards dieting related concerns, and these might influence cognitive performance. Fourth, restraint implies nutritional deprivation and this might have consequences for cognitive performance. However, before reviewing the role of restraint in cognitive deficit, we first consider the concepts of dieting and restraint, and the operationalisation of eating behaviour.

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[1] The terms "affect", "emotion", and "mood" are frequently used interchangeably, although according to Ellis & Moore (1999) these terms do differ. They adopt the following convention: "affect" is the more general term encompassing both emotion and mood (Forgas, 1995). "Emotion" is regarded as having the properties of a reaction, sometimes an intense response to a specific stimulus. "Mood" is regarded as a more subtle, longer-lasting and less intense experience and tends to be more general or non-specific. This convention is adopted in this thesis.

Warsh, 1978). Paradoxically high scorers on the Restraint Scale have been as recognisable for their tendency towards disinhibited eating as they have for their restraint per se (Herman & Mack, 1975; Herman & Polivy, 1975). Heatherton et al. (1988) contend that this double standard is essential for the identification of chronic dieters; this is because in the naturalistic setting chronic dieters are unsuccessful dieters, and are more likely to display restraint punctuated by periods of splurging. In this context disinhibited eating is recognised as a *consequence* of intense dieting (Herman & Polivy, 1975).

More recently, scales have been introduced that measure distinct aspects of eating behaviour, these include the Dutch Eating Behaviour Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986), and the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985). The latter two measures are characterised by one-dimensional scales designed to measure both the cognitive and the behavioural restriction of food intake, aspects of disinhibited eating and, in the case of the TFEQ, hunger. Two aspects of disinhibited eating are identified within the DEBQ: emotional eating and eating in response to external cues. The concept of emotional eating, born from Psychosomatic theory (Kaplan & Kaplan, 1957), refers to the tendency to eat when emotionally aroused, for example when bored, sad or anxious. External eating, derived from Externality Theory (Schachter, Goldman, & Gordon, 1968), refers to the tendency to eat in response to food-related stimuli regardless of the internal state of hunger or satiety. In the context of the DEBQ disinhibited eating is recognised as a measurable trait, found in individuals of all

weight categories and not just the obese (van Strien et al., 1986; van Strien, Schippers, & Cox, 1995).

Research has shown that disinhibited eating in high restrainers that have been identified by the Restraint Scale may be triggered by a variety of events, such as the perception of having over eaten (e.g. Herman & Mack, 1975; Ruderman & Christensen, 1983); anticipated overeating (Ruderman, Belzer, & Halperin, 1985); mere exposure to food related cues without preloading (Fedoroff, Polivy, & Herman, 1997); or by experiencing strong negative emotions (e.g. Herman & Polivy, 1975; Schotte, Cools, & McNally, 1990). However, none of these behavioural anomalies have been shown in high restraint participants who were classified according to the restraint scales of the DEBQ and TFEQ (Lowe, 1993; van Strien, 1999).

Multifactoriality within a scale, such as that found in the Restraint Scale, argues van Strien (1999), is only of value if the research aim is to identify dieters who have a high tendency towards disinhibition of restraint. Confounding restraint and disinhibition is unhelpful if one wishes to distinguish between dieting sub-populations (i.e. those that express high restraint and low disinhibition versus those that express both high restraint and high disinhibition). Therefore, failure to differentiate between aspects of restraint and disinhibited eating may limit the identification of successful and unsuccessful dieters.

Defining Dietary Restraint and Measuring Eating Behaviour: the approach adopted in this thesis

In this thesis restraint will be defined as the cognitive and behavioural restriction of food intake that may or may not occur within the richer context of dieting to lose weight. We define dieting as a goal-directed approach to weight-loss where emotional reaction occurs as a consequence of an individual's failure to manage or maintain dieting goals. Because we need to be able to differentiate between successful and unsuccessful dieters and since the majority of studies that have demonstrated specific diet-linked deficits in cognitive performance have employed the DEBQ (e.g. Green & Rogers, 1995; Green et al., 1994) this scale was selected as our measurement of eating behaviour. Accordingly, when we refer to eating behaviour in this thesis the specific measures referred to are restraint, emotional and external eating.

1.3 Dieting and Cognitive Impairment

Recent research has shown female dieters to demonstrate deficits on tasks of sustained attention (Green et al., 1994; Rogers & Green, 1993), simple reaction time (Green et al., 1994; Kretsch, Green, Fong, Elliman, & Johnson, 1997) and immediate memory recall (Green et al., 1994), relative to non-dieting controls. Finally, Green and Rogers (1998) demonstrated dieters to have smaller working memory capacity relative to non-dieters. Specifically, they demonstrated that dieters perform more

poorly on measures of central executive and phonological loop function. It is unlikely that these effects can be explained purely in terms of retardation of motor speed or lack of motivation, since Green et al. (1994) found dieters to perform better than non-dieters on a task of two-finger tapping speed. Typically, the dieters within those studies were following an unspecified diet and were within the normal weight range with body mass indices (BMI) of less than 25[2]. To our knowledge only one study has examined the cognitive performance of overweight dieters (mean BMI > 30) assigned to a specified diet, and that was the study conducted by Kretsch et al. (1997). They used the same task battery as had been used with the normal weight dieters and they demonstrated diet-linked deficits in simple reaction time, but no deficits on tasks of sustained attention and immediate memory recall. We will return to address the issue of sample selection later. The following sections outline the argument and examine the evidence to support the four proposed routes to diet-linked cognitive deficit, we start with the direct route: an increase in dietary restraint brings about a reduction in attentional capacity leading to cognitive impairment.

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[2] BMI = Weight (kg) / Height (m) ^{2}

Doll, Peterson, & Stuart-Brown (2001) identified the following weight categories base on the WHO-endorsed international classification of obesity: BMI 18.5 to 24.99 = normal weight, BMI 25 to 29.9 = overweight, BMI 30 to 39.9 = moderately obese, BMI 40 plus = morbidly obese.

1.4 The Direct Restraint Mediated Route to Cognitive Deficit

Polivy (1998) argues that attempts to inhibit motivated behaviours (i.e. the desire to eat) may have negative cognitive, affective and behavioural consequences. The overriding or inhibiting of competing urges, behaviours or desires is suggested to be both effortful (Muraven, Tice, & Baumeister, 1998) and reliant upon a limited, consumable resource (Muraven & Baumeister, 2000). Further, this resource may be depleted by seemingly different unrelated acts; for example, the act of resisting temptation has been shown to reduce persistence time on a subsequent difficult and frustrating task (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Processes that do not require self-control neither consume nor require self-control strength (Muraven & Baumeister, 2000). However, under cognitively demanding conditions the self-regulation of eating behaviour and the simultaneous attendance to a demanding cognitive function task may resemble a dual task paradigm, putting the dieter at a performance disadvantage to the non-dieter. Such a dual task may draw upon working memory capacity, specifically executive function resources. The central executive is the coordinating control system within working memory that enables the conscious manipulation and integration of information from different sources and includes the attentional control of action (Baddeley, 1993, 1996). The maintenance of dietary restraint might have consequences on the ability to maintain attention following reduced capacity of the central executive.

The role of restraint as a *mediator* of cognitive deficit remains equivocal. In order to distinguish between the effects of dieting and the effects of restraint, Green and colleagues adopted the technique of splitting the sample according to dieting status followed by restraint status thereby producing three groups: dieters, and high and low restrained non-dieters. On occasion the performance of the high restrained non-dieters has been shown to be compromised on tasks of sustained attention and immediate memory recall (Green et al., 1994) and simple reaction time (Green et al., 1994; Green, Rogers, & Elliman, 2000). But this effect is unreliable. Inaddition, and of even greater concern for the direct hypothesis, in the study where dieters were demonstrated to have smaller working memory capacity (Green & Rogers, 1998) the same was not found to be true of high restrained non-dieters, in fact they performed at comparable levels to low restrained non-dieters. There are two possible explanations for this null result, either (a) the level of dietary restraint maintained needs to reach a threshold before it impacts processing resources, or (b) restraint initiates or acts in conjunction with another diet related factor to impact processing capacity.

1.5 The Affect Mediated Route to Cognitive Deficit

Emotion and attention are intimately linked; states of emotion can influence performance on tasks that require selection of stimuli or intensive concentration (Matthews & Wells, 1999). Typically research has focused on the negative emotions

suggested to elicit two distinct types of effect: *impairment* (effects associated with reduced quality or efficiency of performance), or *bias* (effects associated with prioritisation of processing stimuli of negative valance) (Matthews & Wells, 1999). For example, state anxiety may lead to decrements in short-term memory performance (Idzikowski & Baddeley, 1987) and depressive mood states can impair memory (for a review see Ellis & Moore, 1999). In terms of bias, mildly depressed participants have demonstrated greater attentional bias towards negative valence cues compared to non-depressed participants (e.g. Gotlib & McCann, 1984; Klieger & Cordner, 1990).

As already mentioned, dieting has been associated with mood disturbance. Mood disturbance may be present before the diet starts or it may be brought about by attempts to maintain dietary restraint. Polivy (1998) contends that the inhibition of a highly motivated behaviour (e.g. eating a favourite food when one is hungry) may be difficult and if the reward for inhibition of the behaviour is remote (i.e. weight-loss does not occur immediately following decline of the favourite food) negative feelings of deprivation and resentment may result. In general terms, slowed progress towards a goal may result in an increase in negative affect (Carver & Scheier, 1990) and frustration of goal attainment may produce anger and depression (Klinger, 1987).

However, within the dieting literature the hypothesis that cognitive disruption results from affective disturbance has received little direct evidence. Most studies that have

investigated diet-linked cognitive impairment have found no difference in mood level between dieters and non-dieters (e.g. Green, Elliman, & Rogers, 1997; Green & Rogers 1995). It could be that mood disruption is an unnecessary prerequisite for cognitive disturbance. Alternatively there are at least two methodological factors which may account for the null effects of mood. First, mood in these studies has typically been measured using *only* anxiety and depression scales: scales derived from observations of clinical populations that may be insensitive to non-clinical levels of mood variation. This is important given the finding that individuals who participate in weight-loss interventions are not necessarily clinically depressed (e.g. Williams, Surwit, Babyak, & McCaskill, 1998). Second, subtle changes in mood may be less easy to detect than effects of cognitive task performance, this is because mood rating scales generally have poorer resolution and higher measurement error than measures of cognitive performance (Gibson & Green, submitted). The measurement of affective state is complex; the following section will explore the issues related to the measurement of mood and well-being.

The Measurement of Affective state: mood and well-being

> "Emotional well-being, like physical health, can be judged
> on a variety of dimensions"
>
> *Diener and Lucas (in press).*

This observation is equally applicable to the measurement of mood: judgement could be based on dimensions of time (e.g. current versus over the past few weeks), valence (e.g. high positive affect versus low negative affect), or intensity (e.g. acute versus chronic). The possibilities are extensive. The selection of the appropriate measurement tool will depend upon the theoretical question being addressed. For the purposes of this thesis this review is constrained to the measurement of conscious mood state and subjective well-being.

Measurement of mood.

Aspects of positive and negative affect are suggested to form two distinct factors and it has been proposed that they be assessed as such (e.g. Bradburn & Caplovitz, 1965; Watson, Clark, & Tellegen, 1988). Positive affect reflects aspects associated with positive mood, including feelings of joy, interest, energy, enthusiasm or alertness; negative affect encompasses feelings associated with negative or aversive mood, these include feelings of nervousness, sadness, irritation, guilt, contempt or disgust (Watson & Clark, 1997). Further, aspects of positive and negative affect are not usually symmetrical or parallel in their effects (Isen, 1999). Differentiation between aspects of positive and negative affect will enhance discriminative power providing information that might not have been obtainable through the use of a one-dimensional measure. For example, although negative cognitions are associated with the *onset* of emotional problems, there is evidence that it is the presence of positive cognitions that determine the speed of recovery from emotional problems (Macleod, 1999).

The most popular measurement tool for conscious mood is self-report, the most common technique being the administration of Likert or analog rating scales. Measures may be devised to satisfy the particular needs of a study or a published standardized inventory might be chosen. Unfortunately such measures are susceptible to a variety of biases and distortions, including those due to social norms, expectations, and attributions (Parrott & Hertel, 1999). Some of these problems might be alleviated by the use of scales that include more subtle indices of affective state such as "irritable" or "active" (items from the Positive and Negative Affect Schedule; Watson et al., 1988).

In addition to the quantitative aspects of mood measurement there is the need to consider qualitative issues pertaining to individual reactivity to mood disruption. Research has revealed that it is those participants who demonstrate acute emotional arousal (with a background of chronic increased emotionality) that tend to show cognitive effects most clearly (Williams, Watts, MacLeod, & Mathews, 1997). Further, mood per se is not necessarily predictive of future states of well-being. For such predictions it is necessary to look at the frequency and intensity with which individuals describe themselves in global negative terms (e.g. "worthless") versus positive terms (e.g. "capable") (Williams et al., 1997).

Measurement of well-being.

Modern theories of well-being focus on the processes that underlie happiness; they stress dispositional influences, adaptation, goals, and coping strategies (Diener, Suh,

Lucas, & Smith, 1999). Subjective well-being encompasses a broad array of phenomena. Accordingly the composition of the measurement scales used differ significantly in terms of the ratio of cognitive to affective components (Andrews & McKennell, 1980). Scales that focus on well-being defined as happiness reflect emotive based constructs. Alternatively measures that focus on the broader concept of satisfaction with life are more reflective of cognitive based accounts that require some kind of comparison between a level of achievement and a standard (Andrews & McKennell, 1980; Diener, 1984). It is noteworthy that the cognitive and affective constructs are not linearly related. Campbell, Converse and Rogers (1976) found that feelings of happiness tend to be lower among older people, but feelings of satisfaction tend to be higher. Smith (1978) found that although measures of happiness and affect show seasonal variations over the year, measures of satisfaction remain constant. Further, the cognitive assessment of a persons life can take place at three levels: (a) at the level of life in general; (b) at the level of specific life domains, e.g. positive relations with others; and, (c) at the level of specific facets or aspects within a domain, e.g. relationship with spouse (Alfonso, 1995).

Well-being inventories may take the form of single to multiple item scales, scored using a Likert or analog rating scales. Single item measures have been criticised for the fact that the variance due to the specific wording of the item cannot be averaged out (Diener, 1984). Also, the lack of specificity present in a single item may contribute towards the respondent making an immediate mood assisted judgement rather than giving an evaluation of their life as a whole (Schwarz & Clore, 1983).

However, multiple item scales are not without fault. Although, owing to item variety, such scales are more able to capture elements of both cognitive and affective evaluation this balance may be difficult to establish resulting in some scales producing more of a mood evaluation rather than a global assessment of life (Diener, 1984).

A variety of distortions and bias affecting well-being measurement have been identified, including the fact that values may change depending on the type of scales used, the order of the items, the time-frame of the questions, current mood at the time of measurement and other situational factors (Schwarz & Strack, 1991). Some of the technical problems can be alleviated; Andrews and McKennell (1980) found that measures using response scales consisting of more than three responses gave a more valid indication of an individual's evaluation of their life as a whole. But, to promote good measurement, Diener et al. (1999) stress the necessity to take into account the "Person x Situation" interaction, that is the interaction between internal factors (such as personality) and external circumstances.

In this thesis the extensiveness of affective state is acknowledged. Therefore when considering affect a range of scales will be used to span the breadth of assessment from temporary fluctuation in mood to more cognitive accounts of psychological well-being.

1.6 Psychological Route to Cognitive Deficit

Green and Rogers (1998) suggest that the cognitive deficits that have been observed in dieters are allied "to dieting per se, rather then pre-existing individual differences between dieters and non-dieters" (p. 1063). This conclusion was justified by the observation of more impaired performance in the same individuals when dieting than when not dieting (Green & Rogers, 1995). Further, Green and colleagues have explained diet-linked reduction is working memory capacity as due to a reduction of processing resources incurred following *increased* preoccupation with thoughts concerning food and eating (Green et al., 1997) and body shape (Green & Rogers, 1998). This evidence relied upon self-reported preoccupation, however there is also objective evidence to support this view provided by studies of attentional bias in dieters. First we briefly review the attentional bias paradigm and then describe results found in dieters.

Attentional Bias Paradigms

The study of systematic bias in attention is grounded within the information processing approach to understanding the development and maintenance of emotional disorder. The core feature common to both anxiety and depressive disorder is sensitivity to and preoccupation with stimuli salient to current concern (Williams, Mathews, & MacLeod, 1996). To assess these biases a modification of the Stroop colour naming paradigm has been employed. In this task participants are asked to name the colour of a word as quickly as possible whilst ignoring the meaning; the

dependent variable is the size of the interference effect obtained between the latency to colour name neutrally valenced stimuli and emotive stimuli (words salient to the particular psychopathology under investigation). Colour naming latency is proposed to reflect the extent to which processing resources are allocated to the word content (Mogg & Bradley, 1999). The emotional Stroop effect has been found not to be dependent on conscious strategies (Mogg, Kentish, & Bradley, 1993).

Attentional Bias and Dieting

Colour naming interference is not confined to psychopathological states. For example, Dalgleish (1995) found keen ornithologists to show colour-naming interference for the names of rare birds. Reviewing the evidence, Williams et al. (1996) conclude that for non-clinical participants it is the relatedness of the stimuli to the current concern, rather then the emotional valence of the stimuli that is sufficient to mediate the Stroop effect. Accordingly, the Stroop paradigm has successfully identified attentional bias in female dieters towards food and body shape related concerns. Green and Rogers (1993) used a computer administered task and demonstrated dieters and highly restrained non-dieters to be more distracted by food and body shape related words than neutral words, compared to non-dieting low to medium restrainers. The authors concluded that the observed attentional bias was a function of dietary restraint rather than actual dieting behaviour. Huon and Brown (1996) also used a computer administered task to explore attentional bias in current dieters, but employed a within-subjects design. Their results showed slower

responses to food words compared to neutral words, with no effects for body-shape related words.

Although there appears to be considerable support for the psychological (attentional deployment) hypothesis, there are several areas of weakness in this account. First, direct evidence for a causal relationship between preoccupations and deficit has received only weak support, mainly reliant on correlational data. If the preoccupations experienced by the dieters represent something fundamental about dieting, then their link with the observed deficits may simply be due to their strong relation to dieting and their apparent causal status an artefact of this relationship. Second, although objectively measured diet-linked attentional bias has been found it has not yet been linked to cognitive deficit. Finally, concerning the origin of diet-linked psychological disruption, although Green and colleagues suggest that the disruption is due to dieting rather than pre-existing differences (Green & Rogers, 1995), the level of preoccupation experienced by *intending* dieters has yet to be measured.

1.7 The Nutritional Route to Cognitive Deficit

The effects of nutritional deprivation on cognitive impairment have been widely explored. Research within this field has extended from the investigation of severe and chronic under nutrition to the effects of missing one meal. The current review is

constrained to the examination of the effects of moderate nutritional restriction such as might be incurred in a typical low calorie diet. Specifically we focus on the effects of dieting-related change in serotonergic neurotransmitter function and the influence of hunger.

Dieting and Serotonergic Function

The serotonergic system is one of the most wide ranging of all the neurotransmitter systems (Park et al., 1994). Serotonin pathways are highly implicated in the regulation of appetite and food intake (Blundell & Hill, 1987) and the regulation of mood (Benkelfat, Ellenbogen, Dean, Palmour, & Young, 1994). Evidence from animal studies (Altman & Normile, 1988) and investigation into the effects of Alzheimer's disease (where serotonergic function is diminished; McEntree & Crook, 1991) suggest an important role of serotonin in learning and memory processes. In addition high concentrations of serotonin receptors have been found in the prefrontal cortex (Goldman-Rakic, Lidow, & Gallager, 1990), an area implicated in executive control (Baddeley, 1996).

The synthesis of serotonin in the brain is dependent upon the supply of its precursor amino acid, tryptophan (Grahame-Smith, 1970). Tryptophan shares its transport pathway across the blood brain barrier with a number of other amino acids that tend to be more common in the diet. A period of moderate dieting has been shown to significantly reduce total plasma tryptophan and also the ratio of tryptophan to

competing amino acids in women (Anderson, Parry-Billings, Newsholme, Fairburn, & Cowen, 1990; Cowen, Clifford, Walsh, Williams, & Fairburn, 1996).

Pharmacological manipulation of brain serotonin levels in healthy volunteers, by ingestion of a low-tryptophan drink, has resulted in impairments in cognitive performance comparable to those shown by dieters. Park et al. (1994) examined the impact of experimental depletion of tryptophan in male volunteers on a range of computer administered cognitive performance tasks. Results showed selective impairment with deficits observed in learning and memory retrieval (demonstrated by lengthened thinking times on a task of central executive function but only in participants already familiar with the task). No deficits were seen for tasks involving spatial working memory, attention, and autobiographical memory recall; and, null results for mood measures (analogue ratings of feelings of *sadness, anxiety, irritability, difficulty concentrating* and *energy*) indicated that the impairments found were unlikely to be mood mediated. Riedel, Klaassen, van Someren and van Pragg (1999) examined tryptophan depletion in healthy male and female volunteers on a computer administered task battery. Results revealed specific depletion of long-term memory performance with delayed recall and recognition sensitivity being significantly impaired. However, short–term memory, perceptual and psychomotor function remained intact. No significant sex differences were found. Unfortunately, although participants were screened for depression, the influence of mood state on cognitive performance was not considered. Finally, Klaassen, Reidel, Deutz, van Someren and van Praag (1999) examined the effects of tryptophan depletion in

healthy male and female volunteers. Results showed that tryptophan depletion was followed by impaired memory consolidation (word learning task), increased tiredness and an increase in negative mood.

Tryptophan depletion has been found to reduce subjective ratings of positive mood in healthy female volunteers (Smith, Clifford, Hockney, Clark, & Cowen, 1997), and to increase ratings of negative mood in healthy male volunteers who had family history of affective disorder (Benkelfat et al., 1994). However, the studies reviewed above, concerning tryptophan depletion and cognitive performance, indicate that cognitive deficit may occur in the absence of mood disruption.

The evidence presented for the nutritional mediated route to cognitive deficit is convincing, however there are some problems. First, cognitive deficits have been shown in dieters following a self-specified diet that did not necessarily result in weight-loss. Accordingly, it cannot be assumed that the nutritional content of those diets reduced tryptophan to levels comparable with those induced by the tryptophan-free beverage. Second, tryptophan depletion did not result in short-term memory or attention/vigilance impairment as has been found to occur in naturalistic dieting. This lack of overlap may be due to differences in the tasks used, or it may be reflective of contextual dissimilarity between naturalistic and induced tryptophan depletion.

Dieting and Hunger

There are two possible ways that hunger might interrupt processing efficiency. The first route involves direct neuropsychological consequences of lack of nutrition, including reduced energy, concentration difficulty and biologically motivated increase in vigilance towards food related stimuli. The second route is cognitive in nature and involves hunger-induced preoccupations with food and eating resulting in bias in attention towards food related stimuli. This route has already been described above and will not be reiterated here suffice to say that short-term food deprivation has also been shown to induce attentional bias towards food related concerns. For example, Channon and Hayward (1990) demonstrated fasting participants (24 hours) to be slower to name the colour of food-related words compared to non-fasting controls. These effects were not due to a general state of response retardation (as no difference between groups was found for body-shape related words). Rather the deficit was found to increase as a function of self-rated hunger and desire to eat.

In one of the first studies examining the effects of under nutrition, Keys, Brozek, Henschel, Mickelson and Taylor (1950) observed participants over a six-month period of semi-starvation. During this period participants reported suffering increased irritability, lethargy, negative mood, concentration difficulty and poor memory. The effects of nutritional deprivation on hunger motivation have also been noted after only 6 hours of deprivation (Bellisle, Lucas, Amrani, & LeMagen, 1984). Macht (1996) demonstrated that reduction of the energy content of breakfast and lunch

resulted in increased self-reported motivation to eat and enhanced reactivity to emotional stress during an afternoon testing session. Enhancement of emotional reactivity may be a consequence of heightened hunger motivation, "which implies an increased attention and readiness to react to environmental stimuli" (Macht, 1996, p. 84). Macht suggests that this idea is supported by evidence from animal studies, where food deprivation has been shown to precede an increase in startle response reaction to acoustic stimuli (Anderson, Crowell, & Brown, 1985). Further, Macht notes that such increases in vigilance are biologically appropriate since they increase the likelihood of location of food.

However, counter to the evidence reviewed that would suggest short-term food deprivation to be sufficient to induce cognitive deficits, Green, Elliman and Rogers (1995) found only very limited effects of short-term fasting on cognitive function. Baseline (non-food deprived) performance was compared to performance following three different deprivation conditions: 24 hours of food deprivation, missing two meals and missing one meal. The food deprivation conditions were administered in a counterbalanced order across participants. The task battery comprised measures of vigilance, motor control, reaction speed, memory recall and focused attention. The only significant effect found was that of motor control measured by two finger tapping rate; with participants displaying a slower tapping rate following 24 hour food deprivation than when less deprived or when non-deprived.

1.8 Questions to be Answered

Each of the four proposed routes to diet-linked cognitive deficit appear feasible and yet each has empirical weaknesses necessitating further research. The questions raised by this review, and upon which this thesis will focus, are now summarised. However, it must be noted that this thesis was based on a collaborative research project between Bangor (psychological) and Oxford (pharmacological) research groups. As this thesis was being completed data was being gathered in Oxford concerning the effects of tryptophan on the cognitive performance of dieters using the same cognitive function tasks as employed in this thesis. The examination of the role of tryptophan depletion is not within the scope of this thesis. Tryptophan depletion may form the biological underpinning of diet-linked cognitive deficit, but this thesis focuses on the clarification of psychological context in which deficit occurs.

First, in order to complement existing studies, cognitive deficit needs to be examined in a group of *overweight* dieters who are following a self-specified diet. Second, the exact nature of the relationship between restraint and working memory capacity needs to be examined. We need to know whether an increase in dietary restraint affects other factors that influence cognitive performance or whether restraint per se mediates cognitive deficit. Third, the influence of affective state needs to be examined in more detail using a broad range of measures that encompass aspects of positive and negative mood, well-being, and susceptibility to negative self-reference.

We can then fairly examine the relationship between affect and cognitive performance in the dieting context and answer outstanding questions concerning the precise role of affect in cognitive disturbance; for example, are there direct effects or does affect interact with other factors to produce cognitive deficit (the Person x Situation interaction)? Fourth, the role of preoccupations and attentional bias as mediators of diet-linked cognitive deficit require further investigation. In terms of preoccupations we need to know if preoccupation is high in *intending* dieters, and if so how this affects cognitive performance. In terms of attentional bias we need to compare, in a single study, cognitive performance on the one hand with performance on a dieting concern-related Stroop task on the other. Finally, again in a single study, we need to examine the effects of hunger on attentional bias towards food related concerns and cognitive task performance. Thus, this is the focus of the first study.

CHAPTER 2

THE EFFECTS OF HUNGER ON COGNITIVE FUNCTION

2.1 Introduction

The role of hunger as a mediator of diet-linked cognitive impairment is unclear. Green et al. (1995) found only very limited effects of short-term fasting on cognitive function. And yet, diet-linked deficits have been associated with self-rated "desire to eat" (Green et al., 1997), which could represent a proxy measure of hunger; and, biases in attention towards food related stimuli have been identified in both dieters (e.g. Huon & Brown, 1996) and fasters (e.g. Channon & Hayward, 1990). However, to date attentional bias towards food related concerns and cognitive performance following short-term fasting has not been examined in a single study. In order to fully understand the circumstances that lead to diet-linked cognitive impairment it is necessary to establish whether such deficits are a product of a constellation of factors associated with long-term nutritional restriction, or whether they are also a feature of pure hunger state.

Measurement of biases in attention towards food related stimuli have typically relied upon the use of the Stroop paradigm. However, Mogg, Bradley, Hyare and Lee (1998) have argued that the Stroop merely measures attention distraction, which is incited by aversion *or* desire of the target stimulus. This potential dissociation is of interest in this study because it might be that dieters and fasters show similar trends in attentional distraction, but these trends are mediated by very different attitudes, i.e. the dieters try to avoid food related stimuli, whereas the fasters are more vigilant towards food related stimuli.

In order to measure attentional bias *towards* stimuli, Mogg et al. (1998) used an alternative paradigm: the dot probe task. In the dot probe task a series of word pairs (one target, one control) are presented on a computer screen, one above the other. Immediately after presentation of the word pairs a dot probe occurs in one of the two locations previously held by one of the words. The dependent variable is response time to indicate the position of the probe (upper or lower). Bias in attention towards the target word is demonstrated by faster time to respond when target and probe share the same position. Using this task Mogg et al. demonstrated that participants with high levels of hunger showed greater bias in attention *towards* food-related words when the stimuli were presented under supraliminal conditions compared to control (transport-related) words. There was no discrimination between stimuli when they were presented subliminally.

The working hypothesis of this study was that induced hunger would cause a bias in selective attention towards food related concerns, and this bias would result in cognitive deficit. This study utilised tasks of reaction speed, immediate memory recall and vigilance, tasks that were reflective of those employed in the cognition and dieting studies as reviewed. A task of central executive function, the random number generation task, was also included to assess whether the expected deficits were due to a general reduction in processing efficiency or whether they were specific to executive function capacity. Due to the concerns raised by Mogg et al. (1998) two measures of food related attention deployment were included: the Stroop and the dot

probe task. Supraliminal and subliminal versions of both of these tasks were administered.

2.2 Method

Participants

Twenty-four undergraduates (21 females, 3 males) from the School of Psychology at Bangor University participated in the study in order to gain course credit. Exclusion criteria included those with colour blindness and those currently pursuing a calorie reduced diet. All participants were fluent in spoken and written English.

Materials

Hunger Assessment

Hunger Scale (Grand, 1968).

This 4-item scale measures the number of hours since the respondent last ate (to the nearest 15 min); the number of hours till they expect to eat next (to the nearest 15 min); current hunger (1 = *not hungry at all*, 7 = *extremely hungry*); and, how much favourite food the respondent feels they could eat at the time of testing (1 = *none at all*, 6 = *as much as I could get*).

Cognitive Function Task Battery

The cognitive task battery was administered in a fixed order across participants as presented below. The Random Number Generation task (RNG) was administered on

a Mackintosh Classic computer, the other tasks were presented on an IBM 100MHZ Pentium running MEL V2 (Psychology Software Tools, Pittsburgh PA).

Random number generation task (RNG).

The task was conducted on a specialised keyboard measuring 57 cm x 70 cm consisting of 10 keys labelled 0–9. The keyboard was connected to a computer that emitted a tone at 1-second intervals and recorded each key press response. Participants were required to generate a string of random numbers by pressing one key at random in response to the tone. The RNG index is calculated by the following equation, following Tulving (1962):

RNG = the sum of (fij) times log (fij) / the sum of (fi) times log (fi)

Where the numerator is the sum of the log of all cell (ij) frequencies, and the denominator is a correction factor necessary when the obtained distribution of marginal cell frequencies deviates from (random) 10. The RNG index reflects the disproportion of sequence pairs within the cells adjusted by the disproportion of the marginal cell frequencies. It has a range of values from 0.0 to 1.0, with a higher index reflecting poorer randomness (Evans, 1978).

Simple reaction time task (SRT).

Participants were required to press the space bar of the keyboard as quickly as possible in response to a target stimulus " * " presented on the computer screen. A

variable stimulus onset from the initial presentation of a "Get Ready" message of between 1000 and 1500 ms was included. One hundred trails were administered.

Immediate memory recall task.

Two lists of 20 words were presented to the participant via the computer screen at 2-second intervals. At the end of each list participants were given 4 minutes to recall as many words from the list as possible. The experimenter recorded the responses. Words used were uppercase concrete nouns of between four and seven letters long (see Appendix A).

Vigilance task.

In this task a single target digit followed by a rapid sequence of digit pairs was presented on the computer screen. During the display participants were required to press the space bar of the keyboard as soon as they thought that they had detected the target digit within the digit pairs. The stimulus presentation rate was 100 stimuli per minute, with a stimulus exposure duration of 600 ms. A total of 300 stimulus presentations were administered in three blocks of trials, with eight potential correct hits per block.

Supraliminal food Stroop task.

Participants were asked to make a verbal response indicating the colour of a background strip upon which words appeared. Word included 20 food related words (target words) and 20 music related words (control words), matched for word length

and frequency in written English using norms generated by Carroll, Davies and Richman (1971) (see Appendix A). Blue, green, orange, red and purple background strip colours are used. The words remained visible on the screen until a response was made. Verbal reaction time was the dependent variable of interest, this was recorded using a voice response box connected to a microphone into which the participant spoke. The experimenter recorded the chosen colour to later check for response accuracy. Ten practice trials were followed by 100 experimental trials. At no point did the same word or same colour appear twice in succession.

Subliminal food Stroop task.

This task was based on the supraliminal Stroop described above, however in this version participants were asked to make a verbal response indicating the colour of a background strip upon which a row of X's appeared. Prior to the occurrence of the row of X's food and transport related words appeared for 1 ms upon the screen. A mask was presented 14 ms after the onset of the stimulus word and was displayed until a response was made. Ten practice trials were followed by 100 experimental trials. At no point did the same word or same colour appear twice in succession.

Subliminal Stroop awareness check.

Following the advice of Merikle and Reingold (1990) two perceptual judgement tasks were included to measure participant awareness of stimuli in the subliminal Stroop task. In the first, a presence/absence task, either a word (50% of trials) or nothing (50% of trials) was presented on the computer screen for 1 ms and then

replaced by a coloured strip (blue, green, orange, red and purple), which remained on the screen until a response was made. Words were a selection of 15 as used in the subliminal Stroop task. Participants were asked to indicate whether or not they had seen a word by pressing one of two response keys. In the second, a lexical decision task, words and non-words were presented on the computer screen for 1 ms, these were then replaced by a coloured strip until a response was made. Participants were asked to indicate whether or not they had seen a real word by pressing one of two response keys. For half of the trials food related words were presented (comprising a selection of 15 words as used in the subliminal Stroop task) in the remaining trials a non-word was presented e.g. VBHI. Fifteen practice trials and 60 experimental trials were included in each task.

Supraliminal dot probe task.

In this task each trial started with a fixation cross presented in the centre of the computer screen for 500 ms. The cross was then replaced by a word pair (in upper case), one appearing above the position of the preceding fixation point, the other below. Word pairs remained on the screen for 500 ms, these consisted of 20 food related words (target) and 20 music related words (control) matched for length and frequency in written English using the norms of Carroll et al. (1971) (see Appendix A). Immediately following termination of the word pair display, a dot probe appeared in the position of one of the word pairs and remained until a response was made. Participants were instructed to press one of two keys as quickly as possible to indicate whether the probe appeared above or below the centre of the screen.

Subliminal dot probe task.

In the subliminal version of this task the central fixation cross was followed by a word pair which was replaced by a pair of non-word masks (e.g. BHRTS), matched for word length with the preceding word pair (words as used in supraliminal version). The interval between word pair and mask was 14 ms. The interval between the mask pair and the probe was 186 ms. Thus the total interval between the target word pair and the probe was 200 ms.

Design and Procedure

A between-groups design was employed with the aim of comparing high and low hunger groups instigated by compliance to either a fasting or non-fasting procedure. Fasting participants were required to abstain from eating from the time of their last evening meal until after the experiment on the following afternoon (approximately 20 hours). They were permitted to drink tea and coffee so long as it did not contain sugar. Non-fasting participants were told to eat as normal. Upon testing participants were first required to complete the Hunger Scale followed by the cognitive task battery applied in a fixed order across trials. After testing participants were provided with information regarding the study and issued with their course credit. The Bangor School of Psychology Ethics Committee approved this procedure.

2.3 Results

Data Analysis

There are three sections to this analysis. The first focuses on a comparison of the cognitive performance and attention deployment of groups split in terms of high and low hunger. The second section examines the cognitive performance and attentional state of a proportion of participants who reported the highest levels of hunger. The third section involves a correlational investigation of the relationship between hunger, cognitive processing efficiency, attentional interference and attentional bias.

Data were analysed using the Statistical Package for the Social Sciences (SPSS; 1995). Parametric tests used included *t* test for independent samples and analysis of variance (ANOVA). Pearson product correlation coefficients were used in all correlation analyses (all two-tailed). An alpha level of .05 was used for all statistical tests. The main ANOVA tables are shown in Appendix B.

Section 1: Hunger, Cognitive Performance and Attention

Hunger Assessment

Subjective hunger ratings were significantly higher in the fasting group ($M = 4.42$, $SD = 1.83$) compared to the non-fasting group ($M = 2.25$, $SD = 1.29$), $t\ (22) = 3.35$, $p = .003$. However, considerable overlap was noted between the groups on the other Hunger Scale items. For example, in the fasting group time since last ate ranged from 12 to 24 hours; whereas in the non-fasting group time since last ate ranged from 0 to

19 hours. Therefore following Mogg et al. (1998) participants were reallocated to groups on the basis of their subjective hunger rating. This reallocation produced a "high hunger" group with hunger ratings above the sample median of 3, and a "low hunger" group with hunger ratings of 3 or less. Sixty-seven percent of the high hunger group were fasters. Table 2.1 shows the mean, standard deviation and *t* test values for the Hunger Scale for high and low hunger groups.

Table 2.1.
Mean Hunger Scale Ratings for High and Low Hunger Groups

	High hunger $n = 11$		Low hunger $n = 13$		*t*
Hunger Scale item	*M*	*SD*	*M*	*SD*	
Hunger	*5.09*	1.04	*1.85*	0.90	*8.18****
Amount of favourite food	*4.64*	0.81	*3.15*	1.14	*3.60***
Hours since last meal	*15.02*	6.05	*8.22*	8.94	*2.21**
Hours to next meal	*1.11*	0.79	*2.72*	1.54	*3.12***

Note. Maximum score for hunger = 7, for amount of favourite food = 6.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Cognitive Function Tasks

Performance on tasks of SRT, memory recall, vigilance and RNG was compared between high and low hunger groups. For each task the data was examined for outlying data points and the normality of the distribution within each condition was checked (Kolmogorov-Smirnov test, $z < 1.0$ in all cases). A series of one-way

ANOVA were conducted. Means, standard deviations and individual *F* values are shown in Table 2.2. Results demonstrate no significant between-group differences in cognitive performance, $F < 2.0$ in all cases. Removal of the outliers made no difference to these results.

Table 2.2.
Mean Cognitive Performance Scores for High and Low Hunger Groups

	High hunger $n = 11$		Low hunger $n = 13$		*F*
Measure	*M*	*SD*	*M*	*SD*	
SRT (ms)	270.13	24.53	270.76	28.31	.00
SRT (ms) minus outlier	265.03	18.73	270.76	28.31	.30
Memory recall	8.05	1.75	8.83	2.83	.63
Vigilance (% correct hits)	53	19	58	22	.25
Vigilance minus outliers	58	13	62	17	.36
RNG	.33	.04	.31	.04	1.82
RNG minus outliers	.33	.04	.31	.01	2.04

Stroop Task

For analysis of the Stroop data an interference index was calculated by subtracting mean speed to respond to control words (music) from mean speed to respond to target words (food). In this way a positive interference score indicates more distraction by food words compared to music words, the reverse being true for negative scores.

Subliminal Stroop awareness check.

On the presence/absence task participants were performing significantly better than chance (Binominal test, $p < .01$), with an overall mean correct hit rate of 76%. Performance on the lexical decision task was substantially lower, with a mean correct hit rate of only 52%, indicating that overall performance did not significantly differ from chance level (Binominal tests, $p > .05$). These results show that although the majority of participants were able to detect the presence versus the absence of a masked word stimulus they were generally unable to identify its lexical content.

The Stroop data was examined for outlying data points and the normality of the distribution within each condition was checked (Kolmogorov-Smirnov test, $z < 1.0$ in all cases). Means and standard deviations are shown in Table 2.3. A 2 x 2 repeated measures ANOVA was carried on out using the interference indices, with one between-subjects variable of Hunger (high, low) and one within-subjects variable of Exposure (supraliminal, subliminal). Results showed a significant main effect for Exposure, $F(1, 22) = 5.41, p = .04$, due to participants showing more distraction for food words under supraliminal conditions ($M = 24.07$, $SD = 67.25$) compared to subliminal conditions ($M = -16.82$, $SD = 76.42$). However, neither a main effect of Hunger nor a Hunger x Exposure interaction was demonstrated, $F < 1.0$ in both cases. Removal of outlying data points made no difference to these results, $F < 1.0$ in both cases.

Table 2.3.
Means Stroop Interference Scores for High and Low Hunger Groups

	High hunger $n = 11$		Low hunger $n = 13$	
Measure	*M*	*SD*	*M*	*SD*
Supraliminal	36.59	70.62	13.48	65.17
Supraliminal minus outliers	7.82	30.70	13.48	65.17
Subliminal	-6.16	58.11	-25.84	90.48
Subliminal minus outlier	-6.16	58.11	-8.92	69.77

Dot Probe Task

Following Mogg et al. (1998) the data were cleaned prior to analysis with latencies of less than 200 ms and over 2000 ms discarded as outliers. Less than 2% of the data was lost in this way. Kolmogorov-Smirnov tests showed that the distribution of mean reaction time scores calculated for each group did not differ from normality ($z < 1.0$ in all cases). Means and standard deviations are shown in Table 2.4.

Subliminal dot probe awareness check.

Performance on both the presence/absence task and lexical decision task was poor with respective mean correct hit rates of 34% and 30%, in neither cases did performance significantly rise above chance level (Binominal tests, $p > .05$). These results show that the majority of participants were unable to detect the presence versus the absence of a masked word stimulus and were also unable to identify its lexical content.

A 2 x 2 x 2 x 2 repeated measures ANOVA was carried out on the dot probe speed to respond data with one between-subjects variable of Hunger (high, low), and three within-subjects variables: Exposure (supraliminal, subliminal), Position of food word (upper, lower), and Probe position (upper, lower). The interactions of interest were those involving the Position of food word x Probe position interaction. Results showed none of these interactions to reach significance, $F < 1.5$ in all cases. The only significant main effect was that of Exposure, $F(1, 20) = 24.71, p = .0001$. This was modified by a Hunger x Exposure x Probe position interaction which bordered on significance, $F(1, 20) = 4.31, p = .05$. This interaction was not investigated further as it was not relevant to the hypothesis.

Table 2.4.
Mean Dot Probe Scores for High and Low Hunger Groups

Exposure condition	Position of food word	Position of probe	High hunger $n = 11$		Low hunger $n = 13$	
			M	*SD*	*M*	*SD*
Supraliminal	Upper	Upper	489.66	99.76	529.15	92.43
	Upper	Lower	471.66	60.94	538.44	97.77
	Lower	Upper	483.43	81.11	533.15	89.16
	Lower	Lower	479.23	78.77	531.16	104.43
Subliminal	Upper	Upper	417.64	50.42	484.67	91.11
	Upper	Lower	457.91	67.55	480.25	94.03
	Lower	Upper	432.63	71.47	474.16	69.44
	Lower	Lower	445.73	60.22	469.27	91.44

Section 2: High Hunger Sub-group Investigation

Observation of the raw data showed a sub-group of 7 participants with hunger ratings of 5 (*quite hungry)* or more, who had been allocated to the fasting condition and reported not having eaten for at least 17 hours ($M = 18.14$, $SD = 1.93$). The means produced by this extreme hunger sub-group for scores on the cognitive and attention tasks were compared to the overall sample means to assess sub-group deviation from expected norms. For comparison of the dot probe data, following Mogg et al. (1998) a bias score was calculated separately for each exposure condition by subtracting the mean latency to respond when food stimuli and probe were in the same position from the mean latency to respond when they were in different positions. In this way a positive bias score indicates vigilance for food words, whereas a negative value indicates avoidance of food words.

For tasks of SRT, memory recall, vigilance, RNG and Stroop, the null hypothesis that the sub-group showed no difference in performance from the over all sample was not rejected, $z < 1.0, p < .05$ in all cases. However, for the supraliminal dot probe task the mean of the sub-group was found to be significantly lower ($M = -24.35$, $SD = 70.60$) than that of the parent sample ($M = -1.26$, $SD = 52.90$), $z = 2.05, p = .04$; indicating greater avoidance of food words. There was also a close to significant difference on the subliminal dot probe tasks. However this time the mean of the sub-group was higher ($M = 29.61$, $SD = 71.30$) than that of the parent sample ($M = 12.71$, $SD = 69.83$), $z = 1.89, p = .06$; indicating greater vigilance for food words. The meaning of these results is unclear, we will return to discuss them later.

Section 3: Correlation Analysis

Correlates of Hunger

A correlational analysis was conducted comparing Hunger ratings with cognitive function performance and attention deployment (see Table 2.5). Although there was a trend for greater hunger to be associated with poorer RNG task performance and greater distraction for food related words on the Stroop task, none of the correlation coefficients reached significance, *r* (23) < .22 in all cases.

Table 2.5.
Correlation Between Hunger and Cognitive and Attention Deployment Tasks

	Hunger
SRT	.03
Memory recall	-.18
Vigilance	-.05
RNG	.17
Supraliminal Stroop	.14
Subliminal Stroop	.16
Supraliminal dot	-.22
Subliminal dot	.18

Correlates of Attention Deployment

A correlational analysis was conducted comparing attentional interference and bias with cognitive function performance. The dot probe bias score was used as calculated in Section 2. Results are shown in Table 2.6. In support of the experimental

hypothesis a trend was demonstrated whereby greater bias towards food related words on the dot probe task (both exposure conditions) was associated with poorer performance on the RNG task. However, this pattern of association was not reflected in greater interference on the Stroop task. In addition, and contrary to that hypothesised, a significant negative correlation was found between the supraliminal dot probe and SRT, *r* (22) = -.59, *p* = .004, indicating greater vigilance for food related words to be related to faster reaction time speed.

Finally, the pattern of association between the attention tasks was examined. The two Stroop tasks showed reasonable positive correlation, *r* (21) = .42. However, a weak negative correlation was shown between the two dot probe tasks, *r* (22) = -.29. In terms of inter-scale correlation, a reasonable negative association was shown between the supraliminal tasks, *r* (21) = -.37, but a weak positive association was shown between the subliminal tasks, *r* (21) = .16. It appears that on the supraliminal dot probe task greater bias towards food related stimuli was associated with less bias and less distraction for food related stimuli on the subliminal dot and Stroop tasks. These results are not easily reconcilable; we will now turn to a discussion of these and other results.

Table 2.6.
Correlation Between Attention Deployment and Cognitive Tasks

	Supra. Stroop	Sub. Stroop	Supra. dot	Sub. dot
Supra. Stroop				
Sub. Stroop	.42			
Supra. dot	-.37	-.07		
Sub. dot	.38	.16	-.29	
SRT	.21	.08	-.59**	.08
Memory recall	.35	.08	.12	-.24
Vigilance	-.14	.22	.09	.41
RNG	-.09	.03	.23	.40

Note. High scores on the Stroop indicate greater distraction for food related words; high scores on the dot probe indicate greater vigilance for food related words.
$^*p < .05$, $^{**}p < .01$

2.4 Discussion

In the current study the hypothesis that cognitive task performance declines as a function of hunger mediated distraction for food related stimuli was not supported. No difference in cognitive performance or attention toward food related stimuli was shown between groups split according to self-rated hunger. Examination of a proportion of means from a sub-group who reported the highest levels of hunger, demonstrated a link between high hunger and avoidance of food related words under supraliminal conditions, and, in contrast, greater vigilance for food related words under subliminal conditions. However, these biases in attention were not accompanied by a general reduction in processing efficiency. Finally, correlational

analysis revealed no significant association between hunger and cognitive task performance and hunger and attentional interference or bias for food related stimuli. In terms of the correlation between attention and cognitive function, there was a trend for greater bias for food related words on the dot probe task (under supraliminal or subliminal conditions) to be associated with poorer performance on the RNG task. However, a conflicting trend was found whereby greater bias for food related stimuli on the supraliminal dot probe task was related to better performance on the SRT task.

Before discussing these results there are several methodological limitations to be considered. First, although the effect of fasting instructions on subjective hunger rating was significant, overlap between fasting and non-fasting groups in reported hunger and hours since last ate was noted. This considered the comparison groups were reorganised based on a median split of self-reported hunger. Although this reallocation provided a better test of the experimental hypothesis (that deficits are hunger mediated) the groups were still defined on the basis of self-report. Since participants were students who took part only to gain course credit, "faking good" on the Hunger Scale from participants in the original fasting condition cannot be ruled out. However, there is a degree of confidence in the results obtained given that there was no reason to suspect inflated levels of reported hunger from the non-fasting group, which comprised 33% of the high hunger group and 54% of the total sample. Overall thought it must be noted that the hunger manipulation could have been greatly improved, for example by better control over time of day testing occurred; and, with the inclusion of a "compliance test" such as that implemented by Green et

al. (1995) where saliva samples were taken and participants informed that these might be tested to check for compliance with dietary restrictions.

An additional limitation within this study was that no measure of mood at time of testing was taken. Induced "sad mood" has been associated with failure to inhibit task irrelevant thoughts and to perform more poorly on a test of long-term memory (Gunther, Ferraro, & Kirchner, 1996). Depression itself is characterised by negative rumination and a preoccupation with past loses (Williams et al., 1997). Task irrelevant thoughts are attention diverting, irrelevant of their substance, thus some attempt to control for negative mood could have been included.

One additional limitation to be noted was that although participants claimed not to be dieting at the time of testing, dietary restraint per se has been shown to be related to cognitive deficit (e.g. Green et al., 1994; Rogers & Green, 1993). A measure of restraint such as that included in the Dutch Eating Behaviour Questionnaire (van Strien et al., 1986), could have been administered to control for the effects of high restraint on cognitive performance.

Examination of an extreme hunger sub-group indicated a puzzling link between hunger and performance on the dot probe task: high hunger was associated with avoidance of food related words under supraliminal conditions; alternatively, high hunger was associated with vigilance for food related words under subliminal conditions. There were other irregularities identified within the supraliminal dot

probe data, for example on the supraliminal dot probe task greater bias towards food related stimuli was associated with less bias and less distraction for food related stimuli on the subliminal dot and Stroop tasks.

These findings question the validity of the dot probe results found in this study (including the association between greater bias for food related stimuli and poorer RNG task performance). Further, these observations limit the applicability of those findings which complement existing literature. For example, Mogg et al. (1998) found greater vigilance for food related words under supraliminal conditions only, with no effects noted under subliminal conditions. Potentially we had demonstrated greater vigilance for food related words under subliminal conditions[1].

Overall, and despite the limitations of this study, these results are consistent with those of Green et al. (1995) who also report no detrimental effect of hunger on tasks of simple reaction speed, immediate memory recall and sustained attention. Further, the results of this study indicate that diet-linked cognitive deficit cannot be explained purely in terms of increased hunger associated with short-term nutritional restriction.

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[1] The dot probe task as used here requires further refinement. At this stage in our enquiry it was considered best to leave behind this task to focus on those tasks that have already successfully been used to differentiate between the cognitive performance of dieters and non-dieters. In the studies to follow we will rely on the use of the Stroop task to measure attentional interference, until the need arises to consider an alternative task to measure attentional bias towards a particular stimulus.

CHAPTER 3

DIETING, AFFECT AND COGNITIVE FUNCTION: STUDY 1

3.1 Introduction

The aim of this study was to examine the impact of a three-week unspecified diet on the cognitive performance, mood and well-being of overweight dieters. In addition the affective and cognitive state of dieters was examined before dieting commenced. This was necessary in order to investigate the potential importance of pre-existing individual differences for cognitive performance and affective state under dieting conditions. A secondary aim of this study was to examine the potential mediators of diet-linked cognitive deficit.

In order to span the breadth of affective state, this study used three different mood measures: The Positive and Negative Affect Schedule (Watson et al., 1988); the Depressed States Questionnaire (Teasdale, unpublished) and a Visual Analogue Scale measuring levels of perceived sadness, anxiety, irritability, concentration difficulty and amount of energy. Well-being was assessed using Ryff's (1989) Scale of Psychological Well-being. To date none of these scales have been used to assess the mood and psychological well-being of current dieters. The cognitive test battery included measures of simple reaction time, working memory capacity and vigilance. As in previous dieting studies, distractibility towards food and body-shape related stimuli was measured supraliminal and subliminal using a modification of the Stroop colour-naming task.

It was hypothesised that following a three-week dieting period dieters would demonstrate mood disturbance, reduced well-being and reduced cognitive processing efficiency compared to non-dieters. Concerning the mediation of the predicted cognitive deficits, three possible ways in which restraint might influence deficit were considered. First, in confirmation of the direct hypothesis, a main effect of dieting on cognitive performance at Time 2 was predicted. Use of a correlational analysis would demonstrate greater restraint to be associated with more deficit. Second, in confirmation of the preoccupation/attentional interference hypothesis, an increase in attentional interference in dieters at Time 2 was predicted. Use of a correlational analysis would demonstrate greater preoccupation and greater interference to be associated with more deficit. Third, in confirmation of the mood hypothesis, an increase in mood disturbance in dieters at Time 2 was predicted. Use of a correlational analysis would demonstrate greater mood disturbance to be associated with more deficit. A thorough investigation of baseline difference between intending-dieters and non-dieters was carried out in order to explore individual differences peculiar to the "dieting type".

3.2 Method

Participants

Sixteen intending-dieters were recruited from advertisement in a local paper. A comparison sample of non-dieters (*n* = 13) was recruited from the Bangor School of

Psychology's Departmental Participant Panel[1]. The mean age of the intending-dieters was 41.56 years (*SD* = 13.08); the mean age of the non-dieters was 39.39 years (*SD* = 10.21). All participants had normal (or corrected to normal) vision and reported general good health. Participants were paid £5.00 for completing each testing session and gave written informed consent.

Materials

Self-report Measures

Participants completed the following self-report measures administered in a fixed order across participants as presented below. Two versions of the PANAS were given, one requiring participants to describe their mood "right now"; the other referring to mood as experienced over the month prior to testing: "over last month".

Positive and Negative Affect Schedule (PANAS; Watson et al., 1988).

This scale consists of 10 positive and 10 negative adjectives describing various feelings and emotions. Positive adjectives are *active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud* and *strong*. Negative adjectives are *afraid, ashamed, distressed, guilty, hostile, irritable, jittery, nervous, scared* and *upset*. Respondents rate the extent to which they identify with each item on a 5-point

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[1] Participants from the Participant Panel are members of the community who offer their services to the Psychology School in return for payment. Participants typically complete only one or two studies per year, thus are not over exposed to experimental procedure.

scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*). The internal consistency of this scale was substantially verified by Watson et al. (1988) in a study comprising six large data sets (sample sizes of 586 to 1002), with coefficient alphas ranging .86 to .90 for Positive affect and .84 to .87 for Negative affect.

Scale of Psychological Well-Being (PWB; Ryff, 1989).

This is an 84-item inventory with six sub-scales (each of 14 items) measuring aspects of *autonomy, environmental mastery, personal growth, positive relations with others, purpose in life* and *self-acceptance*. Autonomy is concerned with an individuals locus of evaluation, whether it resides in the self or depends upon the opinions of others, an example item would be, "I am not afraid to voice my opinions, even when they are in opposition to the opinions of most people". Environmental mastery is defined as the ability to choose or create environments best suited to the individual, an example would be, "In general I feel I am in charge of the situation in which I live". A sample item pertaining to Personal growth would include, "In general, I feel that I continue to learn more about myself as time goes by". An example item from Positive relations with others would include, "Most people see me as loving and affectionate". Purpose in life refers to an individual who functions positively, has goals, intentions, and a sense of direction, an example item would be, "I have a sense of direction or purpose in life". Holding a positive attitude towards oneself is typical of Self-acceptance, an example item would be, "In general I feel confident and positive about myself". Responses are made on a 6-point scale ranging from 1 (*strongly*

disagree) to 6 (*strongly agree*). Each scale has high internal consistency with Cronbach's alpha coefficients ranging from .83 to .91 (Ryff & Keyes, 1995).

The Dutch Eating Behaviour Questionnaire (DEBQ; van Strien et al., 1986).

This is a 33-item scale measuring three types of eating behaviour: restraint (10 items), eating in response to emotional cues (13 items) and eating in response to external cues (10 items). Examples of items from the three sub-scales are, "How often do you refuse food or drink because you are concerned about your weight?" (*restraint*); "Do you have a desire to eat when you are depressed or discouraged?" (*emotional eating*); and, "If you see or smell something delicious do you desire to eat it?" (*external eating*). Responses are made on a 5-point scale ranging from 1 (*never*) to 5 (*very often*). All factors on this scale have high internal consistency with Cronbach's alpha coefficients ranging from .80 to .95 (van Strien et al., 1986).

The Depressed States Questionnaire (Teasdale, unpublished).

This mood scale asks participants to rate how they feel when they get depressed. It includes both self-referent and mood descriptors. The self-referent descriptors consist of the following 14 items: *abandoned, inadequate, a loser, pathetic, stupid, unlovable, unacceptable, unwanted, useless, worthless, incompetent, a mess, a failure, rejected.* The mood descriptors consists of the following 14 items: *defeated, dejected, depressed, despondent, downhearted, gloomy, helpless, hopeless, low, miserable, sad, sluggish, tired, unhappy.* Responses are made using a 5-point scale ranging from 1 (*not at all*) to 5 (*extremely*).

Visual Analogue Food & Mood Scale.

This 8-item scale consists of three measures of eating related concerns (preoccupation with food, urges to eat, feelings of lack of control over eating) and five measures related to mood state (sadness, anxiety, irritability, concentration difficulty, perceived amount of energy). Responses are made by marking a point along a 10 cm line anchored between responses of *not at all* and *all the time.*

Cognitive Function Task Battery

Participants completed a range of computer administered tasks assessing general cognitive performance and attentional interference for food and body-shape related words. Tasks were presented in the following fixed order: Random number generation task (RNG); Simple reaction time (SRT); Immediate memory recall task; Vigilance task; Supraliminal Stroop tasks (food and shape); Subliminal Stroop tasks (food and shape); Subliminal Stroop awareness check. These tasks are described in detail in Chapter 2. The additional "shape" version of the Stroop task used shape related words and transport related words (control category) matched for word length and frequency in written English using the norms of Carroll et al. (1971), see Appendix A. For both the memory recall and Stroop tasks participants received a different set of words at testing Time 2, words set presentation being counterbalanced across time (these additional stimuli are shown in Appendix A).

Design and Procedure

A 2 x 2 mixed factorial design was employed. The between-subjects factor was group (dieting vs. non-dieting) and the within-subjects factor was time (Time 1 vs. Time 2).

Testing occurred in two sessions three weeks apart. At the second testing session the dieters had all been pursuing a self-specified diet for a minimum of 3 weeks. At the start of each session participants were informed of the requirement of the study (to answer questionnaires and complete some simple computer based tasks) and gave informed consent. Dieting participants gave information concerning their weight, and at Time 2 their dieting progress. All participants then completed the questionnaires followed by the cognitive function tasks. At the end of each session participants were paid and thanked for their time. At the end of the final testing session participants were provided with an explanation of the studies main aims and hypotheses.

3.3 Results

Data Analysis

There are three sections to this analysis. The first involves an exploration of intending-dieter—non-dieter differences before dieting commenced (baseline). The second uses a mixed design comparing the performance of dieters with their performance at baseline and the performance of non-dieters, to examine diet-linked

differences in mood, well-being and cognitive performance. The third section involves a correlation analysis investigating the three hypotheses concerning the possible effects of dietary restraint on cognitive performance.

Data were analysed using SPSS (1995). Parametric tests used included independent and paired samples *t* test, one-way analysis of variance (ANOVA), and repeated measures analysis of variance to assess change in performance over time. Multivariate analysis of variance (MANOVA) was employed (at baseline only) where high correlation between self-report sub-scales was anticipated. Pearson's product moment correlation coefficients (two-tailed) were employed in all correlation analyses. An alpha level of .05 was used for all statistical tests. The main ANOVA tables are shown in Appendix B.

Section 1: Baseline Comparison

BMI and Eating Behaviour at Baseline

Table 3.1 shows the mean, standard deviation and univariate *F* values for BMI, DEBQ and VAS eating item scores for intending-dieters and non-dieters. Compared to non-dieters, intending-dieters reported significantly larger BMI's, greater dietary restraint, emotional eating, preoccupations with thoughts of food and lack of control over eating.

Table 3.1.
Mean DEBQ and VAS Eating Ratings at Baseline

	Intending-dieters		Non-dieters		*F*
	$n = 16$		$n = 13$		
Measure (min/max score)	*M*	*SD*	*M*	*SD*	
BMI	*29.97*	4.13	*25.02*	4.16	*10.23***
DEBQ (1/5)					
Restraint	*3.01*	1.00	*1.97*	0.60	*9.44***
Emotional	*3.66*	0.79	*2.49*	1.10	*10.40***
External	3.21	0.60	3.40	0.50	0.77
VAS (0/10)					
Preoccupation	*5.72*	2.34	*3.05*	2.13	*8.57***
Urges to eat	5.28	2.25	3.65	1.94	3.57
Lack of control	*4.44*	2.30	*1.60*	2.25	*9.53***

Note. The DEBQ and VAS were analysed using MANOVA procedure with an overall $F > 4.0, p < .05$ in both cases.
$^*p < .05,\ ^{**}p < .01$

Affect at Baseline

Since positive and negative affect are suggested to be independent (Watson et al., 1988) separate MANOVA were conducted for positive and negative measures. Table 3.2 shows the mean, standard deviation and univariate *F* values for the PANAS, Depressed States, VAS mood items and PWB scores for intending-dieters and non-dieters. A series of MANOVA were conducted. Results revealed only a significant between-group differences in reported positive affect, $F\ (2, 24) = 4.65, p = .02$, owing to the fact that compared to non-dieters, intending dieters reported

significantly lower levels of positive mood "over last month"[2]. Although the overall MANOVA results for the VAS and PWB measures failed to reach significance ($F <$ 3.0 in both cases) univariate effects did indicate that intending dieters reported lower levels of perceived energy and less environmental mastery than non-dieters.

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2 The positive affect "over last month" data revealed significant heterogeneity of variance, with the variance within the intending-dieting group (88.90) being greater than four times that of the non-dieting group (19.49). However, since no outliers were found and neither square root nor logarithmic transformation of the data remedied the situation, the results were accepted with caution.

Table 3.2.
Mean Affect Scale Ratings at Baseline

	Intending-dieters $n = 16$		Non-dieters $n = 13$		*F*
Measure (min/max score)	*M*	*SD*	*M*	*SD*	
PANAS (10/50)					
Positive mood “right now”	29.06	4.27	30.55	6.23	0.54
Positive mood “over last month”	*29.69*	9.43	*39.09*	4.41	*9.43***
Negative mood “right now”	15.94	5.71	14.09	6.47	0.61
Negative mood “over last month”	23.88	10.49	21.91	7.87	0.28
Depressed states (1/5)					
Global	2.27	1.13	1.72	0.74	1.98
Mood	2.72	0.83	2.34	0.84	1.31
VAS (0/10)					
Sadness	3.78	2.29	3.25	2.73	0.29
Anxiety	5.25	2.37	3.30	2.91	3.49
Irritability	4.59	2.46	3.20	2.70	1.84
Concentration difficulty	4.03	2.75	3.45	2.33	0.31
Energy	*3.59*	2.03	*5.90*	2.12	*7.66**
PWB (1/6)					
Autonomy	4.09	0.73	4.43	0.75	0.92
Environmental mastery	*3.95*	0.79	*4.59*	0.51	*4.92**
Personal growth	4.55	0.69	5.04	0.54	3.27
Positive relations	4.87	0.81	4.83	0.60	0.25
Purpose in life	4.13	0.87	4.71	0.60	2.97
Self-acceptance	3.93	0.80	4.37	0.55	2.63

$*p < .05$, $**p < .01$

Cognitive Function at Baseline

For each task the data was examined for outlying data points and the normality of the distribution within each condition checked (Kolmogorov-Smirnov test, $z < 1.0$ in all cases). Mean, standard deviation and individual *F* values for tasks of SRT, memory

recall, vigilance and RNG are shown in Table 3.3. A series of one-way ANOVA were conducted. Results showed no significant difference in cognitive performance between intending-dieters and non-dieters, $F < 2.5$ in all cases. Re-examination following removal of outliers in the SRT task made no significant difference to these results, $F < 1.0$.

Table 3.3.
Mean Cognitive Performance Scores at Baseline

	Intending-dieters $n = 16$		Non-dieters $n = 13$		*F*
Measure	*M*	*SD*	*M*	*SD*	
SRT (ms)	290.16	31.67	296.48	57.47	0.14
SRT (ms) minus outlier	290.16	31.67	285.46	43.35	0.11
Memory recall	8.29	2.55	7.50	2.60	0.67
Vigilance (% correct hits)	59	18	50	14	1.44
RNG	.33	.04	.37	.09	2.32

Note. Maximum score for memory recall = 20. A higher score on the RNG indicates poorer performance (less random).

Stroop at Baseline

Subliminal Stroop awareness check.

On the presence/absence task participants were performing significantly better than chance (Binominal test, $p < .01$), with an overall mean correct hit rate of 75%.

Performance on the lexical decision task was substantially lower, with a mean correct hit rate of only 52%, overall performance of the sample did not significantly differ from chance level (Binominal test, $p > .05$). These results show that although the majority of participants were able to detect the presence versus the absence of a masked word stimulus they were generally unable to identify its lexical content.

The Stroop data was analysed using an interference index calculated by subtracting mean speed to respond to control words (music, transport) from mean speed to respond to target words (food, shape). In this way a positive score indicates more distraction by target words compared to control words, the reverse being true for negative scores.

For each task the data was examined for outlying data points and the normality of the distribution within each condition checked (Kolmogorov-Smirnov test, $z < 1.0$ in all cases). Table 3.4 shows the mean scores and standard deviations for food and shape Stroop interference indices for intending-dieters and non-dieters.

Table 3.4.
Mean Stroop Interference Scores at Baseline

	Intending-dieters $n = 16$		Non-dieters $n = 13$	
Interference index (ms)	M	SD	M	SD
Supraliminal Food	23.56	80.85	12.66	59.98
Subliminal Food	-13.30	53.64	-32.68	55.87
Subliminal Food minus 1 outlier	-3.04	40.58	-32.68	55.87
Supraliminal Shape	33.48	136.23	-16.89	45.63
Supraliminal Shape minus 1 outlier	7.99	105.00	-16.89	45.63
Subliminal Shape	-7.09	72.06	4.20	50.08

Note. For interference indices a larger positive score means slower to respond to target words (food & shape) compared to control words (music & transport).

Food Stroop interference at baseline.

Results of a 2 x 2 (Condition x Exposure: supraliminal, subliminal) repeated measures ANOVA revealed a main effect of Exposure which bordered on significance, $F\,(1, 23) = 4.07, p = .06$. This effect was due to the fact that both groups were more distracted by food words when presented supraliminally (M = 18.11, SD = 69.74) compared to subliminally (M = -22.60, SD = 54.47). However, neither the main effect of Condition nor the Condition x Exposure were significant, $F\,(1, 23) < 1.0$ in both cases. Investigation of the subliminal food interference data had revealed a low outlying score within the intending-dieter group of –136.38 (this score was due an extreme high mean score of 743.06 for response time to music related words). Removal of the outlier served only to reduced the magnitude of the Exposure effect, $F\,(1, 22) = 2.96, p = .10$.

Shape Stroop interference at baseline.

Results of a 2 x 2 (Condition x Exposure: supraliminal, subliminal) repeated measures ANOVA revealed no significant main effects or interactions, $F(1, 23) < 2$ in all cases.

Investigation of the supraliminal shape interference data had revealed a high outlying score within the intending-dieter group of 339.45 (this score was due to an extreme high mean score of 1014.30 for response time to shape related words). Removal of the outlier served only to reduced the magnitude of all effects, $F(1, 22) < 1$ in all cases. The supraliminal data also showed heterogeneity of variance. Transformation of the data by logarithm 10 did not remedy the situation, however given the magnitude of the initial effects found this problem was considered inconsequential.

Section 1 Summary

Before dieting commenced intending-dieters were shown to score higher than non-dieters on measures of BMI, restrained eating, emotional eating, preoccupation with thoughts of food and lack of control over eating. Intending-dieters reported having experienced significantly less positive affect over the month prior to testing compared to non-dieters. Further, a trend was demonstrated for intending-dieters to score lower than non-dieters on measures of negative mood and well-being.

Despite the fact that intending-dieters demonstrated a poorer profile of emotional functioning and expressed high levels of preoccupation with thoughts of food, they

demonstrated no impairment in cognitive performance relative to non-dieters. The question arises as to whether an intensified period of dietary restraint would result in a reduction of processing capacity and if so by what mechanism. It is to such issues that we now turn.

Section 2: Changes Over Time

In this section a mixed design was employed to examine the impact of a three-week dieting period on the mood, well-being and cognitive performance of dieters. For each self-report measure and each cognitive task a 2 x 2 (Condition x Time) repeated measures ANOVA was conducted. A univariate approach was favoured (a) to increase power following reduced sample size owing to task failure; and, (b) because the hypotheses concern prediction of between/within group difference, rather than the identification of particular combinations of dependent variables that distinguish between groups (for a brief review of this issue see Schutz & Gessaroli, 1993). The means and standard deviations shown in this section relate to those participants who have both Time 1 and Time 2 data for that variable, accordingly reported *N* will differ per variable.

BMI Changes Over Time in Dieters

Following a three-week dieting period the dieters reported a mean weight-loss of 2.91 kg (*SD* = 1.94). The maximum amount of weight-loss reported was 7.25 kg; only one dieter failed to lose weight. Consequently, paired *t* test comparison of BMI

scores within the dieters showed significantly lower BMI's at Time 2 ($M = 28.95$, $SD = 4.28$) compared to Time 1($M = 29.98$, $SD = 4.13$), t (15) = 6.11, p = .0001.

Eating Behaviour Changes Over Time

Table 3.5 shows the mean scores and standard deviations for DEBQ and VAS eating items for dieters and non-dieters at Time 1 and Time 2.

Table 3.5.
Mean DEBQ and VAS Eating Ratings Over Time

	Dieters $n = 10$				Non-dieters $n = 9$			
	Time 1		Time 2		Time 1		Time 2	
Measure (min/max score)	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
DEBQ (1/5)								
Restraint	2.97	0.85	3.43	0.62	2.01	0.53	2.20	0.57
Emotional	3.63	0.90	3.48	0.98	2.54	1.14	2.54	1.34
External	3.22	0.53	3.34	0.72	3.39	0.49	3.32	0.57
VAS (0/10)	$n = 12$				$n = 8$			
Preoccupation	5.75	2.29	4.88	2.61	2.56	2.09	3.13	2.72
Urges to eat	5.17	2.20	4.63	2.72	3.25	1.87	3.70	2.67
Lack of control	3.83	2.11	2.54	2.33	1.81	2.49	2.25	3.31

DEBQ over time.

Since restraint, as measured by the DEBQ, has been associated with cognitive deficits in non-dieters it was thought necessary to also assess non-dieter change over time in reported eating behaviour.

Analysis of the restraint data revealed a significant main effect of Condition, *F* (1, 17) = 16.70, *p* = .001, and a significant main effect of Time, *F* (1, 17) = 5.34, *p* = .03. The Condition x Time interaction was non-significant, *F* < 1. Post hoc analysis using independent sample *t* test revealed the main effect of condition to be due to dieters scoring higher overall in reported restraint (*M* = 3.20, *SD* = 0.62) compared to non-dieters (*M* = 2.11, *SD* = 0.54), *t* (17) = 4.09, *p* = .001. Investigation of the main effect of Time using paired samples *t* test revealed an overall rise in reported restraint from Time 1 (*M* = 2.52, *SD* = 0.85) to Time 2 (*M* = 2.85, *SD* = 0.86), *t* (18) = 2.37, *p* = .03.

To investigate which group contributed the most towards the change in reported restraint over time, restraint in dieting and non-dieting groups was analysed separately using paired sample *t* tests. Results showed no significant difference in reported restraint over time for dieters (*t* (9) = 1.79, *p* = .11), although their mean restraint score did rise from 2.97 (*SD* = 0.85) at Time 1 to 3.43 (*SD* = 0.62) at Time 2. Conversely a significant rise in reported restraint was found in the non-dieting group (*t* (8) = 2.57, *p* = .03), with mean restraint at Time 1 of 2.01 (*SD* = 0.53) rising to 2.20 (*SD* = 0.57) at Time 2.

Analysis of the emotional eating data revealed a main effect of Condition which bordered on significance, $F(1, 17) = 4.25, p = .06$. Post hoc analysis (independent t test) showed dieters to score marginally higher overall in reported emotional eating ($M = 3.56$, $SD = 0.92$) compared to non-dieters ($M = 2.54$, $SD = 1.23$), $t(17) = 2.06$, $p = .06$.

Analysis of the external eating data revealed no significant main effects or interactions, $F < 1$ in all cases.

VAS eating over time.

Initially the intent was to examine dieter only changes over time on the VAS eating items, however because the non-dieters showed a significant increase in restraint at Time 2 it was thought necessary to also investigate non-dieter changes over time on the VAS scale.

Analysis of the preoccupation with food data revealed a significant main effect of Condition, $F(1, 18) = 8.85, p = .008$, due to dieters reporting greater overall levels of preoccupation ($M = 5.32$, $SD = 1.48$) compared to the non-dieters ($M = 2.84$, $SD = 2.25$). Other effects were non-significant with $F < 1$ in both cases.

Analysis of the urges to eat and lack of control over eating data revealed no significant main effects or interactions, $F < 2.5$ in all cases.

Mood Changes Over Time

Table 3.6 shows the mean scores and standard deviations for PANAS and VAS mood items for dieters and non-dieters at Time 1 and Time 2.

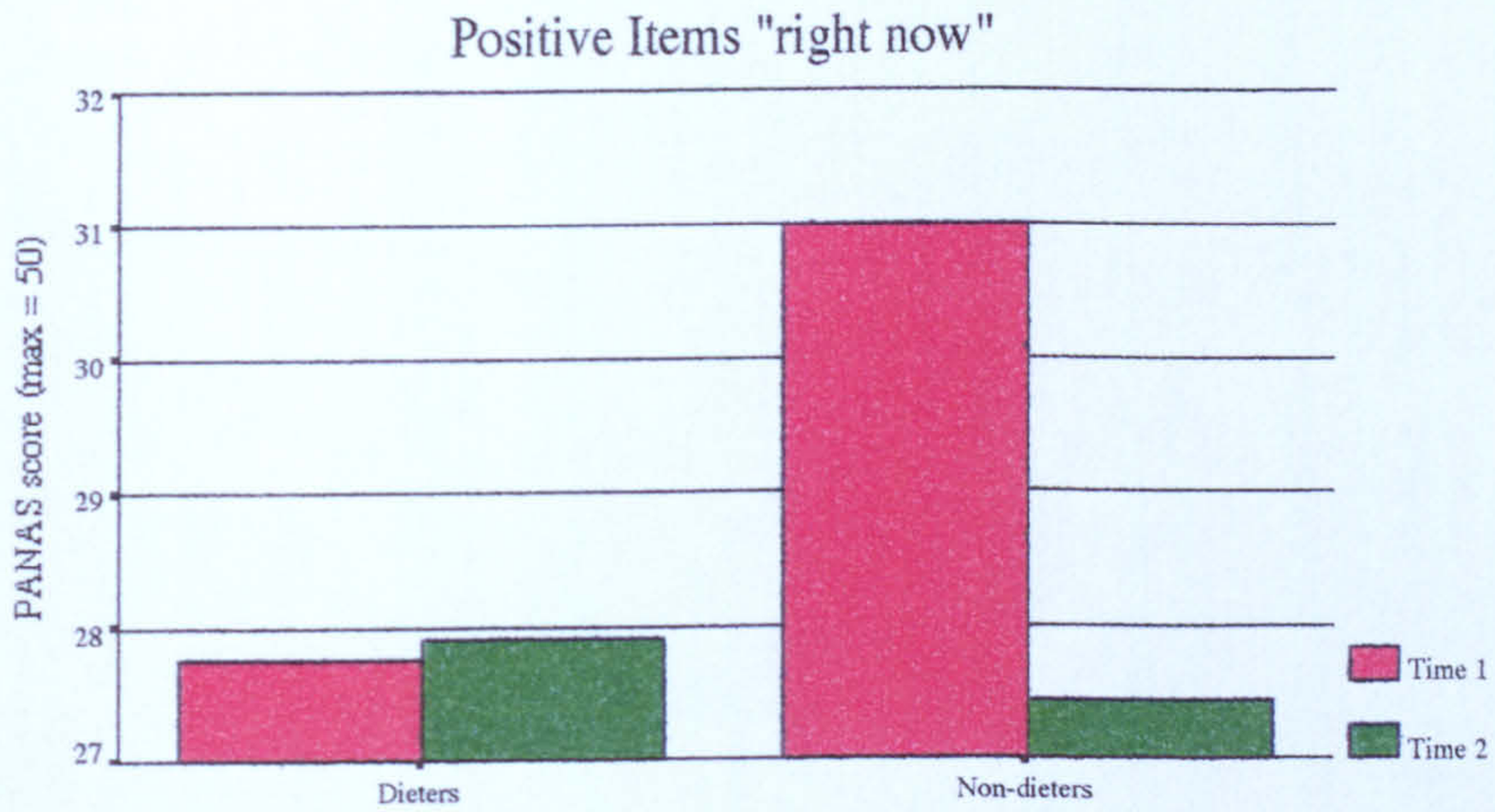
Table 3.6.
Mean Mood Ratings Over Time

	Dieters *n* = 12				Non-dieters *n* = 9			
	Time 1		Time 2		Time 1		Time 2	
Measure (min/max score)	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
PANAS (10/50)								
Positive "right now"	27.75	3.62	27.92	7.90	31.00	5.77	27.44	6.41
Negative "right now"	15.67	4.92	16.17	7.37	14.67	7.09	14.89	6.39
Positive "over last month"	29.08	8.22	28.50	5.45	38.11	4.11	35.22	2.95
Negative "over last month"	22.67	10.41	19.75	7.58	22.11	8.77	20.67	10.82
VAS (0/10)	*n* = 12				*n* = 8			
Sadness	3.46	2.47	4.13	2.85	3.69	2.90	4.75	3.21
Anxiety	5.50	2.36	4.17	3.06	3.57	3.24	4.94	3.22
Irritability	4.92	2.49	4.87	3.08	3.63	2.88	4.19	3.12
Concentrate difficulty	4.54	2.72	5.58	2.87	3.81	2.49	5.50	2.04
Energy	3.71	2.09	5.00	2.39	5.50	2.14	3.25	2.55

PANAS over time.

Results of a repeated measures ANOVA conducted on positive mood "right now" revealed no significant main effects or interactions, $F < 2.10$ in all cases. However viewing the data (see Figure 3.1) it can be seen that positive mood in non-dieters dropped from its initial higher level. Paired *t* tests carried out on data from the non-dieters only revealed positive mood at time of testing to be significantly lower at Time 2 compared to Time 1, $t\ (8) = 2.82, p = .02$.

As with the Time 1 positive mood "over last month" data, Time 2 data also violated the assumptions of homogeneity of variance (Cochran's & Bartlett-Box both $p < .05$). An outlying score of 16 was found within the dieters but neither the removal of this score or transformation of the data remedied the situation. Observation of the data suggested an overall main effect of Condition. Using this observation as a guide against Type 1 error the data was analysed in its original form. Results showed only a significant main effect of Condition, $F\ (1, 19) = 12.87, p = .002$. This result was due to dieters scoring lower overall in positive affect ($M = 28.79$, $SD = 6.05$) compared to non-dieters ($M = 36.67$, $SD = 2.93$). With the Time 2 outlier removed the results were not strongly affected, $F\ (1, 18) = 11.87, p = .003$, with the dieters still scoring lower in overall positive affect ($M = 29.68$, $SD = 5.46$).



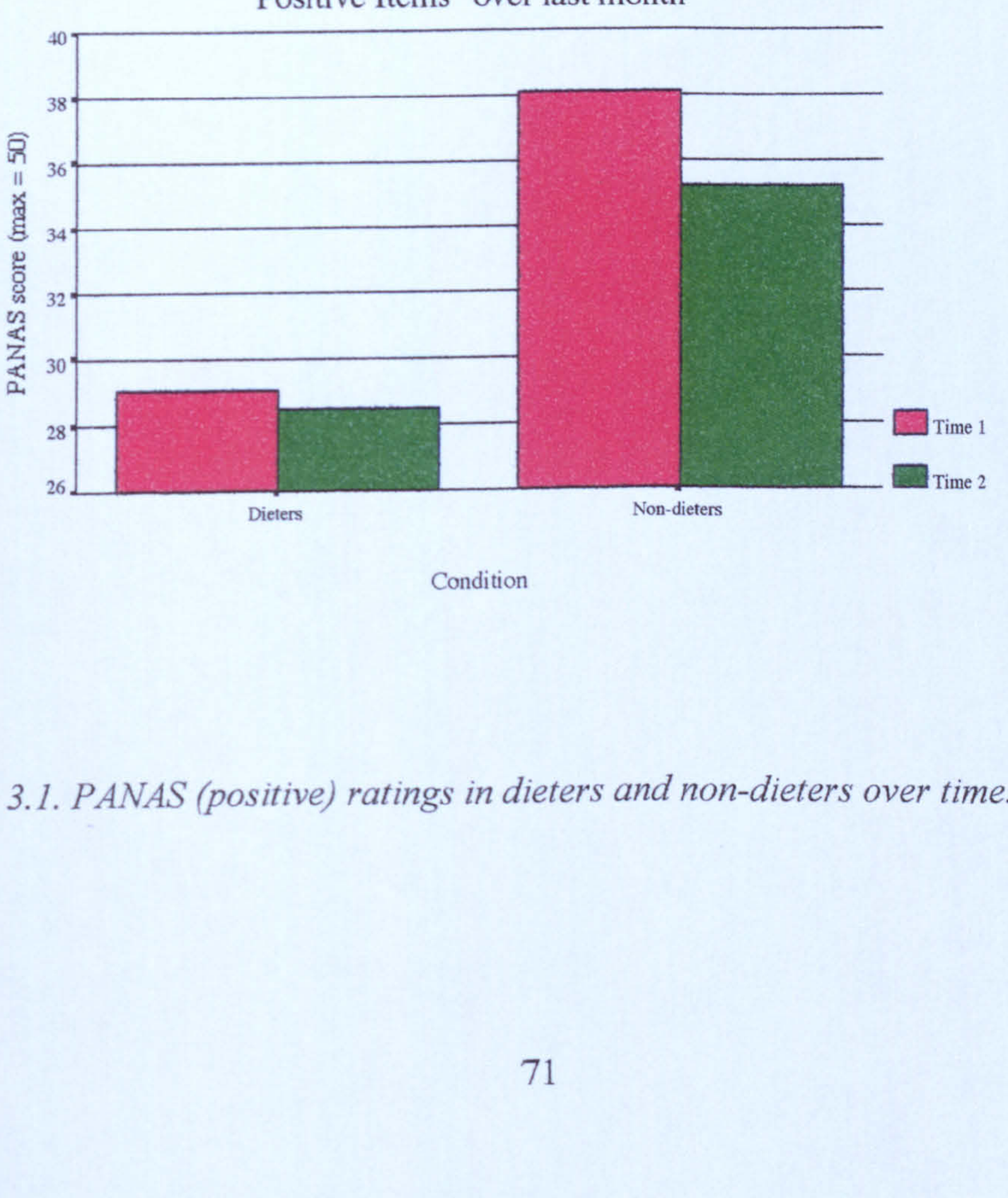


Figure 3.1. PANAS (positive) ratings in dieters and non-dieters over time.

Results of a repeated measures ANOVA conducted on the PANAS negative mood "right now" and separately on the negative mood "over last month" data revealed no significant main effects or interactions, $F < 1.0$ in all cases.

VAS mood over time.

Analysis of the VAS energy data revealed a significant Condition x Time interaction, $F(1, 18) = 5.52, p = .03$. This result was due to non-dieters reporting significantly lower levels of energy at Time 2 ($M = 3.25$, $SD = 2.55$) compared to Time 1 ($M = 5.50$, $SD = 2.14$), $t(7) = 2.81, p = .03$. The converse being true of dieters with greater levels of energy reported at Time 2 ($M = 5.00$, $SD = 2.39$) compared to Time 1 ($M = 3.71$, $SD = 2.09$), however this difference failed to reach significance, $t < 1.20$. These results are demonstrated in Figure 3.2.

For measures of VAS sadness, anxiety, irritability and concentration difficulty no significant main effects or interactions were found, $F < 2.65$ in all cases.

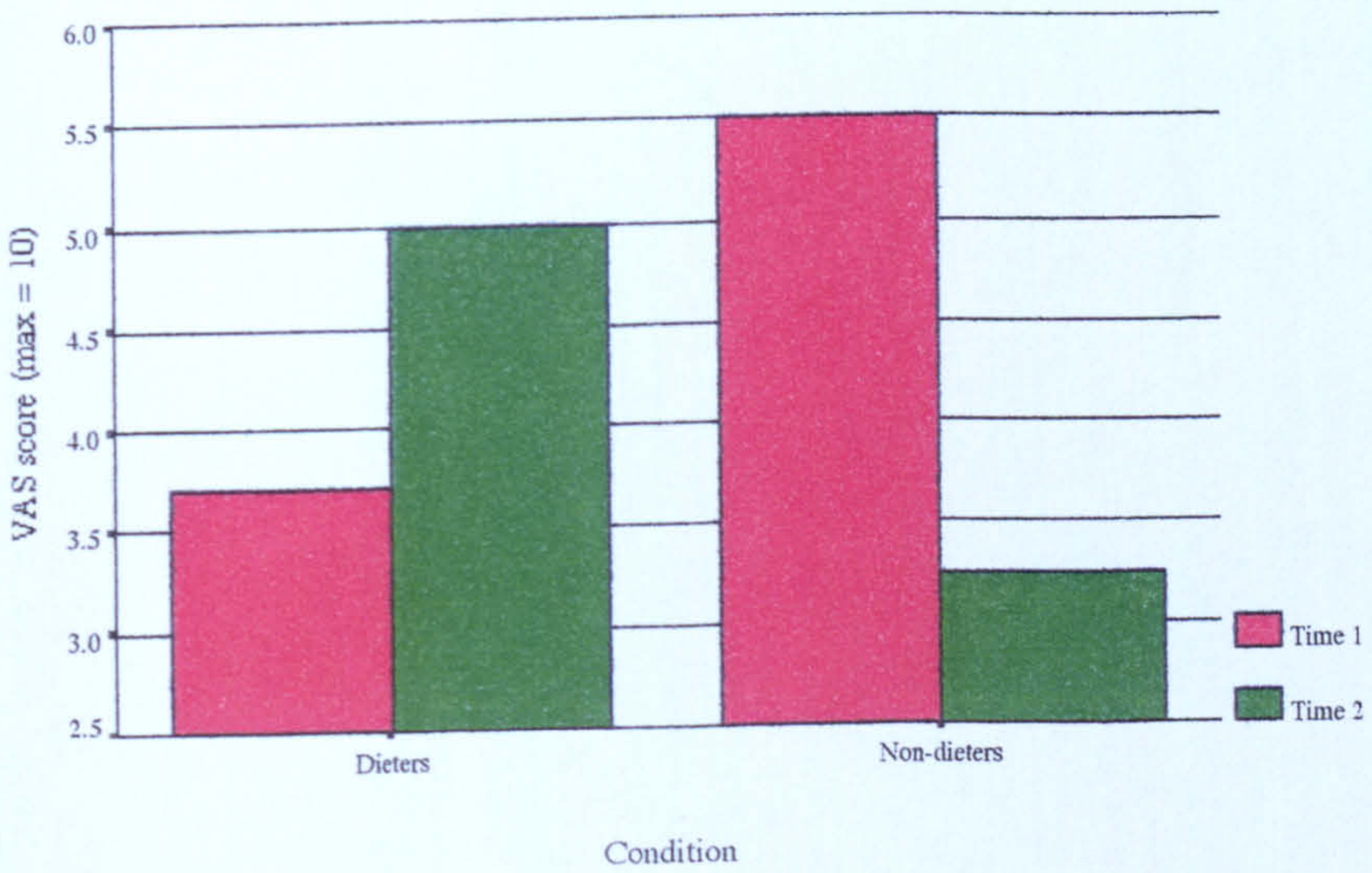


Figure 3.2. VAS energy scores in dieters and non-dieters over time.

Well-being Over Time

Table 3.7 shows the mean scores and standard deviations for well-being (PWB) scores for dieters and non-dieters at Time 1 and Time 2.

A significant main effect of Condition, *F* (1, 20) = 4.74, *p* = .04, and a significant main effect of Time, *F* (1, 20) = 7.70, *p* = .01, was found for self-acceptance. The main effect of Condition was due to dieters scoring lower overall on this measure (*M* = 3.89, *SD* = 0.78) compared to non-dieters (*M* = 4.57, *SD* = 0.62). The main effect of Time was due to a rise in reported self-acceptance from Time 1 (*M* = 4.09, *SD* = 0.76) to Time 2 (*M* = 4.32, *SD* = 0.85).

An approaching significant main effect of Condition was found for environmental mastery, $F(1, 20) = 3.48, p = .08$. This was due to dieters scoring lower overall on this measure ($M = 4.00$, $SD = 0.84$) compared to non-dieters ($M = 4.56$, $SD = 0.55$).

For measures of autonomy, personal growth, positive relations and purpose in life no significant main effects or interactions were found, $F < 2.80$ in all cases.

Table 3.7.
Mean Well-Being Ratings Over Time

	Dieters $n = 12$				Non-dieters $n = 10$			
	Time 1		Time 2		Time 1		Time 2	
Sub-scale	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Autonomy	4.30	0.69	4.20	0.69	4.56	0.72	4.54	0.81
Environmental mastery	3.97	0.84	4.01	0.88	4.59	0.52	4.54	0.67
Personal growth	4.59	0.68	4.73	0.66	5.01	0.58	4.97	0.51
Positive relations	4.86	0.77	4.70	0.80	4.76	0.60	4.71	0.65
Purpose in life	4.09	0.88	4.18	0.80	4.62	0.63	4.69	0.61
Self-acceptance	3.79	0.81	4.01	0.81	4.44	0.53	4.69	0.76

Given the mood and well-being results, with dieters showing little deterioration and even some improvement (e.g. in energy levels), it remains an open question as to what the effects of dieting on cognitive performance will be. It is to this that we now turn.

Cognitive Function Changes Over Time

Table 3.8 shows the mean scores and standard deviations for measures of the four cognitive function tasks: SRT, memory recall, vigilance, RNG for dieters and non-dieters. For each task the data was examined for outlying data points.

Table 3.8.
Mean Cognitive Performance Scores Over Time

	Dieters				Non-dieters			
	Time 1		Time 2		Time 1		Time 2	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Measure	*n* = 16				*n* = 12			
SRT (ms)	290.16	31.67	278.24	29.89	285.46	43.35	272.11	43.89
SRT (ms) minus 2 outliers	298.05	32.65	269.68	19.97	285.46	43.35	272.11	43.89
Memory recall	8.29	2.55	8.34	2.00	7.88	2.32	8.13	2.59
	n = 12				*n* = 9			
Vigilance (% correct hits)	59	18	66	25	53	12	38	19
	n = 14				*n* = 9			
RNG	.33	.04	.35	.05	.37	.09	.41	.10

Note. Maximum score for memory recall = 20. A higher score on the RNG depicts poorer performance (less random).

Simple reaction time.

When the boxplots of SRT data for responses made at Time 1 and Time 2 were viewed two outlying data points were found in the dieting group with high response time values of 335.54 and 340.74 for responses made at Time 2. Results of a 2 x 2 (Condition x Time) repeated measures ANOVA revealed only a main effect of Time, $F(1, 26) = 5.09, p = .03$. With participants being generally faster to respond at Time 2 ($M = 275.61, SD = 35.92$) compared to Time 1 ($M = 288.14, SD = 36.45$). Repetition of this analysis with Time 1 and Time 2 outliers removed showed again only a main effect of Time but with increased magnitude, $F(1, 24) = 5.09, p = .03$. With participants being generally faster to respond at Time 2 ($M = 270.80, SD = 32.50$) compared to Time 1 ($M = 287.39, SD = 37.21$).

Immediate memory recall.

Results of a 2 x 2 (Condition x Time) repeated measures ANOVA revealed no significant main effects or interactions, $F < 1.0$ in all cases.

Vigilance task.

Results of a 2 x 2 (Condition x Time) repeated measures ANOVA (again no Time 1 outliers removed) revealed a significant main effect of Condition, $F(1, 19) = 6.66, p = .02$, modified by a Condition x Time interaction which bordered on significance, $F(1, 19) = 4.26, p = .05$. This effect is demonstrated in Figure 3.3. Post hoc analysis using independent and paired samples *t* tests revealed this interaction to be due to the dieters performing significantly better on this tasks at Time 2 compared to the

non-dieters, t (19) = 2.84, p = .01.

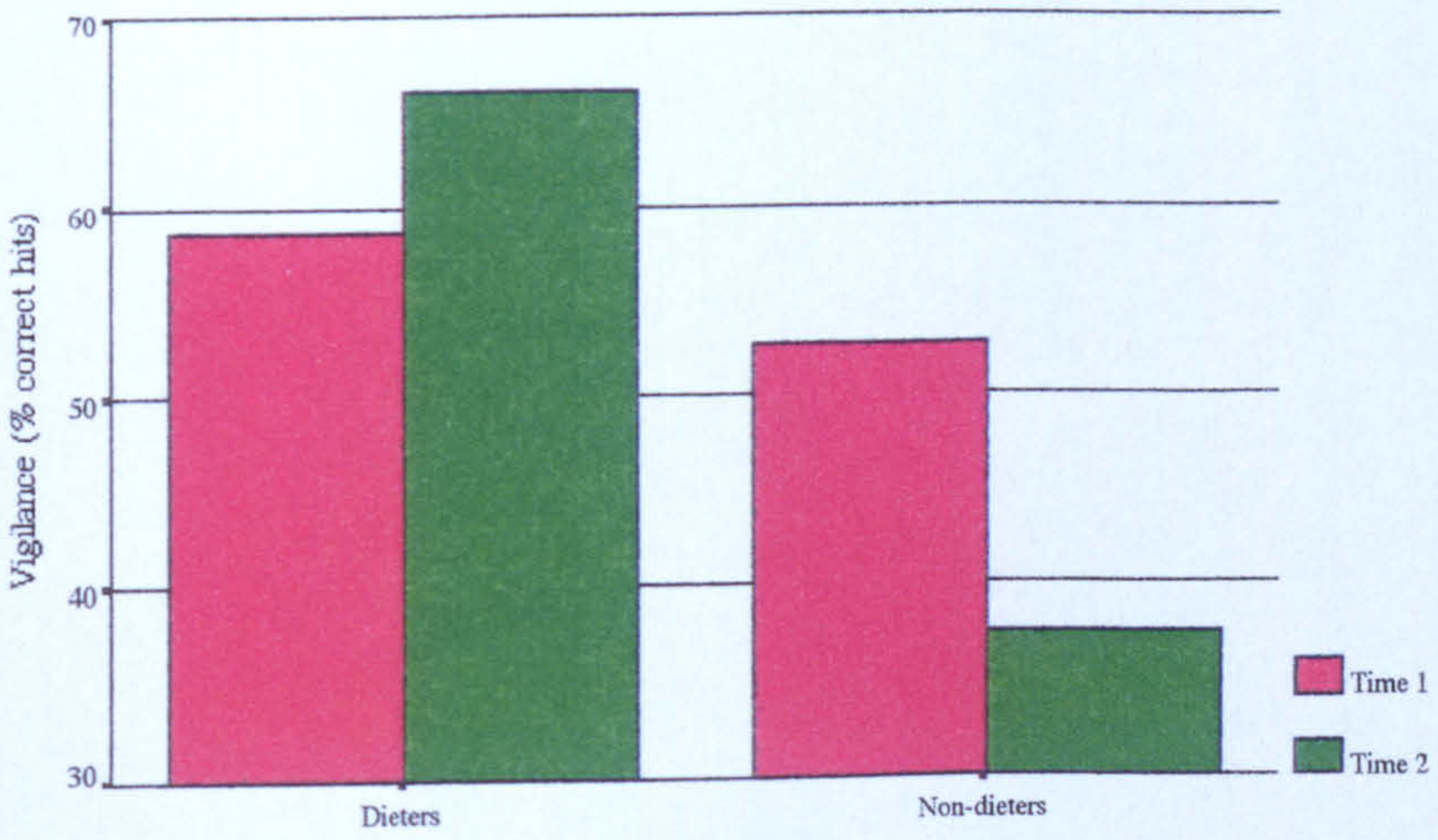


Figure 3.3. Vigilance scores in dieters and non-dieters over time.

RNG task.

Results of a 2 x 2 (Condition x Time) repeated measures ANOVA revealed an approaching significant main effect of Condition, F (1, 22) = 3.66, p = .07, and an approaching significant main effect of Time, F (1, 22) = 3.97, p = .06. Overall dieters were more random on the RNG task (M = .34, SD = .04) indicating better performance compared to non-dieters (M = .39, SD = .09). In addition all participants

performed more poorly at Time 2 (*M* = .37, *SD* = .08) compared to Time 1(*M* = .35, *SD* = .07).

Stroop Changes Over Time

Subliminal Stroop awareness check.

On the presence/absence task participants were performing significantly better than chance (Binominal test, $p < .01$), with an overall mean correct hit rate of 76%. Performance on the lexical decision task showed a mean correct hit rate of 54%; performance did not significantly differ from chance level (Binominal tests $p > .05$).

Table 3.9 shows the mean scores and standard deviations for food and shape interference indices from supraliminal and subliminal versions of the Stroop task for dieters and non-dieters at Time 1 and Time 2.

Table 3.9.
Mean Stroop Interference Scores Over Time

	Dieters *n* = 13				Non-dieters *n* = 9			
	Time 1		Time 2		Time 1		Time 2	
Interference index (ms)	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Supraliminal								
Food	23.56	80.85	9.13	50.05	-1.76	65.33	-48.39	76.93
Food minus outliers	29.13	81.36	17.16	42.65	-17.31	48.90	-26.69	43.85
Shape	33.48	136.23	17.71	100.61	-5.84	40.78	-3.73	70.95
Shape minus outliers	27.16	140.28	1.24	84.83	-5.84	40.78	-3.73	70.95
Subliminal								
Food	-13.30	53.64	-1.66	61.80	-28.41	54.50	4.79	48.93
Food minus outliers	-3.55	42.52	-12.63	54.44	-38.17	49.14	18.64	27.60
Shape	-7.09	72.06	17.54	65.65	13.06	53.49	17.99	39.74

Note. For interference indices a larger positive score means slower to respond to target (food & shape) words compared to control (music & transport) words.

Supraliminal food Stroop interference.

Two outliers were detected within the supraliminal food data at Time 2: one dieter showing a mean interference score of –87.20 and one non-dieter showing a mean interference score of –221.95. Analysis of the data in its original form revealed a significant main effect of Condition, $F\,(1, 20) = 6.01, p = .02$. With the outliers from Time 1 and Time 2 removed and the analysis rerun results showed again only a

significant main effect of Condition, *F* (1, 18) = 7.84, *p* = .01. This result was due to the fact that overall dieters showed a greater degree of distraction for food related words over music related words (*M* = 23.15, *SD* = 40.23) compared to non-dieters (*M* = -22.00, *SD* = 25.78). Figure 3.4 demonstrates these results using the doctored data.

The question as to whether the observed interference is associated with dieting or whether it is peculiar to dietary restraint per se was addressed by covarying for mean levels of reported restraint. The analysis was conducted on the doctored data, results showed a weak, non-significant covariate effect, *F* (1, 12) = 2.93, *p* = .11, and a significant effect of Condition, *F* (1, 12) = 13.58, *p* = .003. Although the power of this analysis is greatly compromised due to the low numbers involved, results do suggest that restraint is not mediating the attentional interference for food related stimuli found in dieters.

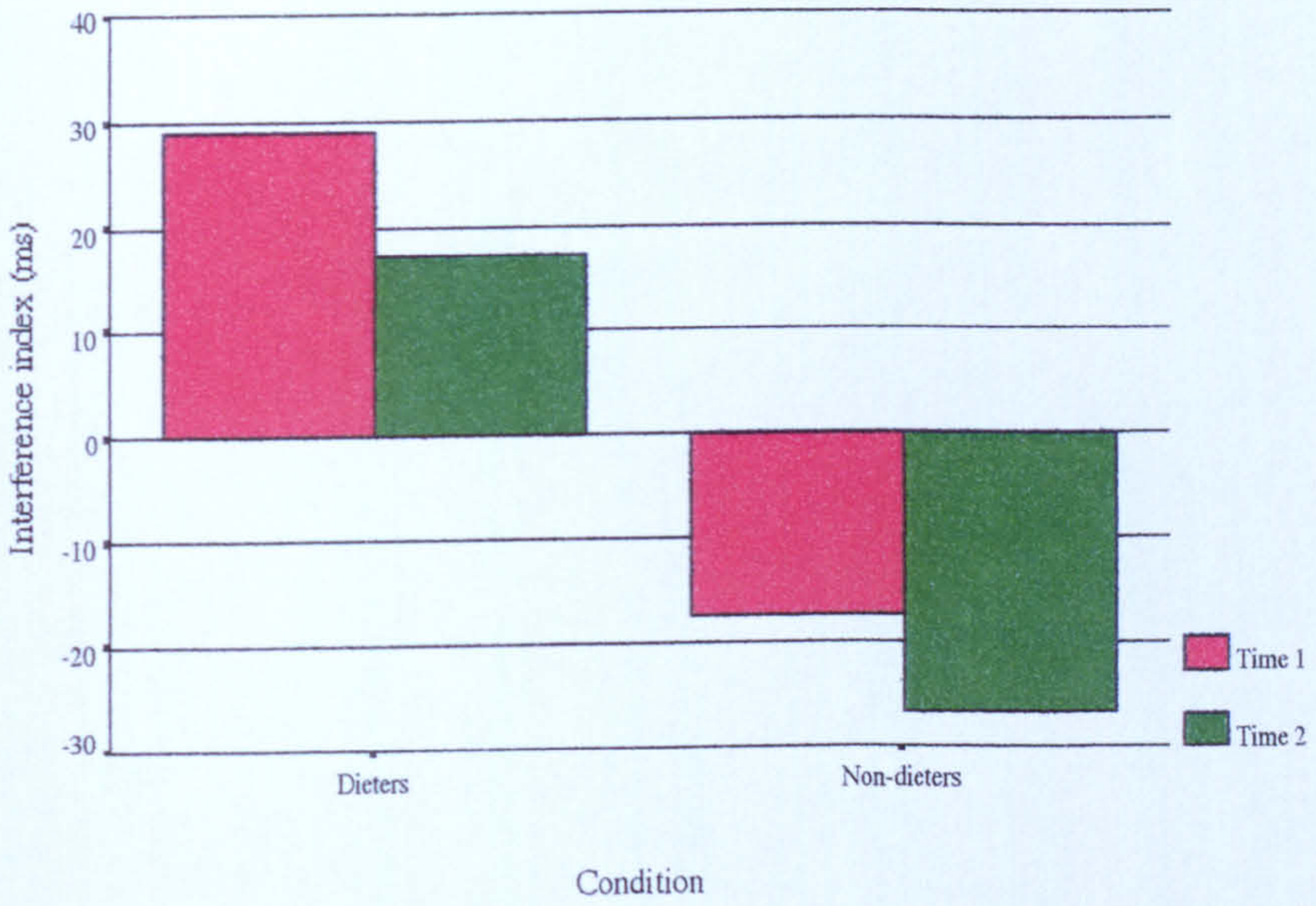


Figure 3.4. Supraliminal food Stroop scores in dieters and non-dieters over time. (Note: a higher positive score indicates greater distraction for food related stimuli.)

Supraliminal shape Stroop interference.

Within the shape supraliminal data one outlier was detected at Time 1 as described previously, no outliers were detected at Time 2. Analysis of the undoctored data revealed no within or between-group differences, $F < 1.6$ in all cases. Removal of the outlier resulted in a reduction in the magnitude of all effects, $F < 1.0$ in all cases.

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The question arises as to whether this increase in distraction for food related stimuli demonstrated by the non-dieters is associated with the rise in restraint and depletion of energy also demonstrated by this group. In order to assess the impact of rise in reported restraint over time a restraint change index was calculated by subtracting restraint a Time 1 from restraint a Time 2. An energy change score was calculated in the same fashion. Correlations were calculated between the subliminal food Stroop interference score at Time 2 and restraint and energy change scores; this was done separately for dieters and non-dieters. Viewing the doctored data (outliers removed) a trend was shown amongst the non-dieters for greater Stroop interference to be associated with decreased restraint and decreased energy, r (6) = -.28 and -.21 respectively, p >.1 in both cases. For dieters respective correlations were -.08 and .33, both, p >.1. Figure 3.6 demonstrates the patterns of association found between Stroop interference and restraint change for dieters and non-dieters. Participant 17 and C11 represent dieter and non-dieter outliers, respectively. Considering the patterns within the data and the low numbers of participants contributing towards the effect, any meaningful association between restraint and Stroop interference is discounted.

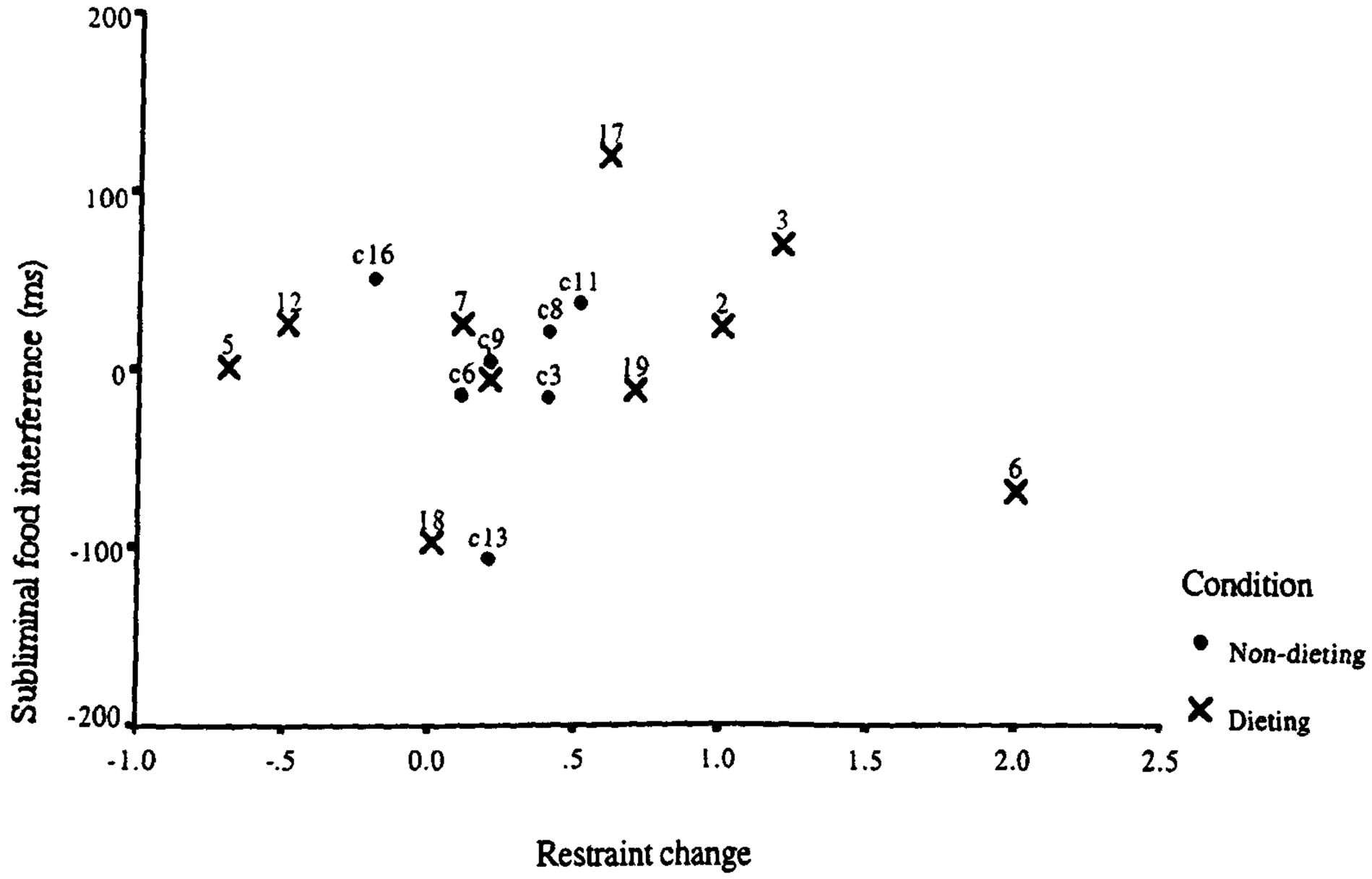

Figure 3.6. Relationship between restraint change and subliminal food interference at Time 2.

Subliminal shape Stroop interference.

Analysis of the subliminal shape interference data revealed no significant main effects or interactions, $F < 1.0$ in all cases.

Section 2 Summary

Dieters showed a significant decrease in reported BMI over time. Although dieters reported the highest levels of dietary restraint, the non-dieters showed a significant

increase in level of reported restraint from Time 1 to Time 2. Although, relative to non-dieters, dieters reported the highest levels of preoccupations with food, lack of control over eating and urges to eat, their scores on these measures showed no significant increase over the dieting period.

In terms of mood, although overall the dieters showed a trend for lower levels of reported positive mood, over time the non-dieters showed a significant decrease in positive mood measured at the time of testing and a trend for decreased positive mood over the month prior to testing. In contrast, non-dieters were shown to report significantly less energy at Time 2 compared to Time 1, this result contrasts with a trend for energy levels in dieters to rise from Time 1 to Time 2. There were no differences in levels of reported negative mood within or between-groups. In terms of well-being only an overall rise in reported self-acceptance from Time 1 to Time 2 was shown.

On the SRT task a practice effect was observed whereby all participants performed better at Time 2 compared to Time 1. On the vigilance task dieters showed an overall better performance, especially at Time 2 where the non-dieters were found to perform particularly poorly. Although all participants performed more poorly on the RNG task at Time 2 compared to Time 1, overall dieters showed the better performance.

On the supraliminal food Stroop no effects of time were demonstrated, with dieters generally more distracted by food related words compared to non-dieters. On the subliminal food Stroop the non-dieters showed greater distraction for food related words at Time 2 compared to Time 1, but this increase in distraction was not related to their reported increase in restraint and decrease in energy. No differences over time were observed for the dieters on the subliminal food Stroop.

These results suggest that three weeks of dieting need not result in mood disturbance or cognitive deficit. However, it is interesting to note that the non-dieters demonstrated a rise in restraint over time and also showed a fall in energy and positive mood. They also showed a slight rise in preoccupation and increased distraction for food related words on the subliminal Stroop. The implications of these changes for cognitive task performance are examined further in the next section.

Section 3: Dietary Restraint and Cognitive Function

In this section the three possible ways in which dietary restraint might bring about cognitive performance deficits was investigated. Despite the fact that the dieters did not show the expected deficits following the dieting period this exercise was considered important given the unexpected changes over time in the non-dieting group. Time 2 data is examined here collapsed across dieting and non-dieting samples.

Hypothesis 1: dietary restraint has a direct effect on cognitive processing efficiency

Setting aside dieting status and considering actual reported levels of restraint, the relationship between dietary restraint and cognitive function was examined. Results showed a significant correlation between restraint and RNG performance, r (19) = -.50, p = .03, such that high restrainers performed better on this task. An approaching significant correlation was shown for the vigilance task, r (18) = .41, p = .09, again indicating that the high restrainers performed better on this task. No relationship was shown between restraint and SRT or recall performance, r < .1 in both cases.

Hypothesis 2: increased preoccupation and attentional interference for food related stimuli may bring about cognitive deficit

The association between cognitive performance and the subjective and objective measures of food related preoccupation were investigated in turn. First however, the relationship between the two measures of preoccupation was examined.

Correlation coefficients between the VAS eating and the Stroop tasks were calculated. A moderately strong link between the subjective measures and the subliminal Stroop at Time 1 was shown, r (23) > .44, p < .05 in every case. However, this pattern was not found between the VAS and the supraliminal Stroop at Time 1 or either of the Stroop measures at Time 2, r (23) < .15 in every case.

Results of a correlational analysis conducted between VAS eating items and cognitive function performance revealed no significant correlation (r (22) < .40, p

>.05 in all cases). Although there was the trend for higher preoccupation, urges to eat and lack of control over eating to be associated with slower reaction speed on the SRT task, this result was counterbalanced by the conflicting trend for higher preoccupation and urges to be associated with better performance on the RNG task.

Results of a correlational analysis conducted between food Stroop interference scores and cognitive function performance revealed only a significant positive correlation between supraliminal food interference and vigilance, r (21) = .48, p = .03; indicating that the more distraction shown for food related words the better the performance on the vigilance task.

Hypothesis 3: mood disruption may reduce cognitive processing efficiency

The association between restraint and mood at Time 2 was examined followed by an examination of the relationship between mood and cognitive function at Time 2. Finally mood change scores were calculated and their relationship to cognitive function examined.

Correlation coefficients calculated between restraint and mood at Time 2 revealed greater restraint to be significantly associated with lower levels of positive mood "over last month" (r (20) = -.77, p = .0001) but higher levels of energy (r (20) = .60, p = .005).

The relationship between mood and cognitive function at Time 2 revealed a significant negative correlation between positive items on the PANAS "right now" and SRT performance (*r* (22) = -.51, p = .02), indicating that the more positive mood felt the faster the reaction speed. A significant positive correlation was shown between negative items on the PANAS "right now" and memory recall (*r* (22) = .49, p = .02), indicating a link between high negative mood and good immediate memory. Although contradictory in terms of our hypotheses, these results do highlight the need to differentiate between positive and negative affect.

A mood change score was calculated using the PANAS data by subtracting Time 1 response from Time 2. In this way a larger positive score indicates an increase in response over time. In a similar way change scores were calculated for the cognitive function tasks. Correlations calculated between mood change scores and cognitive function change scores revealed a significant positive correlation between change in negative mood "right now" and change in SRT performance (*r* (21) = .46, *p* = .04), such that an increase in negative mood was related to a decrease in reaction speed at Time 2. A moderate, positive correlation was shown between positive affect "over last month" and vigilance (*r* (15) = .49, *p* = .06), such that an increase in positive affect was associated with better vigilance performance at Time 2.

Section 3 Summary

For hypothesis 1, examination of the changes over time and between group differences at Time 2 revealed no indication of direct diet-linked deficits. Indeed

high restraint at Time 2 was shown to be associated with better RNG and vigilance task performance.

Hypothesis 2 was unsupported. Greater levels of subjectively and objectively measured distraction for food related concerns were not accompanied by cognitive deficit. Further no consistent pattern of relationship was shown between food related attentional interference and cognitive deficit. Of some concern was the lack of meaningful relationship between the subjective and objective preoccupation measures, suggesting a degree of measurement error.

Examination of the relationships between restraint, mood and cognitive task performance revealed several significant results, these included a link between high restraint and lower positive mood "over last month", and higher positive mood "right now" and faster reaction time speed. Further, change over time scores revealed a link between increase in negative mood and slower reaction time speed, and a trend for increase in positive mood to be associated with an increase in vigilance performance. However, for every result in line with the hypothesis there appeared a conflicting result. For example, higher restraint was associated with higher energy, and higher negative mood "right now" was associated with better immediate memory recall.

3.4 Discussion

The results of this study give little support to the primary hypothesis that following a three-week diet, dieters would suffer an increase in affective and cognitive disturbance. Following three weeks of dieting, dieters reported a slight increase in perceived energy and demonstrated a trend for improved performance on tasks of SRT and vigilance. Although, compared to non-dieters, dieters reported lower levels of positive affect (as experienced over the month prior to testing) there was no accompanying cognitive deficit. Overall (that is pre and during the diet), dieters reported the highest levels of preoccupation with thoughts of food, urges to eat and distraction for food related stimuli on the supraliminal food Stroop compared to non-dieters. However, neither the subjective nor the objective measures of attention deployment were accompanied by cognitive deficit. In contrast to Green and Rogers (1993), the interference for food related concerns found here was not a function of restraint per se, rather it was peculiar to the dieting group.

Although no diet-linked deficits were observed the suggested mediators of cognitive deficit were examined due to the finding that restraint in the non-dieters had increased over time and they also showed some evidence of a reduction in cognitive performance. However, results of a correlation analysis revealed no clear relationship between cognitive deficit, high restraint, preoccupation with food, attentional distraction, or negative mood.

Results from baseline comparisons revealed intending-dieters to show greater preoccupation with thoughts of food and eating and lack of control over eating and to have experienced less positive affect over the month prior to testing compared to non-dieters. Given their weight concerns these results are unsurprising. What is interesting however is that intending-dieters not only showed the highest levels of restraint, but also the highest levels of emotional eating.

Before discussing these results further, some methodological considerations must be noted. First, the numbers used in the current study were small, greatly compromising the power of the analyses performed. This was due to high failure to complete the questionnaires given at Time 2 and data lost due to task failure particularly on the vigilance task. An additional concern with the vigilance task was that it appeared to be possible to score within the 50% correct hit rate by pressing the response key frequently and at random.

The results of the fasting study conducted suggested that the task battery used in this study would be immune to the effects of hunger state. However, hunger state within the context of prolonged restraint may have had more detrimental effects upon cognitive function and should have been considered in the current study. In addition no attempt was made to match groups on time of day (or week) tested. Hunger might have accounted for the effect of increased distraction for food related words demonstrated by the non-dieters on the subliminal Stroop task at Time 2, since no

explanation for these effects could be found in the variables sampled. Subsequent research should include at the minimum a measure of current hunger.

Finally, the type of diet followed was not controlled. This procedure was necessary in order to examine diet-linked deficits in a more naturalistic setting. However, following this procedure we can only speculate over the severity of the diets, even in the context of weight loss. Knowledge concerning the severity of the diet followed is important if we wish to infer deficit based on the tryptophan depletion hypothesis. The dieters examined in this study claimed to be highly restrained in their eating habits and the majority were classified as overweight (at baseline 87.5% were BMI > 25). However, if the diet regime simply involved “healthier eating” or “cutting back” of the wrong kinds of foods then the dieters might have been consuming less calories but not sufficient to afford an increase in vulnerability to cognitive deficit as specified by the tryptophan depletion hypothesis. These issues outline two important differences between this study and those typical of Green and colleagues that might help account for the null effects of cognitive function found here.

First, the dieters seen by Green and colleagues were typically within the normal weight range, with BMI < 25. For a normal weight individual to be cutting back some at least must be eating below daily energy requirements. Indeed, in Green et al. (1994), the average dieter BMI was 21.3 (*SD* = 2.5) and these dieters were shown to be eating at 71% of Estimated Average Requirement for energy maintenance (Department of Health, 1991, as cited in Green et al., 1994). It is perhaps more likely

that the normal weight dieter would be suffering the nutritional consequences of food restriction compared to the overweight dieters sampled in the current study.

Second, because the dieters seen by Green and colleagues, were typically normal weight their weight reduction goals were probably less attainable (or even unobtainable if their real desire was to change body shape rather than lose excessive weight). In the current study the average weight-loss was 2.91 kg (*SD* = 1.94) after approximately three weeks; in Green et al. (1994) dieters lost an average of only 1.8 kg (SD = 0.4) after approximately four weeks. The early weight-loss experienced by the present dieters could have ameliorated, or protected against, tendency towards cognitive dysfunction. In support of this assertion, Kretsch et al. (1997) showed no deficits in sustained attention and immediate memory recall in a sample of obese women who lost an average of 12.3 kg (*SD* = 5.5) over a three-week dieting period.

How might attainment of dieting goals protect against cognitive performance? According to the "control-process" account of affect (Carver & Scheier, 1990) emotions are intrinsically related to goal values and are consequent upon the difference between the expected and the experienced rate of progress towards that goal. Where progress towards the goal occurs at a rate equal to a predetermined standard there is no ensuing discrepancy: the expected and the experienced rate of progress match and contingent state of affect is neutral. Where progress towards the goal is at a rate lower than the standard this will ultimately result in the experience of negative affect. Oatley and Johnson-Laird's (1987) account of the role of emotions

proposes that the experience of negative affect elicited by the failure of a major plan or loss of an active goal will typically result in a transition to one of two response outcomes: (1) give up; or, (2) search for a new plan. Presumably attempts to redress the imbalance of negative affect and/or to search for alternative plans will involve cognitive costs. Although the dieters in the current study showed lower positive affect compared to the non-dieters, good progress made towards weight-loss goals could have been sufficient to protect against increased negative affect and subsequent decline in processing resources leading to cognitive deficit.

If our assumptions concerning goal frustration are true, then negative affect should increase when progress made towards dieting goals slows down. There is evidence to suggest that even in formal diet programmes there maybe initial weight loss but that this is followed by regain (Wadden, Steen, Wingate, & Foster, 1996). Therefore the next study looked at overweight dieters who had been dieting for a *minimum* of five weeks, when the diet becomes more difficult to maintain. In order to control for the type of diet dieting participants were recruited from local Weight Watchers classes. The Weight Watchers diet is controlled but moderate in comparison to the diet imposed by Kretsch et al. (1997).

Although our results showed a suggestion of an effect of mood on cognitive performance, a more refined search aimed at identifying vulnerable groups was thought necessary to examine these effects further. Therefore, since there is evidence to suggest that personality differences predict differences in happiness (Costa &

McCrae, 1980) and individual differences in mood change during dieting (Williams et al., 1998), a personality scale was included in the next study to help identify those participants most vulnerable to emotional disruption during dieting. In addition, in the next study, the cognitive task battery was modified to include an alternative vigilance task employed by Green and colleagues; the use of which has successfully distinguished between dieter and non-dieter performance.

Finally, although Green and Rogers (1995, 1998) suggest that reduced cognitive performance during dieting is related to dieting per se to the exclusion of individual differences, we have shown evidence of higher emotional eating in potential dieters. In the context of cognitive impairment disinhibited eating has received comparatively little attention. In order to extend our investigation of the mediators of cognitive disruption, the influence of emotional eating was examined in the next study.

Despite the limitations noted, this study has successfully replicated the effects of diet-linked distraction for food related words under supraliminal Stroop conditions. Furthermore, it has been demonstrated that attentional interference does not (or need not) impair cognitive performance.

CHAPTER 4

DIETING, AFFECT AND COGNITIVE FUNCTION: STUDY 2

4.1 Introduction

In the preceding study both the intention to diet and current dieting was shown to be associated with preoccupation with and attentional distraction for food related stimuli. However, this interference was not accompanied by impairment in cognitive performance. It was suggested that a three-week dieting period may not have been sufficient to expose cognitive debility in overweight dieters. Accordingly, the aim of this study was to address the limitations of the last, and to expand the measurement of individual differences by examining the mood, well-being and cognitive performance of overweight dieters following at least five weeks of continuous dieting.

As noted in Chapter 1, Green and Rogers (1998) suggest that the cognitive deficits that have been observed in dieters are allied "to dieting per se, rather than pre-existing individual differences between dieters and non-dieters" (p. 1063). However, Green and Rogers' notion that the deficits are specific to the diet does not preclude the *existence* of individual differences between dieters and non-dieters. Neither is there sufficient evidence to discount the possibility that particular characteristics may *predispose* an individual to suffer depletion of processing resources under certain conditions. Such conditions, for example, could include the stressful effects of imposing and maintaining dietary restraint (Herman & Polivy, 1991). What is needed is a way of identifying potentially "vulnerable" sub-groups within the dieting sample.

There is evidence to suggest that individuals who score high on restraint as measured by the Restraint Scale also score highly in terms of neuroticism, maladjustment and emotional instability (Polivy, Herman & Howard, 1988). We know that one of the characteristics of the Restraint Scale is that it identifies dieters who demonstrate both the restriction of food intake as well the tendency to splurge (Heatherton et al., 1988). Therefore we need to differentiate between restraint and disinhibited eating because, as noted in Chapter 1, it is those participants who demonstrate acute emotional arousal (with a background of chronic increased emotionality) that tend to show cognitive effects most clearly (Williams et al., 1997).

Highly restrained non-dieters have shown comparable levels of cognitive impairment to dieters (Green et al., 1994, 2000). Interestingly, on those occasions, it was the high restrained non-dieters who scored the highest in terms of emotional eating. The question arises as to whether the tendency towards emotional eating might serve as a vulnerability indicator, identifying those most at risk for cognitive disturbance when the diet becomes more difficult to maintain.

This study had four aims. First, to replicate the findings of dieting induced deficits in cognitive function and distraction for food and shape related stimuli. Second to further the examination of individual differences between dieters and non-dieters by considering not only aspects of eating behaviour and emotional functioning, but also personality. Third, to examine the impact of eating behaviour on mood and

well-being. Finally, to examine the contribution of disinhibited eating patterns in addition to restraint for affective state and cognitive functioning.

It was hypothesised that dieters would demonstrate greater affective and cognitive disruption in comparison to non-dieters. Dieters would also show a greater attentional interference for food related stimuli on the supraliminal version of the Stroop task. Further it was hypothesised that emotional eating would be as important as restraint for the identification of those most vulnerable to affective and cognitive disruption.

Concerning the role of restraint as a mediator of the predicted cognitive deficits four subsidiary hypotheses were also investigated, these were:

(1) Dietary restraint has a direct effect on cognitive performance, therefore greater restraint would be associated with more deficit;

(2) Dietary restraint induces a general reduction in working memory capacity, which leads to cognitive deficit, therefore poorer performance on a task of working memory capacity would be associated with more deficit[1];

(3) Dietary restraint produces increased preoccupation with food, therefore greater attentional distraction for food related concerns would be associated with more deficit;

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[1] This hypothesis was included to thoroughly examine the impact of restraint on cognitive function. This was particularly appropriate given the results of the first dieting study (Chapter 3) where greater restraint was found to be associated with *better* RNG and vigilance task performance.

(4) Dietary restraint causes an increase in mood disturbance which has a detrimental effect on processing capacity, therefore greater mood disturbance would be associated with more deficit.

In accordance with results from the previous study, no predictions were made concerning the subliminal versions of the Stroop task or the body-shape version of the Stroop task.

4.2 Method

Participants

Dieting participants (who had been dieting for a minimum of 5 weeks) were recruited from local Weight Watcher classes. A comparison group of non-dieting participants was recruited from Bangor School of Psychology's Departmental Participant Panel. In total 28 dieters (mean age = 41.82, *SD* = 12.06) and 28 non-dieters (mean age = 38.21, *SD* = 10.83) matched for age and first language volunteered to participate in the study. In each group 86% of the participants were first language English, the remaining participants were completely fluent in both spoken and written English. All participants had normal (or corrected to normal) vision and reported general good health. Participants were paid £5.00 for taking part in the study and gave written informed consent.

BMI was significantly higher in the dieting group compared to the non-dieting group, mean scores (*SD*) were 29.20 (5.84) and 23.25 (2.95) respectively, $F(1, 48) = 18.92$, $p = .0001$. Seventy five percent of the dieting sample had a BMI > 25, the remainder being > 20; 14% of the non-dieting sample had a BMI > 25.

Materials

Self-report Measures

Participants completed the following questionnaires presented in a fixed order: Hunger Scale; Positive and Negative Affect Schedule (PANAS); Depressed States Questionnaire; Scale of Psychological Well-Being (PWB); Dutch Eating Behaviour Questionnaire (DEBQ); visual analogue food & mood scales (VAS); Eysenck Personality inventory (EPI). Two versions of the PANAS were given, one requiring participants to describe their mood "right now"; the other referring to mood experienced over the month prior to testing: "over last month". The EPI is described below, all other scales are described in Chapter 3 (except for Hunger Scale, see Chapter 2).

The Eysenck Personality Inventory (EPI; Eysenck & Eysenck, 1975).

This 57-item inventory aims to distinguish between neurotic (24 items) and extrovert (24 items) personality constructs. Items consist of questions concerning thoughts, feelings and the way a person might respond in a given situation. An example of an extroversion assessment item includes, "Do you often long for excitement?". An example of a neuroticism assessment item includes, "Does your mood often go up

and down?". A 9-item "lie scale" is included which attempts to assess the truthfulness of the respondents answer, an example item includes, "Are all your habits good and desirable ones ?". This scale can also be used as an index of social conformity. Responses are made by ticking a box labelled *Yes* or *No* to indicate agreement with each item.

Cognitive Function Tasks

Participants completed a range of computer administered tasks assessing general cognitive performance and attentional distraction for food and body-shape related words. Tasks were presented in the following fixed order: Random number generation task (RNG); Simple reaction time task (SRT); Immediate memory recall task; Bakan vigilance task; Supraliminal Stroop tasks (food and shape); Subliminal Stroop tasks (food and shape); Subliminal Stroop awareness check. The Bakan task is described below, all other tasks are described in Chapter 2.

Bakan vigilance task.

This task is a visual analogue of the Bakan task (Bakan, 1959). Participants were presented with a rapid sequence of digits appearing on the computer screen. During the display participants were required to press the space bar if they thought that they had detected a sequence of three-odd or three-even numbers. The stimulus presentation rate was 100 stimuli per minute, with an exposure duration of 600 ms per stimulus and no inter stimulus interval. Three blocks of trials were administered each lasting 1 minute and containing eight potential correct hits.

Procedure

Participants were tested individually in a single session lasting approximately 1 hr. After providing informed consent participants completed a personal details sheet (covering aspects such as age, first language and number of weeks on current diet if applicable) followed by the Hunger Scale. Participants then completed the battery of computer administered cognitive tasks followed by the self-report measures. Upon completion of the tasks questions were answered and an explanation of the studies main aims and hypotheses were given. Participants were then paid and thanked for their time.

4.3 Results

Data Analysis

There are three sections to this analysis. The first section involves comparison of dieter—non-dieter characteristics (including current hunger, eating behaviour and personality), emotional functioning (including positive and negative mood and well-being) and cognitive function. The second section involves a correlation analysis investigating the four hypotheses concerning the possible effects of dietary restraint on cognitive performance. The third section focuses on an examination of the impact relation of eating behaviour on measures of mood, well-being, and cognitive function.

Data were analysed using SPSS (1995). Parametric tests used included analysis of variance (ANOVA), analysis of covariance (ANCOVA), with multivariate analysis of variance (MANOVA) used where high inter correlation between self-report sub-scales was anticipated. Non-parametric tests included the Mann-Whitney *U* and the Kolmogorov–Smirnov distribution test. Pearson's product moment correlation coefficients (all two-tailed) were employed in all correlational analyses. An alpha level of .05 was used for all statistical tests. The main ANOVA tables are shown in Appendix B.

Section 1: Dieting and Non-dieting Group Comparison

Group Characteristics

Reported hunger.

Due to abnormality of distribution within the dieting group the hunger sub-scale was analysed using a non-parametric test and was found to be significantly *lower* in the dieting group compared to the non-dieting group, median scores (*IQR*) were 1.0 (1.0) and 2.0 (2.0) respectively, Mann-Whitney $U = 225.00, p = .01$. No significant differences were shown for amount of food that could be eaten, number of hours since last ate and number of hours till next eat, $t\,(52) < 1.5$ in all cases.

Eating behaviour.

Table 4.1 shows the mean, standard deviation and univariate *F* values for DEBQ and VAS eating for dieters and non-dieters. Results of a MANOVA on the DEBQ data revealed significant between-group differences, $F\,(3, 52) = 24.81, p = .0001$.

Univariate effects revealed dieters to report significantly greater levels of dietary restraint and emotional eating compared to non-dieters, F (1, 54) = 67.77 and 17.05, $p < .001$ in both cases. Groups did not differ significantly in levels of reported external eating, F (1, 54) = 1.62. In terms of VAS eating, significant between-group differences were found, F (3, 49) = 6.55, $p = .001$, with dieters reporting significantly greater levels of preoccupation with food compared to non-dieters, F (1, 51) = 13.51, $p = .001$. No significant between-group differences were shown for levels of reported urges to eat or lack of control over eating, $F < 1.0$ in both cases.

Table 4.1.
Mean DEBQ and VAS Eating Ratings for Dieters and Non-dieters

	Dieters		Non-dieters		*F*
Measure (min/max score)	*n* = 28		*n* = 28		
	M	*SD*	*M*	*SD*	
DEBQ (1/5)					
Restraint	*3.71*	0.64	*2.15*	0.77	*67.77****
Emotional	*3.56*	0.89	*2.54*	0.95	*17.05****
External	3.27	0.63	3.06	0.57	1.62
VAS (0/10)					
Preoccupation	*5.59*	2.74	*2.88*	2.62	*13.51****
Urges to eat	3.93	2.30	3.63	2.31	0.21
Lack of control	3.00	2.18	2.37	2.67	0.90

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Personality.

Results of three separate one-way ANOVA on the EPI data showed significant between-group differences in terms of reported neuroticism, *F* (1, 52) = 10.73, *p* = .002, with dieters reporting higher levels (*M* = 13.15, *SD* = 5.38) compared to non-dieters (*M* = 8.59, *SD* = 4.82). No significant between-group differences were found for measures of extroversion (for dieters *M* = 11.78, *SD* = 4.92; for non-dieters *M* = 11.96, *SD* = 4.84), *F* < 0.05. Similarly no significant between-group differences were found on the lie index sub-scale (for dieters *M* = 3.11, *SD* = 1.69; for non-dieters *M* = 2.63, *SD* = 1.64), *F* < 1.5. The lie index will not be referred to further. Neuroticism is taken into account in subsequent analyses.

Mood Between Groups

Table 4.2 shows the non-transformed means, standard deviation and univariate *F* values for the PANAS, Depressed States and VAS mood scales.

Table 4.2.
Mean Mood Ratings for Dieters and Non-dieters

Measure (min/max score)	Dieters $n = 28$		Non-dieters $n = 27$		*F*
PANAS (10/50)	*M*	*SD*	*M*	*SD*	
Positive “right now”	29.14	8.16	29.07	7.12	0.00
Positive “over last month”	31.43	8.72	35.67	7.16	3.86
Negative “right now”	*13.11*	3.69	*11.12*	1.48	*6.57**
Negative “over last month”	19.75	8.95	17.26	6.40	1.54
Depressed states (1/5)					
Global	1.83	0.84	1.63	0.56	1.09
Mood	2.67	0.92	2.30	0.77	2.52
VAS (0/10)					
Sadness	2.83	2.80	2.10	2.53	1.01
Anxiety	3.39	2.72	3.21	3.19	0.05
Irritability	3.43	3.22	2.63	2.77	0.92
Concentration difficulty	4.06	2.69	2.58	3.00	3.58
Energy	*4.67*	2.02	*6.21*	2.79	*5.35**

$^{*}p < .05$

PANAS.

Since positive and negative affect are suggested to be independent (Watson et al., 1988) separate MANOVA were conducted for positive and negative measures. Results of a MANOVA showed no overall significant between-group difference in positive affect, $F\,(2, 55) = 2.09, p = .14$. However, although univariate effects revealed no significant difference for positive affect “right now” ($F < 1.0$), positive affect “over last month” showed an effect which bordered on significance, $F\,(1, 53)$

$= 3.86, p = .06$. Although weak this effect was anticipated and replicates results found in the preceding study.

Results of a MANOVA showed overall significant between-group difference in negative affect, $F(2, 50) = 3.30, p = .045$, with dieters reporting greater levels of negative affect “right now” compared to non-dieters, $F(1, 51) = 6.57, p = .01$. No significant difference was shown for negative affect “over last month”, $F(1, 51) = 1.54, p = .22$. However, the data showed heterogeneity of variance, with Bartlett Box at $p < .05$ for both variables. Logarithmic transformation of the data stabilised the variance for negative affect “over last month”, but between group differences remained non-significant. However, the negative affect “right now” remained problematic even following transformation and removal of an outlying score of 15 from the non-dieting group, in addition distribution of the scores within the non-dieting group was abnormal (Kolmogorov–Smirnov $z(25) = 1.47, p = .03$). What becomes apparent from observation of the distribution of the data (see Figure 4.1) is the breadth of level of negative affect experienced in the dieters. In comparison the non-dieters represent a more homogenous sample, with a few individuals reporting high negative affect “over last month” but the majority experiencing similar levels.

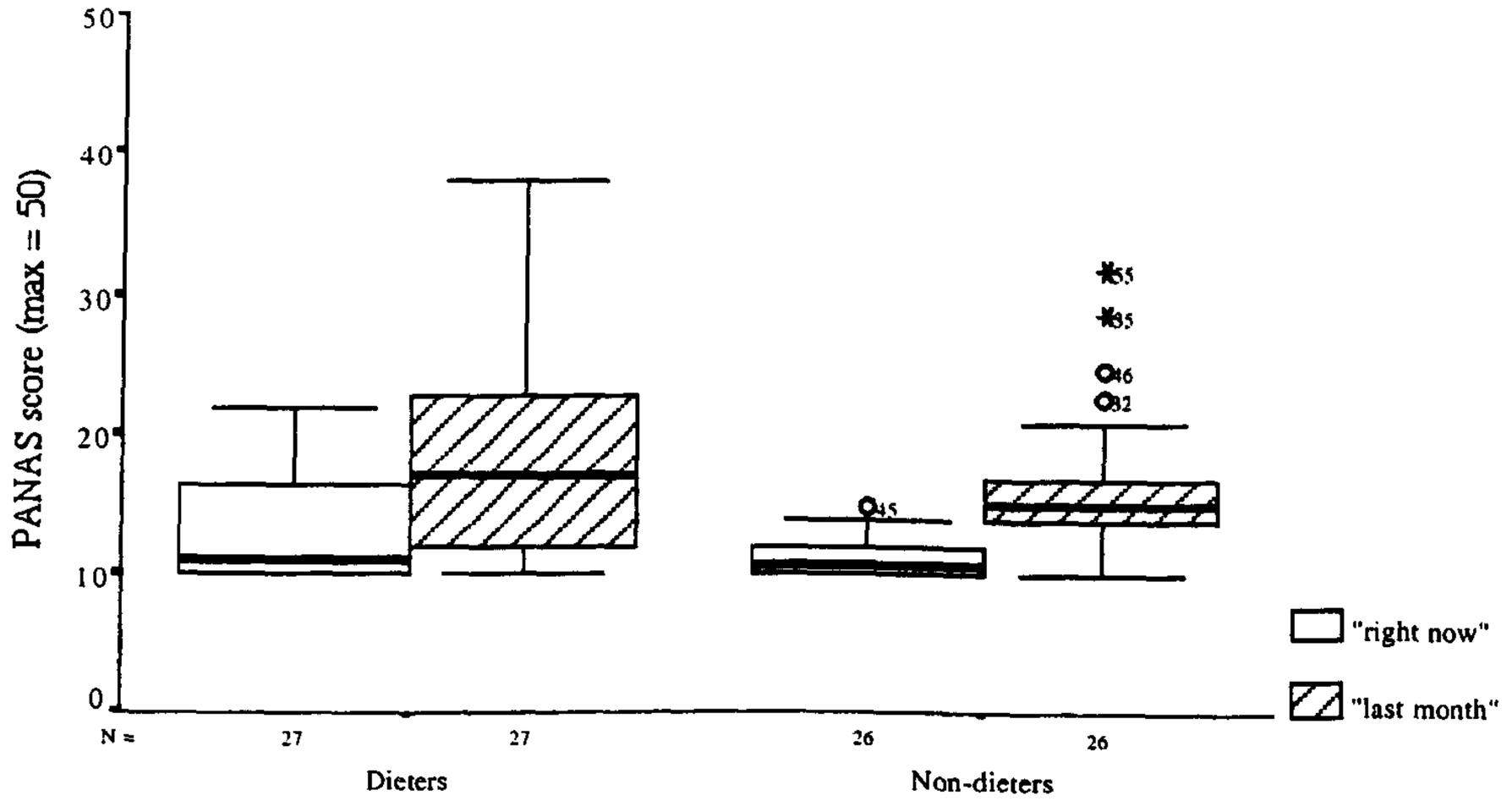

Figure 4.1. Boxplot of PANAS negative item ratings in dieters and non-dieters.

Depressed states.

The two sub-scales of the Depressed states questionnaire were analysed separately using one-way ANOVA. No significant between-group differences were found for either global or mood sub-scales, F (1, 52) = 1.09 and 2.52 respectively, $p > .10$ in both cases.

VAS mood.

Analysis of the VAS mood revealed no significant overall difference between groups, F (5, 47) = 1.61, $p = .17$. Although univariate tests did reveal dieters to report significantly less energy, F (1, 51) = 5.35, $p = .03$, and to show a trend to be

experiencing greater concentration difficulty, $F(1, 51) = 3.58, p = .06$, compared to non-dieters. No between-group differences were found for measures of sadness, anxiety or irritability, $F < 1.0$ in all cases.

Well-being Between Groups

Table 4.3 shows the non-transformed means, standard deviation and univariate F values for the PWB scale. Results of a MANOVA showed no significant overall difference between dieters and non-dieters in level of reported psychological well-being, $F(6, 47) = 1.88$, p = .10. However, univariate effects revealed significant between-group differences in personal growth, positive relations with others and self-acceptance, $F(1, 52) = 7.89, 5.16, 4.94$ respectively, p < .05 in all cases; with dieters scoring lower than non-dieters in each instance.

Table 4.3.
Mean Well-Being Ratings for Dieters and Non-dieters

	Dieters $n = 28$		Non-dieters $n = 27$		F
Sub-scale (max = 6)	M	SD	M	SD	
Autonomy	4.27	0.82	4.46	0.78	0.61
Environmental mastery	4.33	0.96	4.70	0.82	2.20
Personal growth	*4.86*	0.60	*5.26*	0.42	*7.89***
Positive relations	*4.56*	0.86	*5.04*	0.66	*5.16**
Purpose in life	4.63	0.74	4.94	0.56	2.83
Self-acceptance	*4.27*	0.93	*4.76*	0.76	*4.94**

$^{*}p < .05$, $^{**}p < .01$

The question arises as to whether the poorer profile of affective functioning expressed by the dieters is due to individual differences (i.e. neuroticism) or consequent upon diet related factors such as BMI and dietary restraint. To investigate this issue analysis of covariance were conducted on the measures from the PANAS, VAS mood and PWB scale that showed significant between-group differences, sequentially controlling for neuroticism, BMI and restraint. For PANAS negative "right now" there was a significant covariate effect of neuroticism, $F(1, 49) = 10.98$, $p = .002$[2]. When neuroticism was partialled out of the analysis the between-group difference in negative affect failed to reach significance, $F(1, 49) = 0.56$. There were no significant covariate effects of BMI or restraint on negative affect "right now". There were no significant covariate effects of neuroticism, BMI or restraint on VAS energy, $F < 2.0$ in all cases. Results of a MANCOVA conducted on the PWB data showed a significant covariate effect of neuroticism on personal growth, positive relations and self-acceptance, $F(1, 50) = 5.89$, 25.77 and 21.41 respectively, $p < .05$ in all cases. When neuroticism was partialled out of the analysis the between-group differences in well-being failed to reach significance: $F(1, 50) = 2.94$, $p = .09$ for personal growth; $F(1, 50) < 1.0$ for positive relations and self-acceptance. Results of a second MANCOVA revealed a significant covariate effect of BMI on personal growth, $F(1, 45) = 5.12$, $p = .03$. When BMI was partialled out of the analysis the between-group difference in personal growth failed to reach significance, $F(1, 45) =$

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[2] This analysis was conducted on PANAS negative "right now" data transformed by logarithm 10. The data still showed heterogeneity of variance, however the regression of neuroticism on this PANAS data was substantial and is not unprecedented in the literature.

1.98, $p = .17$. There was no significant covariate effect of restraint on well-being, $F < 1.5$ in all cases.

Cognitive Function

The four cognitive function tasks were analysed using separate one-way ANOVA. Table 4.4 shows the mean, standard deviation and *F* values for the four cognitive function tasks: SRT, memory recall, Bakan, RNG.

Table 4.4.
Mean Cognitive Performance Scores for Dieters and Non-dieters

	Dieters $n = 28$		Non-dieters $n = 28$		*F*
Measure	*M*	*SD*	*M*	*SD*	
SRT (ms)	*305.37*	36.38	*282.55*	38.45	*5.20**
Memory recall (max = 20)	*7.52*	2.57	*9.02*	2.85	*4.27**
Bakan (% correct hits)	*39.29*	20.99	*51.25*	17.40	*5.39**
RNG	.37	.07	.36	.05	2.23
RNG minus outliers	.36	.05	.36	.05	0.01
RNG errors	4.71	7.55	7.57	8.10	1.86
RNG errors minus outliers	5.46	7.93	7.00	7.66	0.74

$^*p < .05$

Simple reaction time.

Results of a one-way ANOVA showed dieters to be significantly slower in speed to respond to a stimulus compared to non-dieters, $F(1, 54) = 5.20, p = .03$. Figure 4.2 depicts the distribution of SRT scores within dieting and non-dieting groups, which appear fairly symmetrical and void of outliers.

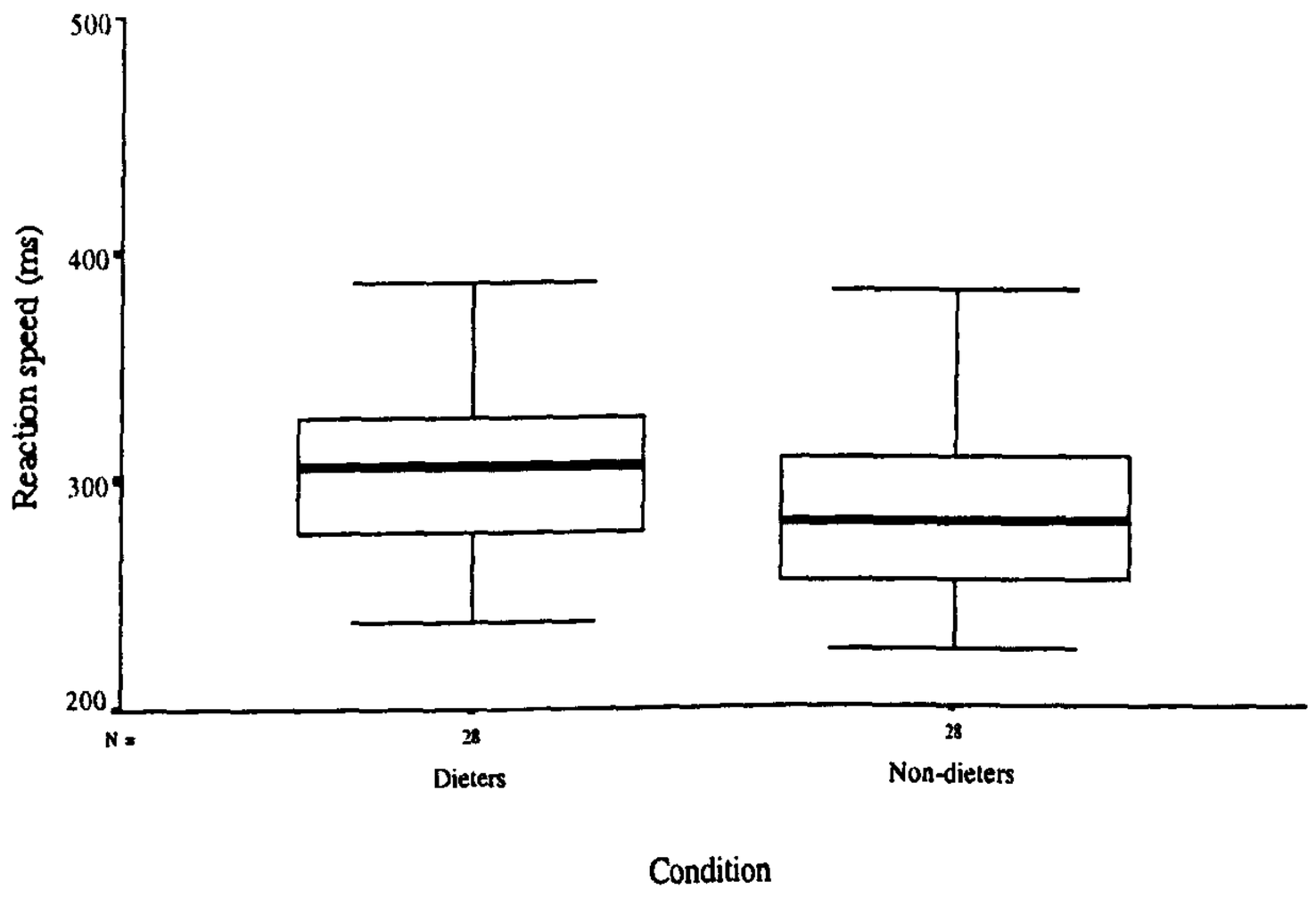

Figure 4.2. Boxplot of SRT performance in dieters and non-dieters.

Immediate memory recall.

Results of a one-way ANOVA revealed dieters to recall significantly fewer words compared to non-dieters, *F* (1, 54) = 4.27, *p* = .04. Figure 4.3 depicts the distribution of number of words recalled within dieting and non-dieting groups; although the data provided from the non-dieters is mildly positively skewed no outlying cases are shown and clear between-group differences in central tendency can be seen.

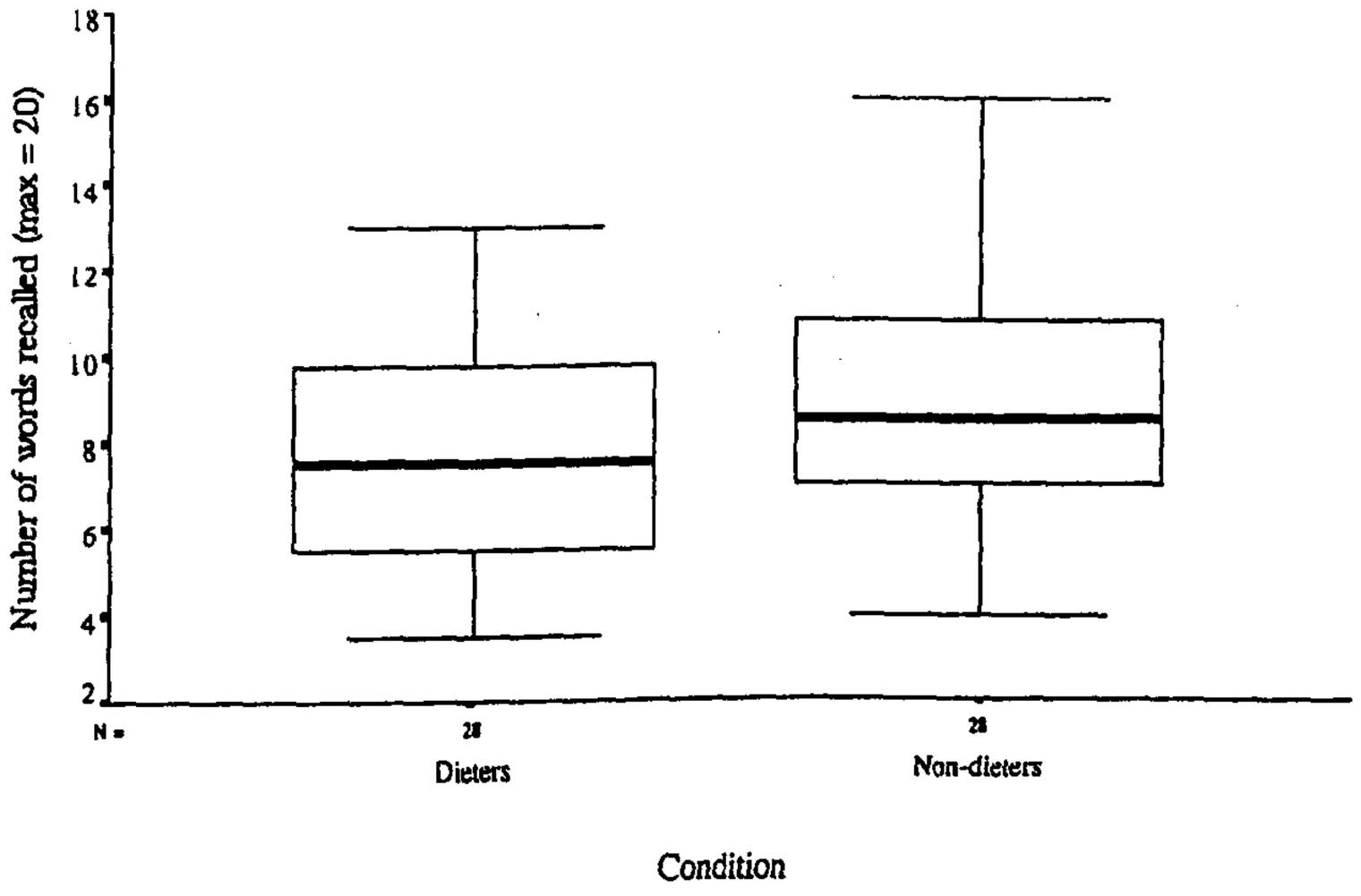

Figure 4.3. Boxplot of memory recall performance in dieters and non-dieters.

Bakan task.

Results of a one-way ANOVA showed dieters to achieve significantly fewer correct hits on the Bakan task compared to non-dieters, *F* (1, 54) = 5.39, $p = .02$. Figure 4.4 depicts the distribution of percentage of correct hits within dieting and non-dieting groups; although the data provided from the non-dieters is mildly positively skewed no outlying cases are shown, and again clear between-group differences in central tendency can be seen.

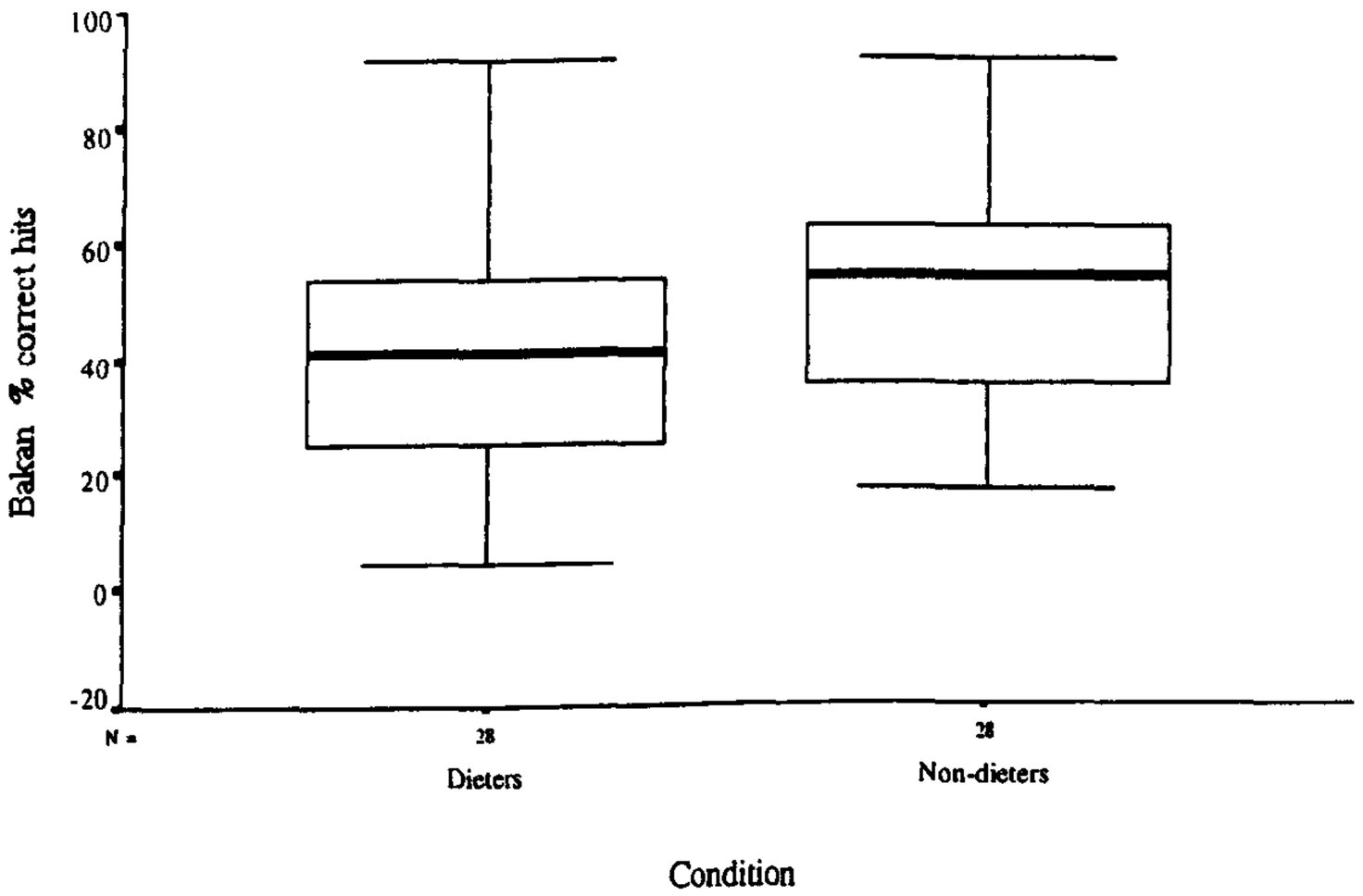

Figure 4.4. Boxplot of Bakan performance in dieters and non-dieters.

RNG task.

Inspection of the RNG data revealed three outlying data points within the dieting group with values of > .50 (see Figure 4.5). Results of a one-way ANOVA on the data in its original form revealed no between-group differences in RNG task performance or anticipatory key press errors, *F* (1, 53) = 2.23 and 1.86 respectively, *p* > .20 in both cases. Following removal of the outliers the magnitude of the effects fell to *F* (1, 50) = 0.01 and 0.74 for RNG and error scores respectively.

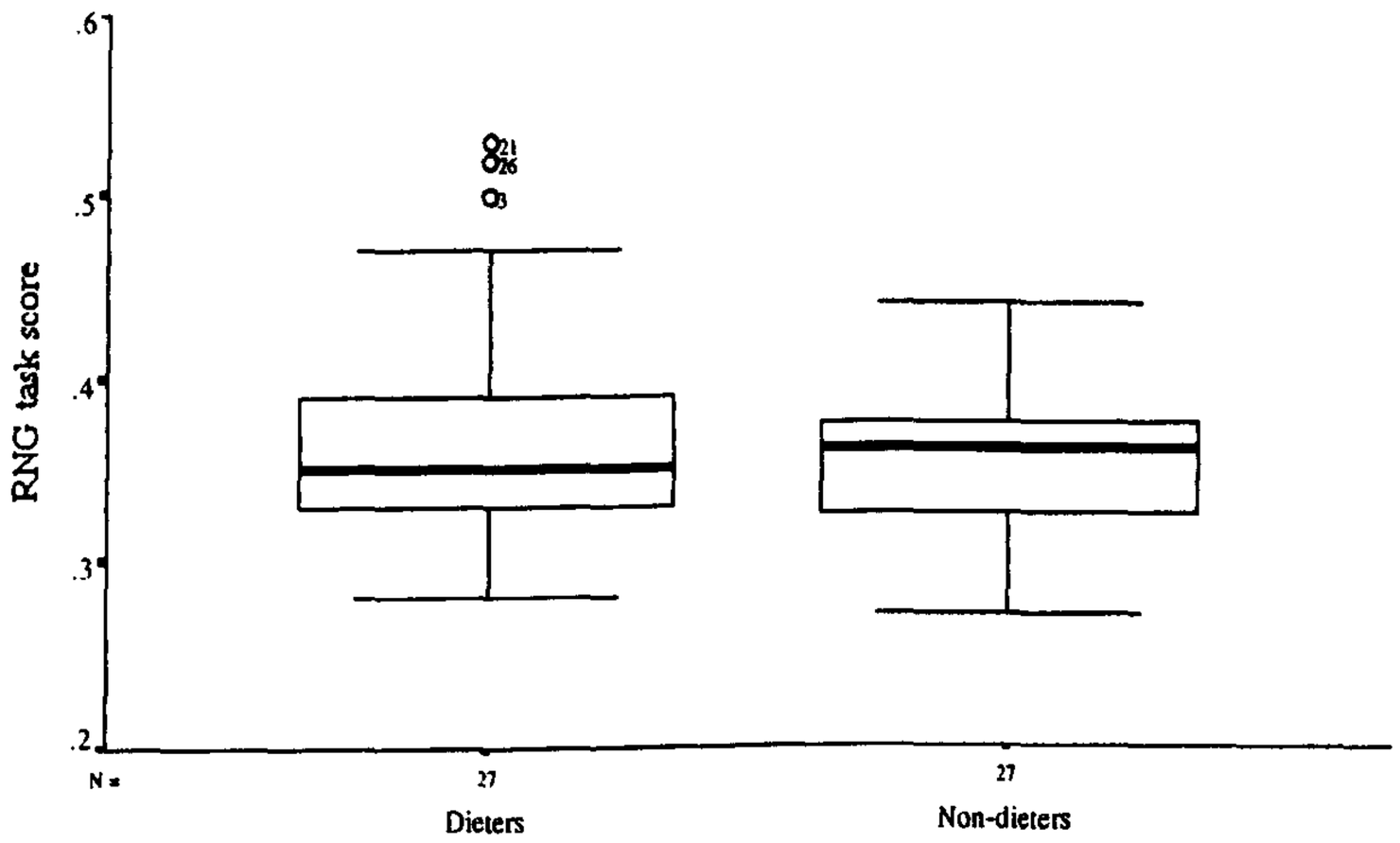

Figure 4.5. Boxplot of RNG performance in dieters and non-dieters.

Stroop Performance

The Stroop data was analysed using an interference index calculated by subtracting mean speed to respond to control words (music, transport) from mean speed to respond to target words (food, shape). In this way a positive score indicates more distraction by target words compared to control words, the reverse being true for negative scores. Table 4.5 shows the mean scores and standard deviations for food and shape Stroop interference indices for dieters and non-dieters.

Table 4.5.
Mean Stroop Interference Scores for Dieters and Non-dieters

	Dieters $n = 28$		Non-dieters $n = 28$	
Interference index (ms)	*M*	*SD*	*M*	*SD*
Supraliminal Food	7.04	57.04	6.93	59.05
Subliminal Food	8.10	67.10	-5.87	56.66
Supraliminal Shape	20.97	82.69	6.94	62.48
Subliminal Shape	0.23	49.01	-1.61	40.85

Note. For interference indices a larger positive score means slower to respond to target words (food & shape) compared to control words (music & transport).

Food Stroop interference.

Results of a 2 x 2 (Condition x Exposure: supraliminal, subliminal) repeated measures ANOVA revealed no significant main effects or interactions,

$F(1, 53) < 1.0$ in all cases. The distribution of the data within each group is shown in Figure 4.6. A number of outliers were found within the dieting group (3 under supraliminal conditions, 6 under subliminal conditions), despite this data distribution did not significantly deviated from normal (Kolmogorov–Smirnov $z < 1.5, p > .05$ in all cases) and between-group variance was sable. Due to the distribution of the outliers (some high, some low) removal was deemed to make little difference to the between-group analysis so the data was not probed further.

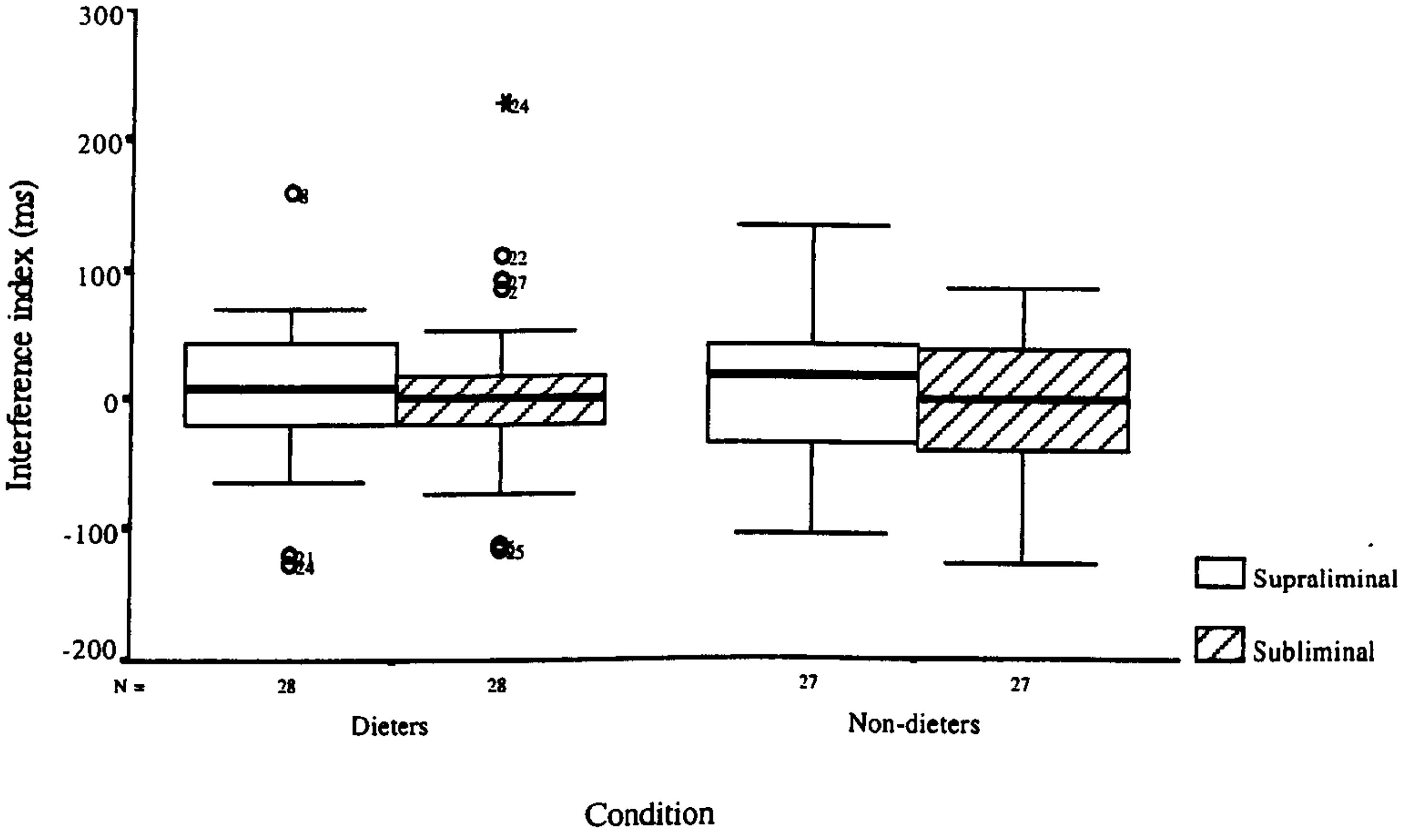

Figure 4.6. Boxplot of food Stroop interference in dieters and non-dieters.

Shape Stroop interference.

The distribution of the data within each group is shown in Figure 4.7. Results of a 2 x 2 (Condition x Exposure: supraliminal, subliminal) repeated measures ANOVA revealed no significant main effects or interactions, $F(1, 53) = 1.62$ for Exposure otherwise $F < 1.\ 0$. A number of outliers were found, mainly representing low scores (more distraction for control words) within the non-dieting group, despite this data distribution did not significantly deviated from normal (Kolmogorov–Smirnov $z < 1.0$, $p > .05$ in all cases) and between-group variance was stable. Again, due to their dispersion, removal of the outliers was deemed to make little difference to the between-group analysis thus the data was not probed further.

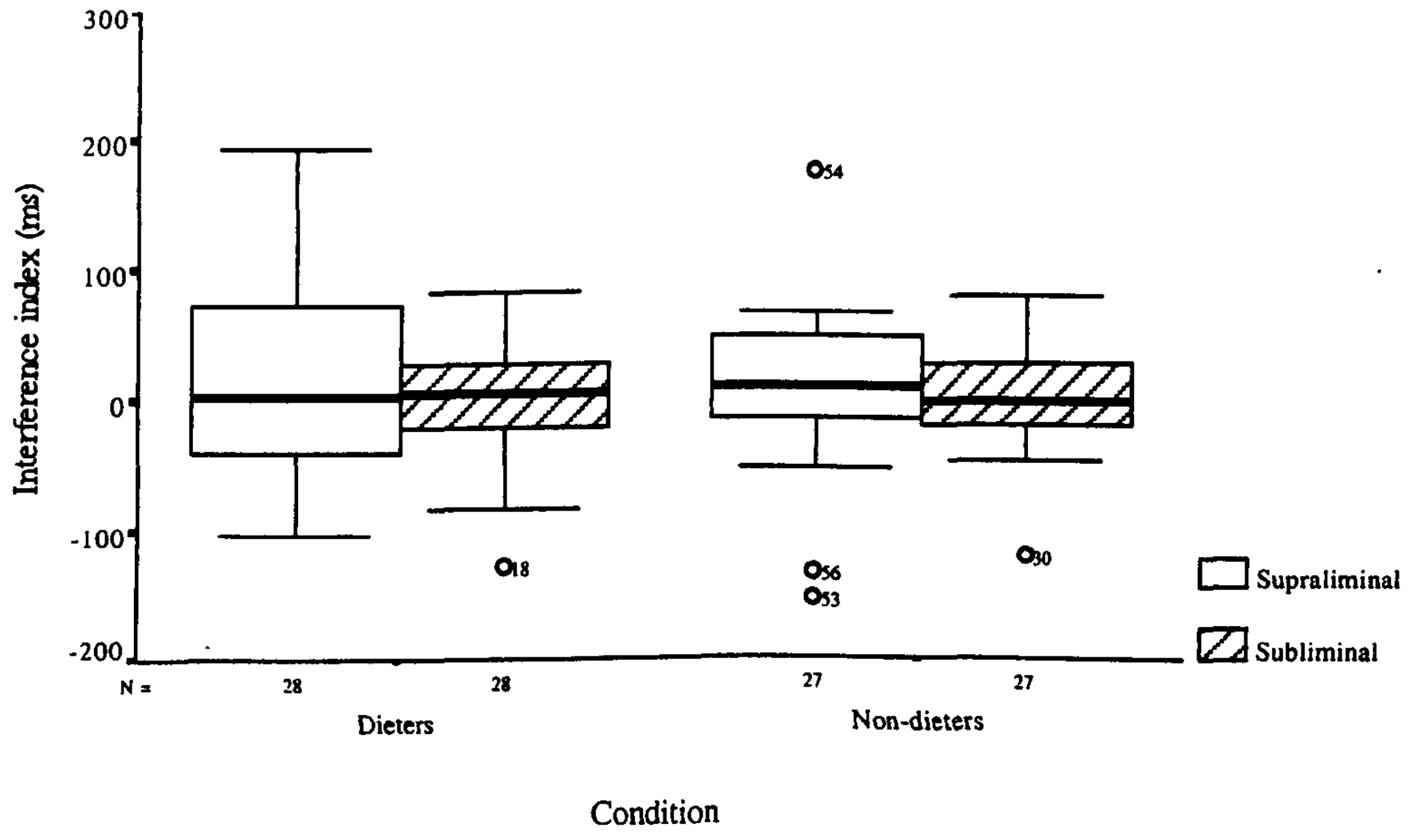

Figure 4.7. Boxplot of shape Stroop interference in dieters and non-dieters.

Subliminal Stroop awareness check.

On the presence/absence task participants showed an overall mean correct hit rate of 67%. On the lexical decision task participants showed an overall mean correct hit rate of 53%. Overall the performance of the sample did not significantly differ from chance level on either awareness check task (Binominal test, $p > .05$ in both cases). These results indicate that although the majority of participants were able to detect the presence versus the absence of a masked word stimulus, they performed at chance levels when attempting to correctly identify its lexical content.

It is worth noting at the end of this section that BMI could not directly account for the differences in cognitive performance shown, since correlation between BMI and the cognitive performance measures ranged from only .11 to -.08 for groups combined, and -.00 to .08 for dieters only.

Section 1 Summary

Dieters and non-dieters showed significant differences in BMI, dietary restraint, emotional eating, preoccupation with thoughts of food and eating and neuroticism, with dieters scoring higher in each instance. Dieters reported significantly higher levels of negative mood "right now", with a trend for greater negative mood and less positive mood "over last month". Dieters reported less energy compared to non-dieters. Dieters also reported poorer well-being denoted by lower scores on aspects of personal growth, purpose in life and self-acceptance. Analysis of covariance revealed that the higher levels of negative mood expressed by the dieters and their

poorer well-being profile might be explained in terms of their higher neurotic tendency. In addition the higher BMI levels of the dieters appear to contribute towards their lower levels of reported personal growth. Interestingly, restraint explained little of the variance in affective functioning. In addition, although dieters showed higher levels of negative mood they did not show increased tendency towards negative self-description. We will investigate this attribute further in Section 3 of this analysis.

Concerning cognitive function, dieters demonstrated impairments in reaction time speed, immediate memory recall and Bakan vigilance task performance relative to non-dieters. Interestingly, despite the other deficits, dieters did not demonstrate poorer working memory capacity (RNG task), neither did they show evidence of greater distraction for food or shape related words on either the supraliminal or subliminal version of the Stroop task. BMI level could not account for the differences in cognitive performance shown. The question arises as to which factors were mediating the deficits shown and it is to this issue that we now turn.

Section 2: Dietary restraint and Cognitive Function Correlational Analysis

In this section the three possible ways in which dietary restraint might bring about cognitive performance deficit was investigated using correlation analysis. In each analysis the data were considered for dieters, non-dieters and groups combined (with distribution checks made where appropriate). Although not significant between groups, the RNG task was included in this section for later reference.

Hypothesis 1: dietary restraint has a direct effect on cognitive processing efficiency

The relationship between dietary restraint and cognitive performance was examined in dieters, non-dieters and groups combined. Results for dieters and non-dieters are shown in Table 4.6. The Bakan task has previously been associated with restraint, indeed in the present study when the groups are combined restraint was shown to be inversely related to Bakan task performance, *r* (56) = -.30, *p* = .02. This result is reflected in a similar trend within the non-dieters, *r* (28) = -.24. However, viewing dieters alone there appears to be little relationship between restraint and Bakan, *r* (28) = -.02. Observation of the distribution of scores (see Figure 4.8) shows two non-dieters who score over 3 on the restraint scale and perform poorly on the Bakan with scores below 40%. Removal of these data points reduces the relationship between restraint and Bakan in the non-dieters to .09. The overall correlation demonstrated between restraint and Bakan appears to be mediated by factors associated with dieting, rather than restraint per se. For tasks of SRT and memory recall a trend was

demonstrated amongst dieters such that the high restrainers performed better on these tasks, r (28) = -.28 and .27, respectively, p > .10 in both cases.

Table 4.6.
Correlation Between Restraint and Cognitive Performance

	Restraint	
	Dieters n = 28	Non-dieters n = 28
SRT	-.28	-.06
Memory recall	.27	.11
Bakan	-.02	-.24
RNG	-.11	.12

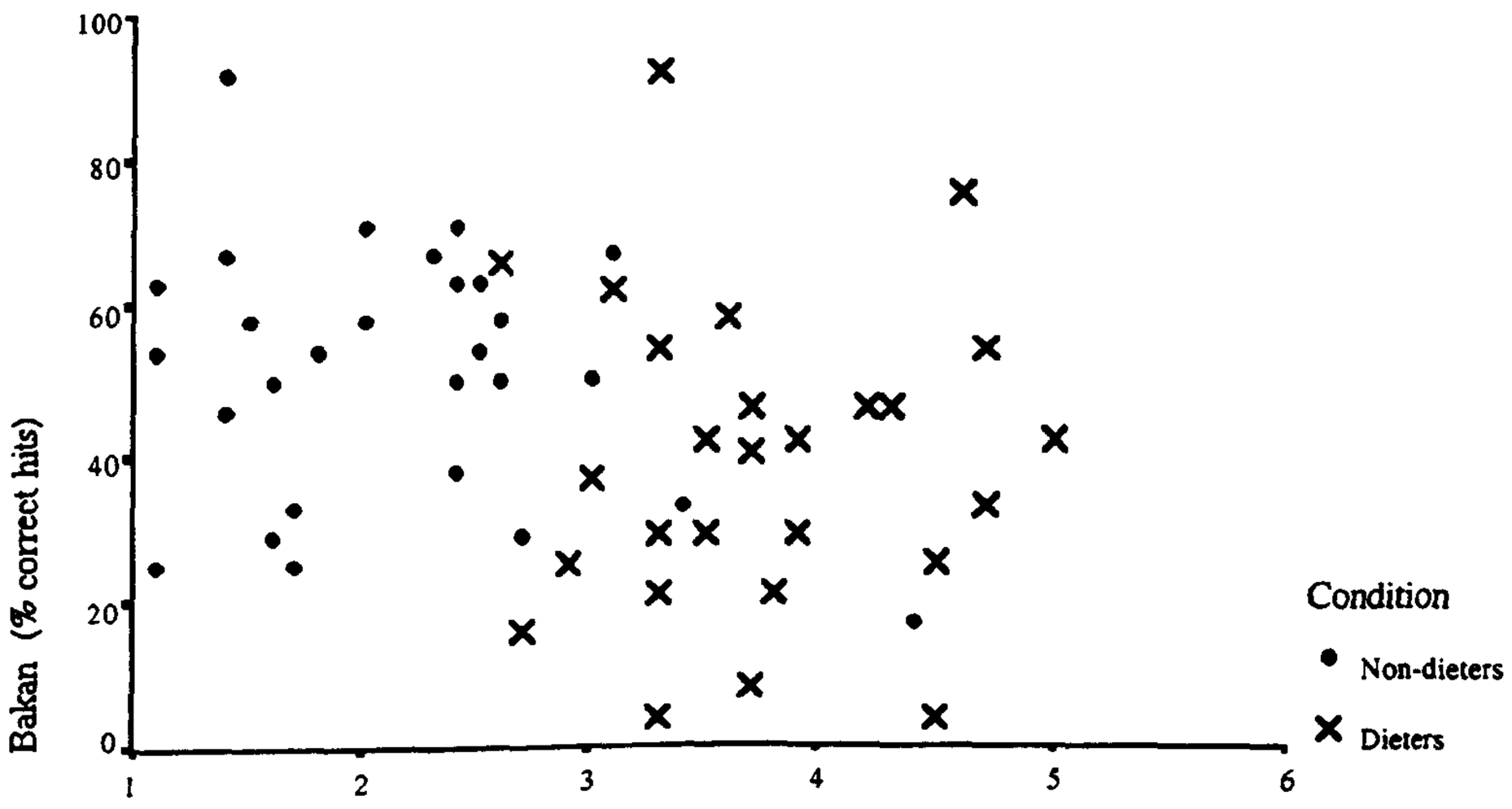

Figure 4.8. Relationship between restraint and Bakan performance.

Hypothesis 2: dietary restraint produces a reduction in working memory capacity which leads to cognitive deficit

Since restraint does not appear to be associated with RNG task performance only the latter part of this hypothesis was investigated by examining the relationship between RNG, SRT, memory recall and Bakan task performance. Groups combined, a consistent pattern of relationship was demonstrated with poorer RNG performance being significantly related to poorer Bakan task performance (r (55) = -.34, p = .01) and weakly related to poorer SRT and memory recall, r (55) = .23 and -.15, p > .05 in both cases. This pattern of relationship was reflected within the dieting group with significant correlations of -.40 and .39 (p < .05 in both cases) for tasks of Bakan and SRT respectively, and –.11 (p > .05) for memory recall. Within the non-dieters the associations were weaker, with poor RNG associated with better SRT; correlations were -.11, -.12 and -.10 for tasks of Bakan, SRT and memory recall respectively. These results suggest that at least within dieters reduced working memory capacity is associated with poorer vigilance, reaction time and immediate memory recall.

Hypothesis 3: increased preoccupation and attentional interference for food related stimuli may bring about cognitive deficit

From the previous section, dieters reported greater preoccupation with thoughts of food and eating but showed no attentional distraction for food related words on the Stroop task relative to non-dieters. The relationship between the subjective and objective measures of attention deployment were compared for dieters, non-dieters and groups combined. A consistent pattern of relationship was demonstrated across

groups with preoccupation being positively related to supraliminal food Stroop interference and showing a negative association with subliminal food interference, however none were significant with $r < .30$ in each instance. The relationship between the subjective and objective measures of attention deployment to cognitive task performance will be considered next.

Preoccupation and cognitive performance.

Considering groups combined, no relationship between preoccupation and cognitive performance was shown, r (53) < .10 in each instance. Within the dieting group greater preoccupation was significantly associated with *better* performance in memory recall, r (27) = .43, p = .03. All other correlation coefficients < .25.

Stroop interference and cognitive performance.

Considering dieters, non-dieters and groups combined, attentional distraction was not associated with poorer cognitive performance. In fact, within the non-dieters greater interference on the supraliminal Stroop was associated with *better* Bakan task performance, r (28) = .51, p = .005. All other correlation coefficients < .30.

Hypothesis 4: mood disruption may reduce cognitive processing efficiency

In Section 1 of these results dieters showed significantly lower levels of positive affect "over last month" and a trend for greater negative affect (both time frames) and concentration difficulty, relative to non-dieters. However, restraint was found to contribute little to these differences. If mood is related to poorer cognitive

performance the association is not mediated by dietary restraint, but other factors peculiar to dieting. For now we will focus on the examination of the relationship between mood and cognitive performance, considering positive affect "over last month", negative affect (both time frames), concentration difficulty and energy.

No consistent pattern of relationship was shown between mood and Bakan task performance, $r < .20$ in every instance. Results for SRT, memory recall and RNG tasks for dieters and non-dieters are shown in Table 4.7. Within the dieters poorer reaction time speed was significantly related to higher levels of reported concentration difficulty, $r\ (27) = .54, p = .004$. Conversely, better memory recall was significantly related to higher negative mood "right now", $r\ (27) = .41, p = .03$, and moderately related to higher negative mood "over last month", $r\ (28) = .37, p = .05$. This latter association was also reflected by the non-dieters, $r\ (27) = .27, p = .20$. Although not specifically relevant to this section it is interesting to note the consistent pattern of relationship between the RNG task and mood. In both dieters and non dieters greater negative mood "right now" was associated with poorer RNG performance, $r\ (27/25) = .44$ and $.46$ respectively, $p < .05$ in both cases. There was also a trend for RNG to be similarly associated with negative mood "over last month" and concentration difficulty, this pattern being reflected by both dieters and non-dieters. We will return to examine the RNG task further in the next section of this analysis.

Table 4.7.
Correlation Between SRT, Memory Recall, RNG and Mood

	Dieters			Non-dieters		
		$n = 28$			$n = 28$	
	SRT	Recall	RNG	SRT	Recall	RNG
Pos. “over last month”	-.11	-.23	-.13	.09	-.18	-.31
Neg. “right now”	-.09	*.41**	*.44**	-.12	.06	*.46**
Neg. “over last month”	.07	.37	.35	-.03	.27	.31
Concentration difficulty	*.54***	.12	.28	-.15	.01	.32
Energy	.16	.08	-.09	.20	-.25	-.22

$^{*}p < .05$, $^{**}p < .01$

Section 2 Summary

In terms of Hypothesis 1, high restraint was not found to be reliably associated with cognitive impairment. Although the data appeared to indicate a relationship between high restraint and poorer Bakan performance, the distribution of the data was such that the deficits appeared to be related to factors peculiar to dieting rather than restraint per se.

Although restraint was not associated with poorer working memory capacity, Hypothesis 2 gained some support in that poorer RNG performance was significantly associated with poorer Bakan and SRT task performance in dieters.

In support of Hypothesis 3, dieters reported greater preoccupation with thoughts of food and eating, however these preoccupations were not reflected in greater

attentional distraction for food related words relative to non-dieters. Neither preoccupation nor attentional distraction for food related concerns was related to cognitive impairment.

Finally, some support was found for the mood-mediated account suggested by Hypothesis 4. Although restraint was not found to be associated with poorer affective functioning, for dieters greater reported concentration difficulty was found to be associated with slower reaction time speed and for both dieters and non-dieters negative mood was associated with poorer RNG, which in turn was associated with poorer Bakan. This suggests that within each condition there are participants who, under the effects of high negative mood, show vulnerability to decreased working memory capacity; but this vulnerability is not directly related to level of reported restraint.

In summary, the cognitive impairment demonstrated by the dieters in this study cannot be adequately accounted for directly in terms of restraint, preoccupation with food, attentional distraction, or the *direct* effects of negative mood.

Section 3: Emotional Eating

In this section the relationship between eating behaviour, mood, well-being and cognitive function was examined to see if emotional eating could be as important in discriminating diet-linked deficits as restrained eating had been hypothesised to be.

Eating Behaviour, Mood and Well-being

When the whole sample is considered together (and only then) restraint and emotional eating are significantly and positively correlated, r (56) = .44, p = .001. To gain a purer picture of the relationship between the two eating behaviours and emotional functioning, partial correlation coefficients were calculated examining the relationship between restraint, mood and well-being, controlling for emotional eating; and, emotional eating, mood and well-being, controlling for restraint. Results are shown in Table 4.8. Unsurprisingly, given the results of the ANCOVA conducted Section 1, restraint showed a weak, if any, association with affective functioning. Conversely, high emotional eating was found to be significantly related to high negative mood “over last month”, high anxiety, high irritability and high concentration difficulty, r (47) = .39, .34, .37 and .42 respectively, $p < .05$ in all cases. High emotional eating was also found to be significantly related to low environmental mastery, low personal growth, low positive relations with others and low self-acceptance, r (47) = -.55, -.30, -.33 and -.43 respectively, $p < .05$ in all cases. High emotional eating was also found to be moderately related to low purpose in life, r (47) = -.28, p = .05. Moreover, high emotional eaters were more likely to attribute negative self-descriptors to their negative mood state, r (51) = .52, p = .0001.

Table 4.8.
Partial Correlation Between Eating Behaviour and Affect

Sub-scale	Restraint minus emotional	Emotional minus restraint
Pos. "right now"	.03	-.05
Pos. "over last month"	-.13	-.26
Neg. "right now"	.18	.18
Neg. "over last month"	-.08	.39**
Depressed states global	-.18	.52***
Sadness	.06	.14
Anxiety	-.17	.34*
Irritability	-.09	.37**
Concentration difficulty	-.11	.42**
Energy	-.20	-.19
Autonomy	-.01	-.15
Environmental mastery	.18	-.55**
Personal growth	-.00	-.30*
Positive relations	-.09	-.33*
Purpose in life	.00	-.28
Self-acceptance	.02	-.43**

*p < .05, **p < .01, ***p < .01

Results from Section 1 revealed that dieters showed significantly higher levels of emotional eating compared to non-dieters. Thus the question arises as to whether the relationship between high emotional eating and poor emotional functioning is a function of dieting status, or whether high emotional non-dieters also demonstrate disturbed emotional functioning.

In line with previous research in this field, participants were classified into three groups according to a split based on dieting status and score on the DEBQ emotional

eating scale. The median emotional eating score for the non-dieters was 2.54. Non-dieters were classified as high emotional eaters if their mean emotional eating score was 2.54 or greater. Non-dieters were classified as low emotional eaters if their mean emotional eating score was less than 2.54. The three groups were dieters ($n = 28$), high emotional non-dieters ($n = 15$) and low emotional non-dieters ($n = 13$). The investigation was limited to the mood and well-being variables that showed significant correlation with emotional eating. For each variable one-way ANOVA were conducted with dieting/emotional eating status as the dependent variable. Mean, standard deviation and F values are shown in Table 4.9. The Fisher's Least Significant Difference (LSD) test was employed for post hoc multiple-comparison as it is recommended for analyses that involve three means (Howell, 1997).

Results revealed significant between-group difference in concentration difficulty, F (2, 50) = 3.41, $p = .04$. Although dieters reported significantly higher levels of concentration difficulty compared to low emotional non-dieters (LSD, $p < .05$) it must be noted that high emotional non-dieters reported intermediate levels. Significant between-group differences were found for measures of environmental mastery, personal growth, positive relations with others and self-acceptance, F (2, 52) = 4.04, 6.26, 5.12 and 5.32 respectively, $p < .05$ in all cases. Post hoc comparison revealed dieters and high emotional non-dieters to score significantly lower than low emotional non-dieters in every instance (LSD, $p < .05$). Although no significant between-group differences were shown for measures of negative mood "over last month", depressed states global, anxiety or irritability, there was a trend for high

emotional non-dieters to score higher than low emotional non-dieters on each of these measures.

Table 4.9.
Mean Affect Ratings for Dieters and High and Low Emotional Eating Non-dieters

	Dieters		High emotional		Low emotional		*F*
	(*n* = 28)		(*n* = 15)		(*n* = 13)		
	M	*SD*	*M*	*SD*	*M*	*SD*	
Neg. "over last month"	19.75	8.95	18.47	7.47	15.75	4.61	1.10
Depressed states global	1.83	0.84	1.82	0.60	1.40	0.43	1.70
Anxiety	3.39	2.72	4.17	3.54	1.91	2.18	1.97
Irritability	3.43	3.22	3.43	3.05	1.55	1.96	1.76
Concentration difficulty	*4.06a*	2.69	3.40	3.59	*1.45b*	1.42	*3.41**
Environmental mastery	*4.33a*	0.96	*4.35a*	0.88	*5.13b*	0.48	*4.04**
Personal growth	*4.86a*	.60	*5.08a*	0.45	*5.48b*	0.26	*6.26***
Positive relations	*4.56a*	0.86	*4.74a*	0.73	*5.38b*	0.34	*5.12***
Purpose in life	4.63	0.74	4.76	0.57	5.16	0.49	2.86
Self-acceptance	*4.27a*	0.93	*4.42a*	0.81	*5.18b*	0.45	*5.32***

Note. Means with different sub-scripts differ at $p < .05$ (LSD).
$*p < .05$, $**p < .01$

In Section 1 of this analysis much of the variance attributable to the between dieter—non-dieter differences in emotional functioning was found to be accounted for by differences in neurotic tendency. Neuroticism was highly correlated with emotional eating (r (52) = .54, p = .001). When neuroticism was partialled out of the above analysis each of the between-group differences involving high emotional non-

dieters failed to reach significance: *F* (1, 50) < 1.5 for environmental mastery, positive relations and self-acceptance; and, *F* (1, 50) = 2.7, *p* = .08 for personal growth. In each instance the covariate effect of neuroticism was highly significant: *F* (1, 50) = 35.44, 21.31 and 18.07 for measures of environmental mastery, positive relations and self-acceptance respectively, *p* < .001 in all cases; and, close to significance for personal growth, *F* (1, 50) = 4.03, *p* = .05. However, most importantly what has been shown here is that emotional eating is related to affective functioning (whether directly or indirectly), but restraint is not.

Emotional Eating and Cognitive Function

From the analysis in Section 2 it appears that restraint per se can explain little of the variation in cognitive performance between dieters and non-dieters. The examination of the relationship between mood and cognitive deficit in Section 2 suggested that high negative mood might contribute towards cognitive impairment (indicated by a reduction in working memory capacity), but not sufficiently to explain the diet-linked deficits demonstrated in Section 1. The question arises as to whether high emotional non-dieters, who show comparable levels of negative affect to dieters, will demonstrate similar deficits in cognitive function.

For each of the cognitive function and Stroop tasks a one-way ANOVA was conducted with dieting/emotional eating status as the dependent variable. Mean, standard deviation and *F* values are shown in Table 4.10. Results revealed that on the SRT task high emotional non-dieters performed significantly *better* than both dieters

and low emotional non-dieters. On the Bakan task the dieters performed significantly poorer than low emotional non-dieters, however the high emotional non-dieters performed at an intermediate level (see Figure 4.9). No significant between group differences were shown for measures of SRT or RNG, however in each case dieters showed the poorest performance with high emotional non-dieters performing at an intermediate level. No significant between-group difference was observed for either supraliminal or subliminal versions of the shape and food Stroop tasks.

Table 4.10.
Mean Cognitive and Stroop Task Scores for Dieters and High and Low Emotional Eating Non-dieters

	Dieters ($n = 28$)		High emotional ($n = 15$)		Low emotional ($n = 13$)		*F*
	M	*SD*	*M*	*SD*	*M*	*SD*	
SRT	*305.37a*	36.38	*267.96b*	29.99	*299.40a*	41.28	*5.46***
Memory recall	7.52	2.57	8.93	2.57	9.12	3.25	2.11
Bakan	*39.29a*	20.99	46.40	17.71	*56.85b*	19.12	*3.79**
RNG	.38	.08	.36	.05	.34	.04	1.44
RNG minus outliers	.37	.07	.36	.05	.34	.03	1.46
Supraliminal food interference	7.04	57.04	9.46	55.72	4.02	64.86	0.03
Subliminal food interference	8.10	67.10	-9.12	66.02	-2.38	47.01	0.40
Supraliminal shape interference	20.97	82.69	8.58	51.62	5.05	75.29	0.26
Subliminal shape interference	0.23	49.10	12.79	35.42	-17.12	41.89	1.55

Note. Means with different sub-scripts differ at $p < .05$ (LSD).
$^{*}p < .05$, $^{**}p < .01$

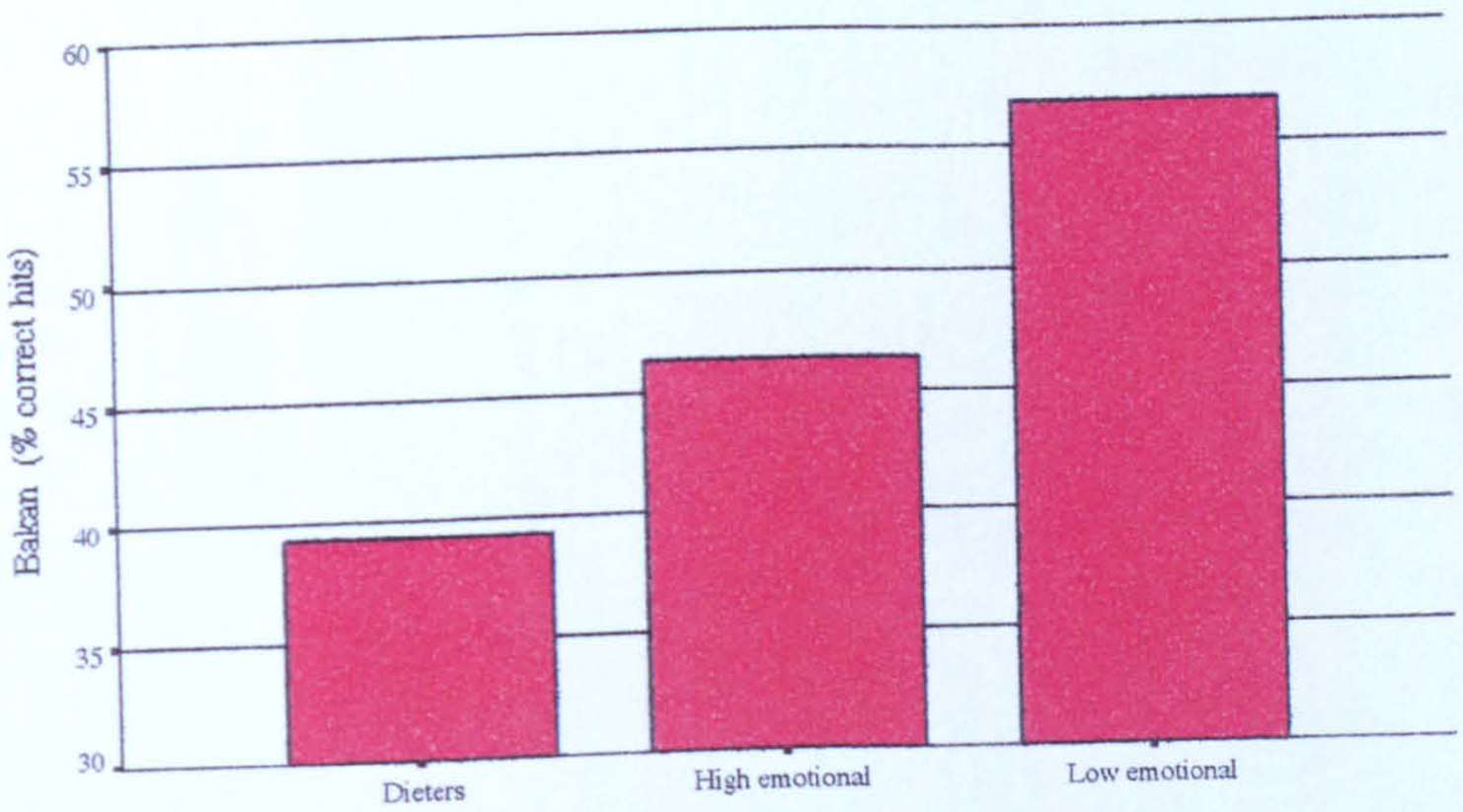

Figure 4.9. Bakan task performance for dieters and high and low emotional eating non-dieters.

Section 3 Summary

The evidence from this section suggests that emotional eating clusters with indicators of low mood, global negative self-reference, poor well-being and high neurotic tendency. Conversely, high restraint shows no such associations.

On the SRT task the high emotional non-dieters performed significantly better than both the dieters and the low emotional non-dieters. However, on the more cognitively demanding tasks (recall, Bakan, RNG) the high emotional non-dieters performed at intermediate level. Although tendency towards emotional eating alone cannot fully account for the severity of the diet-linked impairment found, in this study at least,

emotional eating has proven to be a better determinant of cognitive deficit than level of reported dietary restraint.

4.4 Discussion

The main aim of this study was to investigate the emotional and cognitive functioning of overweight dieters who had been following a moderate diet for at least 5 weeks. Two secondary aims included the investigation of personality differences between dieters and non-dieters and an examination of the importance of emotional eating in determining affective state and cognitive processing efficiency.

It was hypothesised that dieters would demonstrate poorer affective functioning compared to non-dieters. Overall this hypothesis was strongly supported with dieters reporting higher levels of negative mood as measured at the time of testing, less energy and lower levels of personal growth, positive relations with others and self-acceptance, relative to non-dieters. In addition the hypothesis that dieters would demonstrate poorer cognitive function was supported, with dieters performing more poorly than non-dieters on tasks of reaction time, immediate memory recall and vigilance (Bakan). However, contrary to prediction, dieters showed no evidence of greater distraction for food or shape related words on either the supraliminal or subliminal version of the Stroop task; neither did dieters demonstrate an overall deficit in working memory capacity (RNG task). Finally, it was hypothesised that

emotional eating would be as important for cognitive processing efficiency as restraint. Examination of this latter hypothesis was interesting since restraint, contrary to expectation, was not directly related to cognitive deficit, showing only a tentative link with Bakan task performance. However, high emotional non-dieters were found to perform at an intermediate level on the Bakan task. Potential mediators of the deficits were explored and these will be discussed shortly, however, first the limitations of this study need to be considered.

The largest potential confound of this study is the lack of assessment of individual difference in intelligence and in computer familiarity. However, it was observed that both the dieting and non-dieting groups were represented by a variety of occupations from working professionals to full-time students, with neither group being dominated by one particular occupation. In addition, although the non-dieting sample was recruited from the school's participant pool, such participants typically complete only one or two experiments per year and many sampled were newly recruited. However, without control measures we cannot be completely confident that the groups were homogenous in this respect.

Similar to the above concern is the aspect of sampling bias. Dieters were recruited by being approached by the experimenter in person during a Weight Watchers class. It is possible that such a method biased the dieting sample in some way, for example by recruiting more neurotic individuals predisposed towards high test anxiety. This account however is not supported by the data, with dieters and non-dieters showing

no difference in level of social conformity (EPI Lie index) and no difference in levels of reported anxiety. Further, although test anxious participants have shown impaired performance on complex tasks (e.g. Hembree, 1988), there is evidence to suggest that tasks of high sequential demand (within which category the Bakan task fits) actually have a facilitatory effect on the speed and accuracy of high test anxious participants (Dutke & Stober, 2001).

Diet induced cognitive impairment in a group of overweight dieters was successfully demonstrated. However, contrary to previous findings within the literature, level of reported dietary restraint could not explain these deficits. Restraint was only related to Bakan task performance by virtue of the strong link between restraint and dieting status. Further, no adequate explanation could be found in terms of BMI, preoccupation with thoughts of food, or negative mood. Concerning the role of attention in cognitive deficit, we now have evidence from two studies that attentional distraction for food related stimuli is not related to diet-linked cognitive deficit, at least not in overweight dieters.

What can account for the deficits found? Within this study we conducted a subsidiary analysis investigating the importance of disinhibited eating for emotional and cognitive functioning. The results showed that it was the tendency to eat when emotional, not restraint, that best identified those individuals who were most vulnerable to affective and cognitive disturbance. Emotional eating clustered with factors denoting negative mood, anxiety, poor well-being, concentration difficulty

and reduced working memory capacity[3]. These results are highly significant for explaining diet-linked deficit because our main analysis revealed that although dieters showed no overall decrement in working memory capacity (RNG), within that group those individuals with the poorest working memory capacity were also those who showed the poorest performance on tasks of reaction time speed and vigilance. Our next task was to generate and test a model that married these results, depicting a route from emotional eating to cognitive deficit within dieters; this is the focus of the next chapter.

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[3] On the SRT task high emotional non-dieters showed the best performance, however this result is typical of high test anxious participants who excel on simple tasks and fall apart on more cognitively demanding ones.

CHAPTER 5

THE GOAL-FRUSTRATION AFFECT MODEL OF COGNITIVE DEFICIT

5.1 Chapter Overview

In this chapter we first review the evidence from the previous studies concerning the possible roles of affect and emotional eating in diet-linked cognitive deficit. A goal-frustration affect model is generated to identify a route from emotional eating to cognitive deficit within dieters. Predictions made on the basis of this model are then investigated by revisiting the data collected in Chapter 4.

5.2 From Emotional Eating to Cognitive Deficit: generating the model

In Chapter 3 dieters, who had been dieting for a minimum of three weeks, showed no evidence of cognitive deficit or increase in emotional disturbance. These null effects were explained in terms of successful dieting activity. We then predicted that dieters would experience increased mood disturbance following a longer dieting period (due to deceleration of rate of progress towards weight-loss goals) and that this increase in mood disturbance would result in a reduction of processing capacity leading to cognitive deficit. These predictions were incorporated into the second dieting study (Study Three: Chapter 4). But, despite the fact that the dieters showed cognitive deficits, no *direct* link was found between mood and these deficits.

However, to this point our goal-frustration hypothesis had not included emotional eating, it simply assumed that goal violation would produce an increase in mood disturbance and that this would be sufficient to produce cognitive deficit. Evidence from Study Three suggested that emotional eating could provide the missing link. In Study Three, emotional eating was highly correlated with aspects of negative mood, including the tendency towards negative self-description when experiencing negative mood. In addition, an indirect link between mood and cognitive deficit was observed whereby high negative mood was associated with poor working memory capacity, which in turn was associated with poor reaction time speed and poor vigilance performance. This is significant because in Study Three it was the dieters who demonstrated the highest levels of emotional eating and, within the dieting group, those individuals with the poorest working memory capacity were also those who showed the poorest performance on tasks of reaction time speed and vigilance.

How might emotional eating and its associated tendencies bring about cognitive deficit? Following frustration of dieting goals increased mood disturbance may ensue if the dieter has a tendency towards emotional eating because for them the potential of goal violation is raised. If goals are violated a positive feedback loop may be established whereby further goal violation leads to more eating, etc. Rumination over failed goals and increased mood disturbance would result in reduction in working memory capacity, thereby compounding the existing effects of the diet. It is significant that both Green et al. (1997) and Green & Rogers (1998) found a link

between cognitive deficit in dieters and preoccupying cognitions concerning food. Figure 5.1 depicts the proposed goal-frustration affect model of cognitive deficit.

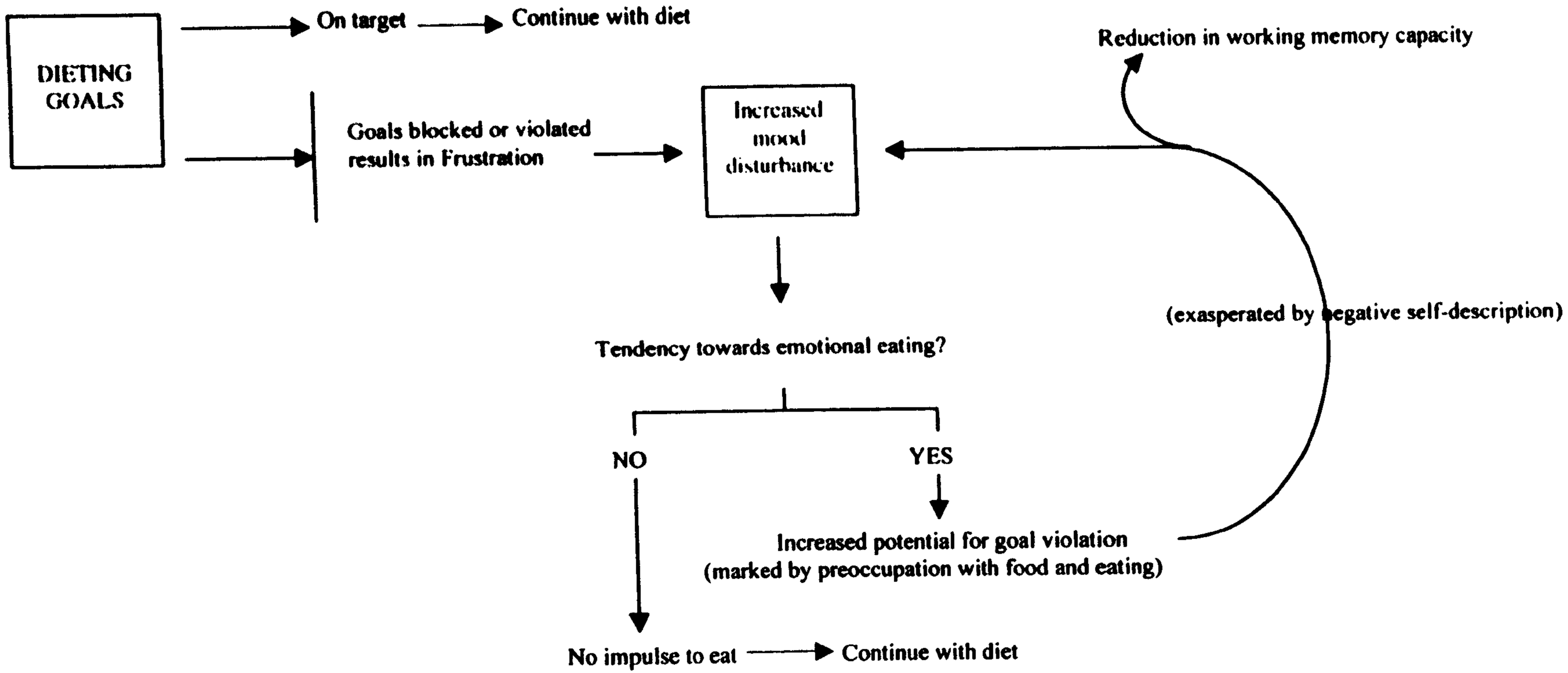

Figure 5.1. *Goal-frustration affect model of cognitive deficit.*

5.3 From Emotional Eating to Cognitive Deficit: testing the model

In order to validate this proposed route from emotional eating to cognitive deficit a path analysis was conducted. Path analysis is an extension of the multiple regression technique and can be used to provide estimates of the magnitude and significance of hypothesised causal connections between sets of variables (Bryman & Cramer, 1990). We selected Depressed states global (the tendency to react to mood disturbance using negative self-descriptors) as a proxy measure of tendency towards rumination over failed goals, and preoccupation with food (from the VAS Food and Mood Scale) as a marker for goal violation. Additional variables selected to test the model were emotional eating, negative mood (measured over the last month prior to testing) and RNG task performance. Only dieters were examined, with data taken from Study Three. Full calculations for the regression analyses are shown in Appendix C.

Table 5.1 shows the zero order correlations calculated between the selected variables (upper half) and the beta coefficients generated from a simultaneous regression (lower half). The resulting path diagram is shown in Figure 5.2. The overall model just failed to reach significance: $R^2 = .32$, $F\,(4, 21) = 2.46$, $p = .08$.

These results indicated that emotional eating had a direct (albeit weak) effect on working memory capacity, and also a small indirect effect via preoccupation with thoughts of food and via tendency towards negative self-description (negative

rumination). The cumulative effect of the variables specified by the goal-frustration affect model accounted for 32% of the total variation in working memory capacity. Considering the potential inadequacy of the proxy measures used and the low number of participants involved this result was considered a satisfactory basis for further hypothesis testing.

Table 5.1.
Zero-order Correlations between Variables (upper part) and Results of a Path Analysis (lower part)

	Emotional eating	Preoc.	DS. global	Negative mood	RNG
Emotional eating		_.47*_	_.45*_	.27	.14
Preoc.			.25	.28	-.16
DS. global	_.45*b_			_.62**_	_.38*_
Negative mood	-.06b	.16b	_.61**b_		.35
RNG	.13b	-.39b	.17b	.39b	

Key. b = beta-coefficient from a simultaneous regression.
*p < .05, **p< .01

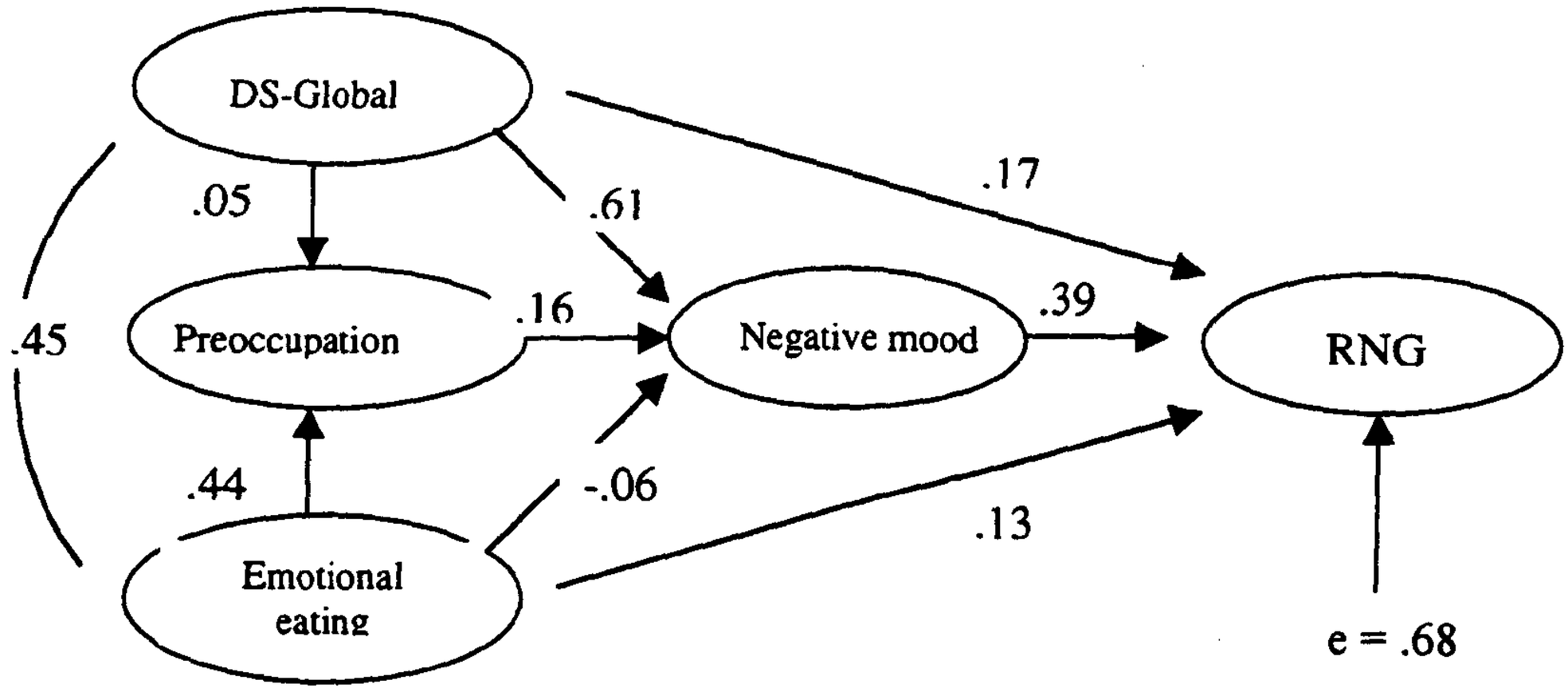

Figure 5.2. Path coefficients predicting working memory capacity (RNG).

Next it was necessary to test the model using non-dieters only from Study Three. Although we would expect high emotional non-dieters to show disturbed affect and reduced cognitive performance relative to low emotional non-dieters, we would not expect the goal-frustration affect model to be applicable to them. The values of the zero-order correlations calculated between measures of emotional eating, preoccupation, depressed states, negative affect and RNG were basically the same as those calculated for the dieters. However, for the non-dieters preoccupation was not significantly related to emotional eating, depressed states or negative mood (*r* (26) = .25, .14 and .07, respectively). Also, as anticipated, when the regression was run

using non-dieters only from Study Three no significant effects were found; for the full model $R^2 = .17$, $F(4, 20) = 1.01$, $p = .43$.

Summary of Results

The path analysis provided reasonable support for the predictions derived from the goal-frustration affect model. Within dieters, emotional eating was strongly associated with both the tendency towards negative self-description and preoccupation with food, these variables in turn had a mood mediated effect on working memory capacity.

Tendency towards emotional eating predisposes an individual to a particular response pattern. For a dieter this response pattern has serious implications for the maintenance of dietary restraint related goals and cognitive processing efficiency. The tendency to eat when emotional is evident in non-dieters and may also be associated with a reduction in processing efficiency (as demonstrated in Study Three). But in a non-dieter cognitive deficit is not as chronic, because for them weight-loss is not a current goal therefore they do not suffer the additional mood disturbance generated by goal violation and self-devaluation.

Limitations of the Path Analysis

Unfortunately preoccupation was found to be a weak predictor of negative mood and only weakly related to Depressed states global (this relationship being largely mediated by emotional eating). One conclusion is that the model is inadequate; but,

considering the fact that we utilised existing measures, it is as likely that the measure of preoccupation available was actually a poor marker of the cognitive ruminations that may occur during diet goal violation.

5.3 Conclusion & Future Directions

Following the identification of emotional eating as a mediator of cognitive deficit, we needed to examine exactly how an affective challenge might trigger disinhibited eating in high emotional eaters.

The goal-frustration affect model suggests that for the emotional eater food (as the source of comfort from distress) should increase in salience following an affective challenge. To this point we had used the Stroop task to examine the impact of stimulus salience on attention allocation. However, we had not identified a link between colour naming interference and cognitive deficit. This null effect may be due to the fact that the Stroop task is sensitive to both positively *and* negatively valenced stimuli. The Stroop task is unable to differentiate between those participants who are attracted to food related stimuli from those who are indifferent or even repelled by food related stimuli. We noted this deficiency in the Stroop paradigm in Chapter 2. This considered, it was time to leave behind the Stroop in search of a task that captured both stimulus salience and attractiveness. It was also important that these attributes be measured using a speeded information processing task in order to

assess the effects of automatic stimulus evaluation. In the following chapter such a task is reviewed.

CHAPTER 6

MEASURING INDIVIDUAL DIFFERENCES IN AUTOMATIC EVALUATION

6.1 Chapter Overview

The aim of this chapter is to introduce the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). First we provide a context for the application of the IAT task, then we describe the background to this task, and finally we provide a detailed explanation of the task paradigm.

6.2 Why Measure Automatic Evaluation?

Affective processing has been defined as the act of determining the location of a stimulus on the affective dimension (De Houwer & Hermans, 2001). Affective processing does not depend upon controlled cognitive processing (Zajonc, 1980); similarly the attitudes that mediate effective evaluation may be introspectively inaccessible (Greenwald & Banaji, 1995). Fazio (2001) contends that attitudes capable of automatic activation (that is without the individual's active consideration) may guide behaviour in a relatively spontaneous manner. The examination of the attitudes held by dieters to dieting related concerns may help to advance understanding of the factors which contribute towards dieting success, dieter well-being and dieter cognitive processing efficiency. Increasing dieter awareness of detrimental attitudes, for example towards food related concerns, may promote dieting success. However, because such attitudes may be unavailable to conscious

awareness and/or masked by self-presentation strategies, indirect assessment of such attitudes is necessary.

6.3 The Implicit Association Test: background detail

The Implicit Association Test was developed on the premise that "implicit attitudes are manifest as actions or judgments that are under the control of automatically activated evaluation, without the performers awareness of that causation" (Greenwald et al., 1998, p. 1464). In this way implicit attitudes are measured by the automatic evaluations that they invoke. The basic idea behind the IAT paradigm is that is should be easier to map two concepts onto a single response when those concepts share some similarity than when those concepts are dissimilar.

The IAT has been used to investigate implicit racial attitudes (Greenwald et al., 1996) and attitude-behaviour consistency for stigmatized behaviour (Swanson, Rudman, & Greenwald, 2001). However, world-wide application of the IAT to date has covered a diverse array of topic areas from self-esteem to brand name marketing (see the IAT website, Yale University: http://www.yale.edu/implicit). An added bonus of the IAT is that it has proven impervious to self-presentation strategies and does not require large category set sizes, with large IAT effects found with target word sets consisting of only five items (Greenwald et al., 1998).

6.4 The Implicit Association Test: design detail

The general IAT procedure involves four categories: two contrasted target concept categories (e.g. *flower* and *insect*) and two contrasted attribute categories (e.g. *pleasant* and *unpleasant*). There are five stages to the procedure, these are depicted in Figure 6.1. Stage 1 involves initial target discrimination; participants are asked to respond "left" to flower related words and "right" to insect related words. Stage 2 involves initial attribute discrimination; participants are asked to respond "left" to pleasant related words and "right" to unpleasant related words. Stage 3 involves the initial combined task; participants are asked to respond "left" to flower and pleasant related words and "right" to insect and unpleasant related words. Stage 4 involves a reversal of the target discrimination response mode; now participants are asked to respond "left" to insect related words and "right" to flower related words. Stage 5 involves the reversed combined task; participants are asked to respond "left" to insect and pleasant related words and "right" to flower and unpleasant related words. Stages 1, 2 and 4 represent category familiarity training blocks each consisting of 20 trials. Stages 3 and 5 represent test blocks each consisting of 40 trials (practice blocks of 20 reversed category trials are administered before Stages 3 and 5). Evaluatively compatible and evaluatively incompatible combinations are predetermined by the experimenter. In this example from Greenwald et al. (1998, Experiment 1) evaluatively compatible combined trials were flower + pleasant and insect + unpleasant, evaluatively incompatible combined trials were insect + pleasant and flower + unpleasant. The IAT effect is obtained by subtracting latency to respond on

evaluatively *compatible* combined trials from latency to respond on evaluatively *incompatible* combined trials. For the task example used here a large IAT effect would represent a greater preference for flower relative to insect related stimuli.

Sequence	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Task description	Initial target discrimination	Initial attribute discrimination	Initial combined task	Reversed target discrimination	Reversed combined task
Task instruction	• FLOWER INSECT •	• pleasant unpleasant •	• FLOWER • pleasant INSECT • unpleasant •	FLOWER • • INSECT	FLOWER • • pleasant • INSECT unpleasant •
Sample stimuli	° ROSE BEE ° ° TULIP WASP °	rotten ° ° happy ° peace ugly °	rotten ° BEE ° ° peace WASP ° ° TULIP ° happy ugly ° ° ROSE	ROSE ° ° BEE TULIP ° ° WASP	ROSE ° ° happy ° WASP rotten ° ugly ° ° peace ° BEE TULIP °

Key. The IAT task involves five stages as represented in the columns labelled Stage 1 – 5. Participants are directed to respond using the left or right hand key of the keyboard (task instruction) when exemplars of the target or attribute dimension are presented on the computer screen (sample stimuli). The bullet points next to the sample stimuli indicate the correct response.

Figure 1. Schematic description of the Implicit Association Test (modified from Greenwald et al., 1998).

CHAPTER 7

EATING BEHAVIOUR AND THE AUTOMATIC EVALUATION OF FOOD RELATED STIMULI

7.1 Introduction

Wardle et al. (1992) found restrained eaters to hold a more negative attitude towards food compared to external eaters. Emotional eaters fell somewhere in between these two groups, but expressed a greater negative attitude to over-eating and showed the greatest tendency towards *situational* loss of control over eating. The goal-frustration affect model suggests that high negative affect contributes towards situational loss of control over eating in the emotional eater. In order to examine this hypothesis further the aim of this study was to examine the impact of eating behaviour on the automatic evaluation of food related stimuli under conditions of high negative affect.

This study employed two IAT tasks designed to measure automatic evaluation of food and body-shape related stimuli. Because of the novelty of the stimuli used the body-shape based IAT task was included as a comparison measure and not explored in detail in this study. Affective state at the time of testing was measured using the Positive and Negative Affect Schedule. It was hypothesised that high emotional eaters who were concurrently experiencing high levels of negative affect would show the largest preference for food related stimuli.

7.2 Method

Participants

Fifty-six female undergraduates were recruited from the School of Psychology at Bangor University; ages ranged from 18 to 43, mean age = 21.09 (*SD* = 5.05). Of these participants 30% were following a calorie-reduced diet of their own specification at the time of testing. Ninety-five percent of the sample was first language English, the remaining participants were completely fluent in both spoken and written English. All participants had normal (or corrected to normal) vision and reported general good health. Participants took part in order to gain course credit and gave written informed consent.

Materials

Self-report Measures

Participants completed the following scales presented in a fixed order: the Hunger Scale, the Positive and Negative Affect Schedule (PANAS), and the Dutch Eating Behaviour Questionnaire (DEBQ). In the PANAS participants were required to describe their state of mood at the time of testing ("right now"). The scales are described in Chapter 3 (except Hunger Scale, see Chapter 2).

Implicit Association Test

The template for the IAT was obtained from the laboratory of Anthony G. Greenwald, programmed for Windows 95 by Shelly Farnham. From this template

two IAT tasks were generated to measure the automatic evaluation of food (Food IAT) and body-shape (Shape IAT) related stimuli.

Word set categories were generated by the author. Food IAT target words included food related words (*cake, chips, pizza, bread, cheese*) and non-food related words (*grass, wood, straw, leaves, sand*). Shape IAT target words included thin body-shape related words (*slim, narrow, slender, lean, trim*) and fat body-shape related words (*tubby, plump, heavy, dumpy, chubby*). Words forming the attribute dimension consisted of positively valenced words (*love, peace, happy, wonderful, joy*) and negatively valenced words (*evil, nasty, awful, horrible, agony*). Word lists were matched within category for similarity of word length only. In order to ascertain that word categories were equal in terms of familiarity a random selection of participants were asked to grade each word on a scale of 1 (very familiar) to 5 (very unfamiliar).

Word ratings from 37 participants revealed a general consensus of category pair equivalence, with mean ratings of 1.3 for food stimuli and 1.5 for non-food stimuli; 1.5 for thin body-shape stimuli and 1.9 for fat body-shape stimuli; and, 1.3 for positive stimuli and 1.8 for negative stimuli.

The IAT effect was obtained by subtracting mean latency to respond under evaluatively compatible conditions (e.g. when food and positive stimuli shared the same response key, and non-food and negative stimuli shared the same response key)

from mean latency to respond under evaluatively incompatible conditions (e.g. when food and negative stimuli shared the same response key, and non-food and positive stimuli shared the same response key). Compatible conditions for the Shape IAT consisted of thin body-shape stimuli paired with positive stimuli.

Apparatus

The IAT was administered on a Pentium 3 500 MHz desktop computer running Windows 95. Participants viewed the display from a distance of approximately 60 cm and gave left responses with the left forefinger (using key A on a standard keyboard) and right responses with the right forefinger (using key 5 on the right-side numeric keyboard).

Procedure

Participants were tested individually in a testing session lasting approximately 40 minutes. After providing informed consent participants completed a personal details sheet (asking about age, first language and current dieting status). Participants then completed the two IAT tasks. The presentation of target/attribute category combinations (e.g. food + positive first verses non-food + positive first) was counter-balanced across participants (presentation order condition). Following this a random selection of participants were asked to judge the IAT stimuli for familiarity. All participants then completed three self-report measures. Upon completion of the tasks an explanation of the studies main aims and hypotheses were given. Participants were then provided with their course credit and thanked for their time.

7.3 Results

Data Reduction

The IAT data gathered for each trial block represents mean latency to respond measured in milliseconds. Following Greenwald et al. (1998) responses of below 300ms and above 3000ms were interpreted as representing errors involving stimulus anticipation or attentional lapse and were replaced with respective values of 300 and 3000. Less than 1.5% of the data were replaced in this way.

Data Analysis

There are three sections to this analysis. First, owing to the novelty of the IAT stimuli used, the basic IAT effects and word category presentation order (i.e. compatible first vs. incompatible first) were examined. Second, a correlational analysis was conducted assessing the association between eating behaviour and the evaluation of food and body-shape related stimuli. Finally, the interaction between eating behaviour and mood on IAT responding was examined.

Data were analysed using SPSS (1995), with *t* test, univariate analysis of variance (ANOVA), and analysis of covariance (ANCOVA) procedures employed. Pearson's product moment correlation coefficients were employed in all correlational analyses (all two-tailed). A significance level of 0.05 is applied in all statistical tests. The main ANOVA tables are shown in Appendix B.

Section 1: Basic IAT Effects

Food IAT

Figure 7.1 shows mean latency to respond to Food IAT stimuli for participants who performed evaluatively compatible trials first ($n = 25$) and participants who performed evaluatively incompatible trials first ($n = 31$). Irrespective of presentation order, the data indicate a general preference for food over non-food stimuli, demonstrated by faster response times to food + positive and non-food + negative combinations (compatible trials) compared to non-food + positive and food + negative combinations (incompatible trials), see Table 7.1.

Table 7.1.
Mean IAT Response Latency for Presentation Order Conditions

	Compatible trials		Incompatible trials		*t*
	M	*SD*	*M*	*SD*	
Food IAT					
Compatible trials first	*782.30*	196.54	*1084.83*	228.29	*7.23****
Incompatible trials first	*752.91*	124.36	*977.26*	231.73	*7.21****
Shape IAT					
Compatible trials first	*744.73*	139.57	*1097.36*	282.60	*8.65****
Incompatible trials first	*804.19*	156.74	*1044.07*	217.73	*7.79****

***$p > .001$

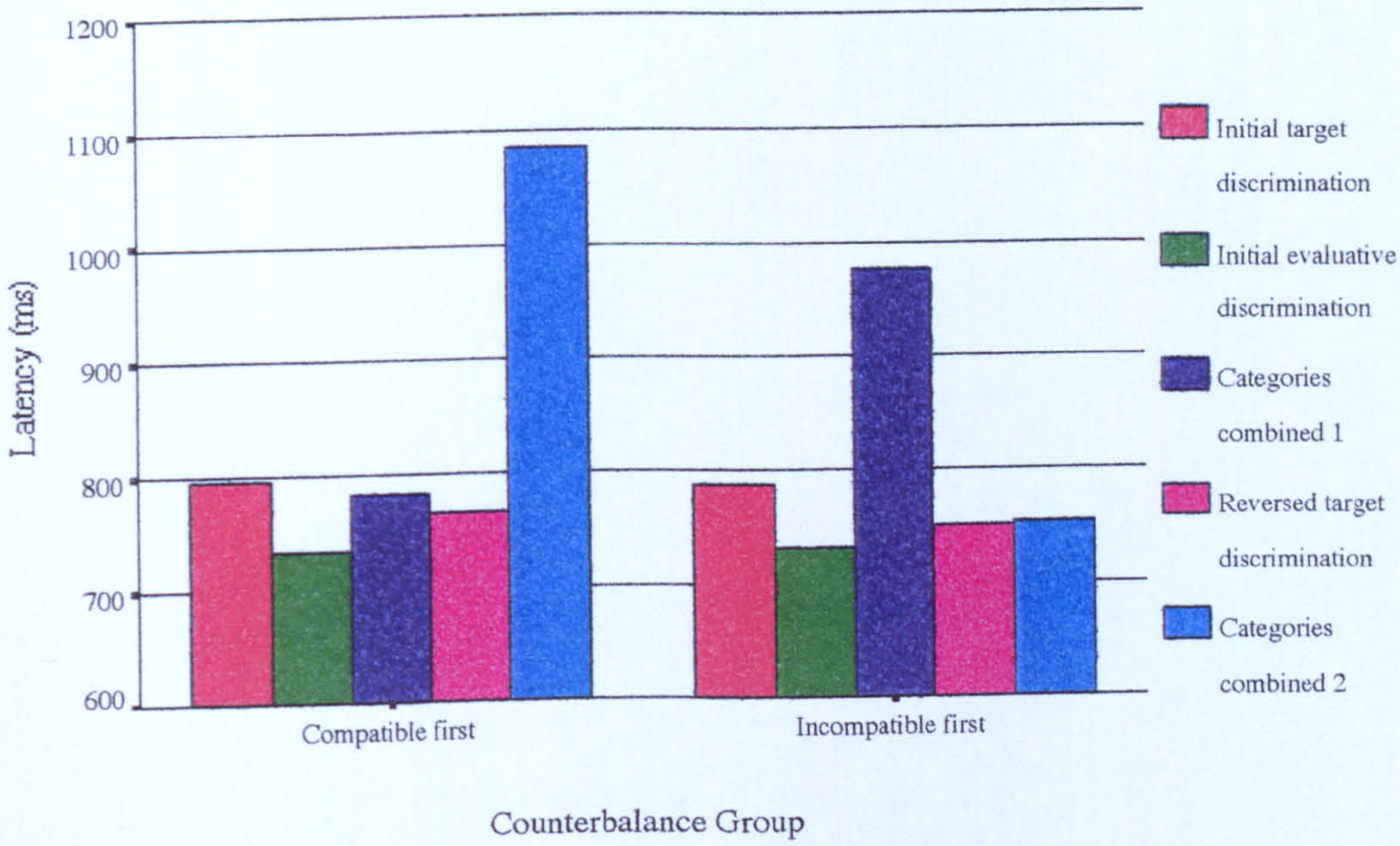

Figure7.1. Mean latency to respond to Food IAT stimuli for participants who performed evaluatively compatible trials (food + positive, non-food + negative) first and participants who performed evaluatively incompatible trials (non-food + positive, food + negative) first. Note that for both groups mean latency to respond is longer for the incompatible trials (block 5 for compatible first group and block 3 for incompatible first group).

On the Food IAT there was a trend for participants who performed evaluatively compatible trials first to show larger IAT effects (*M* = 302.53, *SD* = 209.30) compared to participants who performed evaluatively incompatible trials first (*M* = 224.34, *SD* = 173.19), however this difference was not significant, *F* (1, 54) = 2.34, *p* = .13.

With data from compatibility order groups combined the mean Food IAT effect was 295.25 (*SD* = 192.38) yielding an effect size of $d = 1.54$ (by convention $d = 0.8$ is considered to be a large effect size; Howell, 1997)[1].

Shape IAT

Figure 7.2 shows mean latency to respond to Shape IAT stimuli for participants who performed evaluatively compatible trials first ($n = 29$) and participants who performed evaluatively incompatible trials first ($n = 25$). Irrespective of presentation order, the data indicates a general preference for thin over fat body-shape related stimuli, demonstrated by faster response times to thin + positive and fat + negative combinations (compatible trials) compared to fat + positive and thin + negative combinations (incompatible trials), see Table 7.1.

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[1] Following Greenwald et al. (1998) an effect size for IAT response was calculated by dividing the mean IAT effect by the corresponding standard deviation to give an indication of the difference obtained from zero.

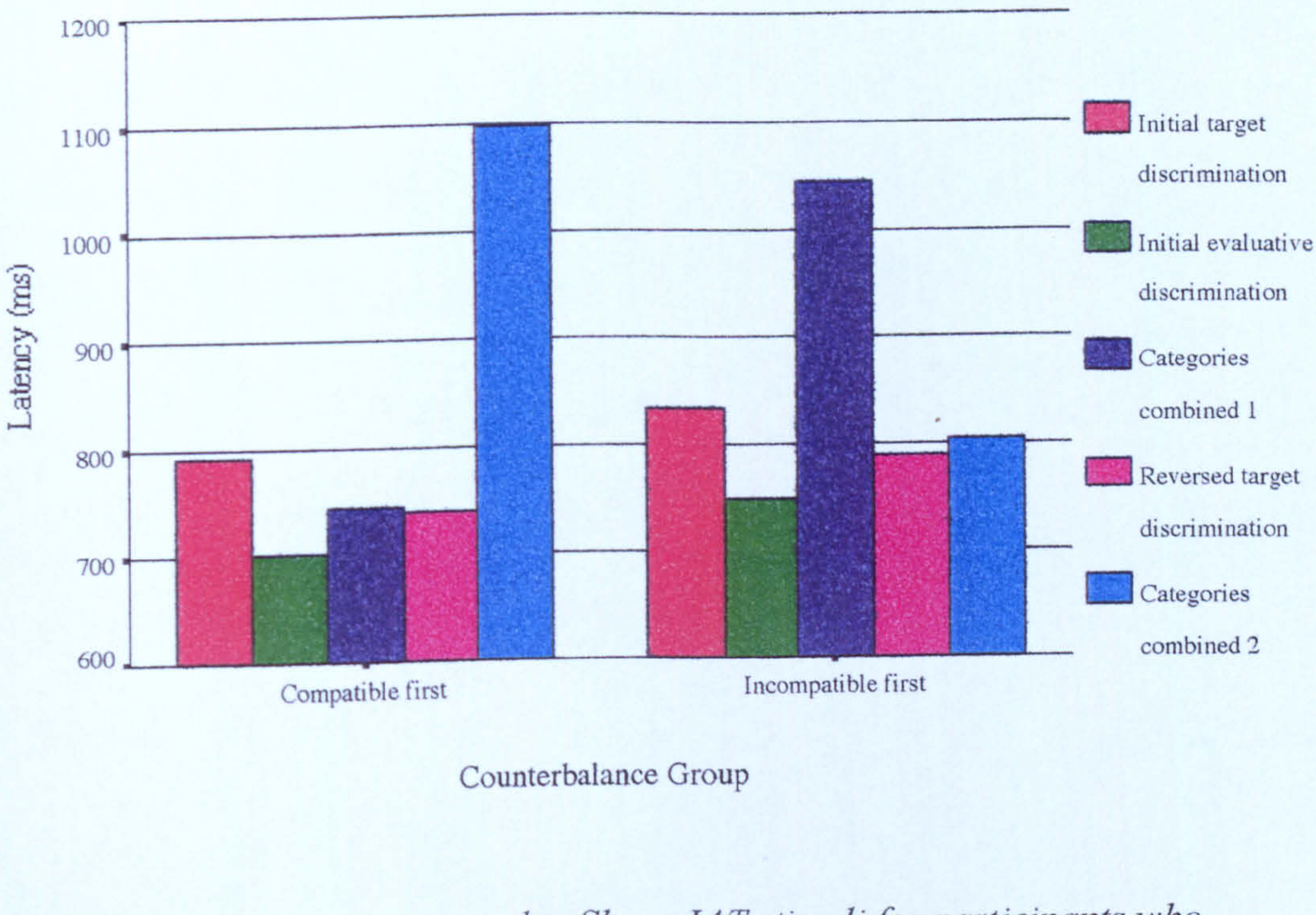

Figure 7.2. Mean latency to respond to Shape IAT stimuli for participants who performed evaluatively compatible trials first (thin + positive, fat + negative) and participants who performed evaluatively incompatible trials first (fat + positive, thin + negative). Note that for both groups mean latency to respond is longer for the incompatible trials (block 5 for compatible first group and block 3 for incompatible first group).

On the Shape IAT participants who performed evaluatively compatible trials first showed significantly larger IAT effect scores ($M = 352.63$, $SD = 219.46$) compared to participants who performed evaluatively incompatible trials first ($M = 239.88$, $SD = 153.99$), $F(1, 52) = 4.63$, $p = .04$. With data from compatibility order groups combined the mean Shape IAT effect was 300.43 ($SD = 199.50$) yielding an effect size (difference from zero) of $d = 1.51$.

Section 1 Summary

A strong preference for food relative to non-food and thin body-shape relative to fat body-shape stimuli was observed. Compatibility presentation order had some influence on the size of the IAT effect scores obtained, particularly for the Shape IAT. However, since the Shape IAT was not central to the experimental hypothesis this effect of compatibility order was considered inconsequential in this study.

Section 2: Eating Behaviour and IAT Effect Scores Correlational Analysis

Pearson correlation coefficients were calculated between the IAT measures, hunger and the separate eating behaviours as identified by the DEBQ, see Table 7.2.

Table 7.2.
Correlation Between IAT Effect Scores and Eating Behaviour Ratings (n = 54)

	Food IAT	Shape IAT
Shape IAT	*.37***	
Hunger	-.15	-.19
DEBQ Restraint	-.05	*.27**
DEBQ Emotional	.06	-.10
DEBQ External	-.09	-.05

**p < .05, **p <.01*

Encouragingly, results showed that greater preference for thin body-shape was significantly related to higher levels of reported dietary restraint. This result gives some credence to the Shape IAT effect measure.

However, the Food IAT was not found to be significantly related to either hunger or eating behaviour. This result could be used to question the validity of the Food IAT as a measure of attitude towards food related stimuli, since, for example, one might expect hungry participants to show larger Food IAT effects. Alternatively, this result implies the need to view the IAT effect within the context for which it was designed. This latter point considered it is to eating behaviour within the context of negative mood that we now turn.

Section 3: Eating Behaviour, Mood and the Evaluation of Food and Related Stimuli

In this section we focus first on the combined effects of negative mood and eating behaviour on the evaluation of food related stimuli using ANOVA procedure and a dichotomisation of the data into high and low eater and high and low mood groups. High and low eater type groups were obtained by splitting the sample by the median score for each of the three eating behaviours (2.80 for restraint, 2.89 for emotional eating, and 3.10 for external eating). High and low positive and negative mood groups were prepared by splitting the sample by the median PANAS positive mood score of 35.0 and median PANAS negative mood score of 21.0. An a priori decision was made to the effect that scores falling on the median were placed in the high

scoring group. A multiple regression was then calculated examining the predictors of the Food IAT effect.

Eating Behaviour, Mood and the Evaluation of Food Related Stimuli

A 2 (Emotional eating: high, low) x 2 (Mood: high, low) ANOVA was conducted. Results revealed an Emotional eating x Mood interaction which bordered on significance, $F(1, 51) = 3.53, p = .07$. Planned comparisons (t test, one-tailed) revealed the largest difference in IAT effect to be between high emotional, high negative ($n = 15, M = 342.60, SD = 218.23$) and high emotional, low negative ($n = 12, M = 190.10, SD = 163.33$) participant groups, $t(25) = 2.10, p < .05$. The pattern of IAT responding is demonstrated in Figure 7.3. No significant main effects were found for Emotional eating or Mood, $F < 1.5$ in both cases.

The influence of dieting status on these results was investigated. A 2 (Emotional eating: high, low) x 2 (Mood: high, low) ANCOVA controlling for dieting was conducted. The regression was non-significant, $F(1, 50) = 0.19$, consequently the Emotional eating x Mood interaction was unaffected , $F(1, 50) = 3.63, p = .06$.

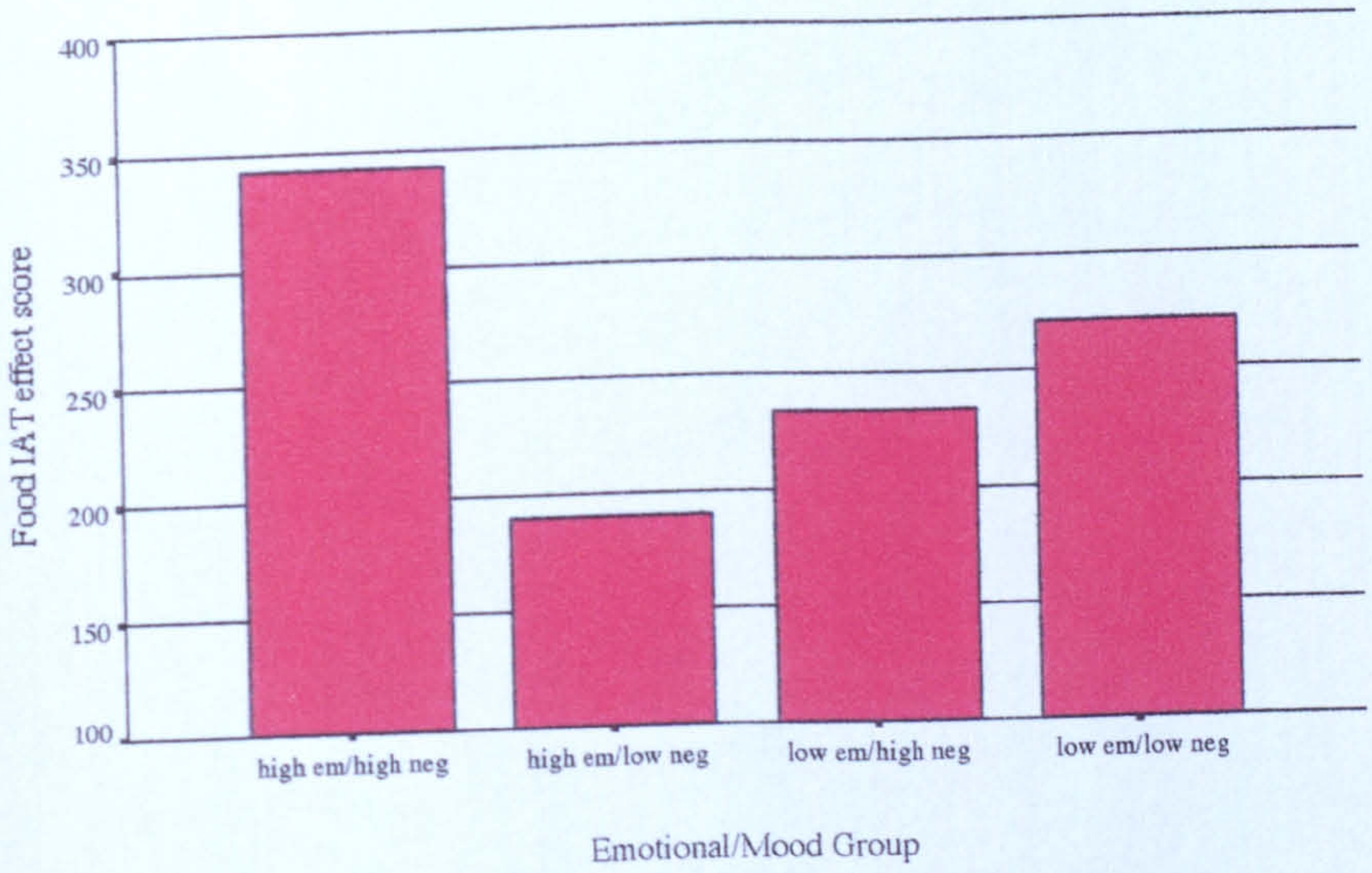

Figure 7.3. Food IAT effect scores split by emotional eating and mood.

The Eating behaviour x Mood analysis was repeated, examining restrained eating in conjunction with negative mood and then external eating in conjunction with negative mood. In both cases results showed no significant main effects or interaction, $F < 1.5$ in all cases.

Again the Eating behaviour x Mood analysis was repeated, but this time examining emotional, restrained and external eating in conjunction with positive mood. In each instance results showed no significant main effects or interaction, $F < 1.5$ in all cases.

Predictors of the Food IAT

In order to examine the predictors of the Food IAT effect two regression analyses were conducted with the Food IAT effect score entered as the dependent variable. First a hierarchical multiple regression was conducted with emotional eating and negative mood entered as a first step and the interaction between these variables entered as a second step. The R^2 associated with the full model was non-significant: $R^2 = .09$; $F(3, 51) = 1.72, p = .17$. In a second analysis a stepwise multiple regression was calculated with independent variables of emotional eating, negative mood, the interaction between emotional eating and negative mood, and Shape IAT effect. The R^2 associated with the full model was significant: $R^2 = .12$; $F(1, 51) = 7.17, p = .01$. However, only Shape IAT performance had a significant positive contribution to the prediction of the Food IAT effect (beta = .35, $p = .01$).

Section 3 Summary

Emotional eating interacted with negative mood to influence automatic preference towards food related stimuli. Neither restrained or external eating interacted with mood to indicate preference for food related stimuli. In addition positive mood had no interactive effect on food preference. Dieting status could not account for these results.

Although dichotomisation of the sample implied tendency towards emotional eating and negative mood influence Food IAT responding, these variables did not emerge as significant predictors of Food IAT responding. The best predictor of preference for

food stimuli was found to be preference for thin body-shape stimuli. We now turn to a discussion of these results.

7.4 Discussion

The aim of this study was to examine the impact of eating behaviour on the automatic evaluation of food related stimuli under conditions of high negative affect. A body-shape related evaluation task was included as a comparison measure. The experimental hypothesis was supported: high emotional eaters in a state of high negative mood showed the strongest preference for food related stimuli. In the prediction of the Food IAT responding the best predictor of preference for food related stimuli was preference for thin body-shape related stimuli. Before these results are discussed further the limitations of this study need to be considered.

The comparison of groups achieved by a dichotomous split of the sample has received much criticism. Such samples have been criticised as being artifactual, and result in great loss of information (van Strien, 1999). This considered, a multiple regression treating emotional eating and mood as continuous variables was also conducted. Unfortunately, the latter method revealed only a weak non-significant effect for the interaction between emotional eating and mood suggesting the possibility that our initial conclusions were subject to Type 1 error. However, there are several factors that may have accounted for the weak effects found. First, we

relied on naturally occurring mood which may not have adequately reflected the state of high emotional arousal predicted to occur following a goal-related challenge. Second, the IAT stimuli used were novel and undeveloped. The target categories used in our IAT effect measures elicited a strong general preference observed across participants. It is likely that the strength of this overall preference made differentiation between particular participant groups difficult. This considered the fact that we did differentiate between groups, and only using the predicted variables, adds a degree of validity to our results.

The finding that the Shape IAT was a significant predictor of the Food IAT is intriguing. There are two possibilities to account for this relationship (a) participants who show the strongest preference for food related stimuli do also have a strong preference for thin body-shape related stimuli; or, (b) the IAT is prone to response bias, some participants produce smaller IAT effects because they are able to respond more appropriately on the more difficult incompatible trials. To examine this latter assertion the IAT needs to be conducted in conjunction with a control task which measures participant response efficiency.

Despite the limitations of this study we have found evidence to suggest that that under conditions of high negative mood emotional eaters do show an increase in attraction towards food related stimuli. Moreover this response appears to be an automatic evaluative response. Potentially, this study has identified tendency towards

emotional eating as the trigger mechanism responsible for disinhibited eating under conditions of high negative affect.

In Teasdale's model of relapse in depression (see Teasdale, Segal & Williams, 1995) the crucial stage for relapse occurs at a choice point following a trigger event. The choice point involves the decision to interpret the trigger event as predominantly positive, neutral, or negative. The outcome of this evaluation is either positive or neutral rumination, or negative rumination which raises the potential for depressive relapse. In the context of dieting a similar model may be applied to goal violation. For a high emotional dieter, negative affect triggers an increase in attractiveness for food related stimuli. The outcome of this evaluation may include increased preoccupation with thoughts of food and eating which raises the potential for disinhibited eating.

However, the findings from this study required further verification. An additional IAT study was therefore proposed involving a mood induction procedure. We needed to gain experimental control over mood to be sure that it was mood that was interacting with eating behaviour to trigger increased reactivity towards food related stimuli and not the effects of a third variable, for example task response bias. Task response bias might have confounded results on the IAT because some participants might have been able to produce smaller IAT effect scores simply because they were able to respond more appropriately on the more difficult incompatible trials.

In addition to verifying these results we were also left with the question as to how this increase in attractiveness towards food related stimuli might affect cognitive function. Previously we found no link between attentional distraction for food related stimuli and cognitive deficit and no direct link between preoccupation with thoughts of food and eating and deficit. Could a rise in stimulus attractiveness function as a mediator of cognitive deficit?

Before examining the influence of stimulus attractiveness on cognitive performance in an improved IAT study, an additional study is reported that examined the combined effects of mood and eating behaviour on cognitive performance using a mood induction procedure.

CHAPTER 8

MOOD, EATING BEHAVIOUR AND ATTENTION

8.1 Chapter Overview

This study formed part of a three year research programme upon which this thesis was based. The study reported in this chapter was conducted whilst I was on maternity leave and, although I was involved in its planning, I did not participate in either the data collection or analysis. It has been included because it forms a part of the research context within which the second IAT study was based. This study is reported in the paper Williams, Healy, Eade, Windle, Cowen, Green and Durlach (Psychological Medicine, in press) and is presented here as an extract from that paper (for proof copy of paper see Appendix D). Following the reporting of the study the research findings are discussed in relation to the goal-frustration affect model of cognitive deficit and the implications for the next IAT study are outlined.

8.2 Introduction

Recent developments in cognition and emotion research (see Williams, Watts, MacLeod, & Mathews, 1997, for a review) show that the effect of long-term traits on current behaviour depends on whether they are "activated" by current mood. (For example, accurate prediction of relapse and recurrence in major depression depends on the measurement of dysfunctional attitudes when mood is disturbed; Segal, Lau & Rokke, 1999). Only by manipulating mood can we see whether the effect of restraint or emotional eating on cognitive performance is moderated by current mood levels.

In this experiment, therefore, we introduced an experimental manipulation of negative mood, randomly allocating participants to receive either a negative or a neutral mood induction procedure and examining their attentional performance. We predicted that high emotional eaters, because of their vulnerability to negative affect, would be more susceptible to show cognitive deficits following a negative mood induction procedure compared to low emotional eaters. By contrast, high restraint would be associated with trait-like cognitive deficits that would not be affected by mood disruption.

8.3 Method

Participants

Thirty-nine participants with a mean age of 48.86 (16.02) were selected to participate [from a previous study]. The mean BMI of this group was 24.99 kg/m^2 (5.45). They were selected on the basis of their scores on the Dutch Eating Behaviour Questionnaire, in order to produce a group of high versus low scorers on the restraint subscale and high and low scorers on the emotional eating subscale. Selecting participants on the basis of their previously known eating behaviour enabled us to investigate emotional eating and restraint on an a priori basis, rather than relying on post hoc division of the groups. 26% of this sample group were currently dieting at the time of testing.

Participants were randomly allocated to receive either a negative or neutral mood induction procedure. Prior to allocation all participants completed the Beck Depression Inventory (Beck et al., 1961) to ensure suitability for the mood induction. (It was planned that participants scoring 15 or above should be excluded from the negative condition, but in the event no-one had to be excluded, so this scale will not be referred to further). There were no significant between group differences in terms of age or BMI.

Measures

In addition to the eating behaviour and mood questionnaires used in Study One, we used a *Visual Analogue Mood Scale* containing four mood descriptors (*happy, sad, refreshed, alert)* which participants rated on a 10 cm scale before and after mood induction. The Bakan vigilance cognitive function task was used [as in Study Three, Chapter 4 in this thesis].

Mood Induction Procedure

A combination of the standard Velten Mood Induction procedure and music was employed. Participants were randomly allocated to receive either 30 negative (self-referent) or 30 neutral (factual) statements typed on individual white cards to be read out aloud whilst listening to the music (10 minutes). For the negative condition participants listened to Prokofiev's “Russia under the Mongolian Yoke”, recorded at half speed; and in the neutral condition Brahm's 2nd and 3rd movements from the 3rd symphony. Both pieces have previously been employed in mood induction studies

(e.g. Clark & Teasdale, 1985). A portable compact disk player with headphones was used.

Design

This study employed a mixed design with Mood Condition (negative/neutral) as a between-subjects factor and Time (pre mood induction/post mood induction) as a within-subjects factor. A second set of analyses focused on the roles of emotional eating and restraint and the differential response of these factors to the mood manipulation. Groups representing high/low emotional eaters and high/low restrainers had been identified a priori in the selection of participants for this study (see participants description). Analyses were performed with a 2 x 2 x 2 (Mood Condition x Eating Behaviour x Time) repeated measures ANOVA on all measures.

Procedure

Participants were seen individually in an experimental room. At the start of each session all participants were given an information sheet describing the nature of the experiment and their informed consent was obtained. This was followed by completion of the BDI, PANAS and visual analogue scales for which they were instructed to answer according to how they were feeling "at that moment in time". Participants completed the baseline cognitive function task. Mood induction procedures followed: participants listened to either the neutral or negative music and simultaneously read the appropriate statements for 10 minutes. For the negative condition we followed the procedure used in previous mood induction research,

informing participants that the procedure would not necessarily produce a negative mood state automatically, therefore they were to try to allow the feelings to occur. Following mood induction, participants completed the mood scales and performed the cognitive task again still listening to the music to maintain the mood. At the end of the experiment all participants were fully debriefed and encouraged to ask questions. Care was taken to ensure that participants in the negative condition were not suffering any lingering effect of the induction.

8.4 Results & Discussion

We first describe a series of analyses investigating the effects of the mood manipulation on mood and cognitive function. We then examine the role of emotional eating and dietary restraint.

Mood Manipulation Check

Since all of the visual analogue mood measures (*alert, refreshed, happy, sad*) were significantly correlated with each other ($p = 0.0001$) a single "negative mood index" was calculated by summing the separate mood scales and taking the average. (Scores on the "sad" variable were reverse scored). A resulting 2 x 2 (Mood Condition x Time) ANOVA with this mood index as the dependent variable revealed a main effect of Time, $F(1,37) = 10.33, p = 0.003$ (due to an overall decrease in mood over time). However, this effect was modified by the predicted interaction between Mood

Condition x Time, $F(1,37) = 4.92, p = 0.03$. Post hoc analyses showed that within group differences on the negative mood index at Time 1 and Time 2 were non-significant within the neutral condition, $t(20) = 0.71, p > 0.05$, but significant within the negative mood condition, $t(17) = 3.87, p = 0.001$. Participants were significantly less happy following the negative mood induction compared to the neutral one.

Mood and Cognition

A main effect of Time which bordered on significance was reported, $F(1,37) = 3.63$, $p = 0.06$, for the Bakan task (*M*, Time 1 = 11.53 and Time 2 = 12.79). Paired *t* tests revealed that this improvement over time was wholly accounted for by change within the neutral condition only, $t(20) = -2.37, p = 0 .03$. Participants in the negative mood condition failed to demonstrate similar improvement over time, $t(17) = -0.57$, *ns*. The explanation for this pattern of results becomes clearer when the differences between emotional eaters and restrainers are examined.

Emotional Eating, Mood and Cognition

Our sample had been selected to yield a group of high emotional eaters ($n = 19$; $M = 3.17$; $SD = 0.10$) and a group of low emotional eaters ($n = 20$; $M = 1.65$; $SD = 0.46$). A series of 2 x 2 x 2 (Emotional eating x Mood Condition x Time) ANOVAs were performed with Emotional eating and Mood Condition as between-subjects factors and Time as a within subject factor. There were no significant main effects or interactions with emotional eating across all the self-report measures of mood ($F < 1$ in all cases). For the Bakan task, the results showed a marginal significant main

effect of Time, $F(1,35) = 4.17, p < 0.05$, due to the well-known practice effect on this task. However, this effect was modified by a significant Emotional eating x Mood Condition x Time interaction, $F(1,35) = 5.51, p = .025$. This interaction was due to the pattern of Bakan performance under different mood conditions for high emotional eaters (see Table 8.1). Planned comparisons revealed that Bakan task performance by the high emotional group in the negative condition at Time 2 (M = 10.88) was significantly poorer compared to that in the neutral condition (M = 15.10). Planned comparisons also revealed a significant improvement between performance at Time 1 (M = 11.90) and that at Time 2 (M = 15.10), $t(9) = -2.40, p = .04$ in the neutral condition for high emotional eaters. In contrast, in the negative condition, there was no improvement in performance (in fact, just the opposite) between Time 1 and Time 2.

Table 8.1.
Bakan Task Performance of High and Low Emotional Eaters Pre- and Post Negative and Neutral Mood Induction

	Negative Mood		Neutral Mood	
	Pre	Post	Pre	Post
Emotional				
Low	11.00 (6.00)	13.33 (8.07)	11.27 (6.98)	12.00 (7.86)
High	12.00 (6.36)	10.88 (3.08)	11.90 (4.45)	15.10 (3.98)

Table 8.2.
Bakan Task Performance of High and Low Restrained Eaters Pre- and Post Negative and Neutral Mood Induction

	Negative Mood		Neutral Mood	
	Pre	Post	Pre	Post
Restraint				
Low	14.11 (5.46)	15.22 (6.13)	14.20 (4.23)	16.10 (4.35)
High	8.88 (5.64)	9.00 (4.60)	9.18 (6.12)	11.09 (7.13)

Dietary Restraint, Mood and Cognition

Our sample had been selected to yield a group of high restrained eaters ($n = 20$; $M = 3.09$; $SD = 0.58$) and a group of low restrained eaters ($n = 19$; $M = 1.96$; $SD = 0.64$). A series of 2 x 2 x 2 (Restraint x Mood Condition x Time) ANOVAs were performed with Restraint and Mood Condition as between-subjects factors and Time as a within-subject factor. The means and standard deviations for the Bakan task for high and low restrainers are shown in Table 8.2.

There was a main effect of restraint on positive items on the PANAS, $F\,(1,35) = 4.67, p = 0\ .04$. High restrainers reported ***higher*** levels of positive affect overall across all mood conditions ($M = 32.05$) compared to low restrainers ($M = 27.17$). For the Bakan task, the predicted main effect of restraint was found, $F\,(1,35) = 10.43, p = 0.003$. High Restrainers had significantly impaired performance on the Bakan task ($M = 19.02$) compared to low restrainers ($M = 29.8$). Given that high

restrainers differed from low restrainers in terms of positive affect we repeated the analysis on the Bakan task covarying for mood. The main effect of restraint remained significant suggesting the effect of restraint on a vigilance task was independent of mood.

Note that whether participants were high or low restrainers made no difference to their performance in the Bakan task under the different mood conditions. Was this because the high restrainers were less affected by the mood induction in the first place? Recall that the high restraint group had higher positive PANAS scores, so they may have changed less in their mood in the negative condition. In order to examine this, we looked at the pre-post changes in mood (positive PANAS, "right now") in high and low restrainers. In the low restraint group (the group that was generally less positive) this score fell by 4.0 points (from 29.44 to 25.44) following the negative mood induction. However, the high restraint group fell by exactly the same amount (from 33.78 to 29.78).

Dietary Restraint and Emotional Eating

The above analyses examined the impact of emotional eating and restraint on cognitive function and mood separately, finding effects of mood in the high emotional eaters, but not in the high restrainers. We wished also to examine how these aspects of eating behaviour might interact to determine Bakan performance. A 2 x 2 (Emotional Eating x Restraint) factorial ANOVA was carried out on the Bakan

task data. Results demonstrated a main effect of restraint for the Bakan task, $F(1,35) = 11.43, p = 0.002$, but no interaction with level of emotional eating.

8.5 Conclusions

This study by Williams et al. (in press) supports the goal-frustration affect model of cognitive deficit to the extent that under conditions of high negative affect it is the tendency towards emotional eating, and not high levels of dietary restraint, that renders an individual most susceptible to cognitive deficit. Combining these results with those from the IAT, it is possible that the tendency towards emotional eating interacts with negative mood to lower processing capacity due to a reallocation of attentional resources towards desirable food and eating related stimuli. This account is similar to that of Green et al. (1997), who propose that the smaller working memory span displayed by dieters is due to task irrelevant cognitions concerning food preferentially consuming limited processing capacity.

In terms of a departure from the predictions made on the basis of goal-frustration affect model, this study reports a main effect of restraint on Bakan task performance but no restraint by emotional eating interaction. The goal-frustration affect model would predict that those most vulnerable to cognitive deficit would be those high in both emotional eating and restraint. A further study was required to address this issue.

Therefore, in a subsequent IAT study we examined the effects of a mood manipulation on the evaluation of food related stimuli and cognitive performance in restrained and emotional eaters. The Bakan task was selected as our measure of cognitive performance because (a) it provided an outcome measure sensitive to the type of deficits experienced by dieters; and (b) it provided an index of cognitive processing efficiency, to be used as a standard for the interpretation of IAT responding. In order to generate distinct eater type groups we categorised participants on an a priori basis into four groups: high emotional eating/high restraint, high emotional eating/low restraint, low emotional eating/high restraint, low emotional eating/low restraint. A positive mood induction was also included to verify that the influence of emotional eating on cognitive performance was mediated by negative affect, and not just the consequence of a general rise in emotional arousal.

CHAPTER 9

MOOD, EATING BEHAVIOUR, ATTENTION AND PREFERENCE FOR FOOD RELATED STIMULI

9.1 Introduction

The tendency to eat when emotional is an important vulnerability factor reflecting intrinsic sensitivity to changes in levels of affect. In an initial IAT task we demonstrated that participants who had a high tendency towards emotional eating and who were concurrently experiencing high levels of negative mood showed a stronger preference for food related stimuli compared to low emotional eaters. This finding is of significant importance since it demonstrates how emotional eating might interact with mood to raise the potential for violation of dieting goals.

However, the previous IAT study had several limitations two of which we hoped to remedy here. The first pertained to the lack of a suitable control task. This was necessary to assess the degree to which large IAT effects were attributable to response efficiency, specifically the ability to respond appropriately on the more difficult incompatible trials. Second, mood condition was determined by a post hoc split of the sample based on naturally occurring mood assessed by self-report. Application of a mood induction paradigm would enable an examination of the causal relationship between mood and cognitive function. Further, mood manipulation was necessary because recent developments in cognition and emotion research show that the effect of long-term traits on current behaviour depend upon whether they are "activated" by current mood (Williams et al., 1997). For example, Gemar, Segal,

Sagrati and Kennedy (in press) used an IAT task to assess beliefs about the self in formerly depressed and never depressed participants. Results showed that only *after* the induction of a negative mood did the IAT reveal more negative beliefs about the self in the formerly depressed participants.

Mood induction procedures (MIP's) can be split into five groups, these are (1) MIP's based on free mental generation of emotional states; (2) MIP's based on the guided mental generation of emotional states; (3) MIP's based on the presentation of emotion-inducing material; (4) MIP's based on the presentation of need-related emotional situations (e.g. participants are given false negative feed-back concerning performance on a test: Success/Failure MIP); (5) MIP's aiming at the generation of emotionally relevant physiological states (Gerrads-Hesse, Spies, & Hesse, 1994). To increase effectiveness a combination of different types of MIP's can be used, for example Film and Story MIP (participants see a valenced film, read a valenced story and are told to "get involved") (e.g. Morrow & Nolen-Hoeksema, 1990); and, Velten and Music MIP (e.g. Teasdale & Rusell, 1983). The Velten procedure (Velten, 1968) consists of a set of valenced self-referent statements, for example "I feel fed up" and "I feel hopeless". Participants are asked to read through the statements (which are either administered typed on card or via a computer screen) and to try to get into the state of mood described. Following a review of nearly 250 MIP studies, Gerrads-Hesse et al. (1994) recommended the Imagination, the Velten, the Film/Story MIP and the Success/Failure MIP procedures for the induction of depression.

This study had two main aims, (a) to investigate the effect of mood on the automatic evaluation of food related stimuli in high and low emotional and restrained eaters; and, (b) to examine the effect of mood on the cognitive performance of high and low emotional and restrained eaters. A subsidiary aim was to assess the predictive power of mood, eating behaviour and preference for food related stimuli for cognitive task performance. Participants were split into four eater type groups (high emotional/high restraint, high emotional/low restraint, low emotional/high restraint, low emotional/low restraint) on an a priori basis and then allocated to receive either a positive, negative or neutral mood manipulation procedure.

Mood was induced by a combination of Velten and Music MIP delivered via a computer screen. The Food IAT was used to assess automatic evaluation of food related stimuli. The Bakan task was used as a both a measure of cognitive function and as an assessment of response efficiency on the IAT task.

It was hypothesised that high emotional eaters who had received the negative mood induction would show the greatest preference for food related stimuli; and, that high emotional/high restrainers who had received the negative mood induction would show the greatest decrement in vigilance for a neutral stimuli (Bakan task). Further, it was hypothesised that high restraint, high emotional eating, negative mood and preference for food related stimuli would be significant predictors of cognitive impairment (poor Bakan task performance).

9.2 Method

Participants

One hundred and twenty female participants were recruited from the School of Psychology Community Panel and from the psychology undergraduate student body at Bangor University. Ages ranged from 18 to 55 ($M = 22.30$, $SD = 6.24$). Of these participants 27% were following a calorie-reduced diet of their own specification at the time of testing. Ninety percent of the sample was first language English, the remaining being completely fluent in both spoken and written English. All participants had normal (or corrected to normal) vision and reported general good health. Participants took part in order to gain course credit or payment (£5.00) and gave written informed consent.

Group Allocation

Following administration of the DEBQ the sample were split a priori into four eating behaviour groups based on mean restraint and mean emotional eating scores obtained

from an earlier study not reported in this thesis[1]. Groups were high emotional/high restraint (n = 28), high emotional/low restraint (n = 26), low emotional/high restraint (n = 31), and low emotional/low restraint (n = 35). Participants were allocated to one of three mood induction conditions, numbers of participants in each condition are specified in Table 9.1.

Table 9.1.
Participant Numbers in Eating Behaviour and Mood Conditions

Mood condition	High emotional/high restraint	High emotional/low restraint	Low emotional/high restraint	Low emotional/low restraint
Positive	9	11	10	10
Negative	10	7	10	13
Neutral	9	8	11	12

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[1] This sample consisted of 128 female participants, comprised of psychology undergraduates and individuals from the School of Psychology Community Panel. Their median emotional eating score was 2.85 (IQR = 0.92) and median restraint score was 2.90 (IQR = 1.05). In this study eating behaviour groups were split according to these norms, with scores falling on or above the median representing high emotional eating or high restrained eating groups.

Materials

Self-report Measures

Participants completed the following questionnaires presented in a fixed order: Beck Depression Inventory; Dutch Eating Behaviour Questionnaire (DEBQ); Visual analogue mood scale; Hunger Scale. The DEBQ and Hunger Scale are as described in Chapters 4 & 2, respectively.

Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock & Erbaugh, 1961).

This 21-item scale measures severity of depressed mood. For each item participants chose one of four responses labelled 0 (least severe) to 3 (most severe). An example item would be, (0) I do not feel sad; (1) I feel sad; (2) I feel sad all the time; (3) I am so sad or unhappy I can't stand it. We adopted Williams' (1992) definition of severity of depression and used the following categories: 0-9 not depressed; 10-15 mildly depressed; 16-24 moderately depressed; 25+ severely depressed. It was planned that participants scoring 15 or above should be excluded from the negative mood induction condition and placed in the next. This happened on 5 occasions. The results of the BDI are not reported in this study.

Affective visual analogue scale (VAS).

This scale was devised to measure aspects of both positive and negative mood simply and quickly using a 10-item visual analogue scale. Affective descriptors used

were: *bad mood, sad, happy, calm, anxious, good mood, tired, happy, alert.* Participants were required to indicate their agreement with the described mood by marking a point along a 10 cm line anchored between responses of *not at all* and *extremely.*

Cognitive Function Tasks

Participants completed the Food IAT task (as described in Chapter 7) followed by the Bakan vigilance task (as described in Chapter 4).

Mood Induction Procedure

A combination of the standard Velten mood induction procedure and music was employed to induce either a positive, negative or neutral mood. A computerised version of the Velten procedure was used, in this task participants read a list of valenced self-referential statements and considered these statements for a total of 10 minutes. While reading these sentences participants listened to a piece of music played through headphones on a portable CD player. For the positive condition participants listened to "Coppelia" by Delibes; for the negative condition Prokofiev's "Russia under the Mongolian Yoke" recorded at half speed; for the neutral condition Brahms's 2nd and 3rd movements from the 3rd symphony. These pieces of music had proved appropriate in previous mood induction studies (e.g. Clark & Teasdale, 1985).

Apparatus

The IAT was administered on a Pentium 3 500 MHz desktop computer running Windows 95. Participants viewed the display from a distance of approximately 60 cm and gave left responses with the left forefinger (using key A on a standard keyboard) and right responses with the right forefinger (using key 5 on the right-side numeric keyboard).

The Bakan and mood induction tasks were presented on an IBM 100MHZ Pentium running MEL V2 (Psychology Software Tools, Pittsburgh PA).

Design

This study employed a mixed design with Time (baseline and post induction) as a within-subjects factor, and Mood (positive, negative, neutral) and Eating behaviour (emotional, restraint) as between-subject factors.

Procedure

Participants were tested individually in a testing session lasting approximately 40 minutes. After providing informed consent participants completed a personal details sheet (asking about age, first language and current dieting status) and the self-report scales in the following fixed order: BDI, DEBQ, VAS, Hunger. During completion of these latter measures responses on the BDI and DEBQ were quickly calculated in

order to screen for level of depression and to allocate the different eater types to one of the three mood conditions. Participants then completed the IAT and Bakan baseline tasks. Mood induction procedures followed; participants listened to either positive, negative or neutral music and simultaneously read the appropriate statements for 10 minutes. Participant in the positive and negative condition were also informed that they were to try to allow the feelings associated with the statements they were reading to occur and not to inhibit them. Following mood induction participants completed an additional VAS measure and performed the IAT and Bakan tasks again. In order to ensure the induced mood was maintained, before the start of the second cognitive task participants were given three appropriately valenced sentences printed on white cards to read to themselves.

At the end of the experiment all participants were fully debriefed and encouraged to ask questions. Care was taken to ensure that participants in the negative condition were not suffering any lingering effect of the induction. The School of Psychology Ethics Committee approved this procedure.

9.3 Results

Data Reduction

The IAT data gathered for each trial block represents mean latency to respond measured in milliseconds. Following Greenwald et al. (1998) responses of below 300ms and above 3000ms were interpreted as representing errors involving stimulus anticipation or attentional lapse and were replaced with respective values of 300 and 3000. Less than 1 % of the data was replaced in this way.

Data Analysis

There are four sections to this analysis. First, the success of the induction procedure was assessed. Second, the interaction between eating behaviour and mood on IAT responding was investigated. Third, the interaction between eating behaviour and mood on Bakan task efficiency was investigated. Finally, the relationship between IAT and Bakan task performance was assessed and the predictors of Bakan task performance based on the goal-frustration affect model were examined.

Data were analysed using SPSS (1995), with paired *t* tests, one-way analysis of variance (ANOVA), analysis of covariance (ANCOVA) and multivariate analysis of variance (MANOVA). Non-parametric tests used included the Chi-squared test. Pearson's product moment correlation coefficients were employed in all correlational

analyses. An alpha level of .05 was used for all statistical tests. The main ANOVA tables are shown in Appendix B.

Section 1: Assessment of Mood Induction Procedure

A mean positive and a mean negative mood score was calculated by summing the appropriate VAS measures.

Within-group Mood Change

Table 9.2 shows the means and standard deviations for reported mood at baseline and post induction for the three mood conditions. For each mood condition paired t tests were conducted to assess within-group mood change. Results showed that participants in the positive mood condition experienced a significant increase in positive mood, t (37) = 5.20, p = .0001, and a significant decrease in negative mood, t (37) = 6.10, p = .0001. Participants in the negative condition experienced a significant decrease in positive mood, t (38) = 6.50, p = .0001, and a significant increase in negative mood, t (39) = 6.98, p = .0001. In the neutral condition no change in reported positive mood was shown following neutral mood induction, t (39) < 1, however negative mood was shown to decrease significantly, t (39) = 2.65, p = .01.

Table 9.2.
Mean Mood Ratings as a Function of Mood Condition and Time

	Baseline				Post Induction			
	Positive mood		Negative mood		Positive mood		Negative mood	
Condition	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Positive	6.41	1.39	4.11	1.79	7.57	1.37	2.89	1.30
Negative	6.83	1.65	3.66	1.38	4.82	1.58	5.56	1.71
Neutral	6.17	1.45	4.62	1.89	6.06	1.16	4.00	1.63

Note. Maximum VAS score = 10.

Post Induction Mood Between-groups

Post induction all groups were shown to differ significantly from each other in level of reported positive mood, $F\,(2, 114) = 38.39, p = .00001$, and level of reported negative mood, $F\,(2, 115) = 28.86, p = .00001$. Participants in the positive condition reported the highest levels of positive affect and lowest levels of negative affect, participants in the negative condition reported the highest levels of negative affect and lowest levels of positive affect, participants in the neutral condition reported intermediate levels of each mood (linear contrasts, $p < .05$) (for means refer to Table 9.2).

Mood Change and Eating Behaviour

In order to check that the experience of mood change was similar across eating behaviour groups, six one-way ANOVA assessing positive and negative mood post induction were conducted, one for each mood condition.

For the positive mood condition results showed no significant differences in the level of reported positive or negative mood between eater type groups, *F* (3, 34) < 1.0 in both cases. The same was true of eater type groups in the neutral mood condition, *F* (3, 36) < 2.0 in both cases. However, in the negative mood condition although eater type groups did not differ in their levels of reported negative mood, *F* (3, 35) < 1.0, they were shown to differ in their levels of reported positive mood, *F* (3, 35) = 3.22, *p* = .03. Post hoc analysis (Bonferroni) revealed that following negative mood induction high emotional/high restraint participants reported significantly greater levels of positive mood (*M* = 5.55, *SD* = 1.63) compared to high emotional/low restraint participants (*M* = 3.38, *SD* = 0.88).

Section 2: Eating Behaviour, Mood and IAT Responding

As in the previous study the Food IAT effect was obtained by subtracting mean latency to respond under evaluatively compatible conditions (e.g. when food and positive stimuli shared the same response key, and non-food and negative stimuli shared the same response key) from mean latency to respond under evaluatively

incompatible conditions (e.g. when food and negative stimuli shared the same response key, and non-food and positive stimuli shared the same response key).

Table 9.3 shows the means and standard deviations of the IAT effect scores obtained at baseline and post induction for each eating behaviour group split by mood condition. A 4 (Eating behaviour: high emotional/high restraint, high emotional/low restraint, low emotional/high restraint, low emotional/low restraint) x 3 (Condition: positive, negative, neutral) ANCOVA was conducted, controlling for baseline IAT performance. Results showed a main effect of Condition, $F(2, 106) = 5.22, p = .007$. However, no main effect of Eating behaviour was shown, $F(3, 106) = 0.44$, neither was there a significant Eating behaviour x Condition interaction, $F(6, 106) = 0.89$. The regression was highly significant, $F(1, 106) = 33.36, p = .0001$. Further analysis revealed the main effect to be due to participants in the negative mood condition showing smaller IAT effect scores ($M = 170.51$, $SD = 173.24$) compared to those in either the positive ($M = 255.54$, $SD = 159.98$) or the neutral ($M = 242.17$, $SD = 154.21$) mood conditions (linear contrasts, $p < .05$). Figure 9.1 shows IAT effect scores at baseline and post induction for positive, negative and neutral mood conditions.

To further investigate the effects of the negative mood induction on IAT responding the separate word set categories that form the IAT effect score (food + positive, non-food + negative, food + negative, non-food + positive) from baseline and post induction were entered into a MANOVA with Condition as the independent variable, means and standard deviations are shown in Table 9.4. The overall model was non significant, $F(16, 220) = 1.38, p = .15$. However, the univariate tests were explored and revealed that the conditions differed significantly *post induction* in their speed to respond to food + positive and non-food + negative word categories, $F(2, 116) = 5.18$ and 3.39 respectively, $p < .05$ in both cases. Post hoc analysis (Bonferroni) revealed that for food + positive combinations participants in the negative condition were slower to respond appropriately compared to participants in either the positive or the neutral condition. For non-food + negative combinations post hoc analysis (Bonferroni) revealed that participants in the negative condition were slower to respond appropriately than participants in the neutral condition. These results are demonstrated in Figure 9.2 where it can be seen that the smaller IAT effect scores demonstrated by participants in the negative condition are due to their slower response time on compatible trials.

Section 2 Summary

Contrary to predictions negative mood did not interact with eating behaviour to influence IAT responding. Alternatively, all participants in the negative mood condition showed the smaller IAT effects. These effects were driven by retarded latency to respond on compatible IAT trials.

Section 3: Eating Behaviour, Mood and Vigilance

Table 9.5 shows the means and standard deviations for Bakan task scores for the eating behaviour groups split by mood condition at baseline and post induction. A 4 (Eating behaviour: high emotional/high restraint, high emotional/low restraint, low emotional/high restraint, low emotional/low restraint) x 3 (Condition: positive, negative, neutral) ANCOVA was conducted, controlling for baseline Bakan task performance. Results showed no significant main effects ($F < 1.0$ in both cases) and only a very weak non-significant Eating behaviour x Condition interaction, $F(6, 102) = 1.62, p = .15$. The regression was highly significant, $F(1, 102) = 149.34, p = .0001$. (A number of outliers had been noted, however removal of these from the analysis made no difference to the null effects accordingly they are not reported.)

Since it was hypothesised that high emotional/high restraint participants would demonstrate impaired cognitive performance following negative mood induction we probed this specific hypothesis further. First, Bakan task performance of high emotional/high restraint participants was examined across mood condition. Results of

an ANCOVA (covarying for baseline Bakan) showed a between group difference which bordered on significance, F (2, 23) = 3.14, p = .06. The regression was highly significant, F (1, 23) = 23.97. This result was due to the fact that the high emotional/low restraint participants in the negative mood condition performed more poorly than both the high emotional/low restraint participants in either the positive or neutral conditions (linear contrasts, p < .05), see Figure 9.3. However, the results from the whole sample (collapsed across Eater Type) revealed a very similar pattern (see Figure 9.4). Even before mood manipulation, participants in the negative condition appear to be at a cognitive disadvantage.

The Bakan task performance of the four eater type groups who had received the negative mood induction were compared. Results of an ANCOVA (covarying for baseline Bakan) showed no significant difference between groups, F (3, 32) = 1.34, p = .28. This pattern of results is shown in Figure 9.5. The regression was highly significant, F (1, 23) = 97.49.

Section 3 Summary

High emotional/high restrainers who had received the negative mood induction appeared to show impaired performance on the Bakan task relative to high emotional/high restrainers who had received either a positive or neutral mood induction. However for some reason high emotional/high restrainers who had received the negative mood induction also showed impoverished performance at baseline. When the four eater type groups who had received the negative mood induction were compared, high emotional/high restrainers performed poorly compared to high emotional/low restrainers and low emotional/high restrainers, but at a comparative level to low emotional/low restrainers. Taken together these results provide little evidence to support the hypothesis that high emotional/high restrainers would be the most vulnerable group for reduced cognitive performance following a negative mood challenge.

Section 4: IAT Response Efficiency and Predictors of Vigilance

In this section we first examine the relationship between IAT and Bakan task performance; second, the predictors of Bakan task performance are examined.

IAT Response Efficiency

In order to assess the implications of response efficiency for IAT effect sizes, performance on the Bakan task was correlated with the latency to respond to the separate IAT word categories. The correlations (two-tailed) calculated for baseline

and post induction scores are presented in Table 9.6. Results indicated a weak to moderate relationship between good Bakan task performance and fast response time on the IAT trials. This is true for both compatible and incompatible word category combinations, suggesting that those who score highest in terms of vigilance are also able to best adhere to the IAT task instructions.

Table 9.6.
Correlation Between Bakan and IAT Word Categories Scores (n = 115) as a Function of Time

	Bakan	
	Baseline	Post Induction
IAT word categories		
Baseline		
Food + positive	*-.24***	
Non-food + negative	*-.23***	
Food + negative	*-.33***	
Non-food + positive	*-.25***	
Post Induction		
Food + positive		*-.38***
Non-food + negative		*-.39***
Food + negative		*-.29***
Non-food + positive		*-.35***

$^{*}p < .05$, $^{**}p < .01$

Predictors of Bakan Task Performance

Following predictions based on the goal-frustration affect model the relationship between post induction measures of Bakan, IAT effect, negative affect and baseline eating behaviour (emotional eating, restraint, emotional eating x restraint interaction) were examined (Pearson, one-tailed). No significant relationship was shown between Bakan and IAT effect scores or eating behaviour, r (115) < .10 in all cases. Negative affect however, showed a significant, albeit weak, negative correlation with Bakan, r (114) = -.23, p = .006. Considering the fact that participants in the negative mood condition performed more poorly at baseline the correlation between Bakan and negative affect at baseline was checked, but proved non-significant (r (114) = -.05, p = .60). Together these results suggest that the mood manipulation did affect cognitive performance, and that the association observed was not just a result of a confound arising from participant allocation.

Although the intent was to examine the predictors of Bakan task performance using multiple regression procedure this was not conducted because negative mood appears to be the only criterion variable related to Bakan performance following mood induction.

Section 4 Summary

On an IAT task designed to measure preference for food related stimuli, participants expressing good attentional vigilance for computer presented stimuli are faster to

respond appropriately to both evaluatively compatible and evaluatively incompatible word categories. The variable most closely related to cognitive performance following positive, negative and neutral mood induction is negative affect: the greater the level of negative affect experienced the poorer the performance on the Bakan task.

9.4 Discussion

The aim of this study was to examine the causal relationship between negative affect, eating behaviour, automatic evaluation of food related stimuli and cognitive performance, testing predictions made on the basis of the goal-frustration affect model of cognitive deficit. It was hypothesised that high emotional eaters who had received the negative mood induction would show the greatest preference for food related stimuli. However this relationship was not demonstrated within the data. Instead the negative mood induction appeared to have a detrimental effect on the responses of all participants. Specifically it produced response retardation on compatible trials whilst leaving performance on non-compatible trials unaffected. Concerning cognitive performance, it was hypothesised that high emotional/high restrainers who had received the negative mood induction would show the greatest impairment. However, contrary to expectation, neither mood nor eating behaviour nor their combined effects, differentiated between groups on the Bakan task. Finally, it was hypothesised that high restraint, high emotional eating, negative mood and

preference for food related stimuli would predict poor Bakan task performance. Following mood induction results revealed only a weak relationship between high negative affect and poor Bakan task performance. Neither eating behaviour nor increased preference for food related stimuli were associated with Bakan task performance. Although in terms of the experimental hypotheses these results appear disappointing, they highlight important methodological issues relating to the IAT procedure. However, before discussing these results further, some methodological considerations must be noted.

First, it is possible that the null results found on the IAT task were influenced by procedural confound. The IAT has been suggested to be susceptible to both long held beliefs and *recent cognitive suggestion* (De Houwer, in press). Since participants completed the DEBQ at the start of the study this scale, asking about weight and eating habits, may have ignited a range of cognitions concerning self-appearance which could have had a general effect on cognitive performance. Research into test-anxiety has indicated that the experience of anxiety may interact with self-focused attention to cause a reduction in the ability to focus on the task, which may result in impaired task performance. In the first IAT study the DEBQ was completed at the end of testing, thus avoiding these possible confounds.

Second, Parrott and Hertel (1999) advise that if the topic of research concerns how people normally react to emotional states then one should opt for a more

surreptitious mood induction. The mood induction used in this study was forthright and participants were even explicitly encouraged to engage the feelings suggested by the negative mood induction. Further, Parrott and Hertel note that the Velten statements include some that suggest impaired cognitive processes, such as "I feel heavy and sluggish". It is therefore possible that the mood induction produced an overly intense emotional reaction with cognitive repercussions that were incompatible with the naturalistic mood state under which the original inter-individual differences on the Food IAT were found.

It could be argued that the results of this study were undermined by not using a dieting sample. Since dieters may represent a more proactive sample, focused on particular weight loss targets, the emotional eaters amongst them may have demonstrated observable cognitive impairment and an increase in preference for food related stimuli following a mood challenge. However, both the IAT and the Bakan effects which we sought to replicate were achieved using samples consisting of less than 30% current dieters (Chapters 7 & 8).

It is unclear why the previous results did not replicate Bakan deficit as previously observed in high emotional eaters who had received the negative mood challenge. There are a few procedural differences between the two studies which may have contributed to the null effects found here. These include age (the sample investigated here were much younger); and, MIP presentation (here the MIP was administered via

computer). However, it is unlikely that these variables alone would be sufficient to nullify a true association between emotional eating and the vulnerability for cognitive deficit under conditions of increased negative affect. One possible explanation for these disparate findings is the involvement of a third variable: personality. People expressing high levels of neurotic tendency are more prone to mood fluctuation, more sensitive to emotional disturbance (Costa & McCrae, 1992) and have been found to be more susceptible to negative mood induction procedures (Larsen & Ketelaar, 1991). This given the combined effects of neuroticism and mood on cognitive performance could have been investigated.

Despite the limitations of this study some interesting methodological considerations for the use of the IAT task were noted. Evidence from the investigation of recovered depressed participants has suggested that performance on the IAT is mood context dependent (Gemar et al., in press). We have extended these findings to show that in normal participants negative emotional arousal may have specific effects on the ability to respond quickly on compatible trials, resulting in overall smaller IAT effects. This phenomenon requires further investigation. However if found reliable it indicates the necessity to control for the effects of individual difference when using the IAT to make inter-individual comparison.

We have also shown that attentional capacity (response efficiency) can bias IAT responding. However, unlike mood, this cognitive bias is not trial specific and reflects

the extent to which an individual is able to respond appropriately to IAT task demands, i.e. participants with high attentional capacity perform well on all trials. This bias is not as concerning as the mood bias in the sense that it does not distort the overall IAT effect score. However, the cognitive bias indicates that the IAT is not purely a measure of implicit attitude, but as a cognitive task of automatic evaluation it is susceptible to individual differences in response efficiency and the experimenter should be aware of such when selecting target samples homogenous only in terms of a single grouping variable.

Considering the results of this study, and thinking back to the relationship identified between neuroticism and emotional eating identified in Study Three (Chapter 4, results Section 3), it may be that the importance of neurotic tendency has been overlooked in this series of studies. Therefore in the following chapter we is revisit the variables of neurotic tendency and extroversion and, using the data provided in Study Three, explore their association with the different eating behaviours.

CHAPTER 10

EATING BEHAVIOUR AND PERSONALITY

10.1 Chapter Overview

The aim of this chapter was to examine the relationship between personality and eating behaviour. Following a brief review of studies that have examined personality in conjunction with eating behaviour, the data from Study Three are revisited to examine our findings concerning the relationship between the different eating behaviours and the personality traits of neuroticism (N) and extroversion (E).

10.2 Eating Behaviour and Personality: previous studies

In a study examining the relationship between eating behaviour, personality traits and body mass in women, van Strien, Frijters, Roosen, Knuiman-Hijl and Defares (1985) found that of the three eating behaviours (identified by the DEBQ) emotional eating had the clearest relationship with a number of personality traits assed by a set of Dutch Personality questionnaires. Controlling for the effects of BMI, the higher the participant scored on emotional eating the more she reported feeling anxious and acting independently, lacking in self-sufficiency, lacking in self esteem, being sentimental and emotionally unstable, being worried, lacking patience, and showing no signs of social desirability. Alternatively, when controlling for BMI, the higher the participant scored on restraint the more she reported having high self-esteem, being authoritarian, and having a need for social ascendance. Emotional eating and restraint correlated at .00 and -.05 when controlling for BMI.

More recently, Heaven, Mulligan, Merrilees, Woods and Fairooz (2001) found both high emotional eating and high restraint (measured by the DEBQ) to be significantly correlated with aspects of emotionality (the tendency to experience emotions intensely) and negative emotions (e.g. anxiety and depression). However, no information was provided in this latter study concerning the relationship between emotional eating and restraint, and no account is given of dieting status at the time of testing. This raises the question as to the interrelationship between emotional eating, restraint, personality and dieting status; considering our own data it is to this issue that we now turn.

10.3 Eating Behaviour and Personality: findings from this research

Throughout this series of studies, in accordance with the authors of the Dutch Eating Behaviour Questionnaire, emotional eating has been referred to as a trait tendency. This would seem wholly appropriate given the association found between emotional eating and N reported in Study Three (Chapter 4). However, since dieters were shown to report significantly higher levels of both emotional eating and neurotic tendency compared to non-dieters this association could simply have been an artifact of dieting status. This considered, we returned to the data obtained in Study Three to fully examine the relationship between dieting status and BMI, eating behaviour (limited to emotional eating and restraint) and personality.

Pearson correlation coefficients (two-tailed) conducted using the sample combined showed significant correlations between N and emotional eating (*r* (54) = .52), N and restraint (*r* (54) = .38), and a weak non-significant association between N and BMI (*r* (48) = .20). Extroversion was inversely and non-significantly related to emotional eating (*r* (54) = -.21) and BMI (*r* (48) = -.22), and showed no association with restraint (*r* (54) = .03). This pattern of relationship considered predictors of N only were investigated.

With N as the dependent variable, independent variables of emotional eating, restraint and BMI were entered in a stepwise multiple regression. Emotional eating emerged as a significant predictor at the first step (beta = .56) accounting for 31% of the variance in N; *F* (1, 46) = 20.77, *p* = .00001. None of the other variables entered made a significant contribution, *t* < 1.5, *p* > .05 in all cases (see Appendix C).

10.4 Conclusions

Emotional eating was found to be a better predictor of N than either restraint or BMI. These results are consistent with those of van Strien et al. (1985). Further they indicate again the necessity to differentiate between restraint and disinhibited eating. As noted in Chapter 4, Polivy et al. (1988) found that individuals who score high on

restraint (as measured by the Restraint Scale) also score highly in terms of N, maladjustment and emotional instability. We have shown that dieters may score higher in neurotic tendency compared to non-dieters, but that it is their propensity towards eating when emotional that renders them such and not their restraint status.

Although we did not explore the role of N in diet-linked cognitive deficit, we have explored emotional eating which could be said to function as a proxy measure of N. If emotional eating represents a true trait tendency the question arises as to whether emotional eating is context specific. That is, within the same individual, does emotional arousal induce a behavioural response that generalises across appetitive behaviours? For example, would "boredom" or "upset" influence the desire to shop, in the same way that it influences the desire to eat. Before we turn to the general discussion at the end this thesis, some findings concerning emotional, restrained and external shopping behaviour are reported in the next chapter.

CHAPTER 11

THE CONSUMER BEHAVIOUR QUESTIONNAIRE

11.1 Introduction

We have demonstrated eating behaviour to be linked to distinguishable personality traits such as neuroticism. The question arises as to whether the three modes of behavioural response (emotional, restrained, external) are specific to the context of eating behaviour, or whether they represent a general response style that is reflected in other appetitive response domains. The consumer behaviour of shopping could be characterised along similar dimensions to those of eating behaviour in terms of restraint, emotional spending and susceptibility to external cues in a retail environment. So, for example, would an emotional eater also be an emotional shopper?

In order to test the generality of these response characteristics a consumer behaviour questionnaire was devised based on the Dutch Eating Behaviour Questionnaire. For construction of the Consumer Behaviour Questionnaire (CBQ) similar sentence construction to that employed in the DEBQ was followed, with eating related terms simply replaced with shopping related terms. Accordingly 13 items relating to emotional spending, 10 to restrained spending and 10 to external spending were generated. For example the question, "Do you have the desire to eat when you are irritated" from the DEBQ was altered to, "Do you have the desire to buy things when you are irritated" in the CBQ. Scoring for the CBQ was as the DEBQ with a scale of 1-5 (*never* to *very often*).

The aim of this study was to see if the constructs of restraint and response to emotional and external cues as they pertain to eating behaviour could be generalised to other behavioural response domains. The Bakan task was also included to examine whether restrained and emotional shoppers are subject to the same decrements in cognitive performance as restrained and emotional eaters have on occasion been found to be.

11.2 Method

Participants

The CBQ was administered to 154 female participants. These consisted of paid participants from the Bangor School of Psychology Participant Pool (50%), Bangor School of Psychology undergraduates participating to gain course credit (40%) and work colleagues and friends who participated voluntarily (10%). Overall 67% of the sample was student, with only 18% of the sample in paid employment. The financial situation of the sample was as follows: 64.5% of participants had an annual household income of less than £5000; 50% of participant used overdraft facilities; 78% reported the use of a credit card; and, 23% reported the use of a store card. Seventy-eight percent of participants had no children; 73% of participants were single. The mean age of the sample was 29.46 (*SD* = 15.22).

Materials and Procedure

Participants supplied information concerning their age, BMI, occupational and financial status and completed the CBQ, DEBQ and Bakan task (the later two measures are as described in Chapters 3 & 4, respectively). The CBQ as administered is presented below.

The Consumer Behaviour Questionnaire.

This questionnaire is concerned with different types of shopping behaviour. We are interested in your shopping for items other than food. Read each statement carefully and decide how much you agree or disagree with the statement. For each statement show your answer by circling the number that corresponds to the statement that BEST DESCRIBES HOW YOU BEHAVE. Please choose only one answer for each statement. Because people are different, there is no right or wrong answer to these statements.

	never	seldom	sometimes	often	very often
1. If you have outstanding debt (e.g. on credit or store card), do you spend less than you usually do?	1	2	3	4	5
2. Do you have the desire buy things when you are irritated?	1	2	3	4	5
3. If things in a shop look attractive to you, do you buy more than usual?	1	2	3	4	5
4. Do you try to spend less on your weekly shopping than you would like to spend?	1	2	3	4	5
5. Do you have a desire to go shopping when you have nothing to do?	1	2	3	4	5
6. If something looks good, do you spend more than you would usually do?	1	2	3	4	5
7. How often do you avoid "special offers" because you are concerned about your spending?	1	2	3	4	5
8. Do you have a desire to buy things when you are depressed or discouraged?	1	2	3	4	5
9. If you see something desirable do you find yourself wanting to buy it?	1	2	3	4	5
10. Do you watch exactly what you spend?	1	2	3	4	5
11. Do you have a desire to go shopping when you are lonely?	1	2	3	4	5
12. If you have bought some new clothes, do you wear them straight away?	1	2	3	4	5
13. Do you deliberately look for the cheaper items?	1	2	3	4	5
14. Do you have a desire to buy things when someone lets you down?	1	2	3	4	5
15. If you walk past a shoe shop, do you have the desire to buy some shoes even though you don't need any?	1	2	3	4	5
16. When you have spent too much, do you spend less than usual over the following days?	1	2	3	4	5

	never	seldom	sometimes	often	very often
17. Do you deliberately watch what you are spending so that you do not overspend?	1	2	3	4	5
18. Do you have a desire to go shopping when you are cross?	1	2	3	4	5
19. If you walk past a market stall, do you have the desire to buy something?	1	2	3	4	5
20. How often do you try not to go shopping between your weekly shopping trips in order to keep your spending down?	1	2	3	4	5
21. Do you have a desire to go shopping when something unpleasant is about to happen?	1	2	3	4	5
22. If you see a lot of people at the sales, do you also have the desire to buy some bargains?	1	2	3	4	5
23. How often on a Saturday do you try not to go into town because you are watching what you spend?	1	2	3	4	5
24. Do you get the desire to buy things when you are anxious, worried or tense?	1	2	3	4	5
25. Do you have difficulty resisting a bargain?	1	2	3	4	5
26. Do you take into account your bank balance when considering how much to spend?	1	2	3	4	5
27. Do you have a desire to go shopping when things are going against you or when things have gone wrong?	1	2	3	4	5
28. Do you have a desire to go shopping when you are feeling fed up?	1	2	3	4	5
29. Do you buy more than usual when you are with others who are spending money?	1	2	3	4	5
30. Do you have a desire to go shopping when you are feeling "let down" or disappointed?	1	2	3	4	5
31. When doing the weekly shopping are you inclined to buy treats?	1	2	3	4	5
32. Do you have a desire to buy things when you are emotionally upset?	1	2	3	4	5
33. Do you have a desire to go shopping when you are bored or restless?	1	2	3	4	5

11.3 Results

Factor Analysis of the CBQ

An exploratory approach to the factor analysis was adopted since the principle aim was to explore the pattern of responding on the CBQ using the factor structure of the DEBQ as a guiding model. The initial item pool consisted of 33 items (13 emotional, 10 restraint, 10 external). Principle-axis factoring was employed with direct Oblimin rotation. A three-factor solution was used for factor extraction.

Oblimin rotation converged in 8 iterations. Factor one contained the thirteen items on emotional spending and one item from restrained spending ("How often on a Saturday do you try not to go into town because you are watching what you spend?"). Factor two contained eight items on restrained spending. Factor three contained the ten items on external spending and one item on restrained spending ("How often do you avoid "special offers" because you are concerned about your spending?").

The two ambiguous restraint items were removed, and the factor analysis repeated using the reduced item pool. Items from emotional and external spending both had high loading on two factors, whereas items from restraint loaded onto only one factor. Table 11.1 shows the item loadings; in the main each item has a loading above 0.4 on the appropriate factor. Table 11.2 shows the inter sub-scale correlations. The coefficients for emotional spending and external spending were significant;

however, restrained spending showed no significant relationship with either emotional spending or external spending. Cronbach's alpha coefficients reflected adequate internal consistency, ranging from .75 to .95 (see Table 11.3).

Table 11.1.
Oblimin Rotated Factor Matrix on 31 Items in the CBQ

CBQ Items	Factor 1	Factor 2	Factor 3
Emotional			
1. Do you have the desire to go shopping when you are feeling let down or disappointed? (CEM30)	.87350	-.18286	.45401
2. Do you have the desire to go shopping when things are going against you or have gone wrong? (CEM27)	.81975	-.01352	.40004
3. Do you have the desire to go shopping when you are feeling fed up? (CEM28)	.81018	.09091	.56937
4. Do you have the desire to by things when someone lets you down? (CEM14)	.80928	-.01583	.39592
5. Do you have the desire to go shopping when you are cross? (CEM18)	.80254	-.10353	.39346
6. Do you have the desire to buy things when you are emotionally upset? (CEM32)	.77569	.01878	.49588
7. Do you get the desire to go buy things when you are anxious, worried or tense? (CEM24)	.77544	-.05008	.31218
8. Do you have the desire to buy things when you are depressed or discouraged? (CEM8)	.77031	-.04091	.51068
9. Do you have the desire to go shopping when something unpleasant is about to happen? (CEM21)	.76953	-.15328	.25559
10. Do you have the desire to go shopping when you are bored or restless? (CEM33)	.73126	.12380	.63091
11. Do you have the desire to go shopping when you are lonely? (CEM11)	.69969	.00414	.40402
12. Do you have the desire to go shopping when you have nothing to do? (CEM5)	.66403	-.02452	.63594
13. Do you have the desire to buy things when you are irritated? (CEM2)	.65191	-.22028	.48002
Restraint			
14. Do you deliberately watch what you are spending so that you do not over spend? (CR17)	-.16174	.84918	-.23411
15. Do you take into account your bank balance when considering how much to spend? (CR26)	-.16579	.74102	-.08379

Continues on next page...

CBQ Items	Factor 1	Factor 2	Factor 3
16. Do you watch exactly what you spend? (CR10)	-.14433	.68078	-.23388
17. When you have spent too much, do you spend less than usual in the following days? (CR16)	-.08645	.61234	-.15623
18. Do you deliberately look for the cheaper items? (CR13)	.09828	.51058	.10769
19. If you have outstanding debt (e.g. on credit or store card), do you spend less than you usually do? (CR1)	-.32927	.41290	-.11485
20. Do you try to spend less on your weekly shopping than you would like to spend? (CR4)	.08179	.25993	.13661
21. How often do you try not to go shopping between your weekly shopping trips in order to keep your spending down? (CR20)	-.02777	.16626	.07703
External			
22. If things in a shop look attractive to you, do you buy more than usual? (CEX3)	.31970	-.16214	.68982
23. If you see something desirable do you find yourself wanting to buy it? (CEX9)	.52495	.01737	.67991
24. Do you have difficulty resisting a bargain? (CEX25)	.47350	-.07159	.63848
25. If something looks good. Do you spend more than you would usually do? (CEX6)	.35068	-.21301	.60697
26. Do buy more than usual when you are with others who are spending money? (CEX29)	.35534	.01876	.60231
27. If you walk past a shoe shop, do you have the desire to buy some shoes even if though you don't need any? (CEX15)	.42527	-.10073	.56310
28. If you see a lot of people at the sales, do you also have the desire to buy some bargains? (CEX22)	.43710	-.00624	.48549
29. If you have bought some new clothes do you wear then straight away? (CEX12)	.16721	.06153	.38036
30. When doing the weekly shopping are you inclined to buy treats? (CEX31)	.37075	-.04530	.37101
31. If you walk past a market stall, do you have the desire to buy something? (CEX19)	.27380	.12521	.30739

Table 11.2.
Pearson Correlation Coefficients Between CBQ Sub-Scales

	Emotional	Restraint	External
Emotional	1.0		
Restraint	-.080	1.0	
External	.494	.005	1.0

Table 11.3.
Descriptive and Cronbach Alpha Coefficients for CBQ Sub-Scales

	Mean	SD	SE	Range	Cronbach Alpha
Emotional (13 items)	2.58	.86	.07	1 - 4.85	.95
Restrained (8 items)	3.64	.62	.05	2 - 5	.75
External (10 items)	3.07	.65	.05	1.40 - 4.80	.81

Correlates of the CBQ

Pearson coefficients (two-tailed) were calculated between the CBQ and DEBQ, these are presented in Table 11.4. Interrelationships between sub-scales of the CBQ and the DEBQ showed some similarity (highlighted in bold in Table 11.4). Emotional and External scales showed high correlation for both the CBQ and DEBQ. Interestingly, the weaker association shown between Restraint and External/ Emotional scales did not follow the same direction of relationship for CBQ and DEBQ. In the CBQ greater restraint was associated with lower emotional and lower external shopping. In the DEBQ greater restraint was associated with greater emotional and greater external eating. This distinction between the scales highlights the potential difficulty in the measurement of eating behaviour: restraint and disinhibition are not antithetic in nature, more of one does not necessarily equate to less of the other.

CBQ and DEBQ sub-scales showed the same pattern of association with age, with disinhibited behaviour falling as age increased. Restraint from the DEBQ was the

only scale to correlate with BMI, with the more restrained eaters showing the larger BMI's.

Finally, the CBQ showed no significant relationship with the Bakan task performance. Interestingly, external eating on the DEBQ showed a weak positive correlation with Bakan task performance: the more prone to externally driven eating the better the Bakan task performance. No significant relationship was found between Bakan and emotional or restrained eating.

Table 11.4.
Correlation Between CBQ, DEBQ, Age, BMI and Bakan

	CBQ_em r (154)	CBQ_re r (154)	CBQ_ex r (154)	DEBQ_em r (138)	DEBQ_re r (138)	DEBQ_ex r (138)
CBQ_em	1.0					
CBQ_re	-.129	1.0				
CBQ_ex	.659***	-.162*	1.0			
DEBQ_em	.398***	-.042	.251**	1.0		
DEBQ_re	.074	.232**	.135	.231**	1.0	
DEBQ_ex	.425***	.020	.528***	.501***	.205*	1.0
Age	-.254**	.124	-.350***	-.266**	-.088	-.232**
BMI	.107	.020	.023	.164	.219*	.126
Bakan	.000	.040	.052	.053	-.087	.170*

*p <.05, **p <.01, ***p <.001

11.4 Discussion

The Consumer Behaviour Questionnaire (CBQ) was designed to measure the propensity of disinhibited (emotional and external) and restrained shopping behaviour. In this initial investigation the CBQ showed high internal consistency and factorial validity for Emotional and External scales. However, revision of the CBQ is necessary with particular attention to the Restraint scale, which showed weak internal consistency and lower factorial validity compared to the two scales of disinhibition. Revised editions should be administered to a more heterogeneous sample, which in the current instance comprised 67% student all with low income.

Preliminary study of shopping behaviour using the CBQ has shown evidence for generalisation of behavioural response between discrete appetitive domains. Emotional shopping shows a moderate positive relationship with emotional eating; external shopping shows a strong positive relationship with external eating; and, restrained shopping shows a positive relationship with restrained eating. Disinhibited behaviour, whether shopping or eating related, is greatest in the younger participants.

CHAPTER 12

GENERAL DISCUSSION

12.1 Summary of Objectives & Main Findings

The aim of this thesis was to examine the phenomenon of cognitive deficit associated with weight-loss dieting, with the specific aim of identifying the mediators of these deficits. To this end we initially focused on mood, and how mood might interact with dietary restraint to produce cognitive deficits. Evidence from previous studies had suggested that dieters can show cognitive deficits independently of affective disturbance. We addressed this issue, and sought to measure affective state through the use of non-clinical indicators of positive and negative mood and well-being. In addition to a mood-mediated account of cognitive deficit, the role of hunger, preoccupations, attentional distraction for dieting related concerns, and tendency towards disinhibited eating were also examined.

The first major goal was to replicate effects of diet-linked cognitive impairment and diet-linked distraction for food and body-shape related concerns. The results of two dieting studies revealed some novel results. In the first, diet-linked attentional interference for food-related stimuli was demonstrated, but was not accompanied by cognitive deficit. In the second, cognitive deficit was found, in the absence of attentional interference for food or body-shape stimuli. A third finding was that despite the fact that dieters expressed greater levels of negative mood and neuroticism, and reported lower levels of well-being, mood per se could not account for the dieter—non-dieter differences in cognitive performance found. In addition, the cognitive deficits did not appear to be directly mediated by restraint or

preoccupation with thoughts of food and eating (although, consistent with the literature, dieters did score high on these measures). As a subsidiary focus we had speculated about the importance of emotional eating for affective and cognitive deficit. Our dieters scored high on this trait eating behaviour and when the influence of emotional eating was examined it emerged as a more significant indicator of vulnerability to both affective *and* cognitive disturbance than did restraint. Although overall no significant dieter—non-dieter difference in working memory capacity was found, within dieters, working memory capacity showed an indirect relationship to emotional eating via negative mood and those dieters with the poorest working memory capacity were also those who showed the poorest performance on tasks of reaction time speed and vigilance.

To explore these findings, we generated a model specifying a route from emotional eating to reduction in working memory capacity: the goal-frustration affect model of cognitive deficit. In addition to emotional eating, the model incorporated aspects of preoccupation with food, negative self-description, and negative mood. The cumulative effect of these variables accounted for a significant proportion of the variation in working memory capacity displayed by the dieting sample in whom cognitive deficit had been identified.

The next task was to find out how an affective challenge might trigger disinhibited eating in high emotional eaters, and what the subsequent implications for cognitive function might be. Using the Implicit Association Test evidence was found to

suggest that emotional eating interacts with negative mood to increase the attractiveness of food related stimuli. Evidence from an additional study, which employed a mood induction procedure, showed negative mood to interact with tendency towards emotional eating to produce cognitive deficit. In neither instance did restraint interact with mood to produce similar effects. The final goal was to replicate these findings in a single study using a mood induction procedure. It was hypothesised that negative mood would interact with emotional eating to raise the attractiveness for food related stimuli, resulting in a reduction of processing efficiency to produce measurable cognitive deficit. Unfortunately, the results of this study were confounded by the fact that negative mood had a global effect on IAT response efficiency. Further, no differentiation between groups split by eating behaviour was demonstrated on the cognitive performance task.

We considered possible methodological artefacts which may have accounted for these null results, but also speculated over the possibility that we might have overlooked the importance of personality. Of the eating behaviours, emotional eating was found to be the best – and the only – correlate of neurotic tendency. Tracking the relationship between emotional eating and neuroticism through this series of studies might have given a better indication of who would be most likely to show experimental effects and under what conditions. This assertion was given some validity by preliminary findings which suggested that emotional eating reflects a stable response characteristic; the tendency to consume when emotional is not

context-bound but can also be observed in other appetitive domains e.g. shopping behaviour.

The balance of evidence from this thesis indicates that it is the tendency towards emotional eating, and not level of dietary restraint, which interacts with mood state and diet related cognitions to raise the potential of affective and cognitive disturbance in dieters. Under dieting conditions, where opportunity for affective disturbance is increased, cognitive deficit is most likely to occur in the high emotional eater because they are highly sensitive to affective disturbance, and for them such disturbance results in preferential allocation of attentional resources to food and eating related cognitions. Before discussing these findings in the context of existing literature some limitations of this thesis must be noted.

12.2 Limitations

Firstly, in terms of internal validity, the goal-frustration account of cognitive deficit accounted for only a third of within dieter variance in working memory capacity, which in turn showed only modest association with the other measures of cognitive performance. Because our dieters were recruited from a Weight Watchers club, and not randomly assigned to a dieting condition, our investigation may have been confounded by factors not directly related to dieting. Such factors include the prevalence of neurotic tendency in our dieting sample, which accounted for a large

percentage of the dieter—non-dieter variation in affective disturbance. However, neuroticism was also found to be strongly related to emotional eating. Therefore the findings from this thesis are qualified by the suggestion that emotional eating clusters with factors denoting negative mood, anxiety and poor well-being. It is this combination of tendencies which together raise the potential for cognitive and affective disturbance under dieting conditions.

In addition, as already noted (Discussion: Chapter 4), a severe methodological flaw was the lack of assessment of individual difference in intelligence and computer familiarity. As we later discovered in the IAT task, when the unit of measurement is latency to respond to a stimulus, response efficiency bias can also be an issue for tasks of evaluative judgement. Task response efficiency is less of an issue where the sample is homogeneous, for example all psychology undergraduates, however where the performance of a community sample was observed at least a basic measure of IQ should have been taken.

In terms of external validity, generalisation from our goal-frustration account of diet-linked deficit is limited due to the fact that it is based on results from a single group of dieters who happened to score highly in terms of emotional eating. Dieters who show high levels of disinhibited eating have been described as unsuccessful dieters, characterised by frequent dieting interspersed with periods of bingeing (Heatherton et al., 1988). Our hypotheses concerning the effects of mood, eating

behaviour and cognitive function may not generalise to dieting samples when the tendency towards emotional eating is not as pronounced.

Concerning measurement issues, although this thesis relied significantly on self-report measures, it used mainly those with proven reliability and validity, and ones which were common to the dieting literature (e.g. the Hunger Scale, the DEBQ). It must be noted however, that inferences central to the goal-frustration hypothesis were made retrospectively and relied on potentially poor proxy measures of central concepts. For example, the measure of preoccupation with thoughts of food and eating, based on a single item scale, could be argued to be a weak indicator of disinhibited eating and potential for violation of dieting goals. Indeed, recent research by Mann and Ward (2001) has suggested that neither increased thoughts nor enhanced desire for a food necessarily results in disinhibited eating. The model requires further verification using more appropriate measures.

The statistical problems within this thesis reside in the fact that the proposed account of cognitive deficit is based and supported in the main by correlational data, although evidence from the first mood induction study (Chapter 8) did establish a causal link between emotional eating, mood and cognitive deficit. This considered, the proposed goal-frustration affect model is discussed with the caveat that further studies are needed to verify a *causal* link between emotional eating, mood, increased attractiveness for food related stimuli and cognitive deficit.

12.3 The Goal-Frustration Affect Model: What is it like?

Essentially we have described an affect-mediated account of diet-linked cognitive deficit. At the onset of this thesis dieting was defined as a goal-directed approach to weight-loss where emotional reaction was seen to occur as a consequence of an individual's failure to manage or maintain dieting goals. In this context affective disturbance arises from a failure to manage diet-related goals and intentions (Carver & Scheier, 1990). The proposed model suggests a possible mechanism behind such management failure. For the emotional eater an increase in negative mood may elicit an implicit conditioned response whereby food related stimuli become more attractive, or more desirable. This reaction is followed by an explicit motivation to eat. Such action is incongruent with dieting related goals and may lead to further emotional arousal and subsequent impulse to eat, thus further violating diet-related goals. This relationship can become self perpetuating. The role of restraint is not critical, except that it sets the stage for potential situations where goals might be violated; individuals high in emotional eating may over-eat when *any* goal is violated so long as such violation creates affective disturbance.

The goal-frustration affect model gives a specific account of the role of affect in dieting. The model is based in the emotion-cognition account of Oatley and Johnson-Laird (1987), who propose that emotions serve as a management system

which coordinates an individuals multiple plans and goals[1] under constraints of time and other limited resources. When a plan fails, or if an active goal is lost, emotion may function as a mechanism of repair by calling into action an alternative plan. However, we have shown that in the context of dieting, given the right conditions, emotion may ironically function as a mechanism of repair, but also as a mechanism via which further disruption is introduced (through the increase desirability of food related stimuli). This account is similar to Wegner's (1994) account of the ironic process of self control: the very mechanism responsible for the monitoring of the occurrence of unwanted thoughts (the look out), can, under the right conditions, serve also to bring such thoughts streaming into consciousness.

Concerning eating behaviour, the goal-frustration affect model gives an account of how the trait tendency towards emotional eating might limit dieting success under conditions of affective challenge. Limitation could be introduced via (a) the maladaptive response of increase in desirability of food related stimuli; leading to, (b) reduced ability to implement the processes of change required to move from current state to goal state.

Following introduction of the goal-frustration affect model, this thesis focused mainly upon the impact of emotional eating on affect and cognition following an

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[1] Goals are defined as "symbolic representations of possible states of the environment that a system will try to achieve"; plans represent the processes of change required to move from current state to goal state (Oatley & Johnson-Laird, 1987, p. 30).

initial diet-linked general increase in mood disturbance (e.g. based on the stress of maintaining dietary restraint). However, an overview of the findings suggests that the trait tendency of emotional eating might pose a threat to dieting success much earlier in the dieting process, possibly even before dieting has commenced. How might this be?

According to Gray (1982) behaviour and affect are under-pinned by two general motivational systems: the behavioural inhibition system (BIS) and the behavioural activation system (BAS). The BIS system is sensitive to signals of punishment, non-reward and novelty. In response to these inputs, BIS activation causes an inhibition of movement towards a goal, an increase in level of arousal and an increase in attention to the environment, especially to novel or threatening factors (for a detailed account see Gray, 1999). BIS function is also thought to be responsible for negative feelings such as fear, anxiety, frustration, and sadness (Gray, 1981). In this thesis, emotional eating was found not only to be related to neurotic tendency (denoting high anxiety), but also to represent a relatively stable response characteristic that generalises to other appetitive-response domains. This considered, the concept of emotional eating fits well within the framework of BIS sensitivity. Further, Carver and White (1994) demonstrated that individuals with high BIS sensitivity experience greater anxiety in situations with cues of impending punishment. Therefore, the high emotional eater could be at an affective disadvantage even *before* dieting commences because (a) due to the significance of food for them, they are most likely to perceive dietary restriction in terms of punishment, and (b) they have higher sensitivity to

punishment. In this way the opportunity for affective disturbance is greater for the emotional eater.

12.4 The Goal-Frustration Model: assimilation with existing literature

Despite the noted limitations, this thesis presents a potentially novel approach to the examination of cognitive deficit. The question now arises as to how these findings relate to relevant dieting research, and how they may complement or extend existing models of diet-linked cognitive deficit and disinhibited eating behaviour.

Green and Rogers suggested that the cognitive deficits associated with dieting are due to dieting per se, rather than mediated by pre-existing individual differences between dieters and non-dieters (Green & Rogers, 1995; Green & Rogers, 1998). In their account preoccupation with body-shape (characteristic of restrained eaters), added to diet-induced food cravings and hunger, combine to exceed a preoccupation threshold. The result of these intrusive, task irrelevant cognitions, is a reduction in working memory capacity (Gibson & Green, submitted). That such deficit has been identified in the absence of significant weight-loss (Green & Rogers, 1998) has been taken to suggest that the phenomenon is psychological as opposed to physiological in nature. Further, no evidence of affective disturbance has been found to accompany the cognitive deficit (Green & Rogers 1995; Green et al., 1997).

The findings from this thesis share a number of common features with those of Green and Rogers, accordingly the goal-frustration account proposed here shares some similarity with Green and Rogers' preoccupation based account of cognitive deficit. First, our account, too, is essentially one of working memory capacity limitation which incorporates aspects of preoccupation with dieting related concerns. Similarly, our account appears more likely to be based upon the psychological impact of dieting, rather than the direct effect of nutritional challenge. In addition BMI did not account for the dieter—non-dieter differences in cognitive function found in this thesis.

However, several of the findings in this thesis also appear inconsistent with Green and Rogers' preoccupation-based account of cognitive deficit. First, we found no effect of hunger on cognitive task performance. Second, no direct relationship between preoccupation or attentional interference for dieting related concerns, and cognitive deficit was observed. Third, we found evidence of affective disturbance and this disturbance showed some relation (albeit indirect) to cognitive deficit. Fourth, we found evidence of pre-existing individual differences in terms of neurotic tendency and emotional eating. However, it was these individual differences which accounted for a significant proportion of the dieter—non-dieters variance in affective disturbance, and combined with other factors (including preoccupation) to influence reduced working memory capacity.

How can we account for the difference in findings between the work presented in this thesis and that of Green and Rogers, specifically those findings that support their preoccupation based account of cognitive deficit? One explanation resides in the difference between the dieting samples assessed. In this thesis, naturalistic, non-experimentally controlled dieting was observed in over-weight dieters. Green and Rogers typically observed dieters who were within the normal weight range. Our goal-frustration model of cognitive deficit features affective disturbance and individual differences in trait tendency. However, if we strip the model back to those core elements which interact to reduce working memory capacity, then both our account and that of Green and Rogers are essentially the same; they are both preoccupation based accounts, but *fuelled by concerns most significant to the particular dieting group*. For example, for the normal weight dieter concerns are body-image focused, with dieting failure per se having minimal impact on self-esteem; alternatively for the overweight dieter, concerns are body-fat focused, with dieting failure (including temporary lapse) having significant impact on self-esteem.

Although highly speculative, these ideas are given some credence by the fact that our dieters were high emotional eaters, and this tendency has been suggested to contribute towards unsuccessful dieting (van Strien, 1999), and to be associated with feelings of low self-esteem and inadequacy (van Strien et al., 1985) and anxiety (van Strien et al., 1995). Indeed, recent evidence suggests that restraint per se has little contribution to over-eating, rather it is the tendency for disinhibited eating in conjunction with over-eating (measured by a scale sensitive to bulimic eating

patterns) that is the better predictor of over-eating (van Strien, Cleven, & Schippers, 2000). However, further work is essential to compare the dieting experience of normal weight and overweight dieters, examining inter-group differences in ruminative focus.

Concerning the concept of emotional eating, the findings from this study have something to add. Psychosomatic theory, upon which the concept of emotional eating is based, states that over eating is due to a confusion of physiological states accompanying negative emotions with physiological correlates of hunger and satiety (van Strien et al., 1995). Using a novel paradigm we have potentially indicated how such confusion may establish a conditioned response. This response is an increase in attractiveness of food related stimuli following affective disturbance. This idea is akin to Clark's (1988) model of panic disorder where misinterpretation of bodily sensations results in an increase in anxiety and heightened arousal, leading to further misinterpretation which may result in a panic attack. Following repeated exposure to this contingency, a bodily sensation alone may be sufficient to trigger a panic response. These findings have potential practical implications for successful dieting, to be discussed in a later section.

Finally, it is important to compare the findings from this thesis with those of a recently published study by Bryman and Tiggemann (2001) that examined the effect of dieting on cognitive function and psychological well-being in overweight dieters. Results of this study showed that being on a prescribed diet had no significant impact

on cognitive task performance. Further, some aspects of psychological well-being were seen to improve over the dieting period; for example dieters on the prescribed diet showed an increase in their sense of control over eating behaviour, and a decrease in depression.

These results actually support many of the findings, and even some of the speculations, presented in this thesis. First, these effects occurred within the context of weight-loss. Following results of the first dieting study (Chapter 3) it was suggested that the experience of early weight-loss could have ameliorated, or protected against, tendency towards cognitive dysfunction. Similarly, Bryman and Tiggemann suggest that when an overweight woman loses weight, she experiences an increase in feelings of well-being which provide protection against any negative effect of dieting. Second, the impact of being on an experimentally prescribed, rather than a self-specified diet, was noted. Bryman and Tiggemann suggest that the prescribed diet eliminates the need to continually think about the diet, in this way the burden on processing resources is limited. This is significant because the dieters from our second dieting study – who showed cognitive deficit – were following a diet plan that required meticulous calorie counting and awareness of eating behaviour (the Weight Watchers Diet). These observations support those aspects of the goal-frustration affect model concerned with self-focused rumination and preoccupations with thoughts of food and eating.

This interpretation of the effect of diet type also sheds light upon the findings of Kretsch et al. (1997), who found minimal effects of dieting on affective and cognitive function in overweight dieters who lost weight over a 12 week dieting period. The type of diet followed was experimentally controlled to the extent that participants actually ate some meals in the laboratory.

Two final points to be noted from this latest study concern emotional eating. The dieters assessed by Bryman and Tiggemann showed a low mean emotional eating score (*M* = 2.95) compared to that of the dieters examined in the dieting study in this thesis where cognitive deficit was observed (*M* = 3.56; Chapter 4). This difference might also have contributed to the more positive experience of the dieters on the prescribed diet. Second, following the prescribed diet, high emotional eating was found to be significantly related to weight-loss. This finding appears counterintuitive in the context of our account of dieting and eating behaviour. Further study is required to assess the impact of emotional eating on weight-loss, over a longer dieting period where a very “food-focused” type of diet is followed.

12.5 Theoretical Implications

Many of the theoretical applications of the goal-frustration affect account of cognitive deficit have already been discussed. However, the findings from this thesis have a broader application, extending also to the study of diet-linked tryptophan depletion, well-being, and other appetitive behaviours such as alcoholism; each of these areas will be now be considered in turn.

The finding that emotional eating is associated with aspects of negative affect, and interacts with current affective state to increase vulnerability to cognitive deficit, may help to clarify some of the findings from studies of dieting and tryptophan depletion. Experimentally induced tryptophan depletion has been shown to result in impairments in cognitive performance comparable to some of those shown by dieters (e.g. Park et al., 1994; Riedel, et al., 1999). In addition tryptophan depletion has been found to produce mood lowering effects in selective groups, including women (Smith et al., 1997) and men who have a family history of affective disorder (Benkelfat et al., 1994). The results from this thesis suggest that diet-induced tryptophan depletion will be most significant for the high emotional eater, where sensitivity to emotional arousal will increase the potential for cognitive disruption.

Diener et al. (1999) stress the necessity to consider, in every assessment of well-being, the Person x Situation interaction. The findings from this thesis support this notion. For example, they indicate the necessity to break larger concepts such as

"dieting" into its more specific aspects such as different eating behaviour patterns in order to get a true sense of the Person x Situation interaction and its consequences for well-being. This would be especially important in the context of dieting if the speculated association between the Behavioural Inhibition System and emotional eating holds true. Davidson (1999) presents evidence to indicate a neurological basis for individual differences in affective style which reside in two fundamental emotional systems (one governing approach, one withdrawal) which are intrinsically linked to the experience of positive and negative affect. The implications of these findings for the dieting experience were not fully explored within this thesis. Further study is required to examine behavioural inhibition and behavioural activation sensitivity and its association with eating behaviour, and implications for dieter well-being.

In terms of appetitive behaviour, evidence from this thesis suggests that the tendency towards disinhibition of restraint may not be context bound within an individual. In this thesis we found, within the same individual, propensity towards "emotional eating" to be related to "emotional shopping" and "external eating" to "external shopping". These provisional findings raise the question as to whether trait tendency towards disinhibition (when conditions are right) will result in increased desire for any consumable stimulus, or whether the contingency is established only through a previously learned response. Existing research provides some support for this latter assertion, with emotional eating showing no relationship to disinhibited use of other substances such as alcohol or nicotine (van Strien et al., 1995). However it was

further noted by van Strien and colleagues that had the substance use base rates been higher (e.g. at clinical levels) eating and substance use problems may well have been related. Further study is needed to first verify the findings from the Consumer Behaviour Questionnaire (Chapter 11), and then to explore how behavioural contingencies are established.

12.6 Practical Implications

The finding that for some dieters the tendency to eat when emotional is associated with vulnerability to affective and cognitive disturbance is potentially important for the promotion of successful dieting. If the proposed goal-frustration affect model holds true we can be more precise about exactly *when* a person is likely to show affective and cognitive disruption. Disruption occurs when (a) a person has a pre-existing tendency to eat when they are emotional; (b) a person believes they have violated a goal (e.g. the goal of eating less); and, (c) that violation creates mood disturbance (compounded by negative self-description).

Findings from this study suggest that the key to successful dieting, for the emotional eater at least, is to learn how to deal with times when there is increased risk of affective disturbance (however caused). Being made aware of the contingency between the increase in emotional arousal and subsequent desire to eat, may raise the

likelihood of being able to inhibit such desires and search for alternative means of gratification (which could be planned in advance).

Type of diet followed is important. Following a specified diet, where thought as to which and how much of a particular food should be eaten is at a minimum, appears advisable. In this way excessive thought towards food and eating may be minimised, and the affective and cognitive consequences reduced. In addition, nutritional supplements, such as tryptophan based supplements, might provide a means of protection against direct nutritionally mediated mood disruption in those most vulnerable, such as high emotional eaters.

Further study is required to fully examine the implications of different eating behaviours for overweight dieters. Specifically, there is the need for a detailed examination of the psychological profile of the individual with high tendency towards emotional eating. In addition a longitudinal study is needed to investigate the impact of this profile on dieting success in prescribed and non-prescribed diets. This seems particularly important given the findings that the tendency to consume when emotional is not context-bound, but can also be observed in other behavioural domains.

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Appendix

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Appendix A

Cognitive Task Stimuli

Table A1.
Memory Recall Task Stimuli

List 1 (20)	List 2 (20)	Additional List 1 (20)	Additional List 2 (20)
PIANO	TABLE	HORSE	DOOR
PUPIL	POLE	BOOTH	TABLE
WOOD	AXE	UMPIRE	CORN
COMPUTER	FRAME	CHORUS	SWAN
LETTER	JUDGE	ADULT	COUCH
PURSE	CLOCK	SUIT	DRAWING
BELL	ANCHOR	HARP	MEDAL
FRIDGE	CAMERA	LAMB	TYPIST
BOAT	MIRROR	FOOT	BOAT
LAKE	CANDLE	CARD	CRIB
FLOWER	SOIL	BRAIN	POOL
BRIDGE	SCENT	MOSS	BEACH
LIGHT	SWITCH	DANCER	GERM
RECORD	COOK	CUP	POLE
TRACK	ENGINE	JACKET	DESK
CURTAIN	BENCH	TOOL	ARM
RECEIPT	VASE	INSECT	HERO
TAPE	PAINT	SILK	ADDICT
HANDLE	FOLDER	TENT	ELBOW
BOTTLE	PICTURE	BRASS	CAKE

Note. Additional task stimuli were used in Chapter 3 only.

Table A2.
Dot Probe Task Stimuli

Supraliminal Food	Supraliminal Music	Subliminal Food	Subliminal Music
CARBOHYDRATE	INSTRUMENT	RECIPE	TRUMPET
SUGAR	SING	GREED	COMPOSE
FEEDING	MUSICALS	GRAVY	FIDDLE
FEAST	SOLO	LUNCH	TENOR
CHIPS	DRUMS	FREEZER	FOLKSONG
POTATO	PIANISTS	MARSHMALLOW	CONCERTINA
DINNERTIME	SYMPHONIES	MENU	HARP
MOUTHFUL	METRONOME	NAPKIN	VIOLIN
PIZZA	BATON	PLEASURE	SOPRANO
SNACK	MAJOR	PORTION	CONDUCT
BREAKFAST	QUINTET	SALAD	VITALITY
BUTTER	LESSON	CHOCOLATE	OPERETTA
CAKE	LYRIC	SLICE	RHYTHM
CHEESE	CHORUS	SPOON	TUBA
CHERRY	CHOIR	TEMPTATION	COMPOSITION
CHICKEN	KEYNOTE	TENDENCY	ORCHESTRA
WEAKNESS	KEYBOARD	CANTEEN	SINGSONG
DIET	KEYS	EGG	EAR
FLAVOUR	CONCERT	GREASE	TENOR
FRUIT	CHORD	GOURMET	CONDUCT

Table A3.
Food Stroop Task Stimuli

Food Stimuli (20)	Music Stimuli (20)	Additional Food Stimuli (20)	Additional Music Stimuli (20)
CARBOHYDRATE	INSTRUMENT	RECIPE	COMPOSE
SUGAR	SING	GREED	ORCHESTRA
FEEDING	MUSICALS	GRAVY	BEAT
FEAST	SOLO	LUNCH	CONDUCT
CHIPS	DRUMS	FREEZER	CONCERTINA
POTATO	PIANISTS	MARSHMALLOW	COMPOSITION
DINNERTIME	SYMPHONIES	MENU	VIOLIN
MOUTHFUL	METRONOME	NAPKIN	RHYTHM
PIZZA	BATON	PLEASURE	SONGBOOK
SNACK	MAJOR	PORTION	OPERETTA
BREAKFAST	QUINTET	SALAD	HARP
BUTTER	LESSON	CHOCOLATE	SINGSONG
CAKE	LYRIC	SLICE	TUBA
CHEESE	CHORUS	SPOON	FIDDLE
CHERRY	CHOIR	TEMPTATION	FOLKSONG
CHICKEN	KEYNOTE	TENDENCY	SOPRANO
WEAKNESS	KEYBOARD	CANTEEN	TENOR
DIET	KEYS	EGG	EAR
FLAVOUR	CONCERT	GREASE	VITALITY
FRUIT	CHORD	GOURMET	TRUMPET

Note. Additional task stimuli were used in Chapter 3 only.

Table A4.
Shape Stroop Task Stimuli

Shape Stimuli (20)	Transport Stimuli (20)	Additional Shape Stimuli (20)	Additional Food Stimuli (20)
SLIM	INN	SHAPED	SUITCASE
ABDOMEN	TRAVELLERS	SCALES	TICKET
WILLOW	POSTCARD	SPAN	TREK
WAIST	CARAVAN	DIMENSION	OVERSEAS
SPARE	DISTANT	SHIRT	TRAIL
FASHION	PASSPORT	CRITICISM	VACATION
ANKLE	AIRPORTS	SATISFACTION	TERMINAL
BEAUTY	CRUISING	REWARD	BREAK
CLOTHES	JOURNEY	APPEARANCE	CUSTOMS
CONFIDENCE	PILGRIMAGE	TRIM	CLOUD
LARGE	BEACH	OUTFIT	CLIMB
WEIGHING	LUGGAGE	REDUCTION	WEEKEND
HIPS	LAND	SLENDER	TRANSFER
STOMACH	LANDSCAPE	DRESS	WEEK
CALORIES	HIGHWAY	GYM	TRAIL
FATTY	JUNGLE	FATTENING	TRANSPORT
THIGHS	LAUNCH	BULGE	TRANSIT
FIT	CAB	WORKOUT	COLONY
SIZES	PACK	EXERCISE	CONCORD
PLUMP	FERRY	IMPRESSION	SPEEDBOAT

Note. Additional task stimuli were used in Chapter 3 only.

Appendix B

Main ANOVA Tables

Table B1.
Chapter 2: Analysis of Variance for Simple Reaction Time Task

Source	*df*	SS	MS	*F*
Treatments	1	2.32	2.32	0.00
Error	22	15636.99	710.77	
Total	23	15639.31		

Table B2.
Chapter 2: Analysis of Variance for Memory Recall Task

Source	*df*	SS	MS	*F*
Treatments	1	3.56	3.56	0.63
Error	21	118.89	5.66	
Total	22	122.46		

Table B3.
Chapter 2: Analysis of Variance for Vigilance Task

Source	*df*	SS	MS	*F*
Treatments	1	0.01	0.01	0.25
Error	18	0.74	0.04	
Total	19	0.75		

Table B4.
Chapter 2: Analysis of Variance for RNG Task

Source	*df*	SS	MS	*F*
Treatments	1	0.00	0.00	1.82
Error	21	0.03	0.00	
Total	22	0.04		

Table B5.
Chapter 2: Repeated Measures Analysis of Variance for Food Stroop Task

Source	*df*	SS	MS	*F*
Between subjects	22	151288.97	6876.77	
Hunger	1	5457.25	5457.25	0.79
Within subjects	22	81568.24	3707.65	
Exposure	1	20068.63	20068.63	*5.41**
Hunger x Exposure	1	34.87	34.87	0.01
Total	44	232857.21		

*p <.05, **p < .01, ***p < .001

Table B6.
Chapter 2: Repeated Measures Analysis of Variance for Dot Probe Task

Source	*df*	SS	MS	*F*
Between subjects	20	880340.75	44017.04	
Hunger	1	96847.10	96847.10	2.20
Within subjects	20	80602.59	4031.03	
Exposure	1	99620.63	99620.63	*24.71****
Hunger x Exposure	1	1128.33	1128.33	0.28
Within subjects	20	18373.92	918.70	
Food	1	708.69	708.69	0.77
Hunger x Food	1	1121.55	1121.55	1.22
Within subjects	20	38996.87	1949.84	
Probe	1	615.34	615.34	0.32
Hunger x Probe	1	723.29	723.29	0.37
Within subjects	20	21770.15	1088.51	
Exposure x Food	1	548.17	548.17	0.50
Hunger x Exposure x Food	1	667.10	667.10	0.61
Within subjects	20	26658.14	1332.91	
Exposure x Probe	1	2449.04	2449.04	1.84
Hunger x Exposure x Probe	1	5746.89	5746.89	4.31
Within subjects	20	2015491.51	774.58	
Food x Probe	1	451.10	451.10	0.58
Hunger x Food x Probe	1	0.88	0.88	0.00
Within subjects	20	25297.96	1264.90	
Exposure x Food x Probe	1	646.08	646.08	0.51
Hunger x Exposure x Food x Probe	1	1807.30	1807.30	1.43

Note. Food = Food word position; Probe = Probe position.
*p <.05, **p < .01, ***p < .001

Table B7.
Chapter 3: Repeated Measures Analysis of Variance for Restraint

Source	*df*	SS	MS	*F*
Between subjects	17	11.55	0.68	
Condition	1	11.35	11.35	*16.70****
Within subjects	17	3.18	0.19	
Time	1	1.0	1.0	*5.34**
Condition x Time	1	0.17	0.17	0.93
Total	34	14.73		

$*p < .05$, $**p < .01$, $***p < .001$

Table B8.
Chapter 3: Repeated Measures Analysis of Variance for PANAS (positive "over last month")

Source	*df*	SS	MS	*F*
Between subjects	19	941.46	49.55	
Condition	1	637.88	637.88	*12.87***
Within subjects	19	332.90	17.52	
Time	1	31.0	31.0	1.77
Condition x Time	1	13.67	13.67	0.78
Total	38	1274.36		

$*p < .05$, $**p < .01$, $***p < .001$

Table B9.
Chapter 3: Repeated Measures Analysis of Variance for Simple Reaction Time Task

Source	*df*	SS	MS	*F*
Between subjects	26	59131.46	2274.29	
Condition	1	402.16	402.16	0.18
Within subjects	26	11173.80	429.76	
Time	1	2188.02	2188.02	*5.09**
Condition x Time	1	6.96	6.96	
Total	52	70305.26		

$*p < .05$, $**p < .01$, $***p < .001$

Table B10.
Chapter 3: Repeated Measures Analysis of Variance for Memory Recall Task

Source	*df*	SS	MS	*F*
Between subjects	26	233.22	8.97	
Condition	1	1.36	1.36	0.15
Within subjects	26	57.50	2.21	
Time	1	0.33	0.33	0.15
Condition x Time	1	0.13	0.13	0.06
Total	52	290.72		

Table B11.
Chapter 3: Repeated Measures Analysis of Variance for Vigilance Task

Source	*df*	SS	MS	*F*
Between subjects	19	8658.24	455.70	
Condition	1	3036.05	3036.05	*6.66**
Within subjects	19	5818.90	306.26	
Time	1	152.24	152.24	0.50
Condition x Time	1	1305.0	1305.0	4.26
Total	38	14477.14		

**p <.05, **p < .01, ***p < .001*

Table B12.
Chapter 3: Repeated Measures Analysis of Variance for RNG Task

Source	*df*	SS	MS	*F*
Between subjects	22	0.18	0.01	
Condition	1	0.03	0.03	3.66
Within subjects	22	0.05	0.00	
Time	1	0.01	0.01	3.97
Condition x Time	1	0.00	0.00	0.53
Total	44	0.23		

Table B13.
Chapter 3: Repeated Measures Analysis of Variance for Supraliminal Food Stroop

Source	*df*	SS	MS	*F*
Between subjects	20	60699.81	3034.99	
Condition	1	18241.97	18241.97	*6.01**
Within subjects	20	128527.39	6426 .378	
Time	1	9912.45	99121.45	1.54
Condition x Time	1	2757.74	2757.84	0.43
Total	40	189227.20		

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table B14.
Chapter 3: Repeated Measures Analysis of Variance for Subliminal Food Stroop Task

Source	*df*	SS	MS	*F*
Between subjects	20	61907.82	3095.39	
Condition	1	199.65	199.65	0.06
Within subjects	20	61360.07	3068.0	
Time	1	5346.56	5346.56	1.74
Condition x Time	1	1235.21	1235.21	0.40
Total	40	123267.89		

Table B15.
Chapter 4: Analysis of Variance for Simple Reaction Time Task

Source	*df*	SS	MS	*F*
Treatments	1	7289.85	7289.85	*5.20**
Error	54	75655.36	1401.03	
Total	55	82945.21		

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table B16.
Chapter 4: Analysis of Variance for Memory Recall Task

Source	*df*	SS	MS	*F*
Treatments	1	31.50	31.50	*4.27**
Error	54	398.48	7.38	
Total	55	429.98		

*$p < .05$, **$p < .01$, ***$p < .001$

Table B17.
Chapter 4: Analysis of Variance for Bakan Task

Source	*df*	SS	MS	*F*
Treatments	1	2004.02	2004.02	*5.39**
Error	54	20066.96	371.61	
Total	55	22070.98		

*$p < .05$, **$p < .01$, ***$p < .001$

Table B18.
Chapter 4: Analysis of Variance for RNG Task

Source	*df*	SS	MS	*F*
Treatments	1	0.01	0.01	2.23
Error	53	0.23	0.00	
Total	54	0.24		

Table B19.
Chapter 7: Analysis of Variance for Food IAT Effect Score by Emotional Eating and Negative Mood

Source	*df*	SS	MS	*F*
Emotional	1	2537.77	2537.77	0.07
Mood	1	44590.88	44590.88	1.27
Emotional x Mood	1	123713.64	123713.64	3.53
Error	51	1787450.50	35048.05	
Total	55	5799074.80		

Table B20.
Chapter 9: Analysis of Covariance for Food IAT Effect by Eater Group and Mood Condition

Source	*df*	SS	MS	*F*
Covariate	1	695592.01	695592.01	*33.36****
Eater	3	27579.33	9193.11	0.44
Mood	2	217628.51	108814.26	*5.22***
Emotional x Mood	6	111000.79	18500.13	0.89
Error	106	2210129.50	20850.28	
Total	119	9158002.50		

**p <.05, **p < .01, ***p < .001*

Table B21.
Chapter 9: Analysis of Covariance for Bakan by Eater Group and Mood Condition

Source	*df*	SS	MS	*F*
Covariate	1	1680.15	1680.15	*149.34****
Eater	3	9.17	3.06	0.27
Mood	2	21.42	10.71	0.95
Emotional x Mood	6	109.22	18.20	1.62
Error	102	1147.54	11.25	
Total	115	23844.0		

**p <.05, **p < .01, ***p < .001*

Appendix C

Regression Summary Tables

Table C1.
Chapter 5: Simultaneous Regression Analysis for Variables Predicting RNG Task Performance in Dieters

Variable	*B*	*SE B*	β
Emotional eating	0.011	0.019	.13
Preoccupation	-0.011	0.006	-.39
Depressed states global	0.016	0.023	.17
Negative affect	0.003	0.002	.39

Note. In the final model $R^2 = .32$ ($p = .08$)

Table C2.
Chapter 5: Simultaneous Regression Analysis for Variables Predicting RNG Task Performance in Non-dieters

Variable	*B*	*SE B*	β
Emotional eating	0.004	0.012	.09
Preoccupation	-0.000	0.004	-.02
Depressed states global	0.022	0.021	.28
Negative affect	0.000	0.002	.10

Note. In the final model $R^2 = .17$ (*ns*)

Table C3.
Chapter 10: Stepwise Regression Analysis for Variables Predicting Neuroticism

Variable	*B*	*SE B*	β
Step 1			
Emotional eating	3.06	0.67	*.56*****
Variables not in equation			
Restraint	-	-	0.17
BMI	-	-	-.03

Note. In the final model $R^2 = .31$ ($p < .00001$)
*****p* < *.00001*

Appendix D

“Mood, Eating Behaviour and Attention”

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