THE EFFECTS OF STRESS ON HUMAN FOOD CHOICE

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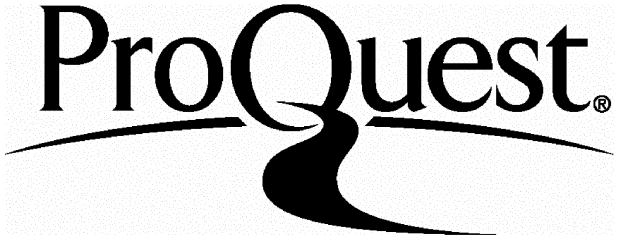

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ABSTRACT

Forming a background to this research are the well-established links between stress and disease on the one hand, and dietary composition and disease on the other. Associations between stressful life events and weight gain, and between perceived stress and serum cholesterol, have been observed in the general population. In addition, studies of obese and dieting populations have revealed that the eating behaviour of some individuals is affected by stress. This raises the possibility that one of the mechanisms through which stress might influence health is via an effect on food intake. Stress is widely believed to influence eating behaviour, but the evidence derives largely from clinical observation and anecdotal report. In the small number of studies that have been carried out in this area, the results have been inconclusive.

These converging lines of evidence suggest that the influence of stress on food intake and, more specifically, food choice, is well worth studying. A link between stress and fat intake, for example, would be of considerable importance both for understanding the psychobiology of food intake, and for interventions to reduce the prevalence of diseases of Western society such as obesity, diabetes and coronary heart disease.

This research aimed to investigate the prevalence and nature of stress-induced changes in eating within the general population, using a variety of methodologies. An initial questionnaire study examined the self reported prevalence of stress induced changes in a population of undergraduate students, looking at the effect of stress on overall intake and also changes in preference for specific foods. It also investigated the possibility that individuals prone to stress-induced changes in eating may be defined by

parameters such as gender or dieting status. Results indicated that the majority of the sample believed their eating to be influenced in some way by stress, with reports of increased eating and decreased eating occurring with approximately equal frequencies, although dieters were more likely to report eating more when stressed. Foods reportedly preferred during stress were predominantly snack foods, this was in agreement with reported increases in snacking with stress among the majority of respondents, and was true of hyperphagics and hypophagics alike. Thus the 'dietary role' of a food appeared to be the dominant influence over stress-induced preference in this sample.

The stress-eating relationship was examined in the laboratory by manipulating stress and assessing food intake and selection during a single meal. Increased intake of sweet, fatty foods was seen by stressed subjects who were emotional eaters. This group also ate a meal that was highly energy dense compared with unstressed emotional eaters.

A longitudinal study of 6 months' duration investigated the stress-eating relationship in the 'real world' environment, by assessing dietary change in department store workers over periods of varying work load. The findings provided tentative support for a general hyperphagic effect of work stress; dietary restraint and emotional eating were not found to influence the stress-eating relationship in this case.

Finally structured interviews in a small sample of self-identified 'stress-eaters' provided descriptive data on the nature of the stress-eating relationship. Interviewees consistently referred to their stress-eating tendencies as providing some sort of emotional nourishment rather than fulfilling any increased physiological need for food.

The findings from this thesis suggest that during certain types of stress, many individuals are prone to increased snack consumption. Implications are discussed.

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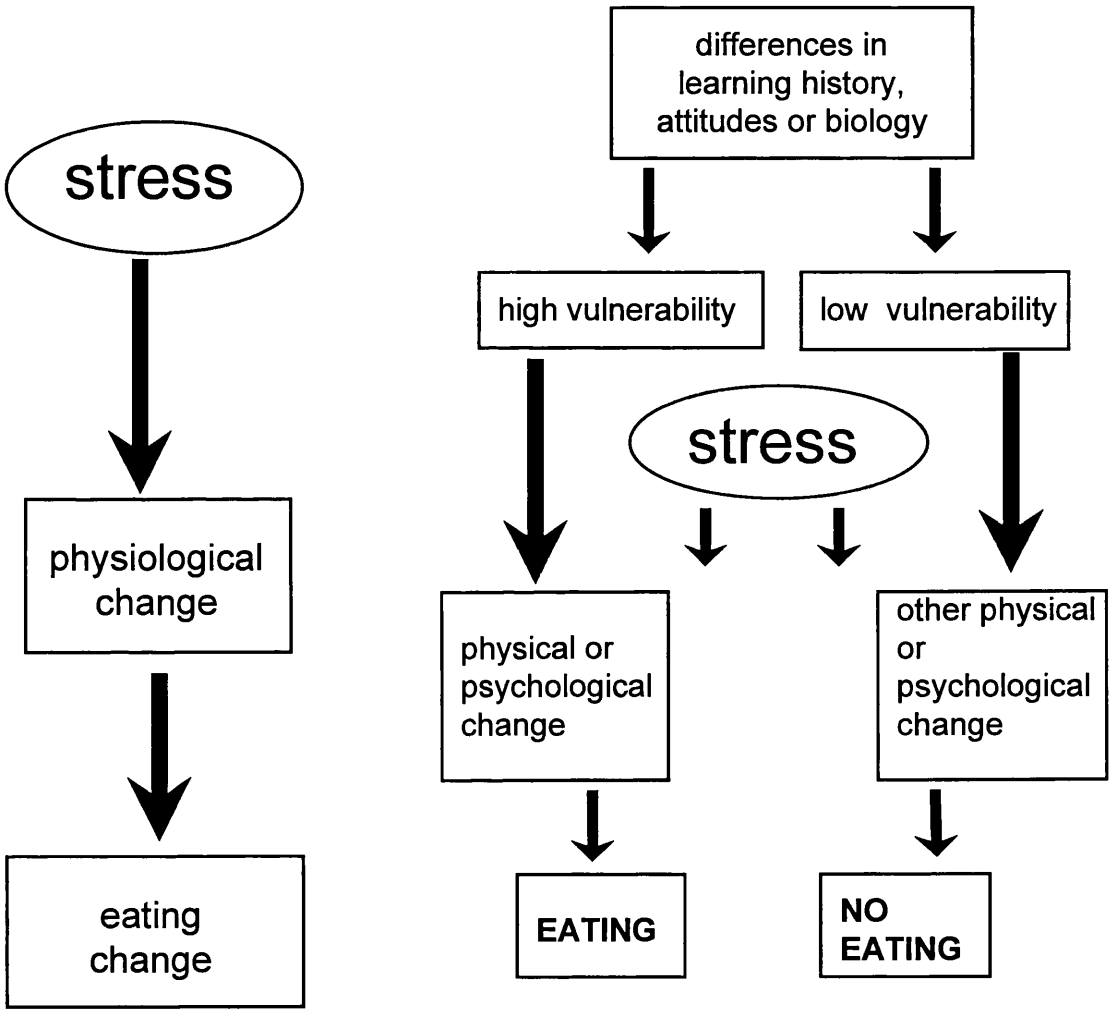
CHAPTER 1: INTRODUCTION

1.1 Background to the stress-eating relationship

A change in eating behaviour has long and widely been assumed to be one of the many effects of psychological stress. Despite this, evidence in support of the relationship appears to be largely anecdotal. The existing scientific literature is relatively sparse and, whilst seeming to indicate an association between psychological stress and food intake, there remains confusion as to the exact nature of this relationship. From what is known about the physiological effects of stress it might be predicted that stress would cause consistent decreases in eating (Cannon, 1915). This type of explanation is offered by so-called 'General Effect' models of the stress-eating relationship (see Fig 1.1; Greeno & Wing, 1994). In addition decreased eating may occur because coping activities directed at reducing stress take precedence over activities such as eating. Also incorporated into a general effect model is the possibility that eating behaviour is increased by stress, because the non-specific arousal induced by stress may energise eating behaviour, or because eating can reduce stress (Krebs, Macht, Weyers, Weijers & Janke, 1996). Both possibilities however leave little scope for the influence of cognitive factors; unsurprisingly much of the research in support of a general effects model comes from studies using animals.

The alternative is an 'Individual Differences' explanation (see Fig 1.1), in which differences in learning history, attitudes or biology determine the effects of stress on eating. The model suggests that identifiable groups will differ in their eating response to stress. Such an explanation would be more fitting in light of the

Fig 1.1 Models of the stress-eating relationship
(from Greeno & Wing, 1994)



The General Effect model

The Individual Difference Model

inconsistent findings from human stress-eating studies. It is becoming increasingly apparent that many factors, both physiological and psychological, are involved, and that the relationship between stress and food intake is far from simple. Furthermore, whilst the precise nature of the stress-eating relationship remains unclear, even less research has addressed the question of whether food choice, as well as overall intake, is influenced by stress.

There is a rather more substantial body of research on the relationship between depression and human eating behaviour. Depression is not synonymous with stress, but the two states may be thought of as overlapping constructs (Greeno & Wing, 1994). Depression, like stress, is an aversive state in which the well-being of the organism is impaired and in which demands outstrip coping resources. Lack of appetite and weight loss have been considered among the principal symptoms of depression (Beck, 1967), and depression in which weight has been gained rather than lost has been labelled 'atypical' (Rabkin et al, 1989). However studies such as those by Stunkard et al (1991) which showed that between 34 and 54% of depressed patients gained weight during their depression, indicate that weight gain may be a more common response to stress than was thought previously. This raises the question of why some depressed individuals gain weight whilst others lose weight; and also whether comparable processes are occurring in the case of stress.

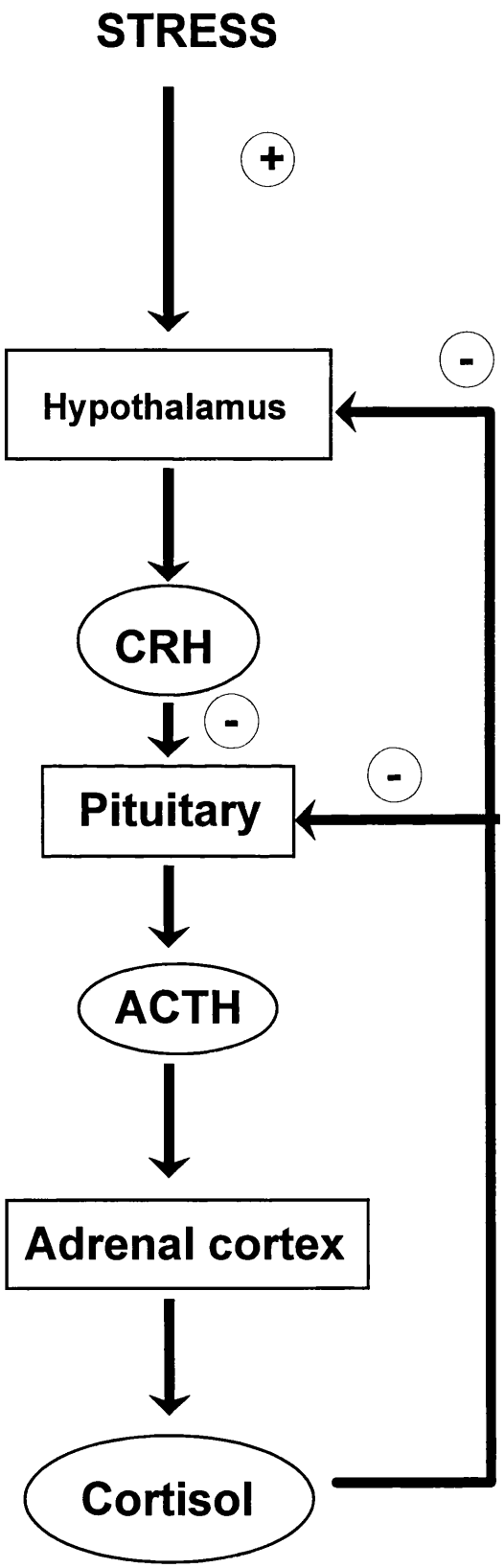
1.2 Stress Physiology and the Stress-Eating Relationship

The experience of an event perceived as stressful evokes a complex physiological response to enable an individual to cope with impending challenge.

Activation of various neuroendocrine systems results in increased levels of circulating stress hormones, predominantly the catecholamines adrenaline and noradrenaline, but also glucocorticoids (predominantly cortisol in humans). Catecholamines exert the dominant influence during acute stress; cortisol plays a greater role in chronic arousal states. Psychological stimuli which affect emotion and result in fear, anxiety or frustration, are the most potent triggers of cortisol release (Mason, 1968). It is important to note that the stress response is essentially adaptive rather than harmful, and its function is to re-establish the state of homeostasis which has been disrupted by stress. It becomes a threat to health only if the stressed state is unduly prolonged, and / or is combined with other threats to health in the form of 'unhealthy' behaviours, for example.

The physiological changes which occur during stress are primarily the result of increased activation of two neuroendocrine axes - the sympathetic adrenomedullary (SAM) and hypothalamic pituitary adrenal (HPA) axes. Both are regulated by negative feedback mechanisms - normally these contain the stress response but they may become altered or overridden in the face of a prolonged state of stress (see Fig 1.2). The SAM axis is concerned with release of the catecholamines adrenaline and noradrenaline, increased levels of which are characteristic of the acute stress response. The HPA axis controls release of cortisol; increased activation of this axis occurs at a later stage in the stress response and has a more homeostatic function. HPA axis activation characterises the chronic stress state - elevated cortisol release is achieved by shifts in production of cortisol-releasing factors; and reduction of negative feedback control.

Fig 1.2 Schematic representation of the HPA axis



An understanding of the physiological response to stress is necessary in any consideration of the stress-eating relationship because of its metabolic effects. These involve mobilising the body's energy stores to prepare an individual for imminent challenge - the 'flight or fight' reaction described by Cannon (1915). This occurs even when the physiological response has been elicited by a psychological stimulus. It is intuitive to suppose that such metabolic changes may affect ingestive processes. The action of stress hormones also produces physical effects on the gastrointestinal system. In addition, changes in levels of various neurotransmitters during stress may influence eating behaviour via effects on motivation / reward pathways.

Parallels between stress and depression in terms of similarity of affect, have been discussed above. It should also be noted that the depressive state shares with chronic stress a sustained increase in cortisol levels. This change is reportedly seen in approximately 50% of patients with major depression (Halbreich et al, 1985; Rubin et al, 1987). Evidence suggests that in depression, as in chronic stress, this hypercortisolaemia is the result of impaired negative feedback control of the HPA axis by corticosteroids, and this adds weight to physiologically-based comparisons between depression and stress with regard to their effects on eating behaviour.

1.2.1 Metabolic Effects of Stress Hormones

(See Fig 1.3)

The metabolic actions of stress hormones serve to increase available energy while protecting the supply of glucose to the central nervous system, by producing a shift in energy substrates from storage sites to the bloodstream. Increased plasma

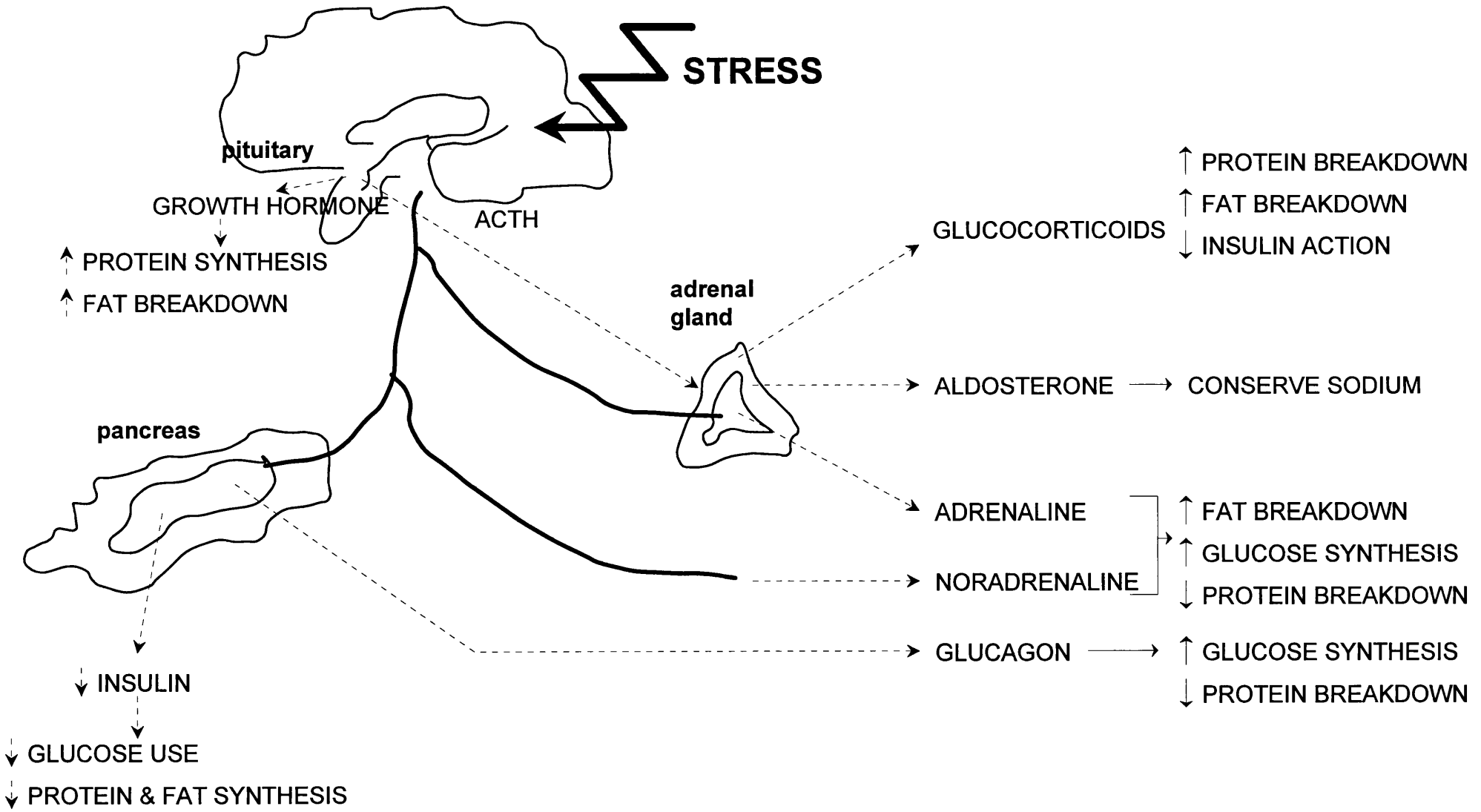


Fig 1.3 Schematic Representation of the hormonal / metabolic cascade triggered in a stress response (after Berdanier, 1987)

glucose is achieved via a number of mechanisms. Direct stimulation of adrenergic receptors in the liver increases hepatic glucose production acutely via enhanced enzyme activity, increasing glycogenolysis. Noradrenaline is capable of producing the same glycogenolytic response as adrenaline, but the circulating levels necessary for direct effects are usually only produced during very severe stress (Silverberg, Shah, Haymond & Cryer, 1978). The main hyperglycaemic action of catecholamines is indirect, and is mediated by alterations in levels of the pancreatic enzymes insulin and glucagon. The role of insulin in glucose homeostasis is to increase glucose uptake into the tissues, so decreasing blood glucose. Glucagon has the opposite effect; it acts to increase plasma glucose by enhancing its production. Secretion of both is in turn affected by blood glucose level.

During stress, direct adrenergic stimulation of the pancreas effectively desensitises it to glucose. Glucose thus becomes less effective at stimulating insulin secretion and inhibiting glucagon release. Normally in a hyperglycaemic situation the pancreas will secrete sufficient insulin to return blood glucose to normal levels. When the pancreas is 'desensitised' by adrenaline during stress, hyperglycaemia will be a less effective stimulant to insulin and inhibitor of glucagon secretion, so the blood glucose level will not be returned to normal, but instead to an elevated level. The catecholamines produced under stress effectively resets the level of glucose around which carbohydrate metabolism is regulated, resulting in hyperglycaemia.

Plasma glucose levels are also increased by the action of cortisol (Rizza, Mandarino & Gerich, 1982). In the liver, cortisol stimulates glucose production by modulating insulin action and enhancing gluconeogenesis (Shamoon, Hendler &

Sherwin, 1981). Thus the normally transient effect of these hormones is converted into a sustained elevation of plasma glucose levels. Cortisol sensitises adipose tissue to the lipolytic effects of catecholamines (Fain, 1980), so decreased insulin action and increased catecholamine stimulation due to stress enhance lipolysis and the supply of fatty acids and glycerol from fat depots. The glycerol is a precursor for gluconeogenesis, and free fatty acids are used directly as fuel by peripheral tissues.

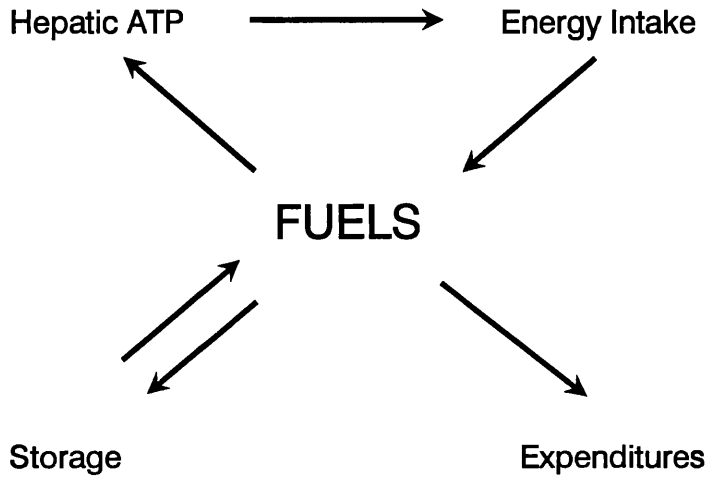
In muscles the decreased effectiveness of insulin combined with increased cortisol action can cause the breakdown of muscle proteins. The amino acids, together with glycerol and lactate, provide additional precursors for gluconeogenesis.

1.2.2 Effects of Stress-Induced Metabolic Change Upon Appetite / Food Intake

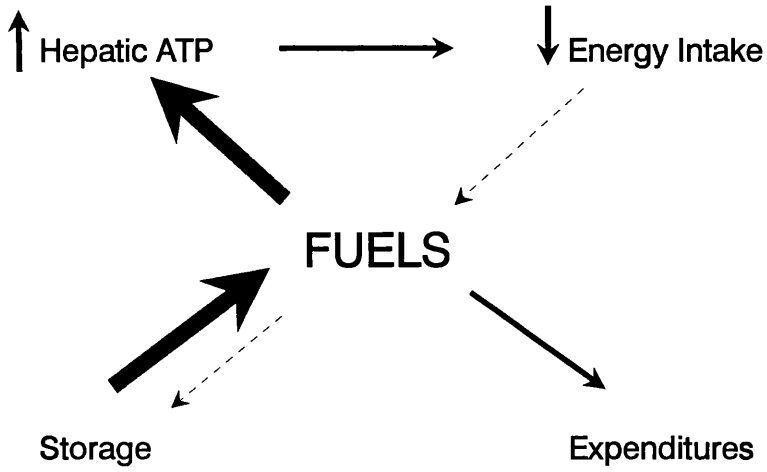
Changes in metabolism of the body's energy supplies, as seen during the stress response, are believed to influence energy intake via metabolic signals from the liver (Russek, 1981; Novin & Vanderweele, 1977; Vanderweele & Novin, 1981) via a change in levels of ATP (Rawson, Blum, Osbakken & Friedman, 1994). This is transmitted to the brain via vagal afferent neurones, and central nervous processes influence appetite and thus energy intake.

Friedman (1995) suggests that the interaction between these components of energy balance can be understood in terms of the 'partitioning of metabolic fuels'. In the normal, or steady state (Fig 1.4, (a)), equilibrium is maintained along all pathways so energy intake is unchanged. In a state of stress however, fuel mobilisation and oxidation are enhanced, a state comparable to the cachexia associated with various pathological states. Cachexia is characterised by anorexia and a rapid weight loss

Fig 1.4 Energy balance via the 'partitioning of metabolic fuels' (Friedman, 1995)



a) Hypothetical relation between fuel partitioning and control of energy intake under normal or steady state conditions



b) Hypothesized mechanism for decreased energy intake associated with excessive fuel mobilisation in cachexia (and possibly stress)

often in excess of what would be expected based on reduction of energy intake. Friedman (1995) suggests that this might reflect a shift in fuel partitioning (Fig 1.4, (b)). Under such conditions an excessive mobilisation and oxidation of body fat may drive ATP production in the liver sufficiently to reduce the signal to eat. The lack of appetite associated with cachexia is effectively the result of consumption of internal energy stores lessening the need to consume food.

As described previously, enhanced mobilisation of energy stores is also characteristic of the stress response, and it is therefore entirely possible that the effect of severe stress, in a manner similar to cachexia, is ultimately to decrease appetite and energy intake, and that weight loss will result.

1.2.3 Effects of Stress Hormones on the Gastrointestinal System

Several other lines of evidence suggest that activation of the biological stress response influences gastrointestinal function, and consequently eating behaviour. During stress, gastric emptying is delayed, while colonic motor activity increases (Monnikes, Schmidt, Tebbe, Bauer & Tache, 1994). These changes are brought about by stimulation from the vagus nerve and peripheral limbs of the autonomic nervous system which innervate the gastrointestinal system (Scolcia, Capella & Buffa, 1987). In addition, secretion of various neuropeptides in the vascular system supplying the gastrointestinal tract provide a direct link with the neuroendocrine and perhaps the immune system (Scolcia et al, 1987). Catecholamine release during stress decreases blood flow to the gastrointestinal system by diverting it to the skeletal musculature (Yardley & Hilton, 1987). In animals, corticotropin releasing hormone (which

triggers corticosteroid release and which is increased during stress (see Fig 1.2) has been found to inhibit gastric emptying, and also to stimulate colonic transit and faecal excretion (Monnikes et al, 1994).

A stress-induced delay in gastrointestinal transit time (as indicated by impaired handling of a glucose load) has been demonstrated in normal weight humans by Wing, Epstein, Blair & Nowalk (1985). Subjects were given an oral glucose load followed by either a 30-minute stressor, or 30 minutes of restful activity. The 30 minutes of stress significantly delayed the peak glucose response by delaying gastrointestinal transit time, as confirmed by assessment of breath hydrogen (Blair, Wing, Wald & McDermott, 1987).

As regards the effect that changes in gut motility might have on subsequent food consumption; procedures that delay gastric emptying have been shown to decrease food intake (Hunt, 1980; McHugh & Moran, 1979). Thus changes in gastrointestinal function as a result of stress may well be expected to decrease food intake and / or appetite.

1.2.4 Influence of the central nervous system on the action of stress hormones

In addition to the main hormones involved in the stress response, there are numerous other substances released during stress which have the potential to influence food intake mechanisms. The two most significant in terms of eating behaviour are opioids and serotonin because of their potential influence on food selection processes as well as on food intake in general.

a) Opioid Involvement

Activity of the endogenous opioid system is known to be increased during the stress response (Grossman, 1988). It is hypothesised that endogenous opioids act to moderate psychological and physiological reactions to stress; however support for this has been largely from observed analgesic and anxiolytic effects of exogenously administered opiates. Independent research has indicated a role for opiates in gastrointestinal motility, food intake and food choice in both rats and humans (Drewnowski, 1992). Opioid receptor antagonists have been found to reduce food intake in humans (Drewnowski, 1992) and it has been suggested from animal studies that opioids influence motivation and reward processes of appetite (Cooper, Jackson, Kirkham & Turkish, 1988; Reid, 1985) and pleasure response to foods (Cooper & Kirkham, 1990) rather than influencing substrate metabolism in the manner of glucocorticoids and catecholamines. In humans it has been demonstrated that where opioid antagonists have reduced food intake they do so without altering ratings of hunger (Trenchard & Silverstone, 1982; Fantino, Brondel, Swiergiel & Lebec, 1990), which also suggests an alteration in motivational rather than metabolic processes. Yeomans, Wright, McLeod & Critchley (1990) found that an orally administered opioid antagonist (nalfemene) selectively reduced intake of the most palatable foods. Recently, Yeomans & Gray (1997) found that the initial increase in appetite stimulated in hungry subjects by a palatable food was prevented by the opioid antagonist, naltrexone.

Drewnowski, Krahn, Demitrack, Nairn & Gosnell (1992) monitored change in preference for, and consumption of, mixtures of sugar and fat by female subjects

after receiving infusions of the opioid antagonist naloxone. It was found that opioid blockade did not affect the perception of sweetness intensity, but it did reduce 'pleasantness' ratings for all the sugar/fat mixtures, relative to control subjects not under opioid blockade. This suggests that opioid blockade decreases the sensory pleasure response to both sweet and high-fat foods, and by inference, that opioids themselves act to increase the pleasure response (although such inferences should be made with caution since opiate antagonists are known to produce nausea).

Whether changes in endogenous opioid levels produced by a stress response are sufficient to induce changes in eating behaviour such as have been demonstrated with endogenous opiates, remains speculative.

b) Serotonergic Involvement

Any discussion of neurophysiological mechanisms linking stress and eating should include the role of the neurotransmitter amine serotonin (5-hydroxytryptamine, 5-HT), which has been implicated in the control of appetite and food choice as well as depression, anxiety, food choice and the HPA axis (Blundell, 1984, 1991; Wurtman & Wurtman, 1984; Deakin & Graeff, 1991; Dinan, 1994; Cowen, 1996). A considerable literature exists to suggest that increased release of 5-HT suppresses food intake. As with research into the effects of endogenous opioids, much of the evidence has been gained from studies using exogenous agents such as the indirect 5-HT agonist / releaser fenfluramine. A role for 5-HT in appetite is also supported by evidence that compounds which suppress 5-HT release or postsynaptic activity increase food intake in rats (Blundell, 1991).

The effect of stress upon 5-HT release appears to be dependent on its temporal qualities. Acute stress in animals has been associated with increases in 5-HT release (Fulford & Marsden, 1998). Conversely, chronic stress appears to be associated with lowered brain 5-HT (Cowen, 1996) which may possibly be explained in terms of the HPA axis. Increased 5-HT activity in acute stress activates the HPA axis, thus increasing secretion of cortisol (Dinan, 1994; van Praag, 1996). However, chronically raised cortisol released during sustained stress reduces 5-HT function via several processes including diversion of its precursor tryptophan into other metabolic pathways (Chaouloff, 1993), and alterations in receptor sensitivity (van Praag, 1996) which are the opposite of those found in response to acute stress. Reduced 5-HT in turn maintains a state of hypercortisolaemia by attenuating feedback inhibition of the HPA axis by cortisol.

Despite the speculative nature of any conclusions which may be drawn, it is clear that the strength and temporal nature of stress may determine its effects. Many data are compatible with reduced appetite or increased satiety during acute stress. By contrast, chronic stress may lead to 5-HT dysfunction and receptor changes which might lead to weakening of satiety mechanisms and perhaps a preference for foods having particularly salient and pleasant qualities.

c) "Self medication" theories of stress-induced eating and serotonergic involvement

Synthesis of 5-HT is sensitive to availability of the precursor amino acid, tryptophan (TRP) (Fernstrom, 1987). TRP is an essential amino acid so cannot be

synthesised by the body and has to be obtained from the diet. Thus it is possible that 5-HT function is influenced by diet (or any effects of diet upon TRP availability to the brain).

An additional complication is that TRP competes with several other amino acids for the same transportation system from the blood to the brain, which means that the amount of TRP relative to these other amino acids crossing the blood brain barrier (BBB) is important. This ratio is affected by the carbohydrate to protein ratio of ingested food. High carbohydrate, low protein meals favour the entry of TRP to the brain for the following reason. Carbohydrate stimulates insulin release which increases the uptake of competing amino acids into the tissues (and so decreases their levels in the blood) (Fernstrom & Wurtman, 1972). Thus with the competition lessened, more TRP can cross the BBB and enter the brain. However, for this situation to occur the protein content of the meal must be less than about 5% of the total energy content (Yokogoshi, 1985; Teff & Young, 1988). The interval since, and nutrient content of the previous meal also have an effect (Fernstrom & Fernstrom, 1995). There is evidence that dietary availability of TRP can influence brain function in humans; a TRP-free diet (which presumably decreases 5-HT function) can induce depression in previously recovered depressives or in people with a genetic predisposition to depression (Delgado, Charney, Pine, Landis & Heninger, 1989; Van Praag, 1996). This has led to the proposal that states associated with reduced 5-HT such as depression (and also chronic stress) can lead to preferential selection of carbohydrate over protein (Wurtman & Wurtman,1984, 1989) in attempts at 'self-medication' to correct 5-HT levels (Wurtman, Wurtman, Reynolds, Tsay & Chew,

1987). Such ideas have been heavily criticised (eg Booth, 1987) as they depend on subjects' ability (human or animal) to recognise and select varying amounts of protein and carbohydrate from mixed diets. This is unlikely; the only possible mechanism is that subjects can learn an association between certain dietary cues and post-ingestional consequences specific to one macronutrient or another. However, changes in 5-HT release have not been found to affect preferences for such learned nutrient-specific dietary cues (Gibson & Booth, 1988; Baker & Booth, 1990). Also it is rare to find foods which contain as little as 5% protein (Teff & Young,1988).

1.2.5 Implications of stress physiology for food choice

As has been discussed, stress physiology may result in suppression of hunger and appetite in the short term, but the mobilised substrates will eventually be utilised leaving depleted energy stores in need of replacement. One adaptive mechanism for ensuring that at least a necessary minimal energy intake is maintained in the face of reduced appetite could be if food preference shifted toward energy dense foods (such as high fat, high sugar foods) which occupy relatively little volume in a situation where gastric function is inhibited. Such energy dense foods are also those which are generally perceived as being highly palatable and so it would be appropriate that preference for these foods may be further enhanced during stress by such opioid and serotonergic mechanisms as described previously (viz Mercer & Holder, 1997).

1.2.6 What are the health implications of stress-induced changes in eating?

Changes in eating behaviour and/or food choice during stress could form an indirect, behaviourally-mediated link between stress and its associated disease states. That stress influences the aetiology and maintenance of illness is already well-established (Steptoe, 1991); explanations have centred largely on the pathogenic potential of the neuroendocrine stress response, although more recently the literature on psychosocial factors in disease aetiology has begun to acknowledge the role of changes in health behaviours (Adler & Matthews, 1994; Steptoe & Wardle, 1994). Dietary selection may be considered a health behaviour in light of what is known about the contribution of excess consumption of certain dietary components, to the development of some of the major diseases of Western society. A high dietary intake of saturated fats, for example, has been associated with an increased risk of developing coronary heart disease (DOH, 1994) and also certain cancers (WCRF, 1997)

Research into health behaviours other than food intake has provided tentative support for a behaviourally-mediated link in the stress-illness relationship. A number of studies have shown associations between life events and excessive alcohol consumption (Jennison, 1992), or correlations between job stress and smoking (Green & Johnson, 1990) and job stress and sedentary lifestyle (Johansson, Johnson & Hall, 1991). These are cross-sectional studies so it is not possible to ascertain cause and effect; the health behaviours could pre-date the onset of adverse life experiences, for example; but the associations do demonstrate that changes in health behaviours have a potential influence on the aetiology of stress-linked disease. Steptoe et al.(1995)

have also found evidence that such behaviours as exercise and healthy nutrition are most vulnerable to disruption by environmental demands, compared to behaviours involving habits or routines, such as seat belt use or substance abuse.

Changes in eating in response to stress may in themselves lead to general over- or under-nutrition if repeated and sustained. Associations between excess consumption of energy and obesity have already been demonstrated (Prentice & Jebb, 1995). Obesity has been linked with the three biggest causes of mortality and morbidity in Western society - circulatory disease, cancers, and respiratory disease (Garrow, 1991). The primary metabolic defect in obesity is reduced sensitivity to insulin, from which follow all other metabolic characteristics associated with obesity, such as increased susceptibility to arterial disease (Shaper, 1988) and hypertension (Modan et al, 1985). Regardless of insulin insensitivity, obesity is associated with an unfavourable plasma lipoprotein pattern (also linked to coronary heart disease) (Shaper, 1988).

A high-fat diet is associated with increased daily energy intake (Tremblay, Plourde, Desprès & Bouchard , 1989; Tremblay et al, 1991) and body fatness (Tremblay et al, 1989). This may be due to the high energy density of fat - approximately double that of either carbohydrate or protein (Porikos, Booth & van Italie 1977; Duncan, Bacon & Weinsier, 1983) - or a passive overconsumption of fat due to its weak satiating ability (Lawton, Burley, Wales & Blundell, 1993; Blundell, 1993). Diets high in fat and low in fruit and vegetables have been associated with increased risk of lung, colorectal, breast, endometrial and prostate cancers (WCRF, 1997).

Sustained deficient overall energy intake resulting from stress-induced hypoglycaemia may also adversely affect health in the long term; tissue depletion of essential nutrients can lead to biochemical changes and eventually to clinical signs and symptoms. Protein-energy malnutrition and vitamin A deficiency are strongly associated with infectious disease and also with cognitive, behavioural and neurological deficits. Lack of dietary lipids has a substantial impact on autoimmunity; whilst insufficient levels of vitamins E and $B_{12,}$ and the minerals zinc, copper and selenium, can also adversely affect the immune system.

In cases where the effects of stress-induced eating have been considered, it has been with a focus on disease states resulting from over-, rather than under-consumption. This is most likely due to the perception of overconsumption as a more relevant threat to health in Western society than is underconsumption, rather than an assumption that hyperphagia is the predominant response to stress. In addition, evidence suggests that body weight regulation is more sensitive to underweight than overweight (Rogers & Blundell,1990); meaning that weight is more easily regained than is excess weight lost. Thus undernutrition is likely to be a more temporary state than is obesity, especially in Western society where there are no limits on food availability.

Threats to health posed by the various dietary practices above, may be enhanced if they are coincident with stress-induced physiological change. This interaction between physiology and behaviour may create a more pathogenic situation than would either process operating alone. For example, acute elevations in heart rate and blood pressure during stress have been implicated in the development of

atherosclerosis by damaging arterial linings (Brod, 1983). If such changes are concurrent with dietary changes also conducive to development of atherosclerosis , such as increased intake of saturated fats (McCann, Warnick & Knopp, 1990) the combined effect is potentially more harmful to health than is either process in isolation.

1.3 Stress and eating literature.

Existing studies have focused upon the effect of stress on overall energy intake, either as a contributory factor to weight gain (life events research, longitudinal studies) or in laboratory demonstrations of eating styles in various sub-groups of the population. The findings are equivocal in their evidence for a general hypophagic response as physiology might dictate. This implicates other factors in the stress-eating relationship.

1.3.1 Negative life events and weight change

Bradley (1985) surveyed 341 overweight people (241 women, 26 men) seeking medical assistance in losing weight, and asked them what conditions they believed had been associated with episodes of weight gain. 18% of the women and 21% of the men claimed that psychological stress had been associated with weight gain, although the reliability of this finding is obviously limited by reliance on self report and its concomitant biases.

In a prospective study of predictors of weight increase in male fire service personnel (Gerace & George,1996); those who reported experiencing financial worries

gained more weight than those free from financial stress over a period of seven years. However no relationship was found between self-reported stress and weight gain.

Rookus, Burema & Frijters (1988) monitored change in body mass index and negative life events using a retrospective questionnaire at 6-monthly intervals for a total of 3 years, in over seven hundred men & women. After one year, experience of many life events was associated with a gain in body mass index (BMI) in both men and women. After two years, however, the weight gained had disappeared in women, possibly due to dieting activity, but not in men, despite dieting attempts. Deurenberg & Hautvast (1989) conducted a longitudinal study in of the prevalence of overweight and obesity in about 4000 adult men and women over a period of 4 years. From twice yearly assessments of body weight and self reported incidence of life events an association was found between experience of life events, and body weight increase. As in Rookus et al's (1988) study, in the women this weight gain was temporary and was resolved by dieting activity.

Van Strien, Rookus, Bergers, Frijters & Defares (1986) investigated the role of emotional eating as a potential predictor of weight gain following life events. They found that, after 6 months, emotional eating (eating in response to various negative affective states) was associated with weight gain in men and women, but after 12 months this was true only of men. This again is suggestive of women's engaging in weight reducing behaviours following negative life events.

It may be the case that women's weight gain during periods of stress represents a natural tendency to gain weight over time which ordinarily would be suppressed or retarded by dieting behaviour and which is not practised by men. The notion that

stress does indeed disrupt weight control practices is supported in a retrospective interview study of 36 African-American women between the ages of 25 and 75 years (Walcott-McQuigg, 1995). Over 50% expressed the belief that stress negatively affected their weight-control behaviour - it is possible however that in this case attributions of the effect of stress have overestimated the association.

Foreyt, Brunner, Goodrick, Cutter et al (1995) conducted a study of the psychological correlates of weight fluctuation in 468 normal weight and obese adults. Those whose weight fluctuated by the greatest amounts over a 1-year period reported higher stress than those whose weight remained stable, regardless of body weight.

In Rand & Stunkard's study of normal weight and obese psychotherapy patients (Rand & Stunkard, 1978), obese individuals were more likely to report gaining weight during negative emotional periods (83% vs. 14%), and also more likely to report eating when depressed, anxious or angry (98% vs. 43%). In contrast, 53% of normal weight individuals reported that they sometimes lost their appetite when upset, and 20% reported losing weight, whereas none of the obese individuals reported losing weight during periods of stress.

Findings from life events studies seem to indicate a tendency to weight gain following negative life events, with this tendency being enhanced in certain groups of individuals. Retrospective studies such as those measuring weight change as a function of life events, are longitudinal but can offer only limited contributions to the understanding of eating behaviour under stress. The extent to which weight change under stress is attributable to diet is unclear since variables such as physical activity or metabolic change may also play a role, and in the existing studies no dietary data

is available. Thus studies with weight change as the outcome are instructive but not direct tests of the role of stress in eating.

1.3.2 Naturalistic studies

In some respects the relationship between stress and eating lends itself to investigation by naturalistic methodologies, which have the advantage of ecological validity and so avoid problems of generalisation to the real world. They allow food choices and eating behaviour to be assessed free from the constraints imposed by a laboratory environment; but in the real world, extraneous uncontrollable factors such as lack of time, availability of foods, social and economic factors, may also contribute to food choice. Methods available for measuring food intakes are limited in accuracy due to their reliance on self report measures known to be open to subjective biases and errors. For example several studies have shown that obese individuals underreport their dietary intake substantially, whether the intake is self recorded or assessed by interview (Black, Jebb & Bingham, 1991; Schoeller, 1990). Furthermore this underreporting has been shown to be selective; being greater for total energy than for protein (Heitmann & Lissner, 1995) which suggests that snack food items (high energy, low protein) are preferentially 'forgotten' in self report dietary measures by obese individuals.

Despite these disadvantages, naturalistic longitudinal studies do allow covariations between stressful events and dietary selection to be revealed which is important in assessing the potential impact on health of stress-induced changes in eating.

Several naturalistic studies have investigated the effect of stress on eating behaviour using examinations as the stressor. School and college examinations have the advantage of being precisely timed stressful events, and they are experiences that may be anticipated for days or even weeks, allowing systematic changes in food choice to emerge. However findings relating exam stress to food choice have been inconclusive, with no dietary changes being observed in some studies (O'Donnell et al, 1987; Niaura et al, 1991); increased energy intake in others (McCann, Warnick & Knopp, 1990; Michaud et al, 1990) and a decrease in 'nutritional quality' of diet occurring in another study (Weidner, Kohlmann, Dotzauer & Burns, 1996).

Michaud et al (1990) asked 225 French High School students aged 15-19 years to record their eating on the day of an examination, and again on a day with no exam. Although boys ate approximately 9% more calories on exam day, and girls only ate approximately 7% more calories, only the difference for girls reached significance. Both boys and girls showed a slight tendency to consume more fat on exam day. The distribution of calories throughout the day was not significantly affected by stress; boys consumed a slightly higher number of calories in snacks on exam day. However this study is weakened by the fact that time constraints affecting eating may be different on stressful days. There is no non-stressed group to dis-confound time and stress-level; a problem seen in many of the naturalistic studies.

Pollard, Steptoe, Canaan, Davies & Wardle (1995) conducted an exam stress study which did include a control group and also assessed trait anxiety and perceptions of social support availability. They found no overall change in total energy intake, nor in the proportion of energy obtained from fats, protein, starch or sugars, between

control and exam stress students; but did find significant interactions between trait anxiety and social support. Anxious students with poor social supports showed an average increase of 19.7% in total energy intake from baseline to exam sessions, while the group with low anxiety and good social supports reduced intake by 14.4%. There was also an increase in total fat intake of 28.5% and in saturated fats of 32.1% in the high anxiety / low social support students in anticipation of exams. This effect highlights the importance of individual differences (trait anxiety, social support networks) in influencing the effect of stress on food choice, and thus may offer some explanation for the discrepancy of findings from studies apparently similar in design.

Other studies have evaluated the impact of work stress on food choice. As with examinations, work load may be quantified objectively as well as subjectively appraised. McCann et al (1990) followed a small group of predominantly female office workers over periods of high and low work-load, using 4-day food diaries to assess food intake. The energy value of the diet, total fat intake, and percentage energy derived from fat were found to be significantly greater during periods of high than low work load. However the validity of these findings is limited by the small sample size (n = 14) and lack of a control group.

Bellisle et al's (1990) study of stress and eating behaviour (also in a small sample of 12 men) used an acute stressor (imminent hernia surgery) and a single meal intake (allowing precise intake measures) as distinct from those studies using 24-hour (or longer) dietary recall schedules. Intake from a buffet-style lunch was measured on the day prior to surgery, and again in the hospital environment one month later. Although the men's rating of anxiety was significantly higher on the day before the

surgery, neither total energy intake nor macronutrient composition of the meals eaten, differed on the two test days. The importance of individual variation is highlighted in this case by the observation that intakes ranged from eating 125% more on pre-surgery day, to eating 53% less, which may have contributed to the apparent overall lack of effect of stress on intake.

Popper, Meiselman, Smits & Hirsch (1990) conducted a study based on the assumption that stress has a general hypophagic effect. This is distinct from the majority of the literature which if anything has tended to assume that stress elicits a hyperphagic response. As such this study has been widely cited, despite its methodological inadequacies. Retrospective questionnaires were used to assess changes in eating habits of 475 male soldiers in combat situations during the Vietnam war. In the first combat situation the soldiers encountered (which was presumably the most stressful due to its novelty), 68% reported eating less and only a small percentage reported eating more. However the reliability of this finding is questionable because the data are based on recall of events occurring at least ten years previously.

Other naturalistic studies, rather than looking at the effect of a specific 'stressor' upon eating, have taken daily measures of mood and food intake, assessing covariations between the two. Leon & Chamberlain (1983) found that those individuals who had been unsuccessful in maintaining a previous weight loss were more likely to eat in response to cues unrelated to eating, such as negative moods. Lowe & Fisher (1983) compared normal weight and overweight female college students by monitoring mood prior to eating for 13 consecutive weekdays. They

found that overweight subjects were more likely to eat when in a negative mood, but not significantly so. Overweight subjects also had a higher intensity of emotion before eating snacks, but again, this was not significant. Lowe & Fisher (1983) also analysed the intake data in terms of meals and snacks eaten, and found an interaction between weight status and type of mood for snacks but not for meals; overweight subjects ate more calories in a snack if they were experiencing a negative mood, for normal weight subjects eating more calories as snacks was associated with a positive mood state. This study thus provides some evidence linking eating with negative emotional states, at least in some overweight individuals.

Stone & Brownell (1994) took a similar approach but measured 'daily hassles' as well as mood; both were recorded on a daily basis and independent of episodes of eating. The period of recording was at least 84 days. However, Stone & Brownell do not present such a detailed record of food intake as do Lowe & Fisher (1983); the former was designed originally to investigate stress and coping. Consequently the intake measure is rather crude, merely requiring participants to respond to the question "Did you eat (1) more, (2) the same or (3) less than usual today?". This aside, the study does reveal some interesting associations between stress and its perceived effect on eating behaviour. A variety of responses were reported by the participants (married couples), although the majority (82%) were consistent in the direction of reported change in eating with successive episodes of stress. Of these, the predominant response to stress was hypophagia (72%). However these data are heavily reliant on self-report and does not take into account variations in awareness of food intake between individuals.

A study by Steptoe, Lipsey & Wardle (1998) used a similar approach to Stone & Brownell (1994) but took much more detailed measures by having participants complete daily and weekly diaries of food intake, psychological stress and hassles. Steptoe et al (1998) assessed the importance to the participants, of choosing foods that help maintain positive moods, using the mood scale of the Food Choice Questionnaire (Steptoe, Pollard & Wardle,1995), and examined the influence of tendency towards 'mood eating' upon eating when stressed. The main finding for all participants was that the number of fast food meals eaten increased during periods of high stress. Cheese was eaten more frequently by high mood eaters under stress, whilst sweet foods were eaten more during stress but only by those with low scores on the mood eating subscale.

No clear conclusions may be drawn from naturalistic studies as to the effects of stress on eating. This is most likely due to their common failure to take into account relevant individual difference parameters, but also to the constraints on accuracy of recorded dietary information in a real world environment.

1.3.4 Laboratory studies of stress and eating

Laboratory studies of stress generally involve exposing subjects to a short-term aversive experience, such as a mood manipulation, cognitive task, or physical stressor. The laboratory situation has the advantage that each subject can be exposed to the same stressful experience, subjective reports of which may be corroborated with physiological stress indices. However laboratory stressors are clearly weaker and more acute than are those experienced in the real world, so the impact on the

individual is likely to be less severe. The laboratory situation allows greater control over the conditions in which eating takes place. Food intake may be determined with greater accuracy than is possible with subjective indices, although the artificiality of the eating environment may offset this advantage.

Early literature in the area of stress and eating focused on obese populations (Abramson & Wunderlich, 1972, Ruderman, 1983). Interest grew from the observation that, when stressed, obese individuals tended to show either no change in intake (Schachter, 1968) or an increased food intake (McKenna, 1972; Ruderman, 1983). This was in contrast to what might have been expected on the basis of prevailing physiological theories of stress (eg Cannon, 1915), where increased blood glucose levels due to increased sympathetic nervous system arousal predicted a stress-induced decrease in eating.

The apparently anomalous response of obese individuals has been interpreted mainly in terms of such psychological characteristics as heightened sensitivity to external environmental cues to eating (Schachter, 1968), or mislabelling of emotional signals as hunger signals (Bruch, 1961). In both cases the explanation involves the overriding of internal physiological signals by psychological cues.

An important departure from this line of thought was the notion that the best predictor of eating behaviour under stress was not body weight, but the degree of 'restraint' which an individual habitually imposed upon food intake. The subsequent proliferation of studies comparing 'restrained' and 'unrestrained' eaters has identified the construct as an important predictor of stress-induced changes in eating, although it should be borne in mind that restraint may merely be a part of a more pervasive,

hitherto undefined set of individual characteristics. Herman & Mack (1975) were the first to classify individuals (on the basis of scores on their Restraint Scale) as restrained eaters (dieters), or unrestrained eaters (non-dieters). The importance of body weight in predicting eating under stress apparent in earlier studies was then explicable in terms of the fact that many obese individuals chronically restrain their food intakes in attempts to lose weight. Subsequent studies have noted a positive correlation between BMI and dietary restriction (eg Wardle & Marsland, 1990) which serves to emphasise this point, although many restrained eaters are of normal weight.

Central to the concept of dietary restraint is the idea that in restrained eaters cognitive influences outweigh physiological influences in dictating eating. This under-reliance on physiological stimuli to eating has been offered as an explanation for the fact that, when stressed, restrained eaters, like obese individuals, increase their intake, often to the point of exceeding the normal intake of unrestrained eaters. This has been termed 'disinhibited eating'; a consequence of the disinhibition of habitually imposed strict dieting rules.

Studies investigating the influence of restraint in the stress-eating relationship have shown a general pattern of hyperphagia (disinhibited eating) in stressed restrained eaters, and no change or decreased eating in stressed unrestrained eaters. In the first such study, Herman & Polivy (1975) manipulated anxiety by leading subjects to expect painful electric shocks (high anxiety) or mild electric shocks (low anxiety). A stress x restraint interaction was found; however, tests of the simple effects underlying this interaction were not entirely consistent with the disinhibition hypothesis. As predicted, unrestrained eaters ate significantly less in the high- than

the low-anxiety condition. However, restrained eaters ate slightly, but not significantly, more in the high- than the low-anxiety condition. The majority of subsequent laboratory studies of stress and eating in restrained and unrestrained eaters did in fact demonstrate disinhibited eating by stressed restrained eaters; Herman & Polivy's (1975) failure to do so has been attributed to the nature of the stress manipulation, in terms of the reaction invoked in subjects. Several other studies comparing obese and non-obese individuals found similar results when using manipulations of physical fear (Schachter , Goldman & Gordon, 1968; McKenna, 1972). Obese individuals did not eat significantly more when anxious; normal weight subjects ate significantly less.

On the other hand, experimental manipulations that threatened subjects' egos or emotional tranquility (failure, or mood manipulations) did support the disihnibition hypothesis; appreciably increasing eating in dieters, whilst having little effect on normal weight, non-dieters (Baucom & Aiken, 1981; Frost, Goolkasian, Ely & Blanchard, 1982; Herman, Polivy, Lank & Heatherton, 1987; Ruderman, 1985; Slochower, 1976; Slochower & Kaplan, 1980, 1983; Slochower , Kaplan & Mann, 1981). Burdon & Paul (1951) listed the ego-threat fear of social failure as being one of the most common factors to precipitate eating by obese individuals. Heatherton, Herman & Polivy (1991) compared effects of anticipation of a shock with an actual ego threat (task failure) and an anticipated ego threat (anticipated speech performance). Ego-threatening stressors, whether real or anticipatory, were found to be particularly potent elicitors of stress-induced hyperphagia in restrained eaters, compared to physical threats. Abramson & Wunderlich (1972) also compared shock

threat with interpersonal anxiety but did not produce similar findings with obese male subjects. One possible explanation for this is that obesity is more highly correlated with restraint in women than in men.

The question arises of what makes these stressors qualitatively different in terms of the reaction they invoke. Herman, Polivy & Heatherton (1990) suggest that physical fear suppresses hunger sensations which are attributed to physiological mechanisms. Ego-disruptive manipulations increase eating in obese or dieting individuals because they disrupt inhibited behaviours and outweigh the suppressive autonomic effects which are in any case weaker for ego-threats. Hodges (1968) found that physical (shock) threats had a more powerful effect on heart rate than did task failure. Task failure, by contrast, was found to have a greater effect upon psychological indices - that is, perceptions of distress. Thus when it comes to eating behaviour, not all stressors are equivalent, and this makes comparisons across studies even more problematic.

An important feature of laboratory stress-and-eating studies is their almost universal employment of a bogus 'taste test' paradigm to assess intake. Food eaten can be recorded accurately using pre-weighed amounts of food, whilst avoiding sensitising subjects to the true focus of the study. There have been few departures from the taste test scenario in terms of presenting food in a meal format or as a selection of foods. The aim of the existing studies has been largely to detect general hyper- or hypophagic effects of stress so creating opportunities for food choice would be an unnecessary complication. Consequently very little can be ascertained from the literature regarding patterns of food selection during laboratory stress.

Foods used in 'taste test' studies include ice cream (Herman & Polivy, 1975; Ruderman, 1983; Herman et al, 1987; Heatherton, Herman & Polivy, 1991); cookies (McKenna, 1972; Polivy, Herman & McFarlane, 1994) and crackers (Schachter et al, 1968; Abramson & Wunderlich, 1972; Baucom & Aiken, 1981; Ruderman, 1985). All these foods may be considered as snack foods and thus carry with them conventions concerning their role in diet, time of day at which they are commonly eaten, and quantities in which they are usually consumed, which is an important consideration.

In several studies eating has been presented as an incidental activity in which subjects could engage if they wished, whilst completing other tasks (Schotte, Cools & McNally, 1990; Steere & Cooper, 1992; Slochower, Kaplan & Mann, 1981). There are obvious problems with this approach; where eating is an optional task the measure obtained may reflect merely the decision to eat or not to eat, and group mean intakes may be lowered dramatically by subjects' choosing not to eat. Quantities eaten may again be influenced by the fact that the foods used are snack foods such as M&M's.

A laboratory study conducted by Grunberg & Straub (1992) is one of the few to investigate food choices under stress, more specifically, the choice of foods from different taste categories. When male and female subjects were given access to a supply of sweet, salty and bland foods, those men who had been watching a stressful film at the time, ate significantly less of all the foods than men watching a 'neutral' film; women who had watched the stressful film showed a trend towards eating more sweet and bland foods than women in the control condition. Despite the attempt to assess food choice, the types of food used in the study were all snack foods ('M&M's,

peanuts, wafer biscuits) and as such did not represent a range of foods with different dietary roles.

A thorough investigation of stress and food choice requires that comparisons be made between, for example, 'meal component' foods and 'snack foods' as well as between foods from different taste categories or with different nutritional compositions. Admittedly this is limited in a laboratory context, yet only one of the naturalistic studies (Lowe & Fisher, 1983) assesses dietary data obtained, in terms of 'meals' & 'snacks' eaten.

Several studies have suggested that hunger level is influential in the stress-eating relationship, yet in general this does not seem to have been taken into account in the literature, particularly in laboratory studies. As a result, subjects in different studies are in widely different states of deprivation at the time of participation. Herman et al (1987) manipulated subjects' hunger using a milkshake preload; then issuing a speech threat. They found that the usual anxiety x restraint interaction in a subsequent taste test was seen only in hungry subjects. When not hungry, neither restrained nor unrestrained eaters were affected by anxiety. The use of a preload to manipulate hunger is, however, questionable, since this manipulation itself is known to disinhibit eating. Steere & Cooper's (1992) study produced opposite findings - anxiety suppressed eating in hungry restrained eaters. Here, hunger level was not manipulated but perceived hunger upon arrival was recorded and used as a covariate in analyses.

Despite the conflicting findings it is clear that hunger does play a role in the stress-eating relationship, at least in individuals whose eating behaviour is vulnerable

to disruption by emotional stress. It can be seen that comparisons across studies are unreliable if hunger is not controlled for.

Existing laboratory studies of stress and eating have identified several mediating factors - namely restraint, hunger level, and type of stress - which should be considered in future studies, whilst taking advantage of the control which the laboratory environment permits over the conditions under which food selection processes may be assessed.

1.3.5 Clinical Studies

Further evidence for an influence of stress on eating behaviour may be drawn from clinical studies. Stress is a factor commonly noted as being associated with the onset of clinical eating disorders such as binge eating and bulimia. Studies have estimated that for around 40% of bulimics the onset of binge eating is associated with negative emotional states such as depression, loneliness or boredom (Yates & Sambrailo, 1984; Johnson et al, 1982). In a questionnaire survey comparing bulimic students and normal controls (Wolf & Crowther, 1983), there appeared to be a relationship between the amount of stress the bulimics believed themselves to have experienced, and the severity of their binge-eating. In addition, various studies have demonstrated a relationship between experience of stress and onset of anorexia nervosa (Beumont et al 1976; Horesh et al, 1995).

Several studies of weight loss attempts by obese individuals have indicated that relapses in dietary control are frequently attributed to negative emotional states created by stress (Leon & Chamberlain, 1973; Sjoberg & Persson, 1974; Rosenthal

& Marx, 1981).

These associations have not been discussed with the implication that similar processes influence stress and eating in non-clinical populations, rather to illustrate the variety of areas in which the stress-eating relationship is of significance.

1.3.6 Animal Studies

Laboratory studies of the stress-eating relationship in animals, though predicting a general effect have as a whole produced conflicting data (Greeno & Wing, 1994). Various external factors have been cited by way of explanation.

An important factor to consider is that a range of different stressors have been employed in these studies. Those using electric shock (Siegel & Brantley, 1951; Ullman, 1951, 1952), noise (Kupferman, 1964; Rasbury & Shemburg, 1971; Wilson & Cantor, 1986), tail pinch (Antelman & Szechtman, 1975; Levine & Morley, 1982) or social conflict (Teskey, Kavaliers & Hirst, 1984) report increased eating. On the other hand, experiments using cold swim stress (Waggoner et al, 1985; Vaswani, Tejwani & Mousa, 1983) or behavioural restraint (Krahn, Gosnell, Grace & Levine, 1986) report decreased eating. The intensity of the stressor has also been shown to modify its effect on eating behaviour in animals. Where electric shock has been used, high intensities decrease, but moderate and low intensities increase eating behaviour (Strongman, 1965; Strongman, Coles , Remington & Wookey, 1970). The duration of the stress also affects eating behaviour. For example, eating is increased by acute noise (Kupferman, 1964) and shock exposure (Ullman, 1951, 1952) but chronic noise (Alaria, Gamallo, Beato & Trancho, 1987) and shock exposure (Pare, 1964, 1965)

appear to decrease eating . Some studies also demonstrate the moderating influence of deprivation level (Mirsky & Rosvold, 1953) and prior stress experience (Wilson & Cantor, 1986) which are potential sources of variation in findings from animal studies. The studies also differ in the timing of intake measures, which could influence results; for example, mild electric shock has been shown to increase food intake during exposure, but to reduce it afterward, compared with a non-shocked control group (Sterritt, 1962, 1965).

Quite apart from the sources of variation mentioned, it is very difficult to ascertain whether a particular manipulation is eliciting 'stress' in an animal, as opposed to any other negative response. Thus the extent to which findings from animal studies of stress and eating, can be applied to human research, is uncertain.

1.3.7 Summary of existing literature on the stress-eating relationship

Different designs have the potential for addressing different questions but there is no good evidence that different designs give systematically different answers to the question of how stress affect eating. Thus there is much to be gained from employing a variety of methodologies in the attempt to further elucidate the nature of the stress-eating relationship. Table 1.1 gives a summary of current findings.

Table 1.1 Summary of studies of stress and eating behaviour

Key: n/w - normal weight; o/w - overweight
R - restrained eaters; NR - unrestrained eaters
(R)RS - (Revised) Restraint Scale

Author	Subjects	Type of stress	Design	Variable(s) Investigated	Type of food	Effect of stress on overall intake (compared to control condition)	Effect of stress on macronutrient selection / intake
Abramson & Wunderlich, 1972	33 n/w and 33 o/w men	Fear (shock threat) vs interpersonal anxiety vs control	Acute, between subjects, taste test	Weight	Crackers	o/w men - No difference between the 3 conditions n/w men - stressor not effective	n/a
Baucom & Aiken, 1981	18 men, 38 women divided into n/w and o/w (n=28 in each)	Negative mood induction - Task failure vs control	Acute, between subjects, taste test	Weight Sex Restraint (self report)	Crackers of different flavours	R : ++ intake with -ve mood NR: No sig effects but slight -- intake with -ve mood ($p<0.06$) No effect of weight	n/a
Bellisle et al, 1990	12 n/w men	Anticipation of surgery	Within subject, test meal 1 day pre-surgery vs. 1 mo. Post-surgery. No control gp	none	Choice of foods from test buffet-style lunch	No difference between stress & non-stress days	No effect
Cools et al, 1991	91 female students	Stressful film (vs comedy film and neutral film)	Acute, between subjects Eating as an incidental activity	Restraint (RRS)	Popcorn provided during films	R: ++ intake with stressful film **and** comedy film NR: no effects	

Table 1.1 contd...

Author	Subjects	Type of stress	Design	Variable(s) Investigated	Type of food	Effect of stress on overall intake (compared to control condition)	Effect of stress on macronutrient selection / intake
Frost et al, 1982	55 female students	Depressed vs elated vs neutral mood induction	Acute, between subjects Eating as an incidental activity	Restraint (RRS)	Candy (M&M's)	R: ++ intake in depressed mood compared to control **and** elated mood NR: No effects.	
Gerace & George, 1996	438 male fire-fighters	Some life stresses	Prospective study of weight gain	none	n/a		n/a
Griffin et al, 1993	32 male and 47 female students	Exam time vs. Non-exam time	Longitudinal, within subject, no control group, medium scale	Sex	'Choosing healthy foods'	no change	n/a

Table 1.1 contd....

Author	Subjects	Type of stress	Design	Varlable(s) Investigated	Type of food	Effect of stress on overall intake (compared to control condition)	Effect of stress on macronutrient selection / intake
Grunberg & Straub, 1992	26 male and 26 female n/w students	Stressful vs control film	Acute, Between subjects, incidental snack intake	Sex	choice of sweet/ salty/ bland snack foods during film	Men: -- intake of all foods Women: no sig effect but + sweet & bland food (almost 2x control women)	?
Heatherton, Herman & Polivy, 1991	75 female students	Fear (shock threat) vs ego threat (task failure) vs anticipation of ego threat (speech anticipation) vs control	Acute, between subjects, taste test	Restraint (RRS)	ice cream	R: no effect with shock threat ++ with real **and** anticipated ego-threat NR: -- intake with shock threat No effect with ego threats	n/a
Herman & Polivy, 1975	42 female students	Fear (shock threat) vs control	Acute, between subjects, taste test	Restraint (RS)	ice cream	R: no effect (non-sig +) NR: -- intake	n/a
Herman, Polivy, Lank & Heatherton, 1987	80 female students	Anticipation of ego threat (performance anxiety) vs control	Acute, between subjects, taste test Hunger manipulated by pre-load	Restraint (RS) Hunger	ice cream	R: ++ intake **if hungry** No effect if not hungry NR: -- intake **if hungry** No effect if not hungry	n/a

Table 1.1 contd....

Author	Subjects	Type of stress	Design	Variable(s) Investigated	Type of food	Effect of stress on overall intake (compared to control condition)	Effect of stress on macronutrient selection / intake
Leon & Chamberlain, 1973	26 female, 2 male 'regainers'vs 'maintainers' vs controls	Subjective (negative affect)	Within subjects; 24 hr dietary recall & mood ratings on 3 separate days incl. one w/e day	Sex Maintenance of weight loss	24 hr food record	regainers more likely to eat high cal foods between meals & in response to non-food cues	?
Lowe & Fisher, 1983	30 n/w and 17 o/w female students	Self reported mood prior to eating, measured on 13 consecutive weekdays	repeated measure, within subject, daily intake	Weight	food record	for o/w subjects, cals eaten in snacks during negative mood sig. higher than cals from snacks in positive mood.	?
McCann et al, 1990	14 women	High and low work load times. No control group.	within subjects; objective and subjective measures of stress	none	total intake over 4 days	higher total energy intake during high work load	higher total fat, sat. fat, % energy from fat ++ cholesterol
McKenna, 1972	40 n/w men 40 o/w men	Fear (shock threat) vs control	Acute, between groups, taste test	Weight Palatability	Tasty cookies; unappetising shortbread	Tasty cookies: increase in stressed o/w, decrease in stressed n/w. No effects for unappetising food	n/a
Michaud et al, 1990	225 school students (78 boys, 147 girls)	Exam day vs 'no-exam' day	Within subjects; 24 hr recalled food intake	Sex	24 hr food record	girls ate more on exam day	boys ate more fat, both more snacks

Table 1.1 contd....

Author	Subjects	Type of stress	Design	Variable(s) Investigated	Type of food	Effect of stress on overall intake (compared to control condition)	Effect of stress on macronutrient selection / intake
Mitchell & Epstein, 1996	32 women	Stroop stress	Acute, between groups, appetite and intake (taste test)	Restraint (RRS)	hunger, food rating, salivation; intake of strawberry yogurt	R: no effect (non-sig +) NR: -- intake	n/a
Pine, 1985	80 white, 80 ethnic males & females, n/w and o/w	shock threat	Acute, between subjects, hi anx 'painful' shock threat; lo anx 'not painful' shock threat	Sex Weight Ethnicity	Peanuts	o/w subjects increase intake under stress n/w subjects no effect	n/a
Polivy, Herman & McFarlane, 1994	96 female students	anticipation of ego threat (public speaking)	Acute, between subject, taste test	Restraint	Cookies - good- vs bad-tasting	R: ++ intake of good **and** bad-tasting cookies NR: no effect for either good or bad-tasting cookies	n/a
Pollard et al, 1995	51 female, 64 male students	exams	within subject, control group no exams 24h dietary recall	Sex (?) Restraint	24 hour dietary record	no main effect of stress	Higher fat

Table 1.1 contd..

Author	Subjects	Type of stress	Design	Variable(s) Investigated	Type of food	Effect of stress on overall intake (compared to control condition)	Effect of stress on macronutrient selection / intake
Popper et al, 1989	475 marines	experience of combat	Reports of change in eating and reasons during combat	none	Recollection of amount eaten	Reduced during combat - lack of time and fear.	N/a
Rookus et al, 1988	745 men & women 20-35	No. of life events	Change in BMI in relation to life events over 1-2 years	Sex	Change in BMI	Men: ++ BMI with many life events at 1yr **and** 2yr follow-up Women: ++BMI with many life events at 1yr but **not** 2yr follow-up	n/a
Schachter, Goldman & Gordon, 1968	37 n/w 43 o/w	shock threat	Acute, between subjects, taste test	Weight Hunger	Crackers	?	n/a
Schlundt et al, 1991	236 o/w women	self reported mood	Naturalistic, within subject, daily intake.	Weight	Food record, daily intake for 14 days	increase under stress for some subjects	??

Table 1.1 contd..

Author	Subjects	Type of stress	Design	Variable(s) Investigated	Type of food	Effect of stress on overall intake (compared to control condition)	Effect of stress on macronutrient selection / intake
Schotte, Cools & McNally, 1990	60 women	stressful vs neutral (control) video	Acute, between groups, incidental eating	Restraint	popcorn	R: ++ intake NR: no effect	n/a
Slochower, Kaplan & Mann, 1981	14 n/w women, 23 o/w women	Medium term(?) stressor (exam); but acute intake measure	Incidental intake during distractor task once during exams then again 3 wks post-exams	Weight	candy (M&M's) - amount eaten 3g in n/w	n/w: no effect o/w: ++ intake during exam time assessment	n/a
Steere & Cooper, 1993	48 female students	False elevated HR feedback	Acute, between subjects; incidental eating	Restraint Hunger	Cashew nuts	R: -- intake if hungry No effect if not hungry NR: no effect, hungry or not hungry	n/a
Stone & Brownell, 1994	married couples (total n=158)	Daily stress	Longitudinal; 84 days; daily record of mood, events, & eating "more/ the same/ less than" usual	Sex	"Did you eat more/same/ less than usual?" for 84 days	**hypophagia** dominant response, especially at higher levels of stress. (higher levels of stress more people ate "less than usual"; no change in "more than usual")	n/a
van Strien et al, 1986	1280 men and women, full data on 302	Life events	Weight change over 18 mo in relation to life stress	Sex Emotional eating	Change in BMI	Men ; high emot. eating & -ve life events - ++ BMI Women: no association	n/a

1.4 Moderating variables & the role of individual differences in the stress-eating relationship.

1.4.1 Gender

Few studies of stress and eating have used mixed gender samples so direct assessment of the role of gender is made difficult. Comparing studies there is an indication that women tend to report eating more under stress (eg McCann et al, 1990; Rosenfield & Stevenson, 1988). In a study by Warr & Payne (1982) investigating reactions to emotional strain; women were significantly more likely than men to report eating more than usual (13% compared to 6%). Studies using male subjects tend to report hypophagic responses to stress (Popper et al, 1990). Bradley (1985) reported that stress was associated with weight gain in women but not in men. These studies are naturalistic; male subjects have seldom been used in laboratory studies because the focus has been invariably upon differences between restrained and unrestrained eaters, and there are so few male restrained subjects. The strong association between restraint and gender (Wardle, 1987) is an important consideration when drawing conclusions about the influence of gender on the stress and eating relationship.

One of the few studies to directly compare gender differences in eating behaviour under stress is that by Grunberg & Straub (1992) who examined differences in consumption of sweet, salty and bland-tasting foods by stressed men and women. They found that stressed men significantly decreased their consumption of all foods presented; women increased their consumption of sweet and bland foods but not significantly so. These findings are consistent with those discussed above, although

they have to be considered in light of the fact that total intake was extremely low for most subjects, with several individuals eating nothing at all. In addition, no measure of restraint was taken so it is quite possible that the apparent sex differences merely reflect differences in dietary restraint.

1.4.2 Dietary Restraint

The influence of dietary restraint in the stress-eating relationship has already been outlined. However it should be noted that restraint is merely a label and may tap into a set of more pervasive, stable traits which manifest themselves in a set of eating-related behaviours which, collectively, describe the restrained eater. It has been argued that restrained and unrestrained eaters differ along physiological dimensions such as experience of hunger and satiety (Herman & Polivy, 1984) but it seems likely that these apparent physiological differences are in fact driven by differences in psychology and that restraint describes a state that is primarily psychological. The fact that disinhibited eating may be elicited in situations where diet rules are falsely perceived to have been broken (Polivy, 1976; Spencer & Fremouw, 1979; Woody, Constanzo, Liefer & Conger, 1981) reinforces this explanation.

There is evidence to suggest that restraint itself is a part of a more collective group of psychological characteristics including traits such as self-esteem. Various studies (eg Polivy, Heatherton & Herman, 1988), have suggested that restrained eaters low in self-esteem may be particularly susceptible to the disinhibiting properties of of ego-threatening events. There is some evidence that restrained eaters as a group do have slightly lower self esteem scores than unrestrained eaters (Polivy,Heatherton &

Herman, 1988; Ruderman & Grace, 1988) although there is great variation between samples. As yet it is unclear exactly how low self-esteem explains disinhibited eating; as with restraint status, self-esteem level simply identifies types of persons who will be most responsive to certain manipulations, and thus is again a predictive, rather than explanatory variable. Ruderman (1986) suggests that restrained eaters' attitude to food is part of a more general set of "perfectionistic, absolutistic beliefs" (p.251) that they hold, characterised by "all-or-nothing", rigid, inflexible thinking. A study by Ruderman (1985c) found a negative correlation between restraint and rationality as measured by the Rational Beliefs Inventory (Shorkey & Whiteman, 1977). Such tendencies in the context of eating could increase the likelihood of disinhibited eating in response to a perceived violation of dietary rules.

1.5 Future Research

From the evidence discussed it is clear that the relationship between stress and eating in humans is far from simple and that many individual difference variables are involved. Thus far several variables have been identified which appear to play a role but the fact that they cannot fully predict eating behaviour under stress suggests that other as yet undefined factors play a part.

Not only does the effect of stress on overall food intake remain incompletely explained, but even less is known about changes in food choice in stressed individuals. Within broad, innate constraints (Booth, 1987), food choice is governed by both internal and external stimuli. Internal stimuli may be physiological (nutritional, metabolic or neurohormonal), or psychological (cognitive or emotional), while

external stimuli may be sensory (taste, texture, odour) or environmental, including social. With such a variety of potential sources of variation it is unsurprising that few consistent answers have been produced by existing research.

The studies described in this thesis take an Individual Differences approach, and aim to investigate the influence of these many factors. These are subject to considerable individual variation, in the physiological as well as psychological domain, although it is psychological factors which will be focused upon here.

A questionnaire study is the starting point for this research. It aims to assess whether individuals believe that stress affects their own eating behaviour, and also investigates beliefs in stress-induced changes in food choices, taking into account the influence of both gender and dieting status.

Subsequent studies aim to test these beliefs. The *status quo* is that behavioural evidence (ie studies involving measurement of food intake) has failed to do either. Laboratory and naturalistic environments each have associated advantages and disadvantages, as has been discussed. The present research has therefore employed both methodologies in separate studies; the design of each attempting to maximise its own advantages, whilst incorporating some measures common to both methodologies for comparative purposes.

Although such studies provide an effective tool for investigating the validity of self report data, they provide only limited insight into the mechanisms underlying the observed behaviours. The interview data presented in the final study attempt to explore the stress-eating phenomenon in greater detail among a small number of individuals for whom eating when stressed is both a habitual and memorable

behaviour. Although such a qualitative study lacks the scientific rigour of quantitative research, such in-depth investigation can provide valuable illumination of the process by which certain patterns of food choice during stress (as evidenced by laboratory and naturalistic studies) may be acquired and maintained.

CHAPTER 2: PERCEIVED EFFECTS OF STRESS ON EATING AND FOOD CHOICE.

2.1 Introduction

The use of self-report measures to assess effects of stress upon eating has been confined largely to longitudinal studies involving recall of daily food intake and concurrent records of stressful events and emotional states (Leon & Chamberlain, 1973; Lowe & Fisher, 1983). Fewer studies have employed as a measure, participants' perceptions of daily intake relative to the amount usually eaten; the added subjectivity is viewed as an unnecessary complication in the already difficult task of accurately assessing intake. Longitudinal studies which have incorporated a 'relative' measure in daily records (eg "Did you eat 1) more; 2) the same; or 3) less than usual today ?") have tended to do so in addition to other recall methods (Rosenfield & Stevenson, 1986; Ogden & Mtandbari, 1997). The use of a relative measure alone (eg Stone & Brownell, 1994) has been criticised for its lack of sensitivity. Stone & Brownell (1994) themselves admit that "More specific measures of eating behaviour would also be desirable in research of this type.....We acknowledge this as a limitation and recommend that future studies assess eating from the outset with more comprehensive measures of food intake" (p.432).

The question of sensitivity aside, it has also been argued that post-hoc, 'relative' recall measures are subject to the influence of individual variation in sensitivity to diet and food intake. Thus, eating chocolate as a snack when stressed, may be an event far more significant and readily recalled for a dieter (who normally tries to avoid eating this food), than for a non-dieter for whom eating chocolate is perhaps less significant. This

may lead to exaggerated reports of stress-induced overeating among dieters relative to non-dieters, for example. However, perceived influences of stress upon eating may contribute to the overall explanatory picture, and so should not be overlooked. Post-hoc recall of eating behaviour when stressed may also have an advantage over daily records of relative intake by avoiding exaggeration of responses by stressed individuals which is caused by state dependency.

To date there are few well-designed self-report studies which address directly the perceived effects of stress on eating. In several studies eating is considered merely as one of a number of health behaviours potentially affected by stress, with the result that intake data lack sufficient detail to be informative (Weidner et al, 1996). Findings from other studies are unreliable due to methodological weaknesses. For example, Spillman (1990) claimed to show that under stress students reported increased consumption of 'comfort' foods and carbohydrates. However the questionnaire administered to the students addressed the issue of stress and habitual methods for its alleviation. The data on types of foods eaten under stress were therefore only available from those students who reported eating as a method of coping with stress, inevitably leading to bias in results. Furthermore the list of foods reportedly eaten during stress appears to have been generated spontaneously so results are not based on frequency of responses to a standard list of foods. Among the foods mentioned by students were those rather ambiguously termed "carbohydrates"; Spillman uses this as a basis for claims that "carbohydrates were most often used as comforting foods for both men and women" (p.502). This spuriously assumes respondents' awareness of the nutritional composition of foods. Popper et al (1989) conducted a retrospective survey using a sample of nearly 500 US marines,

assessing via questionnaire, their eating habits when faced with a stressful combat situation. They concluded that stress has a hypophagic effect on eating behaviour; yet this conclusion is based on responses to questions which are very specific considering the length of time which had elapsed since the stressful event (a minimum of 10 years). The accuracy and reliability of these findings are therefore questionable.

Willenbring, Levine & Morley's (1986) study directly addressed the question of perceptions of stress-induced eating. They administered an eating habits questionnaire to 80 men and 80 women; of whom the great majority were overweight and so might be expected to be sensitive about food intake. In fact 75% of subjects reported being at least somewhat unhappy about their weight, and 73% were currently dieting. The majority (92%) of the sample did report that their eating habits were affected by stress. However, responses were fairly equally distributed between eating more (44% of the sample) and eating less (48%), which perhaps suggests that the selective biases in perception postulated above, are not as strong an influence as might be hypothesised.

More recently, Weinstein, Shide & Rolls (1997) found that approximately half of a student sample reported that they "ate more than usual" or "binged" under stress. This reported hyperphagic response was more common in restrained eaters. Data were combined for the "ate less than usual" and "no change" response categories, so it was not possible to identify the frequency of stress hypophagia.

Perceived changes in types of foods preferred during stress are even less well documented. Willenbring, Levine & Morley (1986) asked their respondents to report whether they "preferred sweet or salty foods" but this was in general rather than specifically during stress.

Very little data exist examining changes in patterns of intake among stressed individuals. Stress may influence, for example, patterns of intake without altering overall intake or macronutrient composition of intake. Alternatively, in situations where changes in macronutrient intake with stress are detected, information about patterns of intake may provide explanations for these differences. Increased fat or sugar intakes as a result of higher intake of snack foods high in fat and sugar, is an example of such a situation.

2.1.1 Aims of this study

The aims of the present study were i) to evaluate the frequency of self-reported stress-induced hyperphagia and hypophagia; ii) to assess their association with dieting; and iii) to test the hypothesis that hyperphagia is mediated through snacks rather than meals, and is more pronounced for highly palatable foods.

2.2 Method

2.2.1 Participants and Procedures

212 undergraduate students (63 men, 149 women) from the Universities of London and Thames Valley, who were studying psychology as a main or subsidiary subject, completed a brief questionnaire during class lectures. They were told that the questions were about stress and eating, and were invited to stay and complete the questionnaire. There were only two uncompleted or spoiled forms.

2.2.2 Measures

(see Appendix 1 for full questionnaire)

Weight concern and Dieting Status.

Perceived overweight was recorded on a five point scale (very underweight, slightly underweight, about right, slightly overweight, very overweight).

Participants were also asked "Are you trying to lose weight at present?" - the response to this was used to indicate dieting status. This was preferred to the question "Are you currently on a diet ?" because this may be interpreted variously by different individuals.

Effects of stress on eating

. The perceived influence of stress on eating was assessed in relation to i) overall amount of food eaten; ii) amount of snacking, and iii) amount eaten of each of a list of specific types of foods. Included in the list were 'meal' type foods (meat or fish and fruit and vegetables), highly palatable snack foods (cakes and biscuits, savoury snacks and sweets and chocolate), and bread. In each case the amount eaten was assessed using the response options "much more than usual", "more than usual", "the same as usual", "less than usual" and "much less than usual". The two highest and two lowest categories were combined for some analyses. Participants were also asked whether, when stressed, they ate snacks instead of, or as well as, meals, or whether there was no change in their snacking behaviour.

2.2.3 Data Analysis

Test-retest reliability of the questionnaire was checked before it was distributed. Twelve subjects completed it on two occasions, two weeks apart. Reliabilities for each item ranged from 0.24 to 1.00 (median value 0.845) (see Table 2.1). The lowest and only non-significant reliability was for intake of cakes and biscuits.

Statistical differences in distributions of responses were assessed using a chi-squared test.

2.3 Results

2.3.1 Participant Characteristics

The 212 participants were predominantly white (69.8%) and female (70.8%). The cultural and gender imbalances reflected a higher proportion of white students and women among the student body rather than higher rates of completing the questionnaire in women. Mean (±s.d.) age of the sample was 24.4 (±7.3) years, ranging from 19 to 54 years. Men and women did not differ significantly in age (Table 2.2).

2.3.2 Weight control / Dieting Behaviour among respondents

Over half the participants (58%) felt that they were at the right weight, 13% rated themselves as slightly or very underweight, and 29% as slightly or very overweight (see Table 2.2). Consistent with many other findings, there was a significant gender difference ($X^2[4] = 16.4$, $p<0.001$). More men than women described themselves as underweight (26% of men and 8% of women), and more women than men as overweight (34% of women and 16% of men).

Table 2.1 - Test-Retest Reliability - Correlations between scores two weeks apart for each item of the questionnaire (n=12)

Item	Spearman's r
Dieting status	1.00***
Perceived weight	1.00***
Overall amount of food	0.61*
Snacking	0.66*
Snacks: meals	1.00***
Bread	0.87***
Cakes & biscuits	0.24
Fruit & veg	0.82***
Meat & fish	0.85***
Savoury snacks	0.92***
Sweets & chocolate	0.79**

*** $p < 0.001$
** $p < 0.01$
* $p < 0.05$

Table 2.2 - Background characteristics of the study participants

	All respondents	Men	Women
N	212	63	149
Age - Mean yrs (±sd)	24.4 (7.3)	23.2 (6.3)	24.9 (7.7)
Currently trying to lose weight (%)	27.8	11.1	34.9
Perceived weight (%)			
very underweight	0.9	1.6	0.7
slightly underweight	12.3	24.2	7.4
correct weight	57.8	58.1	57.7
slightly overweight	26.1	16.1	30.2
very overweight	2.8	0.0	2.8

Twenty eight percent of the sample reported currently trying to lose weight, and will be subsequently referred to as "dieters". Dieting was more common among the women (35%) than the men (11%) ($X^2 = 12.48$, $p<0.001$). Perceived overweight was associated, though not synonymous with, trying to lose weight, with 35% of respondents who felt overweight trying to lose weight, compared with 19% of "correct weight" and 4% of "underweight" respondents. This effect was significant in both men ($X^2[3]= 9.8$, $p<0.05$) and women ($X^2[3] = 25.7$, $p<0.001$).

2.3.3 Overall food intake during stress

Most participants (81%) reported that stress influenced the overall amount of food that they consumed (see Table 2.3) but with approximately equal numbers reporting eating more (42%) as reporting eating less (38%).

Gender Differences

Combining the response category "much less...." with "less...."; and "much more...." with "more..." to give three categories; women were more likely than men to report an influence of stress on the overall amount that they ate; $X^2[2]= 6.54$, $p<0.05$. A higher proportion of women (46%) than men (34%) reported a hyperphagic response to stress; a slightly higher proportion of women (40%) than men (37%) also reported hypophagia in response to stress.

Dieter / Non-dieter Differences

Dieters were significantly more likely to report eating more or much more when stressed (59%) than were non-dieters (36%) ($X^2[2]= 8.9$, $p<0.05$) (see Table2.4). This

Table 2.3 - Amount of food eaten under stress - gender differences

	% all respondents (n = 212)	% of men (n = 63)	% of women (n = 149)
Much less than usual	9.0	3.2	11.4
Less than usual	29.9	33.9	28.2
Same amount as usual	18.5	29.0	14.1
More than usual	36.5	27.4	40.3
Much more than usual	5.2	6.5	4.7

Table 2.4 - Amount of food eaten under stress - dieting differences (percentages)

	Dieters (n = 59)			Non-dieters (n = 153)		
	all dieters (n = 59)	male dieters (n = 7)	female dieters (n = 52)	all non-dieters (n = 153)	male non-dieters (n = 56)	female non-dieters (n = 97)
Much less than usual	5.1	0.0	5.8	10.5	3.6	14.4
Less than usual	23.7	42.9	21.2	32.2	32.7	32.0
Same amount as usual	11.9	14.3	11.5	21.1	30.9	15.5
More than usual	47.5	42.9	48.1	32.2	25.5	36.1
Much more than usual	10.2	0.0	11.5	3.3	7.3	1.0

effect was not due to gender differences as it also emerged when only the women were considered ($X^2[2]= 7.1$, $p<0.05$). Among the female dieters, 61% reported a hyperphagic response to stress and only 28% reported hypophagia. There were too few male dieters to provide a robust test in the men. The distribution of responses amongst non-dieters was more even across categories, and there were no gender differences in response.

Because perceived weight and dieting are associated, it is possible that the apparent dieting effect could be related to (perceived) weight. However, within each weight category, dieters were more likely to report hyperphagia than non-dieters.

2.3.4 Snacking Behaviour During Stress

The majority of respondents (73%) reported eating more snacks when stressed, and only 13% reported eating fewer snacks (Table 2.5). This pattern did not differ significantly between men (68% eating more snacks) and women (75%) or between dieters (81%) and non-dieters (70%) (Table 2.6).

The fact that 73% reported eating more snacks under stress while only 42% ate more food overall, suggests a stress-induced shift from meals to snacks among some participants. This was confirmed by looking at whether frequency of reporting eating snacks "instead of meals", compared to "as well as meals" (See Tables 2.5 and 2.6). 47% of the sample reported eating snacks instead of meals under stress and 43% ate snacks as well as their meals. Differences by gender or dieting status were not significant. The results were consistent with reports of changes in amount eaten.

94% of those reporting increased eating overall also reported eating more snacks than usual. Of these, a significantly higher proportion (66%) reported eating these snacks

Table 2.5 - Snacking during stress - gender differences

	% of All respondents	% Men	% Women
Amount of snacks:			
Far fewer than usual	3.3	3.2	3.4
Slightly fewer than usual	10.0	9.7	10.1
Same number as usual	13.8	19.4	11.5
Slightly more than usual	57.6	53.2	59.5
Many more than usual	15.2	14.5	15.5
Snacks in relation to meals:			
Snacks *instead* of proper meals	47.1	38.1	51.0
Snacks *as well as* proper meals	42.9	52.4	38.8
Don't snack more when stressed	10.0	9.5	10.2

Table 2.6 - Snacking during stress - Dieting differences

	Dieters			Non-dieters		
	% of all dieters	% of male dieters	% of female dieters	% of all non-dieters	% of male non-dieters	% of female non-dieters
Amount of snacks:						
Far fewer than usual	1.7	0.0	1.9	3.9	3.6	4.2
Slightly fewer than usual	3.4	0.0	3.8	12.5	10.7	13.5
Same number as usual	13.8	16.7	13.5	13.8	19.6	10.4
Slightly more than usual	62.1	83.3	59.6	55.9	50.0	59.4
Many more than usual	19.0	0.0	21.2	13.8	16.1	12.5
Snacks in relation to meals:						
Snacks *instead* of proper meals	53.4	57.1	52.9	44.7	35.7	50.0
Snacks *as well as* proper meals	37.9	28.6	39.2	44.7	55.4	38.5
Don't snack more when stressed	8.6	14.3	7.8	10.5	8.9	11.5

as well as meals rather than instead of meals (34%); X^2 [1] = 8.24; $p<0.01$.

2.3.5 Food Choices During Stress

In the sample as a whole (see Table 2.7) the foods most frequently reported as being eaten in greater quantity were sweets and chocolate (70%), cakes and biscuits (60%) and savoury snacks (48%). Foods least likely to be eaten in greater quantity were fruit and vegetables (19%) and meat and fish (9%). Bread was as likely to be eaten less (26%) as more (29%).

Gender Differences

There were some gender differences, with women being more likely to report eating more sweets and chocolate ($X^2[2]= 10.9$, $p<0.01$), less meat and fish ($X^2[2]= 9.9$, $p<0.01$) and less fruit and vegetables ($X^2[2]= 7.3$, $p<0.05$). In order to ensure that this was not due to differences in dieting, the same effects were examined among non-dieters, and the gender differences remained significant.

Dieter / Non-dieter Differences

There were no differences between dieters and non-dieters in tendency to eat more cakes and biscuits, or sweets and chocolate, when stressed, although it is possible that reported intake of these foods may be unreliable, especially among dieters. Dieters were significantly more likely to report eating more bread than usual (48% of dieters compared to 23% of non-dieters ($X^2[2]= 12.4$, $p<0.01$) and they were less likely to report eating more fruit and vegetables (9%) than non-dieters (23%)($X^2[2]= 7.1$, $p<0.05$).

Table 2.7 - Influence of stress on intake of specific food types (percentages)

Food	Amount eaten under stress compared to usual (percentage of respondents)				
	much less	*less*	*same*	*more*	*much more*
Bread†	7.8	18.6	44.1	25.0	4.4
Meat & fish*	14.0	33.7	43.0	8.8	0.5
Fruit & veg*†	14.8	29.1	36.9	17.2	2.0
Cakes & biscuits	4.9	8.8	26.3	48.3	11.7
Sweets & chocolate*	4.3	8.5	17.1	51.7	18.5
Savoury snacks	6.8	10.7	34.6	36.1	11.7

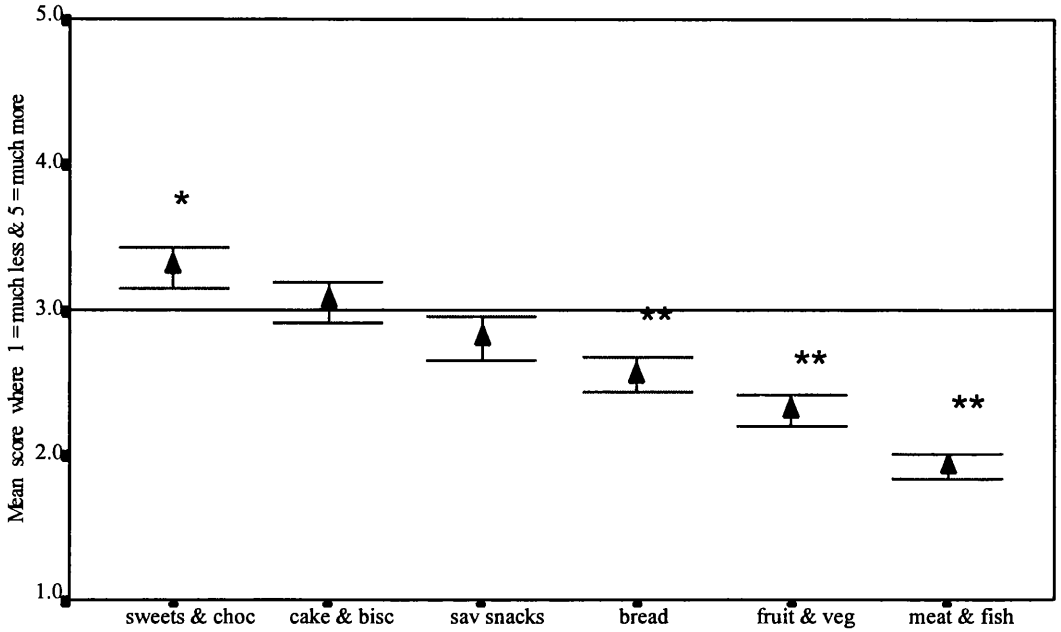
Note: Significant gender* and dieting status† differences. See text for details

Food choice differences between stress hypo- and hyperphagics

Reported changes in food choice under stress were compared for hypo- and hyperphagic individuals (categorised on the basis of their reported change in overall food intake under stress). One sample t-tests were conducted on mean scores for each of the named food types to assess whether responses were significantly different from "same as usual".

Hypophagics reported eating significantly less of all the foods listed except cakes and biscuits (where on average they reported eating more during stress, but not significantly so), savoury snacks (non-significantly less) and sweets and chocolate (where they reported eating significantly more; $t = 2.47$; $df = 80$; $p<0.05$). Hyperphagics reported eating significantly more of all foods except fruit and vegetables (reported eating less; $t = 1.85$, $df=82$, $p=0.068$), and meat and fish (reported eating significantly less; $t=15.9$, $df = 86$, $p<0.001$). Figs 2.1 and 2.2 show the similarity in pattern of results between stress-hypophagics and stress-hyperphagics. The reference lines represent the response "same amount as usual"(= a score of 3). It can be seen that those foods which are particularly preferred during stress by hyperphagics (Fig 2.2) are those which resist being 'rejected' during stress by hypophagics (Fig 2.1). These foods have in common a high palatability and energy density, and are also 'snack type' foods. Similarly, the foods which hypophagics tend to eat less of during stress, are those which are not eaten in greater quantities by stressed hyperphagics, and are the less hedonically pleasant, 'meal' type foods.

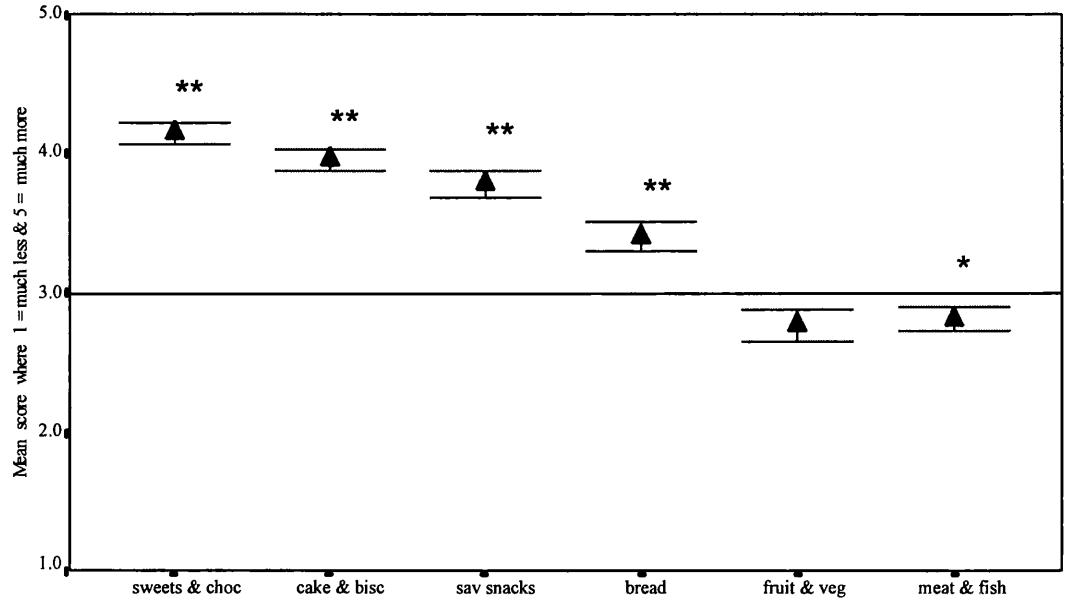
Fig 2.1 Stress-induced changes in food choice - HYPOphagics (mean + / - s.e.)



* $p < 0.05$

** $p < 0.01$ (p values denote significant differences from 3)

Fig 2.2 Stress-induced changes in food choice - HYPERphagics (Mean +/- s.e.)



* $p < 0.05$

** $p < 0.01$ (p values denote significant differences from 3)

2.4 Discussion

2.4.1 Prevalence of perceived effects of stress on eating

The results of this study confirm the expectation that the majority of young adults perceive their eating patterns to be influenced by stress, although they vary in the direction of this effect, with approximately equal numbers reporting eating more (42%) and less (38%). The proportion reporting stress-induced hyperphagia in the present sample was slightly below, though comparable to, the 57% prevalence of "eating more or bingeing" in response to stress that Weinstein, Shide & Rolls (1997) observed among a smaller sample of American students, and very comparable with the findings of Willenbring et al (1986) who reported a 48% incidence of stress-hypophagia and 46% stress-hyperphagia amongst their respondents. Both figures for prevalence of hyperphagia are substantially higher than those indicated by Stone & Brownell's (1994) study in which participants made their daily ratings of stress and also recorded whether they had eaten more, the same as, or less than usual, over a period of eighty-four days. Eighty percent of their participants were consistent in their response pattern, with 28% eating more than usual and 72% eating less than usual, on high stress days.

One explanation for the different results could be the methodological differences, in terms of keeping daily ratings compared with estimating response patterns from memory. Inconsistencies between subjective reports and daily records have been identified in many aspects of behaviour such as premenstrual tension, sleep latency and pain. Another source of variation could be differences in the proportion of the sample that were dieting, given that dieters are more likely to report stress-induced hyperphagia. In the present sample 28% reported currently trying to lose weight; in the sample studied

by Willenbring et al (1986) the prevalence was very much higher (73%) as the majority of the sample were overweight. Stone & Brownell (1994) studied married couples - a population in which the frequency of dieting behaviour is perhaps lower than in students (Weinstein, Shide & Rolls, 1997; present study) or overweight individuals (Willenbring et al, 1986).

2.4.2 The role of individual differences in perceived effects of stress on eating

a) *Gender*

No gender difference emerged in effect of stress on overall intake, and, although this result ran counter to expectations, the same pattern had emerged in both of the other studies which examined gender differences (Stone & Brownell,1994; Weidner et al, 1996). This was surprising in view of women's higher scores on psychometric measures of emotional eating. One explanation may be that the conditions which people consider when answering questions about responses to stress are external demands and constraints such as overwork or financial problems. These may create different internal states to those negative emotional states indicated in measures of emotional eating, and so dietary responses may also be different. This requires a more detailed analysis of the circumstances and nature of responses to stress and distress.

b) *Dieting Status*

In laboratory studies, restrained eaters have consistently shown hyperphagia and non-restrainers have shown either no response to stress, or hypophagia (Heatherton, Herman & Polivy, 1991; Polivy, Herman & McFarlane, 1994; Schotte, Cools & McNally, 1990). Gender differences were thus predicted from the fact that women have

higher levels of restraint and emotional eating (Forster& Jeffery, 1986; Klem, Klesges, Bene & Mellon, 1990; Rolls, Fedoroff & Guthrie, 1991). The present study used only a single item measure of restraint ("Are you currently trying to lose weight ?"). This was due to the need for a brief measure which perhaps carries less ambiguity than the question "Are you dieting?" which could be interpreted as related to dietary regimens other than weight-reducing and so may be liable to over-endorsement. Despite the crude measure of dieting, almost twice as many 'dieters' as 'non-dieters' reported a 'counter-regulatory', hyperphagic response to stress.

2.4.3 Changes in Food Choice During Stress

The third aim of this study was to investigate differences in types of food chosen under stress. Some of the literature on stress and eating suggests that there might be a shift in preference towards more palatable foods, sweeter foods or foods which replenish energy stores more quickly (such as carbohydrates), being preferred at a time when energy demands could be high, but eating may have to take a lower priority in the behavioural repertoire (Greeno & Wing, 1994). There is also a popular view that certain food constituents, in particular combinations (particularly high carbohydrate with very low protein) could modify brain serotonergic status and have a positive effect on mood (Wurtman & Wurtman, 1989), and that such foods would be craved at times of distress (Wurtman, 1988). However this view is not particularly well justified (viz Rogers, 1995). The results from the present study suggest that there were changes in food choice, although the foods assessed in this study limited the conclusions which could be drawn regarding effects of specific nutrients. Sweets and chocolate, cake and biscuits, and

savoury snacks were all reported to be eaten more under stress by the majority of respondents (indeed a higher proportion than reported eating more overall). These foods do not have in common particular taste or textural qualities, nor are their nutritional compositions particularly similar, contrary to predictions of the 'serotonin hypotheses' mentioned previously (Wurtman & Wurtman, 1989). They do however share the properties of high palatability, ease of preparation and high energy density - properties typical, in fact, of most 'snack' type foods. The 'meal' type foods were consistently reported to be eaten less, despite the variation in nutritional content, which also suggests that it is the dietary role of a food which is the more influential factor in stress-induced food choices. Indeed, the fact that both fruit and vegetables and meat and fish are least likely to be chosen during stress, despite their very different protein contents, further reduces the likelihood that theories such as the serotonin hypothesis, are adequate explanations. It is interesting to note that bread, which is commonly eaten as a snack and as part of meals, was as likely to be eaten less, as eaten more.

Unexpectedly, there were few differences between dieters and non-dieters in relation to the specific choice of foods, although we had anticipated that dieters would be more likely to report increases in the kind of foods often proscribed during diets. These observations point to a common pathway in stress-induced food choices which appears to be driven primarily by changes in the type of meal consumed (snacks as opposed to proper meals). Differences in energy intake or intake of specific nutrients may therefore be a consequence of changes in meal patterns.

2.4.4 Snacking behaviour during stress

Given the limited list of foods provided, the most feasible explanation appears to be that people are more likely to select palatable, energy-dense snacks than less energy-dense, 'meal' foods during stress. This was reinforced by the fact that 73% of participants reported eating more snacks under stress. The fact that the majority of 'stress snackers' reported doing so in addition to meals perhaps reflects the mechanism underlying stress induced overeating in susceptible individuals. The fact that snacking was occurring mostly in between meals also suggests that the mechanism is internally, rather than externally, driven. For example, an external factor such as lack of time for preparation of food during a period of stress, might be reflected by increased snacking but instead of meals, and not necessarily accompanied by an increase in overall food intake.

2.4.5 Conclusions, limitations and future directions

In summary, the great majority of a sample of undergraduate students believed stress to influence their eating behaviour; increased and decreased overall intake being reported with approximately equal frequency. Current dieters were more likely to report eating more under stress ('stress eaters') than eating less ('stress non-eaters'). Dieters were also more likely than non-dieters to be extreme in their reports of hyperphagia (i.e. more likely to report eating 'much more' in response to stress).

The types of foods eaten under stress appear to be selected on the basis of their role in diet (snacks being preferred over meal-type foods) rather than on the basis of their nutritional content. Thus the nutritional composition of the 'stressed diet' may be a

reflection of the nutritional composition of snack foods rather than preferential selection of foods rich in particular nutrients or nutrient combinations. Bearing in mind the fact that most snack foods are high in fat and/ or sugar it may be pertinent to highlight the need to make healthier choices when selecting snack foods, if snacks are the preferred foods during periods of stress.

The fact that not all dieters in this study identified themselves as stress-eaters suggests that more detailed information is needed about the variables being measured in this study. For example, a more sophisticated measure of dieting could be employed.

Clarification of the type of stress being referred to would remove ambiguity and ensure that responses obtained are in reference to a specific, known stressful situation; alternatively respondents could be asked about their eating in response to a range of very different stressors (work stress, emotional stress etc.). For example Weinstein et al (1997) questioned subjects about their eating in response to stress in general, and also about their eating in response to a specific, recent stressor. Not only does this reveal whether the stressors being referred to are equivalent; but it also gives an idea of the types of stress perceived to be associated with changes in eating.

It could also be the case that other, unmeasured variables or factors are involved, such as the influence of stress physiology on appetite, which contributes to individual variation, but which cannot be assessed in such a study.

Self-report data such as this are dependent partly on respondents' awareness of the topic in question, and on the extent to which they have rationalised their behaviour in these circumstances. Since the present sample was drawn from a population of

psychology students it is likely that they had more awareness of their own eating behaviour than would a sample from a more general population. In this respect the sample was probably unrepresentative.

Although these data can do little by way of proving the existence of a stress-eating relationship, it does confirm that belief in the phenomenon is almost ubiquitous. With this knowledge, the search may begin for behavioural evidence which either confirms or denies this widespread belief. Initially this will be carried out in a laboratory environment (Chapter 3), which will allow precise control over the variables of interest. It has been demonstrated in this study that gender and dieting status influence beliefs about the effects of stress upon eating. The following laboratory investigation will take these factors into account to determine whether they have a similar influence upon behaviour.

CHAPTER 3: STRESS AND FOOD CHOICE IN THE LABORATORY

3.1 Introduction

In the laboratory, most of the detailed work has been carried out on the effects of stress on overall energy intake in eating-disturbed groups such as obese individuals and restrained eaters. Studies have concluded that eating-disturbed individuals increase their food intake when stressed, whilst normal eaters show no change, or decreased intake when stressed (Herman & Polivy, 1975; Frost et al, 1982; Herman et al, 1987; Heatherton et al, 1991). However it should be noted that the majority of these studies have used particular types of food presented in a particular context - namely snack foods such as crackers, cookies, peanuts or ice cream - presented such that eating is an incidental and optional activity.

A study by Grunberg & Straub (1992) departed from the usual stress-eating experimental paradigm in providing subjects with a range of foods differing in taste qualities (sweet, salty and bland) although the foods were all snack foods presented incidentally to the main task of viewing a film. Grunberg & Straub (1992) found that stress significantly decreased consumption in men for all of the foods present; in women stress was associated with a modest (but not significant) increase in consumption of sweet and bland foods, with no change in intake of salty foods. These gender differences may have reflected differences in dietary restraint which is known to be higher in women (Johnson, Corrigan, Schmidt & Dubbert, 1990; Tepper, 1992; Wardle et al, 1992); which Grunberg & Straub (1992) failed to measure. In addition, the validity of Grunberg & Straub's findings is limited by the fact that the mean amount eaten by the groups of

subjects was very small (less than 20g for the whole sample) and the standard errors of the means were relatively high. This large variance suggests that not all subjects were choosing to eat.

A rigorous examination of food choice under stress requires that people consume greater quantities, from a wider range of foods. In a laboratory setting this may be achieved with a pre-weighed, buffet meal, allowing free food choices to be made by subjects, and precise intake measures to be obtained by the experimenter. In addition, restraint and disinhibition must be assessed because of their importance in determining eating behaviour in certain individuals.

3.1.1 Aims of this study

The present study aims to replicate and extend the work of Grunberg & Straub (1992) in an examination of food choices under stress in a general population. In addition it is hoped that assessment of appetite for, as well as intake of, foods from various taste and nutrient categories will shed light on possible mechanisms underlying stress-induced changes in eating behaviour.

Existing literature has already suggested that women and restrained eaters consume more calories and more fat when under stress (McCann et al, 1990) whilst men and unrestrained eaters show no change in food intake or food choice under stress (Bellisle et al, 1990). It is therefore predicted that in the present study women and restrained eaters in the stress condition will show increased preference for, and consumption of, snack type foods high in sugar and fat; whilst men and unrestrained eaters will show no preferential increase in consumption, or an overall decrease in

consumption as a result of stress.

3.2 Method

3.2.1 Sample and design

A sample of 68 healthy, non-smoking volunteers (27 men and 41 women) from the University of London agreed to participate in a study advertised as an investigation of "The effects of hunger on physiology and mood". Volunteers were recruited via advertisements placed around the campus and were paid £5 on completion of the study. The study design consisted of random allocation to either a high or low stress condition during which they were provided with a buffet lunch in the laboratory. Food intake was recorded by pre- and post- weighing of foods.

3.2.2 Stress Manipulation

Anticipation of a speech performance was used as a stressor. Participants were led to believe that their 4-minute speech performance would be recorded by video equipment set up prominently in the laboratory, and subsequently assessed. Written instructions for the speech task were given, based on those used by Kapczinski, Curran, Gray & Lader (1994) (see Appendix 2). Participants were invited to select one from a list of ten controversial topics for their speech and to make preparatory notes for a period of ten minutes prior to receiving a meal. The speech was scheduled to take place immediately after the meal; participants were led to believe that the variable being investigated was hunger and its effect on performance, and that they had been placed in a 'low hunger' condition which necessitated them eating a meal before making their

speech. This ensured that the anticipatory stress created by the threat of public speaking was sustained whilst subjects were exposed to food, but that there was no active competing task.

No mention of the speech task was made to participants in the control condition. Instead they were given a non-stressful task of comparable duration (10 minutes) which was to listen to a passage of emotionally neutral text (an excerpt from 'Under Milk Wood' (Thomas, 1954). They were instructed to sit and relax whilst listening to the text, after which, they were told, they would receive a meal. They were given to understand that the study was concerned with changes in physiological measurements from before and after a meal.

3.2.3 Assessing the impact of the stress manipulation

Both physiological and psychological indices of arousal were included, as desynchrony between self-reported anxious mood, and physiological measures of arousal has been well-documented (eg Rachman & Hodgson, 1974).

Blood pressure and heart rate were measured using a Copal Digital Sphygmomanometer UA-251 (an average of two readings taken over a 3-5-minute period), and a self-report measure, the Positive and Negative Affect Schedule (PANAS) (Watson, Clark & Tellegren,1988) (Appendix 3), was completed on arrival in the laboratory (Baseline).

3.2.4 Assessment of eating behaviour

Two main measures were used to assess the effect of the stress manipulation on eating behaviour and food choice:

i) Actual intake during a meal

ii) Reported desire for a range of foods immediately prior to eating a meal

In each case, foods had been selected, on the basis of their nutrient contents, to represent three taste categories, sweet, salty and bland. Within these taste categories, foods were additionally divided into low and high fat groups. A total of 34 foods were selected on the assumption, as mentioned, that sweet and salty taste corresponded to actual sugar and salt content, respectively (see Table 3.1).

To validate this assumption, 34 different adults were asked to rate the taste of each of the 34 foods for sweetness, saltiness and fattiness (where 1="not at all...." and 7 = "extremely..."). Perceptions of taste were found to correlate highly with actual nutrient content (sugar, $r = 0.84$, $p<0.001$; salt, $r = 0.76$, $p < 0.001$. Ratings of fatty taste were also correlated with actual fat content ($r = 0.77$, $p < 0.001$); thus validating the use of nutritional composition data to form categories based on taste.

i) *Intake Measure*. Participants were allowed to eat freely for 15 minutes from a buffet lunch consisting of, as far as was practicable, foods from each of the taste categories described above. See Table 3.2 for actual meal composition. All food was weighed before and after the meal to determine consumption.

ii) *Food Desirability Rating*: This assessed subjects' responses to a wider range of

Table 3.1- List of foods included in the food desirability rating, with nutritional compositions
(Source: McCance & Widdowson: *The Composition of Foods*)

Category	Foods	Energy (Kcal $100g^{-1}$)	Sugars (g $100g^{-1}$)	Total Fat (g $100g^{-1}$)	% Total Energy From Fat	Sodium (mg $100g^{-1}$)
Bland, low fat	Steamed rice	138	trace	1.3	8.5	1
	Boiled potatoes	72	0.7	0.1	1.3	7
	Bread (white)	217	3	1.3	5.4	530
	Raw carrot	35	7.4	0.4	10.3	25
	Raw tomato	17	3.1	0.3	15.9	9
	Steamed fish	83	0.0	0.9	9.8	65
Bland, high fat	Avocado	190	0.5	19.5	92.4	6
	Fried cod in batter	247	trace	15.4	56.1	160
	Unsalted peanuts	564	6.2	46.1	73.6	2
	Boiled egg	147	trace	10.8	66.1	140
	Clotted cream	586	2.3	63.5	97.5	18
	Greek yogurt	115	2	9.1	71.2	71
Salty, low fat	Prawns	107	0	1.8	15.1	1590
	Smoked salmon	142	0	4.5	28.5	1880
	Marmite	172	0	0.7	3.7	4500
	Pretzels	381	0	3.5	8.3	1720
	Noodles & soy sauce	70	1.7	0.5	6.4	1424
Salty, high fat	Cheddar cheese	412	0.1	34.4	75.1	670
	Crisps (ready salted)	546	0.7	37.6	62.0	1070
	Dry roasted peanuts	589	3.8	49.8	76.1	790
	Salami	491	trace	45.2	82.9	980
	Frankfurters	274	trace	45.2	82.9	980
	Bacon	422	0.0	36.0	76.8	1990

Table 3.1 contd.

Category	Foods	Energy (Kcal $100g^{-1}$)	Sugars (g $100g^{-1}$)	Total Fat (g $100g^{-1}$)	% Total Energy From Fat	Sodium (mg $100g^{-1}$)
Sweet, low fat	Honey	288	76.4	0.0	0.0	11
	Boiled sweets	327	86.9	trace	trace	25
	Lemon sorbet	131	34.2	trace	trace	69
	Banana	95	20.9	0.3	2.8	1
	Meringue	379	95.4	trace	trace	110
Sweet, high fat	Milk chocolate	529	56.5	30.3	51.6	120
	Vanilla ice cream	194	22.1	9.8	45.5	69
	Jam doughnut	336	18.8	14.5	38.8	180
	Fudge	441	81.1	13.7	28.0	160
	Chocolate-coated biscuit	524	43.4	27.6	47.4	160
	Sponge cake	459	30.9	26.3	51.6	350

Table 3.2 - Composition of meal presented to participants

Food category	Food	Energy (Kcal $100g^{-1}$)	Carbohydrate ($g100g^{-1}$)	of which sugars ($g100g^{-1}$)	Protein ($g100g^{-1}$)	Total fat ($g100g^{-1}$)	Sodium (mg $100g^{-1}$)	Quantity in which provided
Bland, low fat	White bread	252	48.5	1.6	9.6	2.2	500	5 rolls (approx 200g)
	Raw carrot	35	7.9	7.4	0.3	0.6	25	100g
	Raw tomato	17	3.1	3.1	0.3	0.7	9	1 (approx 80g)
Bland, high fat	Peanut butter	592	12.5	6.5	23.6	49.7	400	70g (2x35g jars)
	Flora	739	1.0	1.0	0.2	81.6	800	50g (5x10g pkts)
	Butter	737	trace	trace	0.5	81.7	750	35g (5x7g pkts)
Salty, low fat	Marmite	172	1.8	0.0	39.7	0.7	4500	24g (3x8g pkts)
Salty, high fat	Cheddar cheese	412	0.1	0.1	25.5	34.4	700	100g, grated
	Ready salted crisps	557	49.9	0.4	4.5	37.7	600	30g
	Salted peanuts	600	8.6	3.8	29.0	50.0	500	200g
Sweet, low fat	Mandarin	35	8.0	8.0	0.1	0.9	2	2 x med (approx 300g)
	Grapes	60	15.4	15.4	0.4	0.1	2	100g
	Strawberry jam	265	66.0	66.0	0.4	0.1	Trace	70g (2x35g jars)
Sweet, high fat	Cake (cherry slices)	407	50.9	34.2	3.9	20.8	80	100g approx. (3x slices)
	Chocolate biscuits	493	66.5	28.5	6.8	24.1	450	70g approx (4x biscuits)

foods than could realistically be included in a single meal. Photographs of each of the 34 selected foods were accompanied by a scale on which to indicate "How much you fancy eating some of this food at the moment" (from 1= "I definitely don't want to eat this food at all at the moment" to 7= "Right now I really want to eat this food"). The desirability rating had been previously found to show adequate test-retest reliability when administered to 12 different adults on two occasions 30 minutes apart (mean $r= 0.83$, $p < 0.01$). The desirability rating was completed after the stress (or control) manipulations, immediately before eating the meal. The order of presentation of the foods was randomised for each subject to control for possible order effects between sequentially presented foods.

3.2.5 Individual Difference Variables

I) Trait Measures - assessed prior to participation.

Trait anxiety was assessed with the trait scale from the State Trait Anxiety Inventory (STAI) (Spielberger et al, 1983) (Appendix 4).

Self-Esteem - The Rosenberg Self-Esteem Questionnaire (Rosenberg, 1989) was used (Appendix 5).

Motives for Food Choice - Food Choice Questionnaire (Steptoe, Pollard & Wardle, 1995) (Appendix 6). Of particular relevance to this study is the 'mood' subscale, six items measuring the extent to which food choice is influenced by its perceived effect on mood.

Eating behaviour - The Dutch Eating Behaviour Questionnaire (DEBQ; van Strien et al,1986) was used; this questionnaire incorporates subscales of dietary restraint, emotional and external eating (Appendix 7).

General Food Preferences - For each of the 34 foods listed in the desirability rating, subjects were asked to indicate how much they liked the food "in general". Responses were recorded on a Likert scale where -4 = "*I really dislike this food*" and +4 = "*I really like this food*". Subjects were asked to indicate if they had never tried a particular food.

ii) State Measures - Hunger Rating

Participants had been asked to refrain from eating for four hours before the study, to ensure a reasonably standardised level of deprivation, resulting in a substantial intake from the meal. Ratings of current hunger (on a 7-point Likert scale where 1 = `Not at all' and 7 = `Extremely') were taken on arrival in the laboratory (at baseline) and following the stress / control manipulation.

3.2.6 Procedure

The study was carried out between 11.30am and 1.30pm - that is, at a time when a meal would usually be eaten. This is in contrast to the usual laboratory eating paradigms in which snack consumption is measured without regard to meal times.

On arrival at the laboratory participants confirmed that they had eaten nothing in the previous four hours, and baseline measures of blood pressure, heart rate and mood (PANAS), hunger and thirst, were completed. They then received instructions for either the stress or control task, according to their random allocation, and were left alone for the ten minute duration of the tasks.

At the end of the 10-minute period, blood pressure, heart rate and mood were reassessed in all subjects. Hunger rating, and also the food desirability rating, were

completed. Participants then received a meal. The foods were presented on separate plates on two trays; the position of the plates on the trays being varied for each participant. They were instructed that they could eat whatever they wished from the selection, and in whatever quantities they desired "just as long as they ate something and were less hungry at the end of the meal". The experimenter explained that they would be left alone to eat for 15 minutes.

At the end of the meal the experimenter returned and the true nature of the study was explained. The debriefing included a rating of the perceived stressfulness of the study (on a 7-point Likert scale where 1 = "Not at all stressful" and 7 = "Extremely stressful"), and a rating of fear of public speaking in general (on a 7-point scale where 1 = "Not at all afraid - it doesn't bother me at all" and 7 = " Extremely afraid - I can't think of anything worse"). Finally age, height and weight were recorded.

3.3 Results

3.3.1 Participant Characteristics

The background characteristics of the group are summarised in Table 3.3. The mean age of the sample was 26.0 years (sd 5.7yrs), ranging from 18 to 46 years. The men were predictably heavier ($F [1,64] = 117.17$, $p<0.001$) and taller ($F[1,64] = 46.04$, $p<0.001$) than the women, but body mass index (BMI) did not differ between the sexes. One male subject was obese (BMI = 32.1) and so was excluded from the analyses. There were no differences between the group randomised to stress or control conditions on any of these measures.

Table 3.3 - Characteristics of Participants
(Data are expressed as mean ± standard deviation)

	STRESS GROUP		CONTROL GROUP	
General	**Men**	**Women**	**Men**	**Women**
N	14	20	13	20
Age (yrs)	25.6 ± 4.8	26.5 ± 7.0	26.9 ± 6.7	25.3 ± 4.2
Body weight (kg)	70.9 ± 8.8	58.5 ± 8.7	76.3 ± 9.4	59.7 ± 7.8
Height (m)	1.80 ± 0.07	1.63 ± 0.7	1.82 ± 0.06	1.66 ± 0.05
Body Mass Index	21.7 ± 2.2	22.0 ± 2.5	23.1 ± 2.6	21.7 ± 2.3
Psychological indices				
Trait anxiety (STAI)	40.9 ± 10.7	44.2 ± 8.7	42.1 ± 11.2	42.3 ± 10.8
Self esteem (Rosenberg)	21.29 ± 4.8	22.25 ± 3.9	22.54 ± 4.6	23.00 ± 5.7
Measures of eating behaviour (*DEBQ*)				
Dietary restraint	2.15 ± 0.89	2.49 ± 0.81	1.66 ± 0.60	2.79 ± 0.85
Emotional eating	2.18 ± 0.71	2.59 ± 0.86	2.50 ± 1.08	3.07 ± 0.91
External eating	3.09 ± 0.62	3.21 ± 0.49	3.33 ± 0.51	3.37 ± 0.53
Motives for food choice - subscales				
Affect	2.05 ± 0.77	2.52 ± 0.61	2.38 ± 0.76	2.42 ± 0.88
Natural content	2.12 ± 0.83	2.92 ± 0.66	2.23 ± 0.63	2.86 ± 0.68
Weight control	1.88 ± 0.83	2.25 ± 0.93	1.54 ± 0.75	2.86 ± 0.93
Familiarity	1.52 ± 0.57	1.63 ± 0.61	2.23 ± 0.85	1.95 ± 0.64
General Food Liking Scores				
Bland, low-fat foods	1.57± 0.81	1.82 ± 0.96	2.01 ± 0.52	1.84 ± 1.15
Bland, high-fat foods	1.78 ± 0.60	0.96 ± 1.10	1.32 ± 1.03	0.81 ± 1.20
Salty, low-fat foods	0.96 ± 1.64	1.82 ± 1.14	1.37 ± 1.23	0.47 ± 1.54
Salty, high-fat foods	1.92 ± 0.89	0.73 ± 1.58	1.88 ± 0.90	0.56 ± 1.43
Sweet, low-fat foods	1.37 ± 0.96	1.27 ± 1.29	1.62 ± 1.24	1.36 ±1.31
Sweet, high-fat foods	1.99 ± 1.25	2.08 ± 1.27	2.50 ± 0.87	1.61 ± 1.79

Trait measures

There were no significant between-group or gender differences in trait anxiety or self-esteem. As expected, dietary restraint scores were significantly higher in women, $F[1,64] = 13.50$, $p < 0.001$. Women also scored more highly than men on the emotional eating scale, $F[1,64] = 4.99$, $p < 0.05$; but there were no gender differences in reported external eating. There were no differences between stress and control groups in dietary restraint, emotional or external eating.

The 'food familiarity' subscale of the Food Choice Questionnaire revealed that subjects in the control group were significantly more neophobic than those in the stress group ($F[1,64] = 9.76$, $p<0.01$). There is some evidence to suggest that stress increases food neophobia but the effect appears to be restricted to novel foods (Pliner, Eng & Krishnan, 1995), and thus is unlikely to affect food choices in the meal given here which consisted of familiar foods.

Women rated items in the weight control scale of the food choice questionnaire more highly than did men, $F[1,64] = 14.92$, $p < 0.01$, and also rated the importance of 'natural content' of foods more highly than did men, $F[1,64] = 16.91$, $p < 0.001$.

General Food Preferences

Fatty, sweet foods were most liked by the sample as a whole (see Table 3.3). The salty, low-fat foods in the list were the least preferred. There were no significant differences in general food preferences between stress and control group subjects.

Men reported liking fatty-bland and fatty-salty foods significantly more than women, $F[1,64] = 6.65$, $p<0.05$ for fatty-bland foods; $F[1,64] = 15.12$, $p<0.001$ for fatty-

salty foods.

State Measures

Men and women did not differ in their hunger rating recorded at baseline, nor were there significant differences between participants allocated to stress and control groups. For the sample as a whole, initial hunger ratings were reasonably high (mean rating 4.87, sd 1.23), so a substantial intake could be expected during the meal.

3.3.2 Effectiveness of the Stress Manipulation

At baseline there were no differences between stress and control groups in heart rate, systolic blood pressure (SBP) or diastolic blood pressure (DBP) (see Table 3.4). Men in both groups had significantly higher SBP, $F[1,64] = 25.98$, $p<0.001$ and DBP, than women, $F[1,64] = 4.28$, $p<0.05$. Women had heart rates that were slightly higher than the men, but not significantly so.

Heart rate post stress was slightly higher than at baseline in the stress group, and slightly lower in the control group. However a repeated measures analysis of variance of heart rate with time as the within-subject variable and group and sex as between-subject variables showed no significant effect for time (baseline vs. T1) and no significant interaction for group x time, although the direction of the changes was as predicted, $F[1,64] = 2.82$, $p = 0.098$.

For systolic blood pressure a comparable repeated measures analysis of variance revealed a significant effect of time (baseline to T1), $F[1,64] = 7.37$, $p<0.01$ and a group by time interaction, $F[1,64] = 14.41$, $p<0.001$. The stressed group showed an overall increase in SBP over time, whereas the control group showed a decrease. The pattern

Table 3.4 - Effectiveness of Stress manipulation

	STRESS GROUP				CONTROL GROUP			
Physiological indices	**Men**		**Women**		**Men**		**Women**	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Heart rate (bpm) at baseline	65.6	9.4	68.2	12.4	63.9	8.7	71.6	13.7
Heart rate at T1	66.0	11.2	71.4	11.6	62.9	9.4	69.1	12.8
Change in Heart rate from baseline (bpm)	*0.4*	*10.0*	*3.3*	*8.2*	*-1.0*	*8.5*	*-2.5*	*7.8*
Systolic Blood Pressure at baseline (mmHg)	129.1	15.5	113.1	13.0	132.2	14.6	114.8	10.8
Systolic Blood Pressure at T1 (mmHg)	130.4	14.5	114.2	13.7	124.5	10.1	108.4	8.7
Change in SBP(mmHg)	*1.3*	*10.2*	*1.1*	*9.2*	*-7.7*	*6.9*	*-6.4*	*8.2*
Diastolic Blood Pressure at baseline (mmHg)	82.6	10.9	75.1	9.5	81.5	10.1	79.2	8.5
Diastolic Blood Pressure at T1	81.6	11.4	80.9	13.8	81.2	10.7	76.9	6.8
Change in DBP (mmHg)	*-1.0*	*4.9*	*5.8*	*7.4*	*- 0.3*	*6.3*	*-2.3*	*8.4*

Table 3.4 contd...

	STRESS GROUP				CONTROL GROUP			
Psychological Indices	**Men**		**Women**		**Men**		**Women**	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Baseline Positive Affect score	28.6	6.5	28.6	5.3	33.4	5.8	30.2	5.9
Positive Affect score at T1	27.6	6.5	29.3	5.3	29.9	6.6	26.9	5.6
Change in Positive affect score	*-0.9*	*2.9*	*0.7*	*5.5*	*-3.5*	*2.9*	*-3.3*	*3.9*
Baseline Negative affect score	14.2	4.3	14.5	5.0	12.9	2.4	12.3	2.8
Negative affect score at T1	15.7	5.1	16.6	6.4	12.4	2.5	10.7	1.1
Change in Negative affect score	*1.5*	*3.5*	*2.1*	*6.1*	*-0.5*	*1.9*	*-1.6*	*2.6*
Perceived stressfulness of manipulation	4.1	1.5	4.4	1.4	1.7	0.9	1.6	1.0

was the same for men and women. For diastolic blood pressure there was also a significant interaction between group and time, $F[1,64] = 4.42$, $p<0.05$, with DBP falling more in the control than the stress group.

The expected effect of the stress manipulation on mood was an increase in the negative subscale with no change or even a sight decrease in this scale in control subjects.

At baseline there were no significant differences between stress and control subjects in negative affect scores, although subjects in the stress group scored slightly higher on this scale. Control subjects scored significantly higher on the positive affect subscale at baseline than stress subjects $F(1,64) = 5.12$, $p < 0.05$.

Negative affect scores were log transformed to produced a normal distribution. As predicted, the repeated measures ANOVA revealed a significant group x time interaction, $F[1,64]=14.41$, $p < 0.001$, with subjects in the stress group showing a significant increase in negative affect from baseline, while those in the control group showed a reduction in negative affect relative to baseline. There was also a significant group x time interaction for the positive affect scores $F[1,64]= 10.00$, $p < 0.01$, but not in the predicted direction. Subjects in the control group showed a <u>decrease</u> in positive affect from baseline to T1 whilst in stressed subjects positive affect remained constant over time.

Overall the manipulation achieved significant, if modest differences between groups in both physiological and psychological indices of stress. This was borne out by the post hoc subjective ratings of perceived stress (on a 7-point Likert scale where 1= "*Not at all stressful*" and 7= "*Extremely stressful*"). Subjects in the stress group rated their experience as significantly more stressful (Mean rating = 4.26,sd =1.4) than those

in the control group (Mean rating = 1.62, sd = 1.0), $F[1,64] = 69.12$, $p<0.01$. These between-group differences applied to both men and women. Additionally, there were no differences between the groups or between men & women, in ratings of general fear of public speaking.

3.3.3 Eating Measures

Grunberg & Straub (1992) looked at gender differences in the effect of stress on total intake in both grams and kilocalories (calculated from the amount eaten of each food and its energy content per gram); and also intake from each of the three taste classes sweet, salty and bland. They also analysed intake in terms of macronutrients (carbohydrates, protein and fat)

They found that stressed men ate significantly fewer grams overall, than unstressed men, whilst stressed women ate more than unstressed women but not significantly so. This was also true if intake was analysed in terms of total energy consumption.

Grunberg & Straub (1992) did not give details of analyses conducted on data from the different taste categories but reported that men ate significantly less of all types of food when stressed whereas women ate more sweet and bland food under stress but not significantly so. Findings were presented in terms of amount eaten by stressed subjects, as a percentage of the amount eaten by subjects in the control group. Compared to those in the control group, stressed men ate 61% sweet, 37% salty and 15% bland food. Stressed women ate 202% sweet food, 93% salty and 173% bland food.

The aims of the present study are initially to establish whether Grunberg &

Straub's (1992) findings are replicable using public speaking as a stressor, and when subjects are exposed to a 'meal'-type eating situation.

3.3.3a Gender Differences

Men ate significantly more grams of food overall than women, as would be expected from their significantly higher body weight and consequent greater daily energy requirement (see Table 3.5). Controlling for body weight removed this gender effect; no significant main effect of stress on intake was seen, nor were there any interactions between stress and gender, so in this respect the present study failed to replicate that of Grunberg & Straub (1992).

Intake Measures

When overall intake in grams was converted to energy intake (using weights of each individual food item eaten multiplied by its energy density), men were consuming more calories than women (see Table 3.5). This was controlled for using estimated daily energy requirement as a covariate[1]. As would be expected, daily energy requirements were significantly greater in the male subjects (mean 3031.0 ± 236.9 kcal per day), than in the female subjects (mean 2172.6 ± 185.1 kcal per day), $F[1,64]= 284.6$, $p < 0.001$.

1

Estimated daily energy requirements are calculated from basal metabolic rate (BMR) which is dependent on age, sex & weight, multiplied by Physical Activity Level (PAL). Since no data were available for activity levels, moderate levels were assumed for both occupational and non-occupational activity in both men (PAL value 1.7) and women (PAL 1.6).
The equations for predicting energy requirements are as follows:

	kcal / day	
Age	Males	Females
18 - 29	(15.1w + 692) x 1.7	(14.8w + 487) x 1.6
30 - 59	(11.5w + 873) x 1.7	(8.3w + 846) x 1.6

w = body weight in kg
Equations outlined by the COMA Panel on Dietary Reference Values (DoH, 1991).

Table 3.5 - Effect of stress on intake of sweet, salty and bland foods - Gender differences

	STRESS GROUP				CONTROL GROUP			
	Men		**Women**		**Men**		**Women**	
Amount Eaten / g	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
All bland foods	**204.2**	74.6	**155.3**	60.2	**217.8**	72.0	**154.6**	63.7
Bland, low-fat food	**189.1**	70.3	**142.3**	51.2	**200.8**	75.9	**142.5**	64.5
Bland, high-fat food	**15.0**	11.7	**13.0**	13.9	**17.0**	13.0	**12.1**	10.8
All salty foods	**57.1**	44.3	**44.3**	32.2	**60.4**	28.8	**39.5**	25.0
Salty, low-fat food	**2.4**	6.4	**0.5**	1.7	**1.5**	2.5	**0.8**	1.4
Salty, high-fat food	**54.7**	45.1	**43.8**	32.2	**58.8**	28.8	**38.7**	25.4
All sweet foods	**117.7**	96.2	**111.1**	95.4	**113.6**	84.6	**122.5**	73.1
Sweet, low-fat foods	**72.4**	67.5	**76.1**	76.9	**75.1**	72.2	**92.2**	68.4
Sweet, high-fat foods	**45.3**	49.6	**35.0**	41.3	**38.5**	34.3	**30.2**	29.5

Analysis of variance controlling for energy requirements removed gender differences. No main effect of stress on intake was observed, nor were there any interactions with gender. Energy requirements were controlled for in subsequent analyses involving energy intake.

It is noteworthy that, overall, male and female subjects were consuming roughly one third of their daily caloric requirements during the course of the meal - thus the meal in this respect at least, may be said to resemble a 'real life' situation. There were no differences between stress and control groups in terms of the percentage of daily energy consumed during the meal.

Food intake was analysed in terms of total weight of food eaten from each taste category (see Table 3.6), controlling for body weight and also for general food preference for each taste category[2]. No effects were seen for any of the taste categories sweet, salty or bland, nor were any effects seen when low and high fat foods from each of the categories, were examined separately.

Analysis of intake in terms of energy derived from foods from each taste category, controlling for daily energy requirements and general food preference (see Table 3.6) also failed to reveal any stress-induced differences or interactions with gender and thus the results did not replicate those of Grunberg & Straub (1992).

Total intake was analysed in terms of total carbohydrate intake, and intake of starch and sugar separately, also protein and fat, controlling for body weight. No significant differences were seen between stressed and control subjects, nor were there

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2

General preference for a particular food taste class was represented by calculating the mean preference rating for all foods within that class (see Table 3.1).

Table 3.6 - Macronutrient Breakdown of Food Intake - Gender Differences

	STRESS GROUP				CONTROL GROUP			
	Men		**Women**		**Men**		**Women**	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Total food intake /g	**378.9**	135.6	**310.7**	110.6	**391.8**	140.6	**316.6**	94.4
Total energy intake / Kcal	**884.4**	402.2	**686.9**	282.3	**922.5**	293.1	**637.3**	203.6
Energy density of meal eaten / $Kcalg^{-1}$	**2.31**	0.51	**2.26**	0.64	**2.45**	0.74	**2.09**	0.63
Carbohydrate intake / g	**96.9**	37.8	**74.1**	33.3	**103.0**	37.2	**72.1**	21.5
% energy from carbohydrate	**42.7**	7.4	**40.8**	9.1	**42.3**	8.5	**43.7**	9.6
Starch intake / g	**64.5**	29.2	**49.2**	21.4	**68.8**	25.0	**44.1**	14.1
% energy from starch	**28.4**	6.0	**27.1**	5.5	**28.5**	7.3	**27.2**	8.0
Sugar intake / g	**32.1**	20.6	**24.5**	16.3	**33.9**	21.0	**27.7**	12.8
% energy from sugar	**14.1**	8.8	**13.6**	7.4	**13.6**	5.8	**16.4**	6.2
Protein intake / g	**25.6**	25.6	**18.5**	9.3	**26.9**	8.2	**18.1**	6.9
% energy from protein	**11.7**	3.7	**10.6**	3.3	**12.0**	2.3	**11.5**	2.5
Fat intake / g	**44.0**	24.5	**35.3**	16.6	**44.8**	17.1	**30.8**	14.7
% energy from fat	**42.9**	5.7	**45.6**	8.3	**42.9**	8.5	**41.8**	9.0
Sodium intake / mg	**1169.0**	598.7	**837.8**	378.9	**1187.8**	401.9	**776.5**	218.7

any interactions with gender.

To assess the effect of the stress manipulation on the overall composition of the meal eaten, the energy density (kcal per gram) of the total intake was calculated and used in analysis. In addition the percentage of the total energy intake derived from each of carbohydrate, protein and fat was calculated using amount eaten in gram of each macronutrient, and its energy density (carbohydrate - 3.75kcalg^{-1}; protein - 4 kcalg^{-1}; fat - 9 kcalg^{-1}). No significant effects were seen of any of these analyses (see Table 3.5).

Self-Reported Desire for Foods

Desire for foods from each of the taste categories were completed immediately prior to eating (see Table 3.7) as measure of intention adjunct to the behavioural measure (actual intake). The mean desire rating for individual foods from a particular category was taken as an indicator of desire for foods included in that taste class (Table 3.1). Analyses of variance were conducted with desire rating for a taste class, and gender, as factors, controlling for general preference for that taste class (to assess desire rating independent of general liking for a taste class). A stress x gender interaction was seen for sweet foods ($F[1,63] = 4.89$, $p < 0.05$), but in the opposite direction to the intake pattern seen in Grunberg & Straub's (1992) study. In the present study, stressed men expressed greater desire for sweet foods than stressed women, whilst in the control group, women expressed greater desire than did men. Breaking down the taste categories into low- and high-fat examples revealed that the findings for sweet foods as a whole, was due to the significant interaction for high-fat, sweet foods, $F[1,63] = 5.84$, $p < 0.05$.

Overall the present study failed to replicate the findings of Grunberg & Straub

Table 3.7 - Reported desire for foods from different taste classes - Gender differences

	STRESS GROUP				CONTROL GROUP			
	Men		Women		Men		Women	
DESIRE RATING	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
All bland foods	**4.30**	0.80	**4.23**	0.78	**4.04**	1.34	**4.01**	0.90
Bland, low- fat foods	**4.56**	0.96	**4.53**	0.85	**4.37**	1.48	**4.33**	0.92
Bland, high-fat foods	**4.05**	0.82	**3.92**	0.91	**3.71**	1.42	**3.68**	1.00
All salty foods	**4.14**	1.30	**3.99**	0.91	**4.01**	1.06	**3.46**	0.87
Salty, low-fat foods	**3.96**	1.21	**4.15**	0.96	**3.78**	1.20	**3.43**	1.12
Salty, high-fat foods	**4.29**	1.58	**3.86**	1.30	**4.19**	1.20	**3.48**	1.02
All sweet foods	**3.98**	1.17	**3.71**	1.18	**3.43**	1.18	**3.94**	1.41
Sweet, low-fat foods	**3.57**	0.89	**3.31**	1.08	**2.94**	1.21	**3.52**	1.47
Sweet, high-fat foods	**4.32**	1.62	**4.05**	1.36	**3.85**	1.27	**4.28**	1.59

(1992) and this suggests that in this case gender is a poor predictor of eating behaviour and food choice under stress.

3.3.3b Dietary Restraint Differences

Grunberg & Straub (1992) suggest that the gender differences they observed may have been due to differences in dietary restraint and admit an oversight in their failure to measure restraint; despite its established importance in the stress-eating relationship.

Predictably, in the present sample female subjects had significantly higher scores on the restraint scale of the DEBQ; $t=3.60$, $p < 0.01$. A median split of restraint scores was used to distinguish restrained and unrestrained eaters, and sex was used as a covariate. Unsurprisingly there were significantly more female than male subjects in the high restraint group, $X^2=4.98$, $p < 0.05$.

Intake Measures

There were no significant differences in intake between restrained and unrestrained eaters, and no interaction between restraint level and condition when total intake was analysed in terms of grams or kilocalories (Table 3.9). Analyses grouping foods in terms of taste classes (Table 3.8), macronutrients, energy density of overall intake and percentage energy from carbohydrate, protein and fat (Table 3.9) all failed to reveal any significant main effects or interactions.

However for some of the intake measures the pattern of the data was in the predicted direction - i.e. stressed restrained eaters eating more; unrestrained eaters under stress eating less. This was true for intake of sweet foods; where restrained eaters in the stress group ate almost twice the amount as unrestrained eaters, $t=1.89$, $df=32$, $p=0.068$;

Table 3.8 - Effect of stress on intake of sweet, salty and bland foods - Restraint differences

	STRESS				CONTROL			
	Low Restraint		High Restraint		Low Restraint		High Restraint	
Amount Eaten / g	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Bland, low- fat food	**166.0**	63.5	**157.2**	64.7	**177.5**	75.0	**152.0**	72.5
Bland, high-fat food	**14.6**	14.4	**13.1**	11.7	**16.5**	12.0	**11.5**	11.3
All bland foods	**180.6**	69.7	**170.3**	71.7	**194.0**	71.7	**163.5**	73.0
Salty, low-fat food	**1.4**	5.8	**1.2**	2.3	**1.4**	2.2	**0.9**	1.7
Salty, high-fat food	**46.3**	35.9	**50.3**	40.6	**46.3**	32.2	**46.5**	24.4
All salty foods	**47.7**	34.4	**51.4**	41.5	**47.7**	31.6	**47.3**	25.0
Sweet, low-fat foods	**53.9**	68.6	**95.2**	71.5	**86.5**	79.4	**84.9**	60.1
Sweet, high-fat foods	**30.5**	39.1	**48.0**	48.9	**35.8**	33.4	**30.9**	29.7
All sweet foods	**84.4**	78.1	**143.2**	102.0	**122.3**	85.3	**115.8**	69.2

Table 3.9-Macronutrient breakdown of food intake - restraint differences

	STRESS GROUP				CONTROL GROUP			
	Low restraint		**High restraint**		**Low restraint**		**High restraint**	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Total food intake / g	**312.7**	123.9	**365.0**	122.6	**364.0**	142.6	**326.7**	87.9
Total energy intake / Kcal	**730.3**	357.2	**806.2**	339.8	**799.9**	327.5	**692.9**	209.1
Energy density of meal eaten / Kcalg $^{-1}$	**2.33**	0.59	**2.24**	0.60	**2.24**	0.68	**2.22**	0.72
Carbohydrate intake / g	**78.5**	39.1	**88.5**	34.1	**90.5**	39.1	**77.3**	21.7
% energy from carbohydrate	**41.0**	8.4	**42.2**	8.6	**43.5**	10.1	**42.8**	8.2
Starch intake / g	**55.9**	27.5	**55.2**	24.6	**57.4**	22.4	**49.7**	22.1
% energy from starch	**29.4**	6.6	**25.8**	4.1	**28.4**	8.4	**27.0**	7.1
Sugar intake / g	**22.4**	17.4	**32.9**	18.1	**32.8**	19.1	**27.4**	13.3
% energy from sugar	**11.5**	7.6	**16.2**	7.6	**15.0**	5.7	**15.7**	6.6
Protein intake/ g	**20.4**	11.9	**22.5**	12.1	**23.1**	8.8	**19.8**	8.1
% energy from protein	**11.0**	3.7	**11.1**	3.2	**11.9**	2.1	**11.4**	2.7
Fat intake / g	**37.0**	20.3	**40.7**	20.9	**38.4**	19.4	**33.9**	14.2
% energy from fat	**44.7**	8.4	**44.2**	6.4	**41.5**	9.9	**42.9**	7.5
Sodium intake / mg	**968.1**	482.0	**980.2**	534.6	**1001.5**	337.7	**866.1**	376.9

Fig 3.1 Effect of stress on intake of sweet food - restraint differences

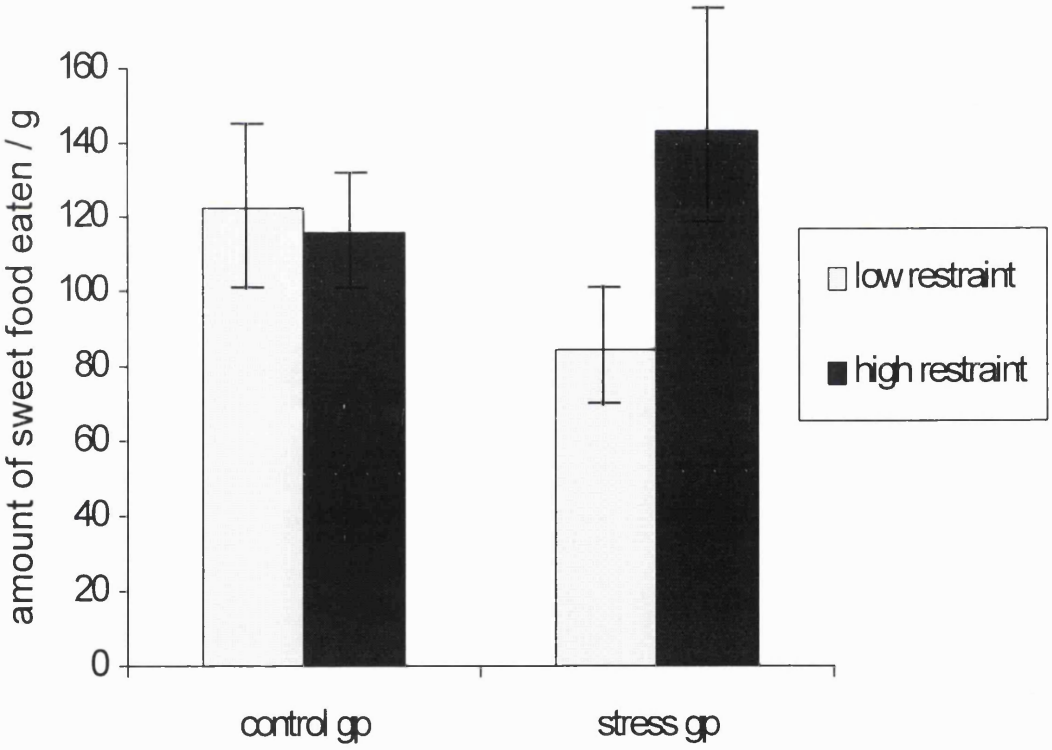
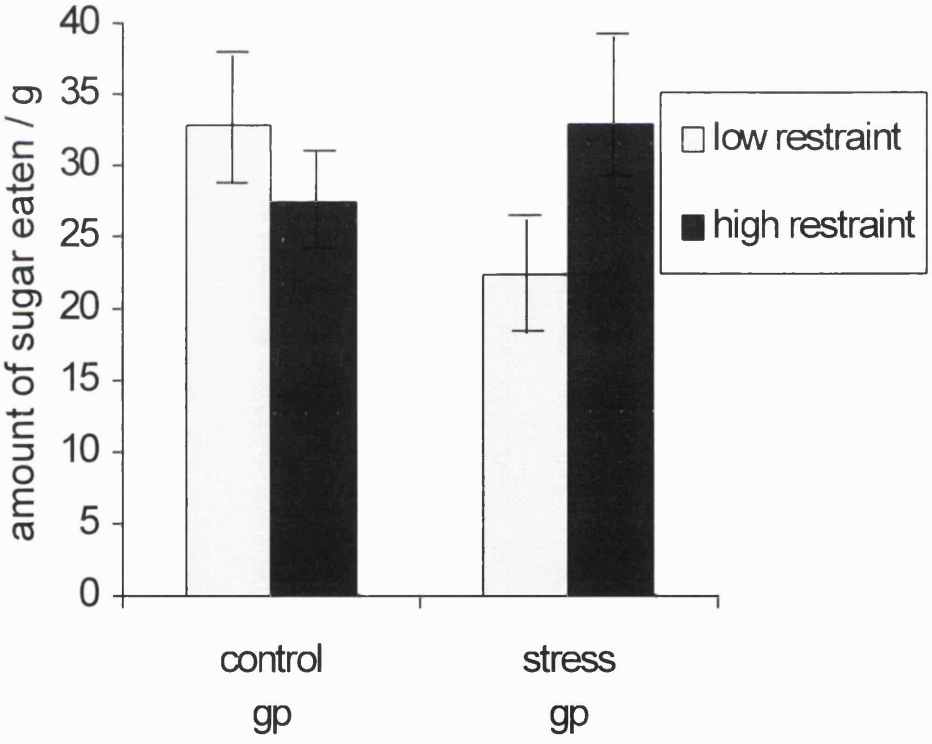


Fig 3.2 Effect of stress on sugar intake - restraint differences



(Fig 3.1). This effect was reflected in the analysis of nutrient intake by a trend towards a stress x restraint interaction for sugar intake, though this was not significant (Fig 3.2). This pattern was also seen in the percentage of energy in the meal derived from sugar. Although there was no significant interaction effect, analysis of the stress group alone showed that restrained eaters consumed a greater proportion of energy as sugar than did unrestrained eaters; t=1.82, df=32, p=0.079, and also starch, t=1.89, df=32, p=0.068.

Self-Reported Desire for Foods

In the self reports of desire for various food categories there was a restraint x stress interaction for bland, fatty foods which approached significance., F[1,63]=3.04 , p=0.086.(Table 3.10). There were no other significant effects or interactions with restraint level.

Thus the apparent effect of restraint on the eating behaviour of stressed subjects was much weaker than predicted though there is some evidence for a trend in the data in the predicted direction. Possible reasons for the absence of a stronger effect will be discussed.

3.3.3c Emotional Eating Differences

Restrained eaters scored significantly higher on the emotional eating subscale of the DEBQ ; t=3.23 $p<0.01$. Women were also more emotional eaters than were the men; t=2.26, $p<0.05$, so it could be that differences in emotional eating were driving gender differences in Grunberg & Straub's (1992) study, and indeed, the weak effects of dietary restraint seen in the present study.

Subjects were divided, on the basis of a median split, into high and low emotional

Table 3.10 - Reported desire for foods from different taste classes - Restraint differences

	STRESS GROUP				CONTROL GROUP			
	Low restraint		High restraint		Low restraint		High restraint	
DESIRE RATING	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
All bland foods	**4.27**	0.92	**4.24**	0.64	**4.29**	1.23	**3.75**	0.81
Bland, low- fat food	**4.63**	1.1	**4.46**	0.7	**4.54**	1.2	**4.16**	1.0
Bland, high-fat food	**3.92**	1.0	**4.02**	0.7	**4.05**	1.4	**3.33**	0.7
All salty foods								
Salty, low-fat food	**4.02**	1.0	**4.12**	1.1	**3.84**	1.1	**3.29**	1.2
Salty, high-fat food	**4.03**	1.6	**4.04**	1.3	**3.93**	1.2	**3.58**	1.0
All sweet foods								
Sweet, low-fat foods	**3.35**	0.9	**3.48**	1.2	**3.44**	1.4	**3.16**	1.4
Sweet, high-fat foods	**4.00**	1.4	**4.32**	1.5	**4.26**	1.5	**3.96**	1.4

eaters (or 'emotional-eaters' and 'non emotional-eaters') which actually resulted in higher numbers of low-, than high-emotional eaters in the stress group, and higher numbers of high- than low-emotional eaters in the control group , $X^2[1]=3.76$, $p=0.052$.

Intake Measures

No differences were seen between low and high emotional eaters when intake was analysed in terms of total grams eaten, or total energy intake (see Table 3.12).

Looking at intake of sweet, salty and bland foods - no effects were seen for the taste classes as a whole (see Table 3.11), however when the categories were sub-divided into high and low fat foods a stress x emotional eating interaction was seen for sweet, fatty foods, $F[1,63] = 4.02$, $p<0.05$. In the stress group, high emotional eaters ate almost twice the weight of sweet, fatty foods than did low emotional eaters (Fig 3.3) whilst in the control group low emotional eaters ate more than high emotional eaters but not significantly so. No effects were seen for sweet, low-fat foods. The interaction was also seen in analysis of the energy content of foods from the separate taste classes, controlling for daily energy requirements, $F[1,63]= 4.08$, $p<0.05$.

Analysis of macronutrient intake revealed that high emotional eaters ate more grams of of protein than did low emotional eaters, $F[1,63] = 4.16$, $p<0.05$. No other macronutrient effects were seen (Table 3.12).

There was a significant interaction for the energy density of the meal eaten , $F[1,63] = 6.17$, $p<0.05$. In the stress group the energy density of high emotional eaters' intake was significantly higher than that of low emotional eaters, $t=2.22$, $p<0.05$; and almost significantly higher than the energy density of the meal eaten by high emotional eaters in the control group; $t=1.96$, $p=0.058$ (Table 3.12, Fig 3.4). There were no

Table 3.11 - Effect of stress on intake of sweet, salty & bland foods - emotional eating differences

	STRESS				CONTROL			
	Low Emotional Eating		High Emotional Eating		Low Emotional Eating		High Emotional Eating	
Amount Eaten / g	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
All bland foods	**172.6**	69.8	**180.0**	72.4	**151.6**	46.1	**195.6**	82.0
Bland, low- fat food	**160.0**	64.0	**164.1**	64.6	**136.1**	42.6	**182.5**	83.9
Bland, high-fat food	**12.6**	11.8	**15.9**	14.8	**15.4**	13.2	**13.1**	11.0
All salty foods	**45.5**	41.1	**56.1**	31.5	**42.9**	27.0	**50.3**	29.0
Salty, low-fat food	**1.4**	5.3	**1.1**	2.3	**0.7**	1.4	**1.3**	2.1
Salty, high-fat food	**44.1**	41.2	**55.0**	31.8	**42.2**	27.5	**49.0**	28.9
All sweet foods	**109.0**	86.3	**121.6**	109.4	**112.6**	68.0	**123.0**	82.8
Sweet, low-fat foods	**80.0**	71.4	**65.7**	75.2	**73.9**	68.7	**93.0**	70.4
Sweet, high-fat foods	**28.9**	33.8	**55.9**	55.2	**38.7**	33.4	**30.0**	30.1

Table 3.12 - Macronutrient breakdown of food intake - emotional eating differences

	STRESS GROUP				CONTROL GROUP			
	Low emotional eating		**High emotional eating**		**Low emotional eating**		**High emotional eating**	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Total food intake / g	**327.1**	119.0	**357.7**	134.9	**307.1**	75.9	**369.0**	134.4
Total energy intake / Kcal	**687.4**	330.2	**898.8**	341.3	**735.9**	224.4	**752.9**	308.7
Energy density of meal / $Kcalg^{-1}$	**2.11**	0.60	**2.55**	0.46	**2.44**	0.55	**2.10**	0.74
Carbohydrate intake / g	**75.1**	29.9	**97.0**	43.0	**83.3**	28.3	**84.3**	34.5
% energy from carbohydrate	**42.5**	8.8	**40.1**	7.8	**43.2**	10.2	**43.1**	8.5
Starch intake / g	**50.3**	22.8	**64.0**	28.6	**53.7**	18.6	**53.5**	24.7
% energy from starch	**28.3**	6.3	**26.5**	4.6	**27.8**	6.6	**27.7**	8.4
Sugar intake / g	**24.7**	16.4	**32.4**	20.7	**29.0**	13.4	**30.7**	18.3
% energy from sugar	**14.2**	8.7	**13.3**	6.6	**15.2**	6.4	**15.4**	6.1
Protein intake / g	**19.1**	12.5	**25.4**	10.0	**20.3**	7.2	**22.2**	9.3
% energy from protein	**10.7**	3.5	**11.6**	3.4	**11.6**	2.3	**12.1**	2.4
Fat intake / g	**34.5**	21.0	**45.8**	18.0	**36.1**	13.5	**36.2**	19.0
% energy from fat	**43.6**	8.4	**45.9**	5.4	**43.5**	8.4	**41.5**	9.0
Sodium intake / mg	**893.5**	551.4	**1104.5**	393.1	**893.3**	258.2	**958.9**	413.4

Fig 3.3 Effect of stress on intake of sweet, fatty foods - emotional eating differences

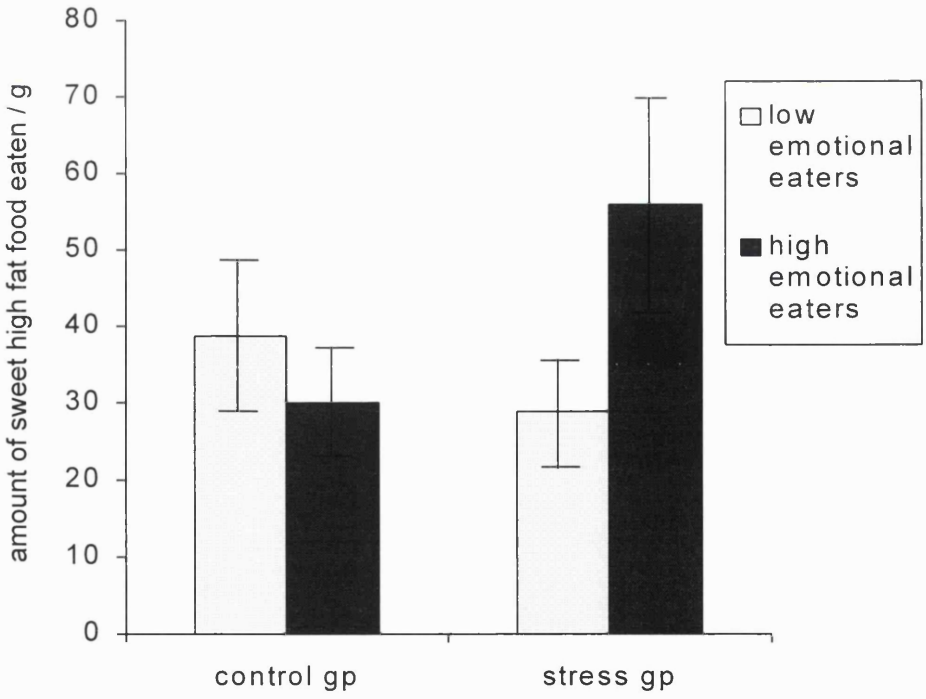


Fig 3.4 Effect of stress on energy density of meal - emotional eating differences

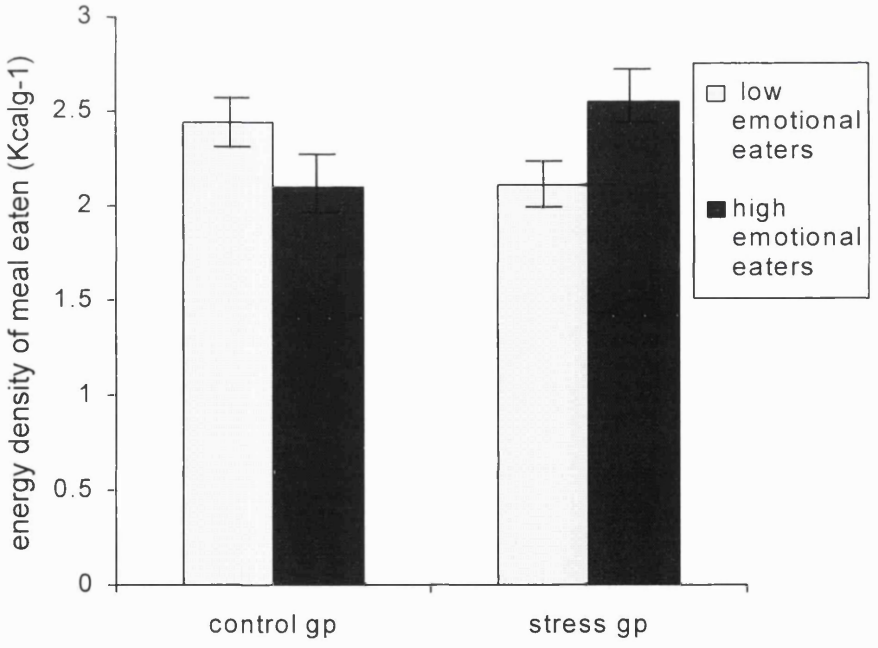


Table 3.13 - Reported desire for foods from different taste classes - emotional eating differences

	STRESS GROUP				CONTROL GROUP			
	Low Emotional eating		High Emotional eating		Low Emotional eating		High Emotional eating	
DESIRE RATING	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
All bland foods	**4.11**	0.83	**4.49**	0.66	**4.13**	1.12	**3.95**	1.05
Bland, low-fat foods	**4.44**	0.91	**4.72**	0.84	**4.42**	1.25	**4.30**	1.11
Bland, high-fat foods	**3.79**	0.92	**4.27**	0.69	**3.83**	1.08	**3.60**	1.22
All salty foods	**3.71**	0.98	**4.59**	1.02	**3.83**	1.11	**3.57**	0.88
Salty, low-fat foods	**3.79**	1.14	**4.52**	0.74	**3.78**	1.15	**3.43**	1.15
Salty, high-fat foods	**3.65**	1.29	**4.65**	1.45	**3.87**	1.12	**3.68**	1.15
All sweet foods	**3.72**	1.16	**3.99**	1.19	**3.66**	1.14	**3.79**	1.47
Sweet, low-fat foods	**3.36**	1.00	**3.51**	1.04	**3.15**	1.13	**3.39**	1.55
Sweet, high-fat foods	**4.02**	1.44	**4.40**	1.51	**4.09**	1.28	**4.13**	1.61

significant differences in the percentage of total energy intake derived from any of the macronutrients, and no significant interactions.

Self Reported Desire for Foods

There were no interactions between emotional eating and stress in terms of reported desire for foods. High emotional eaters as a group reported significantly greater desire for salty foods, $F\ [1,63]= 4.65$, $p<0.05$, specifically, salty, fatty foods, $F[1,63] = 6.23$, $p<0.05$, and also a higher desire for sweet, fatty foods, $F[1,63] = 7.63$, $p < 0.01$ (Table 3.13).

3.4 Discussion

The present study finds no evidence for a general hypophagic effect of stress on men; nor does it reveal stress-induced hyperphagia in women; thus the findings of Grunberg & Straub (1992) are not replicated here. It is possible, of course, that these findings are unrepresentative and repetition of the study would result in successful replication of Grunberg & Straub's (1992) findings. There are, however, several alternative explanations. The present sample has been taken from a population of British students, whereas Grunberg & Straub's (1992) subjects were US adults who may differ on a number of eating-related dimensions. The manner of presentation of food, and the type of food presented to participants in the present study is very different to that of previous studies. Grunberg & Straub (1992) gave snack-type foods to non food-deprived subjects, with eating being presented as an incidental activity whilst performing a more central task. This has been the format for most previous studies of stress and eating. The present study is unusual in providing participants who have been food-deprived for a

standard period of time, with a meal, which hoped to overcome the problem of low intake seen in Grunberg & Straub's (1992) subjects, and also incorporate a wider range of foods to allow more accurate assessment of food choice.

In retrospect it appears, however, that the effect of stress on food intake may be mediated through snack consumption, rather than via changes in quantity of food eaten during meals. This is also seen in a naturalistic study of stress and eating which used a real meal situation as an eating measure (Bellisle et al, 1990). No differences were seen between the total intake nor in the composition of a meal eaten on a high compared to a low stress occasion. In the present study the foods preferred by stressed emotional eaters were sweet high fat foods (cake and chocolate biscuits), habitual consumption of which is not confined to meals; in fact these foods are more usually eaten as snacks. A previous study (Lowe & Fisher, 1983) and also data from a survey of reported food choices under stress (Oliver & Wardle, *in press*) suggest that the snack-meal distinction is important.

The present study also differs from that of Grunberg & Straub (1992) in its choice of stress manipulation; preparation and anticipation of a public speaking task is arguably more 'active' and also more ego-threatening than viewing a distressing film as was required of Grunberg & Straub's subjects. Previous research has shown that various qualities of stress manipulations may have different effects on eating behaviour; more specifically that stressors which are highly ego threatening are especially likely to elicit disinhibited eating in susceptible individuals - one study identified highly restrained individuals with low self-esteem as being particularly vulnerable to ego-threats (Polivy, Heatherton & Herman, 1988).

Despite what may have been predicted on the basis of prior research, the present

study did not reveal an influence of dietary restraint upon eating behaviour under stress - although there was a trend toward the predicted pattern in some of the intake data. The weakness of the effect may have been due to its measurement using the restraint scale of the DEBQ, which contains items pertaining only to restraint, and thus is not a measure of vulnerability to dietary disinhibition. This is in contrast to those scales used to assess restraint in the majority of previous studies - the Restraint Scale (Herman & Mack, 1975) and later Revised Restraint Scale (Herman & Polivy, 1980) and the Three Factor Eating Questionnaire (TFEQ)(Stunkard & Messick, 1985). The feature which has characterised the eating behaviour of dietary restrainers under stress has been their propensity to lose their habitual control over eating, thus it is understandable that differences in eating behaviour under stress were not revealed in this study when subjects were classified in terms of scores on a pure restraint scale rather than one incorporating items relating to disinhibition. In the DEBQ it is the emotional eating scale which is a measure of disinhibition tendencies (Wardle, 1987), and in the present study it is emotional eating score which predicts eating behaviour under stress.

Individuals scoring highly on emotional eating reported significantly higher desire for sweet, high fat foods than low emotional eaters, and this was reflected by increased intake of sweet fatty foods in high emotional eaters under stress. This may represent some kind of disinhibition effect; emotional eating in this sample was correlated with dietary restraint ($r = 0.38$, $p<0.01$), so a high proportion of emotional eaters would also be restrained eaters and therefore probably trying to restrict their intake of foods high in sugar and fat. It may be that, under stress, they experience disinhibition resulting in increased intake.

As expected with a higher intake of fat, the meal of stressed emotional eaters was also of higher energy density than that of low emotional eaters.

These findings are perhaps less interesting than if eating behaviour under stress was found to be explicable in terms of a more distal factor; but the results are important nevertheless. They demonstrate the existence of stress-induced eating as a behavioural as well as subjective phenomenon, and also suggest an effect of stress upon food choice, since the increased eating is confined to certain foods, specifically those which current health recommendations suggest should be limited.

3.4.1 Conclusion - Limitations and future directions.

In summary, this study provides some evidence that change in eating under stress is a measurable behavioural phenomenon, at least in this laboratory environment. In addition , desire ratings for a range of foods, some of which were included in the test meal, made it possible to gain some information concerning mechanisms for the stress-eating changes. Notably, reported desire for foods appeared to have little influence on behaviour, which has implications for self-report data of this kind.

Regarding the intake measure, it may in retrospect have been informative to have made some record of the order in which participants ate their food, and in which combinations. The meal was presented as a buffet, providing participants with the opportunity to choose any combination of foods in any desired order. However the choice was limited to foods which would commonly be eaten in a 'lunch' context, and so have associated cultural / social influences concerning the order of eating foods (eg savoury foods before sweet). Thus an individual eating two chocolate biscuits at the start

of the meal may be eating them for a very different reason from the individual who eats the same chocolate biscuits as a dessert at the end of the meal. Along these lines it may also have been worthwhile noting the rate at which various foods were consumed, and whether various groups of individuals were distinct in the speed at which they ate.

As with any laboratory study carried out in this area, the impact of the stressor on the participants will be less severe than in the case of events occurring in the real world. Although subjects in the stress group rated their experience as significantly more stressful than did subjects in the control group, this was self reported retrospective data in response to the question asked during the debriefing session, so answers may have been subject to the influence of social desirability. The impact of the stressor could have been heightened, for example, by actually having participants perform the speech task. Various studies (eg Droppleman & McNair, 1971; McNair et al, 1982) have demonstrated that actual performance of a public speaking task increases physiological indicators of anxiety beyond those produced by merely anticipating the task. However in the present study the extra impact gained by actual performance of a speech, would have been offset by practical problems concerning timing of the meal, making it difficult to avoid subjects eating whilst in a relieved rather than stressed state.

With regard to the impact of the stressor, it is important to note that the nature of the sample will also determine the effectiveness of any chosen stress manipulation. The sample in the present study was derived almost entirely from an undergraduate population and the stress task was chosen accordingly - on the basis that it is a task which students tend to find particularly unpleasant. In one study of nearly 800 college students (Geer, 1965), fear of public speaking was reported to be one of the five most intense fears

reported.

Despite the limitations described, this study is unique in its assessment of the effect of stress on food choice in the laboratory, by presenting a range of foods in a relatively natural context in the form of a meal. A range of different types of foods are used, with varying nutritional compositions, taste and textural qualities, and dietary roles (snack foods vs. 'meal' foods etc). Perhaps the way forward from here would be to use this eating paradigm in the assessment of various other stressors.

However 'realistic' the manner of presentation of food in comparison to the real world; eating in the laboratory will always be an artificial environment and so inevitably will not be an entirely accurate reflection of natural eating behaviour. As an example, it could be the case that restraint differences were not revealed because the eating context was such that it was apparent - to both the subject and the experimenter - from the food remaining at the end of the meal, how much had been eaten. It has been demonstrated that awareness of one's intake, or the knowledge that one's intake will be observed, is sufficient to inhibit stress-induced disinhibition in restrained eaters.

To gain a more accurate representation of eating behaviour during stress involves going beyond the controlled manipulations of the laboratory to a real world environment.

CHAPTER 4: STRESS AND FOOD CHOICE IN A NATURAL ENVIRONMENT: A LONGITUDINAL STUDY OF DEPARTMENT STORE WORKERS

4.1 Introduction

As discussed in the introductory chapter, eating and food selection in the real world may be viewed as one of a range of health-related behaviours potentially affected by stress. The relationship between stress and other health behaviours has been investigated in several studies; stress being associated with increases in 'negative health behaviours' (those which threaten health) such as alcohol drinking and smoking , and decreases in 'positive health behaviours' (those which promote health) such as sleep and physical activity (Conway, Vickers, Ward & Rahe, 1981; Steptoe, Wardle, Pollard, Canaan & Davies, 1996).

Dietary selection may incorporate both positive health behaviours (such as high intake of cancer-protective fruit and vegetables) and negative health behaviours (such as high intake of saturated fat, because of its known links with cardiovascular disease and certain cancers) From what has already been demonstrated with regard to other health behaviours and stress, it may be predicted that an effect of stress on food choice might be to increase intake of saturated fat and decrease intake of fruit and vegetables. Existing studies are inconsistent in their support for these predictions. Most have focused on overall energy intake or general changes in eating rather than on patterns of selection. As discussed previously, changes in eating habits during stressful episodes have been reported in several questionnaire studies (Spillman, 1990; Alexander & Walker, 1994; Ogden & Mtandbari, 1997; Oliver & Wardle, 1998) (Chapter 2). Naturalistic studies which have recorded intake in high and low stress periods show varied results. Some

studies report increased eating under stress (McCann, Warnick & Knopp, 1990; Michaud, Kahn, Musse, Burlet, Nicolas & Mejean, 1990), and a few report hypophagia as the dominant response (Popper, Meiselman, Smits & Hirsch, 1989; Stone & Brownell, 1994). It would seem from the literature that eating more (stress hyperphagia) and eating less (stress hypophagia)are both observed, which may be the reason behind an apparent lack of effects in some studies. For example, Bellisle et al's (1990) study of a single meal intake in a group of twelve men pre- and post-surgery, showed no average difference in either energy intake or dietary composition between the two occasions. However the men did in fact show considerable variation, ranging from one man eating 125% more on pre-surgery day, to another who ate 53% less. One study has suggested that the direction of change in amount eaten is a characteristic which is stable over successive episodes of stress (Stone & Brownell, 1994) and which may be determined by a variety of individual difference parameters.

Few conclusions may be drawn from existing naturalistic studies because of the diversity of stressors being investigated, and the variety of methodologies used, ranging from daily measures of stress and food intake, to retrospective self reports of intake relative to usual intake, in response to a specific stressful event.

The majority of naturalistic studies, have focused on the issue of whether stress increases or decreases eating behaviour in a general sense. As with the laboratory literature, studies addressing the issue of food choice under stress, are rather fewer. It was suggested above that stress may act to increase intake of dietary fat. There is some evidence to support this hypothesis; these studies invariably also report increases in overall energy intake, presumably due to the higher intake of fat with its high energy

density. McCann et al's (1990) study related changes in dietary intake to serum lipids as a result of varying workloads in a small group of office workers. The workers reported a higher percentage of energy intake from fat (and also higher overall energy intake) in two high work load periods compared with a normal work load period, although changes in serum cholesterol did not map onto reported differences in dietary intake. Michaud et al (1990) studied the impact of a major school examination on the eating behaviour of 225 French high-school students. They found that the amount of fat in the diet (and total energy intake) were significantly greater on the day of an examination compared to intake on a control day on which there was no examination. Separate analyses of boys'and girls' intake revealed that the increased fat intake was apparent only for the boys, whilst overall energy intake was affected only in girls. This suggests that differences in dietary composition, especially in the proportion of fat in the diet, may not be entirely responsible for differences in overall energy intake, as might have been thought. A study by Weidner, Kohlman, Dotzauer & Burns (1996) found similar changes in eating under examination stress.

One weakness of these studies is the lack of non-stressed control groups to dis-confound time and stress level. Consequently it is difficult to exclude the possibility that any changes in diet during stressful periods were due to differences in food availability influencing food choices during low and high stress periods. This is more relevant when formulating a mechanistic explanation of stress-induced food choice; however it is noteworthy that another study of examination stress which did include a control group, found no overall nutritional difference between students taking examinations, and others for whom there were no examinations scheduled at that time (Pollard et al, 1995).

One issue worth discussion is the role of individual difference parameters in naturalistic studies of stress and eating. Laboratory studies have largely aimed to identify individual traits and characteristics predictive of eating behaviour under stress. Typically they have focused on dietary restraint, as measured by the Restraint Scale (RS) (Herman & Polivy,1980) and, by association, gender, as individual difference variables. Results have consistently shown that women who are higher-scoring on the RS show stress hyperphagia, whereas non-restrained women are either hypophagic or do not differ in food intake in relation to stress (Baucom & Aiken, 1981; Herman, Polivy, Lank & Heatherton, 1987; Heatherton, Herman & Polivy, 1991; Schotte, Cools & McNally, 1992; Polivy, Herman & McFarlane, 1994). However there have been few attempts to generalise these findings to normal eating behaviour outside the laboratory. In the one naturalistic study which did include a measure of restrained eating (Pollard et al, 1995), there was no evidence for a mediating effect of dietary restraint. This could be because the measures of restraint used are valid only within a laboratory context; or because the phenomenon of stress-induced disinhibition of eating is expressed only within an artificial environment such as the laboratory.

4.1.1 Aims of this study

With this and the findings from previous naturalistic studies in mind, the present study has the following aims:

I. To study the effect of a significant naturally occurring stressor, on food intake and food choice. Work stress was selected because of its general relevance to everyday life, and because of the public health significance of deleterious changes in dietary behaviour

associated with work characteristics. There is already a large body of literature linking work stress with ill-health (eg Steptoe, 1991). The use of work load as the operationalisation of the stressor also means that work stress may be quantified objectively and independently of the effects of stress. The study will take place over a more extended period of time than has been found in previous literature, to allow assessments to be made on several occasions of varying work load. In order to reduce the variability associated with different types of job, a group of working people were selected who had similar job roles and who would be available on several occasions - shop workers in the retail industry. In addition, this group have a relatively low educational and occupational status compared to the university students assessed in the previous exam stress studies.

ii. To study the effect of work stress upon food choice in addition to overall intake, using dietary recall to assess actual intake, as well as retrospective self report of appetite for specific foods in the recent past (in effect a retrospective form of the 'desire rating' employed in the laboratory study in Chapter 3). Body weight will also be assessed over the period of the study, to assess the contribution of dietary change to overall energy balance during stressful and non-stressful periods.

iii. To assess the role of individual difference parameters relating to eating style, in a 'real world' environment.

It is hypothesised that energy intake, the proportion of energy as fat and body weight will be greater in high work load periods, especially among workers with higher levels of dietary restraint and emotional eating.

4.2 Method

4.2.1 Sample and design

The employees of a large department store in central London were invited to take part in a study of work and health. They were eligible to participate if they worked for more than 20 hours per week, had been employed at the store for at least 6 months and expected to continue working there for the next 6 months, and had no psychiatric history or chronic medical problems.

Assessment sessions were scheduled over four time periods; early November, mid December, mid January and early March. The four sessions of each participant were ranked according to the number of paid work hours completed over the past seven days. The principal analyses investigated nutritional differences between the two higher and two lower workload sessions for each participant; associations between nutritional status and average levels of stress over the entire study period were also examined.

There were 95 volunteers, of whom 90 (58 women and 27 men) attended at least two assessment sessions, and 71 (44 women and 27 men) completed all four sessions. The findings reported here are based on analyses of data from the 90 subjects completing 2 or more sessions, excluding 8 subjects who, despite completing four sessions, had worked for the same number of hours on each occasion, and so experienced no variation in workload. This gave a final working sample size of 82 (55 women and 27 men)

4.2.2 Measures

Stress was measured at each of the four assessment sessions.

Objective Stress Measure: Work load.

Work load was measured in terms of hours of paid work completed in the last seven days, and in terms of the extent to which work interfered with home life and vice-versa, on 5-point scales where 1= *not at all* and 5 = *a great deal.* Participants also indicated whether they had enough time to carry out duties both at home and at work, on a scale where 1 = *not at all* and 5 = *plenty of time*. Time spent on unpaid work (domestic duties, child care etc) was also recorded and added to the hours of paid work to give a measure of total time spent working over the past week.

Subjective Stress Measures.

Perceived stress. Perceived stress over the previous 4 weeks was assessed using the 10-item version of the Perceived Stress Scale (PSS) (Cohen, Kamarck & Mermelstein, 1983) (Appendix 8).

Emotional Well-Being. The 28-item version of the General Health Questionnaire (GHQ) (Goldberg, 1972) (Appendix 9) was used to assess emotional well-being over the previous 4 weeks.

Diet-Related Variables

Body weight. At each session, participants' body weight was recorded and BMI was calculated from their height as recorded at the initial assessment session.

Dietary Assessment. At each session, food intake over the previous 24 hours was assessed by a dietician using a standard interview protocol. The 24 hour recall was selected over a diary because, despite its shortcomings, it imposes a lower demand on participants

during high work stress periods, and because record-keeping leads to reactivity in subjects. Dietary data were analysed using a standard nutrient analysis programme (Microdiet, University of Salford), which is based on McCance & Widdowson's (1991) tables of food composition.

Appetite and hunger ratings. At each session participants rated their overall hunger over the previous week, as compared to usual ("*Much more hungry than usual / more.../same as.../ less.... / much less..*".). They also rated their appetite for a list of specific foods over the previous week, compared to usual ("*Felt like eating it much more than usual / more than... / same as.../ less than.../ much less than..*".), and their snacking behaviour over the previous week (*"Many more snacks than usual / more.../ same as.../ fewer.../ many fewer..."*).

Other variables potentially influenced by stress were also assessed, including serum cholesterol, alcohol consumption, smoking behaviour, and physical activity levels, however these will not be discussed here.

<u>*Moderating Variables*</u> - These were measured on a single occasion prior to the initial assessment session.

Anxiety. Trait anxiety was assessed with the State-Trait Anxiety Inventory (Form Y) (Spielberger, Gorsuch, Lushene, Vagg & Jacobs ,1983) (Appendix 4).

Eating Style. Restrained and emotional eating were assessed using the appropriate scales

from the English version of the Dutch Eating Behaviour Questionnaire (DEBQ) (van Strien, Fritjers, Bergers & Defares, 1986; Wardle, 1987) (Appendix 7). These indexed participants' tendency to restrict their food intake and to eat more when emotionally disturbed. Motives for Food Choice were assessed using the Food Choice Questionnaire (FCQ)(Steptoe, Pollard & Wardle, 1995)(Appendix 6). The FCQ has scales assessing the importance of health, taste, weight control and 'mood control' in the individual's choice of foods.

4.2.3 Procedure

The procedures of the study were explained and ethical consent forms were signed. Interviews were held at the work place either before work or during work breaks, and were always scheduled on a day following a working day rather than a weekend or day off. Participants were interviewed in private and the time of day was held constant over assessment sessions for each person.

Prior to the first session, socio-demographic information was obtained, and the questionnaires for the moderating variables were completed. On this and each subsequent session, work load, subjective experience of work, the perceived stress scale and GHQ were completed. A 24-hour food recall was conducted to assess intake. Alcohol consumption and physical activity over the previous week, were also recorded.

4.3 Results

4.3.1 Participant Characteristics

Background demographic characteristics are shown in Table 4.1 for men and

women separately, although the only significant gender difference was in the number of hours usually worked per week; men worked an average of 3.1 hours more than women ($t = 2.46$, $df = 80$, $p < 0.05$).

Physiological results, averaged over completed assessments, are shown in table 4.2. They indicate, as would be expected, that men were taller, heavier, and had a higher BMI than did women.

Psychological measures taken at baseline show that women had higher scores on the DEBQ restraint and emotional eating scores. They were also higher on concern about health, weight control and mood control in the Food Choice Questionnaire. There were no gender differences in trait anxiety measured at baseline but averaging scores of perceived stress over completed sessions revealed that women scored more highly than did men, $F[1,80] = 3.82$, $p = 0.054$.

4.3.2 Associations Between Physiological, Nutritional and Behavioural Factors

These associations were based on averaged values for nutritional and physiological indices over all sessions (see Tables 4.2 and 4.3) to give more robust estimates. Measures of eating style were associated with nutritional and physiological measures. Emotional eating was positively correlated with BMI (controlling for gender) ($r = 0.32$, $p < 0.01$) although no association was seen between BMI and restrained eating. Restrained eating was negatively correlated with reported energy intake ($r = -0.34$, $p < 0.01$) ;emotional eating was not, however, related to reported intake.

The average level of perceived stress over the sessions was not associated with any of the averaged behavioural or nutritional variables.

Table 4.1 - Background Characteristics of Participants in the study (Mean ±sd)

	Women	Men	sig
N	55	27	
Age (yrs)	36.7 ± 12.1	32.9 ± 8.0	ns
Marital status (% married)	44	30	ns
No. of children	2.2 ± 0.75	2.0 ± 1.0	ns
Age on leaving school (yrs)	16.6 ± 1.4	16.3 ±1.3	ns
Attended college (% yes)	53	48	ns
Supervisor at work (% yes)	46	44	ns
Smokers (%yes)	36	41	ns
Usual hours worked	38.2 ± 5.0	41.3 ± 6.2	$t = 2.46$ $p < 0.05$

Table 4.2 - Psychological and Physiological Status of Participants in Study

	Women (N=55)	Men (N=27)	sig
Height / m	1.62 ±0.06	1.72 ± 0.07	F[1,77] = 44.1 p<0.001
Weight / kg*	63.5 ± 11.5	77.1 ± 11.7	F[1,80] = 25.00 p<0.001
BMI*	24.1 ± 3.7	25.9 ± 3.2	F[1,77] = 4.70 p<0.05
Perceived stress*	17.87 ± 6.2	15.10 ± 5.7	F[1,80] = 3.82 p = 0.054
GHQ total score*	6.12 ± 4.36	4.53 ± 3.79	ns
STAI	44.5 ± 9.3	42.1 ± 9.9	ns
DEBQ restraint	2.55 ± 0.88	1.91 ± 0.59	F[1,80] = 11.88 p<0.001
DEBQ emotional	2.43 ± 0.91	1.87 ± 0.60	F[1,80] = 8.23 p < 0.01
FCQ weight control	2.61 ± 0.89	2.09 ± 0.69	F[1,80] = 7.25 p < 0.05
FCQ mood control	2.49 ± 0.66	2.06 ± 0.75	F[1,80] = 7.12 p < 0.01
FCQ health	3.04 ± 0.76	2.64 ± 0.73	F[1,80] = 5.26 p<0.05

* Mean value of sessions completed

Table 4.3 - Nutritional status of Participants in Study (Values are averaged across completed sessions)

	Women	Men	sig (df = 80)
Total energy intake / kcal	1932.2 ± 491.0	2645.5 ± 696.2	t = 5.36, p<0.001
Total fat intake / g	81.8 ± 23.5	108.9 ± 30.1	t = 4.45, p<0.001
Saturated fat intake / g	29.7 ± 11.2	40.3 ± 13.3	t = 3.76, p<0.001
% total energy derived from fat	37.8 ± 5.3	37.1 ± 4.7	ns
% total energy derived from saturated fat	13.9 ± 4.0	13.8 ± 3.6	ns

4.3.3 Low vs. High Work load periods

To analyse the effects of low and high work stress in the longitudinal data, responses were averaged across the two sessions with the lowest number of hours of paid work (low work stress condition) and the two highest (high work stress condition). Work load varied across the sample at each session, this resulted in a good representation of each assessment point for each stress level. Individuals who had completed all four sessions but who had worked for the same number of hours on each occasion, were excluded from the analyses to give a sample of 82 participants. In the event of a participant having worked for equal hours on the middle two sessions, total work hours - derived by summing hours of paid and unpaid (domestic) work - were used to assign the sessions to low and high work stress categories. The results are shown in Table 4.4. Participants worked for an average of 10 hours longer per week in the high workload (STATS) sessions, and reported significantly more interference between work and home. Although the difference in overall emotional well being as indexed by GHQ scores was not significant, perceived stress was significantly higher in high workload sessions.

Thus it can be concluded that the objective measure of stress - hours worked - was corroborated by the subjective measure of perceived stress.

4.3.4 Food intake during low and high work stress periods

Direct comparisons of nutritional variables across the two sessions (Table 4.5) revealed a significantly higher carbohydrate intake during the high work stress periods; $t = 2.11$, $p < 0.05$. However when starch and sugar intakes were examined separately, neither were found to change significantly as a result of increased work stress. None of

Table 4.4 - Comparisons between High and Low Workload Periods

	Low Work load	High Work load	sig
Hours paid work	34.9 ± 7.4	44.7 ± 7.2	$t = 12.59$ $p < 0.001$
Interference (work/home)	2.61 ± 1.29	3.17 ± 1.27	$t = 4.49$ $p < 0.001$
Perceived stress	16.4 ± 6.4	17.5 ± 6.7	$t = 2.34$ $p < 0.05$
GHQ total score	5.43 ± 5.21	5.74 ± 4.88	ns

Table 4.5 - Food Intake During High and Low Work Stress Periods

	Low Work Stress	High Work Stress	sig
Total Energy Intake / kcal	2133.9 ± 749.1	2195.7 ± 714.7	ns
Carbohydrate / g	245.3 ± 88.4	261.9 ± 97.3	t =2.11, df =81, p<0.05
Starch / g	143.1 ± 49.9	152.0 ± 61.6	ns
Sugar / g	100.8 ± 56.9	109.5 ± 62.0	ns
Protein / g	74.5 ± 28.1	71.8 ± 22.3	ns
Total fat / g	89.7 ± 34.3	91.3 ± 33.9	ns
Saturated fat / g	32.1 ± 15.5	34.0 ± 14.3	ns
Unsaturated fat / g	58.1 ± 22.3	57.4 ± 22.9	ns

the other nutrients analysed (protein, total fat, saturated and unsaturated fat) revealed any significant differences, nor was there a significant difference in total energy intake between low and high work stress sessions.

In order to reduce the considerable within-subject variation, the results were also analysed in terms of percentage changes from low to high stress periods for each individual (see fig 4.1, Table 4.6). This revealed significant percentage increases in energy intake, carbohydrate intake (both starch and sugar), total fat intake and saturated, but not unsaturated, fat intake, as well as significant increases in perceived stress and GHQ score (denoting decreased wellbeing). These changes in intake give tentative support for a general hyperphagic effect of work stress. Percentage change in weight between the two levels of workload, was not significant.

Changes in level of perceived stress from low to high work stress sessions were also investigated and were found not to be associated with changes in any of the intake measures.

4.3.5 The Role of Individual Differences

a) Gender Differences

There were no differences between men and women in any of the effects described above.

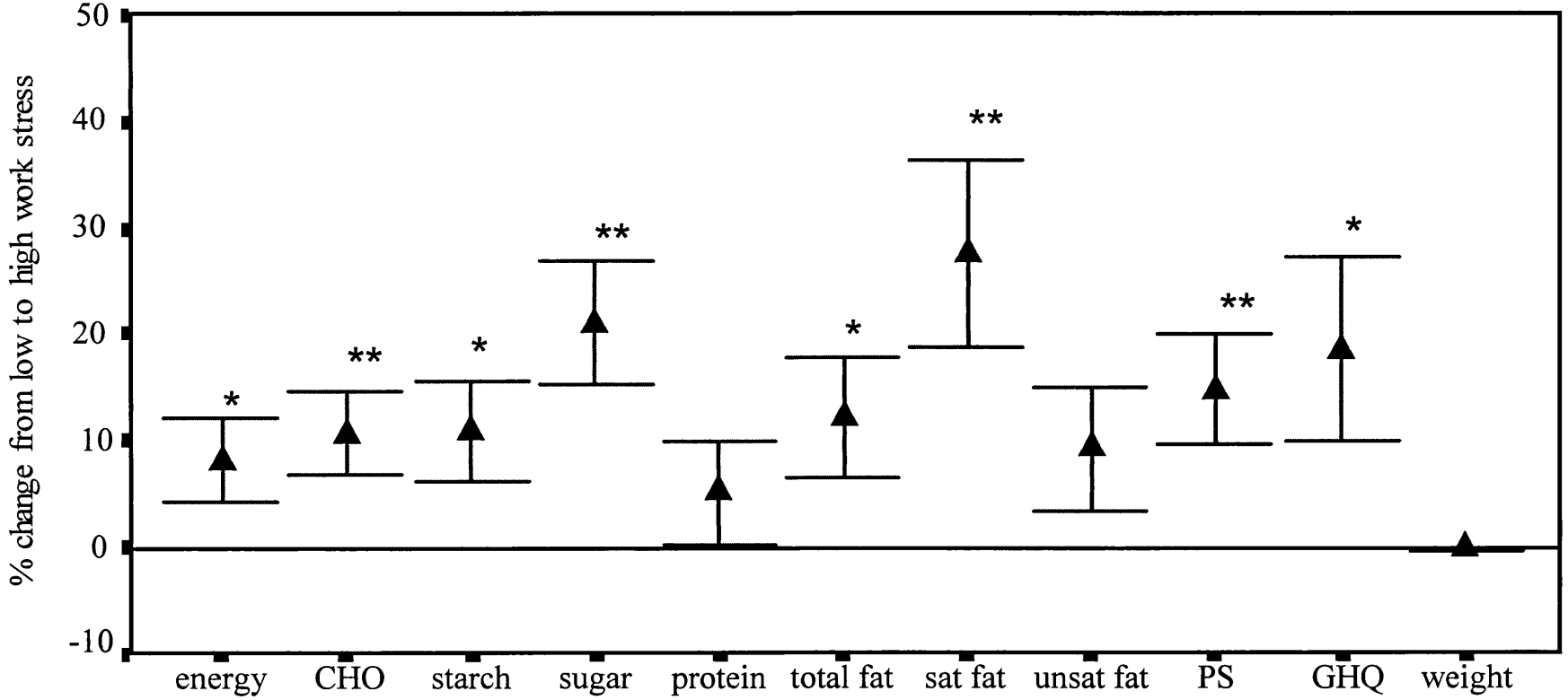
b) Dietary Restraint Differences

Subjects were divided on the basis of a median split of scores on the DEBQ restraint scale, into restrained and unrestrained eaters. Significantly more women than men were in the high restraint category, X^2 [1]= 19.9, $p<0.001$. Contrary to what might

Table 4.6 Percentage changes in 24 hour food intakes and stress indices from low to high work stress periods

	Percentage change from low to high work stress (± s.e.'s)	sig
Total energy	+ 8.1 ± 3.9	t = 2.10, p<0.05
Carbohydrate	+ 10.6 ± 4.0	t = 2.68, p<0.01
Starch	+ 11.0 ± 4.7	t = 2.35, p<0.05
Sugar	+ 21.1 ± 6.0	t = 3.54, p<0.01
Protein	+ 5.2 ± 4.9	ns
Total fat	+ 12.1 ± 5.7	t = 2.13, p<0.05
Saturated fat	+ 27.5 ± 8.9	t = 3.10, p<0.01
Unsaturated fat	+ 9.2 ± 5.9	ns
GHQ likert scale	+ 18.5 ± 8.7	t = 2.13, p<0.05
Perceived stress scale	+ 14.8 ± 5.3	t = 2.80, p<0.01
Weight change	- 0.21 ± 0.23	ns

Fig 4.1 Percentage changes from low to high work stress



* $p<0.05$

** $p<0.01$

be predicted, however, there was no evidence of any interactions between work stress and dietary restraint level for any of the intake measures assessed.

c) *Emotional Eating Differences*

In the present sample, scores on the restraint scale of the DEBQ were weakly correlated with emotional eating score, $r = 0.25$, $p<0.05$. As with restraint, subjects were divided into high and low emotional eaters by a median split, and, as with restraint, more women than men were in the high emotional eating category, X^2 [1]= 4.47, $p<0.05$.

As with restraint, there was no evidence for an influence of emotional eating upon any aspect of food intake during low and high work stress.

4.3.6 Changes in appetite, hunger and eating patterns with work stress

Across all participants, average self-reported hunger over the previous week was significantly correlated with mean appetite rating (the mean of a range of appetite ratings for the individual foods). This was true for both high work stress sessions, $r = 0.30$, $p < 0.01$ and low work stress sessions, $r = 0.46$, $p<0.001$. Self reported hunger over the previous week was also related to total energy intake as calculated from the 24 hour dietary recall, but only in the high stress session, $r = 0.23$, $p<0.05$. Energy intake was related to average reported appetite for foods on both high stress sessions, $r = 0.25$, $p<0.05$ and low stress sessions, $r = 0.34$, $p<0.01$.

Data on changes in appetite and meal patterns in the highest and lowest workload sessions are shown in Table 4.7. The distribution of ratings, combining 'much more than usual' with 'more than usual' and 'much less than usual' with 'less than usual' is shown for the highest and lowest workload weeks.

Table 4.7 - Self reported appetite for specific foods during highest and lowest work stress sessions - distribution of responses (percentages)

	Lowest work stress session			Highest work stress session		
	less than usual	same as usual	more than usual	less than usual	same as usual	more than usual
Hunger over past week	30.5	53.7	15.9	23.4	53.1	23.5
Number of snacks over past week	20.7	50.0	29.3	27.1	46.9	25.9
Appetite for cheese	28.2	51.3	20.5	25.6	57.7	16.7
Appetite for crisps	43.8	35.6	20.5	29.6	47.9	22.5
Appetite for fruit	12.6	53.2	34.2	18.2	50.6	31.2
Appetite for meat	31.5	61.6	8.2	34.8	58.3	6.9
Appetite for biscuits	37.9	43.2	18.9	33.3	48.0	22.7
Appetite for bread	17.1	63.4	19.5	12.3	71.6	16.0
Appetite for chocolate	28.2	32.1	39.7	24.7	40.3	35.1
Appetite for salty foods	28.4	62.2	9.5	15.3	66.7	18.1
Appetite for fried foods	37.5	51.4	11.1	34.3	54.3	11.4

In both high and low workload weeks, 'same as usual' is the most commonly endorsed option. For hunger the distribution is very similar for high and low stress weeks, and likewise for the number of snacks eaten.

Reports of appetite for each of the food types selected also showed that the predominant category on both high and low work occasions was 'the same as usual', which averaged 50% of reports in the low stress sessions and 55% of reports in the high stress sessions. Next most common on both occasions was wanting the foods 'less than usual' (35% in the low stress sessions and 25% in the high stress sessions). Wanting to eat the food more than usual was the least common category, averaging 25% of reports in the low stress session and 20% in the high stress session. The pattern of responses varied for individual foods, with both chocolate and fruit attracting more 'more than usual' reports than the other foods. However this effect emerged both in high and low stress sessions, suggesting that individuals perceived a constant upward trend. In contrast, crisps, meat, biscuits and fried foods tended to be rated as wanted 'less than usual', again in both sessions. Again, this may reflect the influence of general food preferences upon recalled responses.

a) *Gender Differences*

Differences associated with gender were examined in the high stress condition. Men's and women's distributions, for hunger, snacks and each of the foods were found to be very similar.

b) *Dietary Restraint Differences*

Analysis of appetite and hunger ratings during stress in restrained and

unrestrained eaters revealed two significant effects; dieters reported lower appetite for crisps than did non-dieters ($X^2 = 14.0$, $p<0.01$) and a lower appetite for fried foods in general ($X^2 = 10.2$, $p<0.05$).

c) *Emotional Eating Differences*

Analysis by level of emotional eating revealed that more emotional eaters than non-emotional eaters reported increased appetite for salty foods during the high work stress period (28.9% vs 5.9%), $X^2 = 11.0$, $p<0.05$.

Similar analyses on appetite reports in the lowest stress session showed no effects of dietary restraint, emotional eating or mood eating.

4.4 Discussion

4.4.1 Changes in food intake with work stress

The present study was designed to evaluate both general changes in diet which might represent a significant factor in mediating the effects of stress on health, and to test the prediction that individual differences in eating style could moderate the effects.

The dietary data supported McCann et al's (1990) results on work stress, finding modest, but significant percentage increases in energy, fat and carbohydrate intake during periods of high compared to low workload. This effect did not seem to be explained by changes in the subjective aspects of stress, since there was no association between change in perceived stress and change in food intake. This suggests that other factors are responsible for the observed dietary changes. Time pressure is one factor, which might limit the opportunity to prepare food, or modify the kind of meal prepared, leading to

consumption of more 'convenience', energy-dense meals when workload was higher. Indeed, self report data recorded at each session indicates that participants felt they had significantly less time to carry out their work and home duties during high, compared to low workload sessions ($t = 3.25$, $df = 81$, $p<0.01$). Thus the 'convenience food' hypothesis seems viable.

4.4.2 The role of Individual Differences

Individual variability in dietary responses to stress has been identified in a raft of experimental studies as has been mentioned. Typically, dietary restraint is associated with a greater tendency to an acute hyperphagic response, but the circumstances of consumption in the laboratory may not replicate the outside world. The assessment session is usually a single episode, the intake is usually snack food rather than meals, the food is supplied rather than sought, and typically it is highly palatable. One of the very few studies to include a measure of restraint in an evaluation of everyday eating in relation to stress found no evidence for moderation by restrained eating (Pollard et al, 1995). The results were the same in the present study; restrained eaters showed no differential responses to work stress in either food intake or weight, nor was the cross-sectional correlation between perceived stress and food intake modified by restraint level. However, both these studies have used the 'Restrained Eating' scale of the DEBQ to measure restraint. This scale has been characterised as focusing on successful restriction, rather than on the mixture of restraint and disinhibition which seems to underlie that Revised Restraint Questionnaire which is used in most of the North American studies (Allison, 1995). The present study also included a measure of disinhibition (the

'Emotional Eating' scale of the DEBQ) to assess whether disinhibition, rather than restraint per se, was the key factor, and food choice motives were assessed to determine whether deliberate use of food as a strategy for coping with stress, predicted stress hyperphagia. Neither variation in emotional eating, nor mood control as a food choice motive, predicted the dietary response to work stress. This again is consistent with the idea that increases in food intake when work demands are high are likely to be related to other aspects of the situation than responses to emotional stress.

The present study implicates higher workload in increasing food intake. The sample size of this study was significantly larger than existing longitudinal studies of work stress and diet, but nevertheless, larger sample sizes still may be needed to detect small, but potentially significant effects on disease risk factors. A hyperphagic response to work stress, especially if this involves increases in fat intake, could represent a significant health hazard and so an understanding of the mechanisms is extremely important.

4.4.3 The discrepancy between absolute and percentage changes in energy intake

In terms of percentage increases from low to high stress sessions there was a significant increase in overall energy intake, and also in intake of carbohydrate (and both starch and sugar separately), total fat, and saturated fat. However, absolute intakes in high work stress sessions were not significantly higher than in low work stress sessions, implying that the effect was being driven by a particular sub-group of the sample. Taking the "low workload" sessions as representing a 'baseline' measure, participants may be categorised on the basis of total energy intake, into 'small eaters' and 'big eaters'

(corresponding to 10th percentile (≤1367 kcal) and 90th percentile (≥ 3323 kcal) respectively). The mean energy intake for small eaters is 1180 kcal and for big eaters mean intake is 3762 kcal. Thus it may be seen that a given absolute change in energy intake from low to high workload sessions will form a greater percentage of the baseline (low workload session) value in small eaters than in big eaters. Using this categorisation of subjects produces the following values for percentage changes in energy intake from low to high workload sessions:

	Total energy intake: Low work stress sessions	Total energy intake: High work stress sessions	% change in total energy intake
small eaters	1179.9 ± 172.2	1553.2 ± 396.6	+ 31.6
medium eaters	2052.3 ± 478.9	2167.0 ± 633.7	+ 5.6
big eaters	3761.5 ± 452.5	3075.3 ± 812.7	- 18.2

Here the 'big eaters' are actually showing a percentage decrease in intake as a result of increased work stress, and the fact that the percentage increase in intake shown by the 'small eaters' is larger, drives the overall effect. The question remains, then, as to what factor(s) are responsible for the differential effects of stress on 'big' and 'small' eaters.

Michaud et al (1990) conducted a similar analysis on the data they obtained for food intake of high school students on the day of a stressful examination compared to a non-exam.day. They also found that the 90th and 10th percentiles for total energy intake showed that students who had low energy intake on the control day increased their intake

on the stressful day, whereas those students whose energy intake was high on the control day decreased their consumption on the day of the examination. It should be noted, however, that in both the present study and that of Michaud et al (1990), these findings may in fact merely be an example of regression to the mean, whereby in repeated measures of a normally-distributed variable, extreme scores tend to become less extreme (that is, nearer the mean) on subsequent occasions.

4.4.4 Changes in appetite and eating patterns

The increases in food intake seen during high work stress periods were apparently not reflected in reports of increased hunger or increased appetite for specific foods during high work stress sessions, which has implications for explanations of the mechanism of stress-induced eating in this case. There was no evidence for reported increases in snacking behaviour, in contrast to findings of the self-report study (Chapter 2).

4.4.5 Conclusions - Limitations and future directions

As far as this particular study is concerned, a valuable exercise would have been to analyse the 24-hour food recall data in terms of the foods eaten, in addition to analysis of overall energy and macronutrient intake. The latter are useful but they give little information about the processes driving food choice, since individuals select foods, not nutrients. Bearing in mind the findings from the self-report study (Chapter 2) and also the laboratory study (Chapter 3) it would seem that what characterises foods chosen during times of stress is primarily their role as snack foods; the fact that they tend to be high in carbohydrate and fat leads to apparent selection of particular nutrients.

In a more general criticism of naturalistic methodology, the contribution of these results is constrained by the methods used to measure both stress and food intake. Stress was operationalised by workload, which shows only a limited association with perceived stress. From a perspective such as public health the effects of workload are salient in themselves but as a means of investigating the association between stress and diet, stressors with more emotional impact might be more relevant.

Food intake was assessed with a sequence of 24-hour recalls. The shortcomings of this method have been well-documented (Bingham et al, 1994). They provide only a very approximate index of food intake, being limited by selective underreporting as well as by people's inability to recall their intake with sufficient detail to allow a valid nutritional analysis. However they do have the advantage of good compliance in a free-living subject population, compared with the difficulties involved in persuading participants to keep full dietary records. Nevertheless they are unsatisfactory and highlight the need for behavioural and nutritional scientists to develop more accurate methods for assessing changes in diet in free-living populations.

Finally, analyses of percentage change from high to low work stress, rather than absolute changes, should be interpreted with caution. For a given absolute change the percentage change will be larger for scores in the lower region of a distribution, which increases the possibility of Type I errors. In this study the enhanced percentage change relative to absolute change is apparent (p.145), where the percentage increase in energy intake in small eaters is sufficient to drive the effect in the sample as a whole. Use of absolute changes however increases the risk of Type II error so the choice of method should be carefully considered.

CHAPTER 5: INTERVIEWING 'STRESS-EATERS'

5.1 Introduction

Naturalistic and laboratory studies may provide valid information on the incidence and nature of stress-induced eating - quantitative methods, involving separation and measurement of the relationship between objectively assessed variables - is appropriate for constructing broad models at a 'macro' level. Other questions may more usefully be addressed by employing a qualitative methodology which operates at a 'micro' level; investigation at the level of the individual provides a valuable unit for determining mechanisms behind stress-eating. The use of the interview as a tool relies upon the assumption that people think about their eating habits, and that their verbalisations on the subject, reflect those thoughts. Also assumed is a link between physiological state, cognition, and verbal recalled response - an approach which is derived from the social cognition paradigm of social psychology. Existing qualitative studies in the area (Leon & Chamberlain, 1973; Lowe & Fisher, 1983), as with those employing quantitative methods, have tended to focus on specific populations such as restrained eaters and obese individuals. This specficity is less of a problem in the qualitative domain as the object of the exercise is to capture how particular individuals perceive and respond to themselves, rather than application of findings to the general population.

There are also a number of studies of clinical populations of eating disordered women. Comparisons of accounts suggest that there are many parallels between clinical and non-clinical populations in terms of their descriptions of stress-induced eating

episodes. It may be that those with a tendency toward stress-eating are in fact exhibiting sub-clinical symptoms of eating disorders. The implication of this explanation, however, is that stress hyperphagia is an atypical behaviour. In fact, as demonstrated in a number of studies, increased and decreased eating in response to stress occur with comparable frequencies. It is true that hyperphagia is the more extensively studied response to stress, but this probably reflects its greater problematic status in terms of physical and psychological health, rather than its greater prevalence relative to hypophagia.

There are number of qualitative accounts of stress and eating in non eating-disordered individuals. Hamburger (1951) studied a sample of eighteen obese patients undergoing psychotherapy who were suffering from either chronic or intermittent hyperphagia. In all cases, emotional stresses were cited as triggers to overeating, the preferred foods at these times were invariably reported to be very sweet. Loro & Orleans (1981) found that, among their sample of obese individuals,"anxiety, frustration, depression and other unpleasant emotions" were frequently reported to precede binge eating episodes.

Gormally, Rardin & Black (1980) conducted a number of interviews to determine correlates of a successful response to a behavioural weight control clinic, and found that relapse at follow-up was associated with reported high levels of stress. In a similar vein, Sjoeberg & Persson (1979) interviewed nine individuals on a weight-reduction course, to study the conditions leading to volitional breakdowns, and the type of reasoning preceding such breakdowns. The breakdowns were reported typically to have occurred under mood pressure due to strong emotional stress.

Edelman (1981) conducted interviews on a randomly selected population of men

and women. Forty percent of subjects reported binge eating more than three times a month (with significantly more women reporting this). The most frequent reasons given for binge eating were emotional stressors such as family discord and frustration with work.

5.1.1 Aims of this study

The present study aims to examine the processes involved in hyperphagic responses to stress among individuals who identify themselves as 'stress eaters', using semi-structured interviewing. Of particular interest will be the issue of food choice; whether stress-eaters report increased preference for certain foods, and also their conscious awareness (or at least, attributions) of the factors leading them to make these choices. The fact that the sample are self identifying stress eaters means that the data can in no way be said to reflect a general population, or even 'stress-eaters' in the general population. It is likely that those who volunteer to be interviewed do so because the topic is of particular salience to them, and so it is likely that they view their stress-eating as problematic. The aim of the interviews is thus to produce a plausible and coherent explanation of the stress-eating phenomenon in a specific group of individuals.

5.2 Method

5.2.1 Participants

Interviewees were self-selected in response to posters displayed around the University of London campus, advertising for volunteers whose eating was affected by stress. A wider population was also targetted via a letter in the editor's page of a local

newspaper. During a brief telephone screening , the purpose of the study - "investigating changes in eating habits with stress" - was made explicit to each respondent, and it was ensured that volunteers were not currently suffering from a diagnosed eating disorder. All those who volunteered initially were subsequently invited to take part in the interviews, and all agreed to participate.

5.2.2 Procedure

Prior to attending the interview, participants were sent questionnaires concerning their eating habits - the Dutch Eating Behaviour Questionnaire (DEBQ) (van Strien et al, 1986) and the Food Choice Questionnaire (FCQ) (Steptoe, Pollard & Wardle, 1995). Participants were also asked to report their age, height and weight.

Interviews took place at the University of London with the exception of one house-bound participant for whom the interview was conducted over the telephone. Upon arrival, participants were given the following information:

> *" Research into stress and health behaviours has found that when people are under stress they may show changes in certain behaviours that can affect health - for example, changes in smoking, drinking alcohol or physical activity.*
>
> *One behaviour which is commonly reported to change as a result of stress is eating. Despite this, there has been remarkably little research into the exact nature of these changes in eating. As you've told me already that your eating habits are affected by stress, I'm hoping that you can tell me a bit more about this so I can build up a picture of the kinds of foods people eat when they're stressed, and why."*

Interviews ranged from approximately half an hour to an hour in duration and, with the participant's permission, each interview was tape-recorded for subsequent transcription. To facilitate comparison across interviews, a semi-structured technique was employed to enable interviewees to express themselves fully and in depth whilst

Table 5.1 - Points addressed during the interviews

'Stress' Questions

1. What situations in your life do you find stressful?
2. How do you notice in yourself that you are under stress?

'Eating' Questions

1. What are your usual eating habits ?
2. How do your eating habits change when you're stressed?
3. What happens to your dieting or weight watching behaviour when you are stressed?
4. Do you notice any change in your weight following a period of stress?
5. Why do you think your eating habits change when you're stressed ?
6. How do these changes in eating habits affect you ?
7. Do these changes occur whenever you're stressed, or do particular kinds of stress trigger them off ?
8. Has stress always affected your eating? Is it a problem for you ?

adhering loosely to a standardised question format to allow comparison across interviews. These questions are presented in Table 5.1.

5.3 Results

5.3.1 Participant Characteristics

A total of thirteen self-identified 'stress-eaters' volunteered to be interviewed. All were female, and their mean age was 45.7 ± 12.3 years, ranging from 23 to 63 years. Participants were The mean BMI of the sample was 29.0 ± 9.2 but ranged from underweight (lowest 18.6) to very obese (highest 51.0). Of the 13 interviewees, three failed to give details of their height and weight so BMI could not be calculated. Of the remaining nine, one woman was underweight, two were of normal weight and six were overweight or obese.(see also Table 5.2)

Women in the present sample had profiles of self-reported eating behaviour more akin to bulimic patients than either to the general female population or to overweight dieting women in terms of emotional eating and external eating scores (see Table 5.3). Dietary restraint in the present sample was only slightly higher than in the general population. Thus it may be said that individuals who are prone to stress-eating are also, unsurprisingly, likely to be emotional eaters ; furthermore they are likely to be more influenced by external factors in their eating habits, though they are not particularly restrained in their habitual eating behaviour.

In addition, weight control and mood control were reported to play a greater role in influencing the food choices of women in the present sample, than they are in the general population.

Table 5.2 - Individual Participant Characteristics

Subject	Age	BMI	Restraint Score	Emotional Eating Score
TB	44	25.5	2.90	3.85
JB	60	37.0	2.20	3.54
RN	40	26.9	2.30	3.62
JA	55	22.0	3.00	2.08
CG	34	27.3	3.50	4.33
RH	23	24.2	3.60	5.00
JP	*	*	4.30	4.31
MO	*	*	2.30	4.62
CB	41	18.6	3.70	4.62
MF	63	26.8	2.60	3.54
JF	*	*	2.30	3.69
BP	53	30.5	4.00	4.62
HA	44	51.0	2.80	4.62

* Interviewees failed to supply data

Table 5.3 - Characteristics of Sample (N = 13) compared with general and specific populations

Measure	Sample mean (n = 13)	General Population (Women)	Weight watchers‡ (n = 107)	Bulimic patientsO (n = 61)
FCQ Weight control	2.97 ± 0.81	2.60 ± 0.79*		
FCQ Sensory appeal	3.06 ± 0.61	3.00 ± 0.60*		
FCQ Health	3.14 ± 0.59	3.01 ± 0.62*		
FCQ Mood Control	2.96 ± 0.52	2.21 ± 0.74*		
DEBQ Restraint	3.04 ± 0.71	2.75 ± 0.79†	3.71 ± 0.63	3.73 ± 0.76
DEBQ External	3.65 ± 0.61	3.12 ± 0.51†	3.15 ± 0.68	3.45 ± 0.86
DEBQ Emotional	4.01 ± 0.80	2.65 ± 0.72†	3.05 ± 0.68	3.83 ± 0.94

* Values for general population are derived from a sample of n = 404 women (Steptoe, Pollard &Wardle, 1987)

† Values for general population are derived from a sample of n = 102 women (Wardle, 1987).

‡ Values for female, overweight, dieting population (Wardle, 1987)

O Values for female bulimic patients (Wardle, 1987)

5.3.2 Themes Derived from the Interviews

1. *Reasons for eating when stressed*

Increased feelings of hunger were rarely mentioned by the interviewees. Where eating was attributed to physiological needs such as "getting a quick energy supply", the interviewee was, on follow-up, less restrained and also had an emotional eating score in the lower part of the sample range:

> *"Well, I don't really know if it's a physiological thing or a psychological thing, so if it's a physiological thing I assume it's because I'm more stressed, I'm burning calories faster ...but, if it's psychological, then it's just...I don't know! It's just a stress thing!" (JF)*

Much more common were comments linking stress-eating with negative emotions. Several of the interviewees used the rationalisation "comfort eating" to describe their behaviour, the idea being that eating in some way served to fill the emotional void which stress had created:

> *"I think if I get terribly bored or stressed, I do comfort eat to a certain extent."(JB)*

> *".....it's a comforting thing, you know - a cup of tea and a cake. I think so, yeah." (CG)*

> *"...I think in the home situation, it's to make up...to compensate for other things that I would like to have but that I haven't got, so I think that's probably why. It's a more sort of comfort-eating."(RN)*

> *" I think this comfort-eating is probably what's happening with me - I think they're sort of things like - a not very satisfactory relationship, say, with my husband.....I think I do use food to make up for that, you know, where I'm not getting emotional support from him, then I'll turn to food.....if you haven't got someone at home, or someone who's interested in talking to you, then you have*

to do something - either watch the television, or do some gardening, or eat!" (RN)
".....I think one of the reasons why I eat more, snack more and drink more, is because I'm not.....I haven't filled my life yet." (MF)

".....I know I eat more because I feel empty.....trying to fill myself up... I think it's kind of conditioning, isn't it, from when you're a child? If you're sort of, upset or something, and your parents say "Oh, have some sweets!" I think it's like, conditioned in the back of your mind - "Oh, I'm feeling a bit miserable, I'm unhappy, I'll just have some sweets 'cos that'll make me feel happy." It doesn't work, but you just sort of think like that.....I don't know why....." (RH)

2. <u>*Types of food preferred during stress*</u>

The foods most commonly reported to be preferred during stress are best described collectively as energy dense, sweet foods. Nine of the thirteen interviewees claimed to experience increased desire for sweet foods when stressed:

"it's always sweet stuff - chocolate cakes - and not necessarily chocolate cakes"(BP)

"If I get nervous, it's straight for something sweet, a chocolate bar or something , you know..." (CG)

"....it has to be sweet..... I mean, if it were a cheese sandwich it would have to be a cheese and pickle sandwich, or cheese and something sandwich. It couldn't be just cheese ...or, you know, it would be a cheese and jam sandwich.....or it would be a pudding, or it would be chocolate, or it would be...you know, 2 or 3 yogurts.... that sort of thing."(HA)

The most popular 'stress food' was chocolate, mentioned by seven of the 13 interviewees. Also frequently reported were ice cream, cheese and bread.

"I want to eat all the bad foods, all the chocolate and the cheese;

I want to just pig on it. Yeah. I mean, if I'm feeling down, the first thing I want to reach for is the chocolate cake ....Things like that, yes, definitely!"(CB)

"...the great "comfort foods" - chocolate and ice-cream and so on..... I really like Italian food, really tasty food, I sort of, will eat, like, huge piles of pasta and stuff, you know....."(JP)

"I really crave biscuits, or chocolate, or sometimes big things like sandwiches or bread.....sometimes it's like, cheese. Never fruit, unfortunately!"(RH)

"Sweet. Anything sweet. Or breads.....I will make myself, like, pickle and mayonnaise sandwiches....name anything that you can quickly get on bread...and have a sandwich"(TB)

"I'm very aware that I don't want salad on those occasions - I don't want....I mean, pasta salad would be alright, because that's quite...chewy..... And filling ..." (HA)

3. <u>*Reasons given for food choices during stress*</u>

Again, interviewees tended to give reasons for eating particular foods which were unrelated to sensory qualities such as taste, and more concerned with their 'comforting' properties. Amongst those interviewees who were currently attempting to lose weight 'stress foods' were those which they considered as 'bad' or 'forbidden' because they were calorifically dense:

".....breads, because I'm not allowed breads..... I love anything greasy....'cos I reckon I'm not allowed it. And because I'm not allowed it, it must be wonderful!" (TB)

"....."comfort foods" ..... they've become sort of, more so, because....they don't form part of my diet any more , so they really are....I know that, you know, I'm stressed out when I'm turning to

those because I wouldn't normally eat them - I don't have them in the house or anything....." (JP)

".....I want something that I can really bite, like, you know - a 3-tier sandwich or something like that.....I don't want a salad...a salad wouldn't do at all. It's got to be something stodgy and filling and....you know, something that you can really feel satisfied for having demolished at the end of the meal..."(HA)

4. <u>*Does stress-eating have the predicted / desired effects ?*</u>

Most interviewees reported anticipating that eating their 'stress foods' would provide emotional comfort and security, and so lessen negative feelings. In fact, in most cases, eating more when stressed seemed to create feelings of guilt and self-reproach:

"..I want to eat because I think it's going to make me feel better, and of course it doesn't - it doesn't actually take all the stress away - so then I won't feel satisfied with what I've eaten, and I'll eat some more, and then I'll quickly get to the point where I just feel pissed off because I've been eating too much and it hasn't worked, and then I've gone and eaten loads as well, and that's even worse !" (JP)

" ....I feel guilty, because I think I'm going to get fat, but I feel better." (CB)

"Any form of stress.....then I'll have to go and .....just go to binge .... and then I'm annoyed with myself because of it." (BP)

"Sweet things, yeah. They just make me feel better. And then afterwards, I think "Oh, no!"....." (CG)

"[I feel] a bit better.....then it's like normally guilty cos you think "God, why have I eaten that chocolate ?"" (RH)

There was some evidence that the guilt value of certain foods actually contributed

to their perceived attractiveness during times of stress, especially among the dieters:

> *"..... while I'm eating I think "I shouldn't be eating this - I should be eating something good for me" .....you know what you should be eating and what you shouldn't be eating; you hear the health promotion stuff about low fat, low calorie, you know, high fibre stuff. And there's just something a little bit naughty about eating...well, I don't know...fish and chips.....but fish and chips is what you really, really want, especially if it's got Heinz' Tomato Ketchup on it , and salt and vinegar on the chips..... that's what I really, really want, and that's what'll make me feel better. And afterwards, you know, you have regrets because you think "Well, I shouldn't have had fish and chips, I should've had a jacket potato, or baked beans"" (HA)*

5. <u>*What type of stress causes stress-eating?*</u>

Increased eating seemed to occur most frequently in response to relatively minor stresses and 'daily hassles'. Many of the cited stressors involved interpersonal factors and relationships, or time pressures:

> *".....personal disappointments...just dealing with people, really..." (HA)*

> *"...it seems that what can cause stress, like when there's a disagreement with your line manager, say you don't see eye-to-eye, that type of thing;.....but I think more of my stress seems to be around family relationships..."(RN)*

When asked to consider more severe stressors, interviewees tended to say that their food intake actually decreased:

> *".....what I do find is that when it's really stressful, I don't eat at all. You know, simply because, most of the time, I don't have time, or I'm too busy thinking about stuff. You know, I wouldn't eat a meal - I'd probably just eat a chocolate bar because I'm aware that I need a sugar fix. ....Once the stressor's sort of...dissipating, and I have time to eat properly, you know, eat a meal, then I would eat something stodgy and filling ..... I mean, I think the pattern it takes; that I really don't eat at all when I'm very, very stressed, apart from something very quick that I can slip in now to get a sugar fix.*

And...and then when it's beginning to dissipate, then I would eat hugely vast amounts....."(HA)

".....[With severe stress]I do have this sort of physical feeling ...down there [stomach]..... that I get ...and when I've been stressed, and when I've been ill, it gets the other way and I don't eat..... I feel quite sick, really, I think that's what it is, so I don't really want to eat, and then it's usually if I'm, sort of, upset - if I need comforting, but if I'm actually just really stressed, or fearful, that's not going to do it, so....it tends to go the other way....."(JP)

6. <u>Eating patterns during stress</u>.

Several interviewees reported preferring snacks to meals during times of stress:

"Usually - [I eat] 3 meals a day with ...might have a little sort of nibble with a cup of tea...a piece of bread or something.....but then I'd be satisfied; but if I'm stressed, then I'll tend to sort of keep eating, and not sort of keeping it to mealtimes. It'll be sort of, ongoing..."(RN)

".....I don't sit for a meal; I'll just eat biscuits and tea and chocolate bars and things like that; whatever's there - I'll prefer that over food, actual sitting down for a meal or anything like that." (CG)

5.4 Discussion

5.4.1 Stress-eating - which foods, and why?

The most significant point which may be drawn from the collective interview data is that, although the entire sample reported eating more when stressed, this eating appeared to be in response to emotional rather than physiological needs - that is, increased hunger was rarely cited as the cause of eating during stress.

The range of foods spontaneously reported to be preferred by the interviewees was quite small; and mostly consisted of sweet foods; yet when questioned about their

reasons for these choices, qualities such as taste were rarely mentioned. Instead the foods were reportedly chosen for their symbolic qualities (symbolising security, comfort, or something 'naughty' or 'forbidden').

5.4.2 The experience of stress-eating

A question which is prompted, yet unanswered by the data is why the behaviour of stress-eating is maintained when its performance results in negative affective states. Findings from numerous studies of emotional eating in obese individuals have also found affect reduction to be a prominent consequence of emotional eating (Bruch, 1973; Loro & Orleans, 1981; Weintraub & Aronson, 1969; Wooley, Wooley & Dyrenforth, 1979), often with associated guilt, self-hatred and regret (Bruch, 1973; Gormally et al, 1982). Speculatively it may be said that the positive reinforcer is anticipation of eating, or maybe the first few mouthfuls of eating the food. Beyond this, negative aspects such as guilt at having eaten 'bad' foods, outweigh the positive. The behaviour may be maintained by a mechanism involving state dependancy - to a stressed individual, recall of positive affect associated with anticipation and/ or eating a particular 'stress food' will be enhanced relative to negative feelings associated with having eaten the food. Corroborative data are documented by Hetherington & Macdiarmid (1995) in a study of chocolate consumption in dieters. The majority reported negative affect (such as feelings of guilt or depression) after eating chocolate, yet their overall opinion of chocolate was very positive. Similarly, Weingarten & Elston (1991) found that chocolate was a frequent food craving among women, but in conjunction with this were more negative attitudes and feelings towards indulging their craving which male chocolate cravers did

not report. Rodin, Silberstein & Striegel-Moore (1985) hold that this is consistent with the view that concerns about dieting and weight represent a "normative discontent" among women.

5.4.3 Comfort foods

There also remains the long standing question of why certain foods are perceived as 'comforting'. Prior conditioning may play a part - a child who is given food along with emotional reassurance will eventually associate that food with comfort and security, independent of emotional reassurance. The question is why it is sweet foods in particular have this 'comfort' role - this may be attributable to the widespread belief in an innate sweet preference (eg Desor, Maller & Greene, 1977). Whether or not this is the cause (Booth, 1987) ,sweet foods, especially if high in fat are generally preferred over other tastes by adults (Drewnowski & Greenwood, 1983) moreover, such foods obviously can, and do act as powerful reinforcers .

5.4.4 "Forbidden fruit"

The phenomenon of dieters eating 'forbidden' foods when stressed has received considerable attention among the literature dealing with relapse (eg Sternberg, 1985), and the frequent failure of weight control attempts. Some theories have explained dietary slips in terms of a passive loss of control and motivational collapse during periods of vulnerability, with a resultant 'giving in' to overpowering drives to eat created by chronic caloric restriction (Herman & Polivy, 1984). More recently it has been demonstrated that dieters may respond to 'dietary challenges' with an increase in an active state of mind and

a shift in cognitive set to a more rebellious state of mind. Thus the overeater may actively decide to overeat as a form of rebellion against self-imposed food restrictions. Ogden (1997) suggests that at times, eating as a form of rebellion may not only be a response to food deprivation, but may also indicate a rebellious statement against the deprivation of, for example, emotional support (Bruch, 1974), which is also suggested by several of the interviewees in the present study:

> *"....my husband tries to keep me under a whole lot of pressure to keep my weight down, and so he just sort of gets quite nasty, actually....and he's so fierce about what I eat at home, that I come to the University and I say to myself "Damn him..... I'm just going to eat myself through this packet of biscuits.". And I sit at my desk and just eat whatever I can get a hold of that's free and lots. Just sort of, for the release of eating something.....If he was less fierce with me..... looked at me and said "I love you the way you are", I think all this would go away. I think I could probably control my diet just fine." (TB)*

This rebellious state of mind has also been described in obese binge eaters who report binge eating as "a way to unleash resentment" (Loro & Orleans, 1981).

5.4.5 Conclusions - Limitations and future directions

The present study has attempted to elucidate how the phenomenon of stress eating manifests itself, and also to begin to piece together an account of stress eaters' beliefs about their behaviour. As has been mentioned, these accounts are likely to be biased because individuals for whom stress-eating is a problem are probably more likely to volunteer to be interviewed. How widespread the 'stress-eater's mind set is among women or among the general population remains to be established. Certainly if lay theories are to be believed, such behaviour is common as to constitute the norm in

certain sections of the population; a belief which extends into the literature. For example, Charles & Kerr (1986) argue that "almost all women have an extremely problematic relationship with food" (p.538). Their views on the phenomenon are from a feminist perspective and they claim that :

> "Many unhappy and stressful situations lead women to resort to food as a comfort, and this contradicts with their need to deny themselves food (and pleasure) in order to remain sexually attractive, and, at a deeper level, to maintain control. This insoluble contradiction can lead to an almost obsessional relationship with food" (Charles & Kerr, 1986 p.560)

Thus it would seem that for the stress-eater, eating during stress has less to do with food being a necessary fuel and more to do with food meeting deficient emotional requirements. Furthermore it may be speculated that those likely to become stress-eaters are those for whom food in everyday life, for whatever reason - early conditioning, being a dieter, being female in a Western society - has a meaning beyond the physiological. Certainly the data from the present study would appear to support this.

6.0 DISCUSSION

This thesis has aimed

I. To investigate associations between stress and eating in non-clinical populations;

ii. To investigate the relative frequencies of stress-induced hyperphagia ('stress eating') and hypophagia ('stress fasting');

iii. To identify the factors which predispose individuals to stress-induced changes in eating behaviour;

iv. To investigate the types of foods eaten during stress among stress-eaters, stress-fasters, and those in whom stress does not affect overall energy intake, and to assess the contribution of food choice to changes in overall energy intake during stress;

v. To investigate the factor(s) governing food choices during stress, examining the potential influence of characteristics such as taste, nutrient content, psychological significance ('comfort' foods, 'forbidden' foods) and practical features such as ease and speed of convenience foods, availability of snack foods, etc.

6.1 The prevalence of stress-induced changes in eating in the general population

The contrast between the ubiquity of lay belief in, and scarcity of scientific evidence supporting a relationship between stress and eating behaviour was the starting point for this research. The initial study (Chapter 2) aimed to assess the actual prevalence of this purportedly widespread belief that stress influences eating. Over two hundred undergraduates completed the novel 'stress and eating' questionnaire. A large majority

(80% of respondents) confirmed that they believed their own eating habits to be affected by stress. Of these individuals, 48% indicated that they ate less overall during stress (38% of the whole sample); whilst 52% reported an increase in their overall intake when they were stressed (42% of the total sample). Thus among those reporting an effect of stress on their eating, frequency of reporting hypo-, compared to hyperphagia is comparable to, and not, as most existing studies suggest, dominated by, hyperphagia. In fact the bias in the literature is probably a reflection of the greater clinical relevance of stress-induced hyperphagia, rather than an implication that the default reaction to stress is to eat more. The state of Western society today is such that overeating is more of a health threat than is undereating, at least among the population at large.

As has previously been discussed, a knowledge of the physiological changes which occur during stress would lead to the expectation of reduced eating (Blair, Wing & Wald, 1991), although the data in Chapter 2 demonstrate that hypophagia is no more the 'usual' response to stress than is hyperphagia.

Drawing on this physiological evidence, and also taking into account the self report data from Chapter 2 and findings from clinically-based studies, this research has taken the following view. Whilst the biological tendency is to eat less when stressed, clearly not everyone shows this response, which suggests an influence of other factors, be they environmental or psychological. The studies described have attempted to identify these factors and also to investigate whether changes in food choice accompany changes in intake.

6.2 Are stress-induced changes in eating general changes, or selective changes in preference ?

In the present series of studies the self report data provide strong support for a perceived effect of stress upon food choices. Sweets and chocolate, cakes and biscuits and savoury snacks were reportedly preferred and eaten relatively more during stress; this was reported by stress hypophagics as well as hyperphagics, suggesting that stress has the same influence over preference regardless of its effect on overall food intake. The fact that the preferred foods are all 'snack type' foods is in accordance with reports of increased snacking behaviour during stress in this study, and is reported in a number of other studies (Spillman, 1990; Zerbe, 1993;Steptoe, Lipsey & Wardle, 1988).

The naturalistic study described in Chapter 4 provides some support for a general hyperphagic effect of stress, showing evidence of a proportional increase in overall energy intake and also in intake of various nutrients when analysed separately - consistently with other studies (McCann et al, 1990; Michaud et al, 1990). Closer inspection of the findings in Chapter 4, however, reveals that these increases are not seen for protein, or for unsaturated fat. Thus whilst there is no direct evidence for stress induced changes in food choice, one may speculate that the observed percentage increases with work stress reflect selectively increased consumption of foods high in carbohydrate and saturated fats, very likely snack foods and convenience foods. This is in agreement with the findings from the self report study (Chapter 2).

The laboratory study (Chapter 3) provides no evidence for changes in overall intake as a result of the stress manipulation. However, a selective increase was seen intake of sweet, fatty foods by stressed emotional eaters. In this study, foods comprising

this category were cake and chocolate biscuits, which again endorses the notion that, where stress eating does occur, it is highly energy-dense, snack type foods which are preferred, at least by certain individuals.

The interviewees in Chapter 5 were all stress hyperphagics by admission. They reported selective increases in consumption of certain foods, and again, these foods were invariably high in fat or sugar, or both. As with the laboratory study, in which high emotional eating score was predictive of stress-eating of sweet, fatty foods, most of the women interviewed scored way above the population mean for emotional eating assessed by the DEBQ (Wardle, 1987).

From the findings from the present series of studies it may thus far be concluded that:

1. Stress-induced changes in eating are characterised by selective increases in certain foods, these foods tend to be energy-dense snack foods high in fat and / or sugar.

2. There is some suggestion from the data discussed so far, that a high score on the emotional eating scale of the DEBQ may predict individuals with a heightened tendency toward eating these foods when stressed.

6.3 Emotional Eating and other Individual Differences

Existing literature has focused on gender differences and differences in dietary restraint in attempts to explain conflicting findings. This section will examine the role of these variables in the present studies, and also the role of emotional eating and its relationship with gender and restraint.

6.3.1 Gender

As mentioned in the introduction, few studies of stress and eating have used mixed gender samples, which has rendered difficult the direct assessment of the role played by gender. In the studies presented above, gender differences in stress and eating appear most strikingly in self-reported data (viz. Chapter 2) so whether these differences are merely a reflection of gender differences in perception of eating behaviour is uncertain. For example in the questionnaire study (Chapter 2), women were more likely to describe themselves as overweight (whereas men were more likely to describe themselves as underweight), and dieting was more frequently reported in women than in men. This is in accordance with other studies showing that women are less satisfied with their perceived body shape than men and perceive themselves as overweight, whereas men are more likely to see themselves as underweight (Connor-Greene, 1988; Drewnowski & Yee, 1987). Women were slightly more likely to report a hyperphagic response to stress than were men but this was largely attributable to the observed differences in dieting behaviour, since dieters were significantly more likely to report stress-induced hyperphagia than non-dieters, and among non-dieters there was very little gender difference. The issue of the association of gender with dietary restraint will be discussed subsequently.

Assessment of actual intake of stressed and non-stressed male and female subjects in the laboratory (Chapter 3) did not support the self report data, and were not in agreement with the mixed gender study on which it was based (Grunberg & Straub, 1992). No interactions were seen between condition (stress or control) and gender once differences in energy requirements between men and women had been controlled for. In

the naturalistic study (Chapter 4) again, no differences between men and women were seen in terms of the effect of workload on energy intake or on intake of particular nutrients, or in the effect of workload on perceived hunger or appetite for specific foods.

The interview data presented in Chapter 5 is perhaps the most clear demonstration of the existence of gender differences in eating during stress. The fact that this self-selected sample consisted entirely of women is indicative of the fact that eating, especially certain foods, when stressed, is a phenomenon more to the forefront of female consciousness, most likely because it is an experience which they find problematic. That is to say it is not necessarily the incidence of stress-eating among men which is lower, but instead the frequency with which it is perceived as problematic. Hence the lack of male volunteers to be interviewed. Again this brings to attention the fact that where gender differences do occur, they are more likely due to the association of gender with other eating related variables such as restraint and emotional eating.

There is some evidence to suggest that overeating in men is less likely to be associated with stress and concurrent negative affect; in a study by Forster & Jeffery (1986) men tended to report social situations as triggers of overeating, whereas women reported eating more in response to mood states and periods of low self-esteem. Similarly, while women attribute food cravings to stress, negative mood and boredom, men tend to interpret food cravings as initiated by hunger (Weingarten & Elston, 1991).

Gender differences in eating during stress would thus appear to be driven by differences in perception of food. Women are less likely than men to view food purely in terms of its nutritional value. For many women, food has emotionally significant, and often contradictory roles - both as a 'friend in times of stress and emotional disturbance"

and "...an enemy whose consumption will spoil the ideal.....shape" (Charles & Kerr, 1986, p.540). Dieting is now so common amongst women (Alexander & Tepper, 1995) that it has become almost the norm to consider foods in terms of 'good' and 'bad'(Rodin, Silberstein & Striegel-Moore, 1985).

6.3.2 Dietary restraint

There is a strong association between gender and dietary restraint, that is, restrained eaters are vastly over represented in the female population. In both the laboratory and naturalistic studies presented here, women were significantly more restrained according to the DEBQ subscale. In the self report data, a significantly higher proportion of women than men reported "currently trying to lose weight". Charles & Kerr (1986) interviewed 200 women (who were mothers of pre-school-aged children). Only 11.5% had never dieted or worried about their weight in any way. The vast majority (88.5%) were, or had been concerned enough to attempt to lose weight by dieting at some point in their lives, and for a significant minority it was a major preoccupation.

In existing studies of dietary restraint, stress and eating, restrained eaters have been shown to increase their food intake when stressed, whereas unrestrained eaters eat less (see Ruderman, 1986). In the self report data (Chapter 2), dietary restraint was assessed (admittedly crudely) by the question "Are you currently trying to lose weight?". Classification on the basis of response to this question into 'dieters' and 'non-dieters' produced results comparable to findings of many existing studies. Dieters (the majority of whom were female) were significantly more likely to report eating more when stressed

than were non-dieters, which is in agreement with intake data from many existing studies of restraint. Dieters were also significantly more likely to report overeating than undereating in response to stress.

In the remainder of the studies presented here, however, dietary restraint had apparently no influence on food intake during stress. The laboratory study (Chapter 3) revealed no interactions between stress and dietary restraint level. In the naturalistic study (Chapter 4) it was mentioned that the hyperphagic effect was being driven by a small subset of the sample who had a very low calorie intake when unstressed; this could be characteristic of restraint differences but presumably it would have been revealed by a main effect of restraint, which was not the case. In Chapter 5, the self-identifying stress-eaters who were interviewed, were no more restrained than were women in the general population.

It is possible that the discrepancy between self-report data and observed intake data reflect a tendency of dieters to over-report episodes of overeating, since for them it is a proscribed activity - that is, there is in actual fact no difference in stress-eating between dieters and non-dieters. However this would not be in agreement with the results of existing studies. Alternatively, or additionally, the choice of scale for the measurement of restraint could be the reason for an apparent lack of effect of dietary restraint on the stress-eating relationship in the present studies.

Most studies reporting an interaction between dietary restraint and stress with regard to amount eaten, invariably have used versions of the Restraint Scale or Revised Restraint Scale (Herman & Polivy, 1980), whereas the present series of studies has used the restraint subscale of the DEBQ (van Strien et al, 1986). The latter scale is an

assessment of successful dietary restraint activity. By contrast the Restraint Scale is often criticised for its lack of unidimensionality (van Strien et al, 1986) and has been shown to contain factors reflecting fluctuations in body weight and concern about dieting as well as items reflecting disinhibition (eg "I diet in public and splurge alone") (Drewnowski, Riskey & Desor, 1982; Blanchard & Frost, 1983) - that is, factors concerned with attempts at restrained eating as well as failures. This has had the consequence that individuals may score highly on the Restraint Scale simply on the basis of large weight fluctuations in the past, without currently dieting. Since weight fluctuation is likely to reflect tendency towards disinhibited eating, the Restraint Scale may in fact be more a measure of disinhibited eating in the 'restrained' eaters of previous studies.

6.3.3 Emotional Eating

Level of emotional eating, assessed by the DEBQ, was found to predict eating behaviour under stress in several of the present studies. This is perhaps unsurprising given the nature of many of the items in this subscale ("Do you have a desire to eat when you are fed up?" "Do you get a desire to eat when you are anxious, worried or tense?") which refer to eating in response to negative affective states.

Van Strien et al (1986) reported that emotional eating was related to emotional problems and in a previous study found that, among women, emotional eating was associated with feelings of inadequacy, low self-esteem, low sociability and social anxiety (van Strien et al, 1986; van Strien & Bergers, 1988). This may be taken as an indication that the DEBQ Emotional Eating Scale measures a type of overeating that

corresponds closely with the psychosomatic view that overeating in some individuals is associated with emotional distress (Bruch, 1974; Ganley, 1989).

The self-identifying stress-eaters interviewed in Chapter 5 scored very highly on the DEBQ emotional eating score; far higher than would be expected in the general population. The data revealed that for these individuals food and emotions were very closely linked. This is in agreement with several previous studies examining the links between emotional eating and obesity (Ganley, 1989). In a study by Weintraub & Aronson (1969) all of the female subjects "shared a certain pattern of overeating which may be described as follows: the craving for food was generally preceded by feelings of depression or 'loneliness'. These feelings of 'loneliness' commonly were precipitated by minor incidents of 'rejection' or 'abandonment'" (p.740). This echoes the comments made by many of the interviewees who described their stress-eating as a way of filling an 'emotional void' created by negative events.

In a review of the literature investigating the contribution of emotional eating to obesity, Ganley (1989) identified several features characteristic of the phenomenon.

Firstly, emotional eating appears to occur only when there is sufficient overall stress and not necessarily during brief or transitory bouts of emotion (Bruch, 1973, Rand & Stunkard, 1977). The types of stress often cited as triggering such eating are interpersonal crises, specific disappointments or general unhappiness with life (Craddock ,1978). This may explain why the naturalistic study in Chapter 4 failed to show any effect of emotional eating with stress; because the stressor being investigated (work stress) did not come into the same emotional sphere as the above.

Secondly, emotional eating involves ingestion of high-calorie or high-

carbohydrate food, often with idiosyncratic choices (Loro & Orleans, 1981; Rand & Stunkard, 1977,1978). This is in agreement with the findings for stress-eaters in the self-report study (Chapter 2) and also stressed emotional eaters in the laboratory study (Chapter 3) and the interviewees in Chapter 5.

Thirdly, different emotions (for example, anger, depression or boredom) have been found to precipitate emotional eating in different individuals (Edelman, 1981), which may explain why different types of stressor may produce different results even among a population consisting entirely of emotional eaters. Furthermore, stress-eaters may be considered as belonging to a subset of emotional eaters, and as such share many of the associated psychological characteristics.

A number of studies have suggested that emotional eating is related to dietary restraint. Dewberry & Ussher (1994) found an association between dietary restraint and greater likelihood of overeating in response to dysphoric mood. Further evidence for a restraint-emotional eating link comes from the literature on depression and eating. Weissenburger, Rush, Giles & Stunkard (1986) and Zielinski (1978) have both shown that restrained eaters who were depressed reported higher weight gain than unrestrained eaters, which suggests an interaction between restrained and emotional eating.

6.4 Chocolate - the ultimate 'stress-food' ?

The positive correlation between stress and chocolate consumption is strongly and widely endorsed. This lay belief was confirmed in the interviews conducted, where seven out of 13 interviewees mentioned chocolate as their preferred 'stress food'. In the experimental study, chocolate biscuits were preferentially selected by stressed emotional

eaters. In the interviews conducted, the idea that chocolate was 'craved' was often verbalised. In a study by Weingarten & Elston (1991) chocolate was the food craved most intensely by a sample of over one thousand undergraduates. This raises the question of the mechanism, physiological or psychological, for chocolate craving during stress. Possible explanations may also be generalisable to other "stress foods".

Various claims have been made concerning the desirable psychopharmacological effects which chocolate can produce (Weil & Rosen, 1983; Mercer & Holder, 1997) or that chocolate contains addictive psychoactive chemicals (di Tomaso, Beltramo & Piomelli, 1996; Max, 1989) which supposedly explain why chocolate is so frequently the object of craving, particularly at times of stress. Upon closer inspection, however (see Gibson & Desmond, 1998; *in press*) such theories are less likely than the simpler explanation that consumption of chocolate provides the ultimate in 'sensory gratification' (Rodin et al, 1991). Its near universal appeal probably stems from its unique combination of orosensory characteristics - a sweet taste and creamy texture, which are hedonically highly pleasurable (Drewnowski & Greenwood, 1983) - and its positive connotations, developed from childhood, when it is often given as a reward or as a 'treat' on special occasions (Barthel, 1989).

In addition to this, there is the added appeal of chocolate being a 'forbidden fruit' (James, 1990), especially for those who are dieting and trying to avoid chocolate as a high energy-density foodstuff. Indeed, evidence suggests that chocolate is often perceived as 'bad' or 'fattening' (Rodin et al, 1985) which may add to its desirability.

As to why chocolate is desired particularly during times of stress; again, psychological rather than biological mechanisms appear to offer the most feasible

explanations. Having established possible reasons as to why chocolate is so often the object of craving, we may address the issue of why these cravings are triggered by stress, and in whom this reaction is elicited. Hill et al (1991) found a strong relationship between cravings and disinhibited eating; in particular, individuals identified as 'strong cravers' displayed a tendency to eat in response to negative mood states. Other studies found chocolate cravers to score highly on Emotional Eating scales (Macdiarmid & Hetherington, 1995; Gibson & Desmond, *in press*).

Gibson & Desmond (*in press*) propose that chocolate craving in certain states reflects a learned appetite, acquired through repeated experience of eating this food when in a particular state. They found that eating chocolate when hungry was more likely to lead to the acquisition of this learned appetite, while eating chocolate when full resulted in loss of craving and liking for chocolate. This poses the question whether stress-chocolate-cravers have acquired the habit by eating in response to increased hunger.

Although these explanations have been presented for chocolate in particular, it is likely that they may also explain the appeal of other "stress foods"; many of which share similar characteristics with chocolate.

6.5 Implications of present findings for the role of physiological processes in stress and food choice

The potential role of physiological processes in stress-induced eating and food choice was discussed in the Introduction, although none of the subsequent studies involved direct neuropsychological investigations. The introductory section was intended as a reminder that any stress-induced changes that do occur, do so against a backdrop of

potentially influential neurohormonal activity. Likewise, the final discussion merits a return to stress and eating physiology, and, with the present findings in mind, suggests some possible interpretations of the observed results.

6.5.1 Overall food intake during stress

A knowledge of 5-HT function, appetite and stress may help to explain why some people eat more whilst others eat less in response to stress, as has been confirmed by findings from the present studies. Animal studies have shown that acute stressors, such as handling, injection and exposure to novel environments, are associated with increases in 5-HT release (Marsden, 1996). Administration of some 5-HT agonists has been shown to produce anxiety, probably by their action on certain types of 5-HT receptor (namely 5-HT2A and 5-HT2C), while anxiolytic benzodiazepines such as diazepam (Valium) act to reduce 5-HT release (Gibson et al, 1996). Alongside this, it has been demonstrated that 5-HT agonists acting at these receptors, as well as being anxiogenic, can suppress food intake in both rats and humans (Curzon et al, 1997; Walsh et al, 1994). Mice which selectively lack 5-HT2C receptors have been found to overeat and become obese (Tecott et al, 1995). All this evidence suggests that activation of this 5-HT pathway by stress may also have the effect of reducing eating and appetite, as is reported by approximately half those surveyed whose appetite was affected by stress (Chapter 2).

However, reports of increased eating under stress occurred with comparable frequency amongst those who reported an influence of stress on eating in this study. An explanation in terms of 5-HT influences is also feasible for stress-hyperphagics, given that there is an overrepresentation of women and dieters amongst stress hyperphagics.

There is evidence that the caloric deprivation resulting from dieting in women can lead to a functional deficit of 5-HT in certain pathways - indicated by increased sensitivity of 5-HT2C receptors (Cowen et al, 1996). This is possibly due to reduced levels of the serotonin precursor, tryptophan (Anderson et al, 1990; Walsh et al, 1995). Furthermore it has been shown that pharmacological suppression of 5-HT activity in rats results in increased eating that has been likened to the hyperphagia elicited by mild stressors in animals; recent findings also suggest that this is not the result of a general increase in appetite, but rather a specific susceptibility to salient and rapidly reinforcing food stimuli (Balleine et al, 1996). Thus in dieters the satiating ability and threatening nature of some foods may be weakened. This might disinhibit eating of foods perceived as fattening, and then experience of energy dense foods during caloric deficit would rapidly reinforce their value, leading to a habit of choosing such foods.

Interestingly, there is recent evidence that a carbohydrate-rich, protein-poor meal (which raised the plasma TRP/LNAA ratio) can prevent the acutely depressing effect, and cortisol response, caused by a psychological stressor, but only in "stress-prone" subjects (Markus et al, 1998). These (mainly female) subjects may well have similar personality characteristics to stress-eaters (van Strien et al, 1986; van Strien & Bergers, 1988). It is tempting to speculate that stress-eaters may thus learn that eating protein-poor foods aids coping with stress, perhaps via enhanced supply of TRP for brain 5-HT synthesis. However, it should be noted that a meal-induced rise in TRP entry to the brain would depend on the previous meal that day also being very low in protein (Fernstrom & Fernstrom, 1995), as was the case in that study: such a dietary regime is likely to be rare (Teff et al, 1989).

6.5.2 Neurohormonal activity and food choices

It is a working hypothesis of this thesis that the choice of food an individual makes under stress will confer some form of 'relative benefit'. That benefit could be the alleviation of stress via direct psychological and/or physiological reward, or merely through the lessening of an aversive state. In principle too, an effect on food choice may result from avoidance of certain foods, i.e. selection through exclusion. It might also involve a trade-off between motivational processes, for instance a need for sensory experience versus a dry mouth and gastromotor inhibition. An individual need not be consciously aware of such a benefit; rather, the underlying processes can come to elicit and control food choice through learning, or the interaction of learning with innate influences on appetite. Stress-induced changes in physiology and neurochemistry may alter appetite and satiety by unlearned effects, e.g. on gut activity or nutrient utilisation, or by more complex effects on motivational processes. However, such changes in physiology cannot change food choice behaviour in isolation as if it were a ghostly secretion of the brain: rather, to have an impact on food choice, such endogenous effects must ultimately interact with learned habits and reactions acquired through a lifetime of food selection and consumption. Nevertheless, an understanding of how physiological systems may influence food choice in this way should help to contribute to strategies for prevention and treatment of unhealthy food choice behaviour.

In this context, it seems plausible that stress-eaters acquire habits of eating sweet fatty foods because of the likely ability of such foods to activate opioid systems that may alleviate stress (Blass, Shide & Weller, 1989). Other work suggests that

opioid activity is necessary for such foods to be perceived as palatable (Drewnowski et al, 1992; Yeomans & Wright, 1991; Yeomans & Gray, 1997). Given the evidence also that stress itself enhances endogenous opioid release (Mercer & Holder, 1997), presumably as a homeostatic response, it seems possible that stress could initiate a positive feedback process: that is, stress may activate opioid activity, which could result in sweet fatty foods seeming especially palatable, while eating such foods might further enhance opioid activity. Even though this upward spiral is probably constrained by endogenous negative feedback systems, it could provide a powerfully reinforcing cycle capable of dominating eating behaviour in certain individuals. With suitable experience, any stimulus associated with stress could come to elicit such behaviour.

In general, stress-eaters also seem to prefer energy dense snack foods. It is probable that this habit results in part from the ability of stress to inhibit nutrient absorption and prolong gastric distension by slowing of gastric emptying and diversion of blood from the gut to skeletal muscles (Gue & Bueno, 1996). Energy dense food, whose sensory properties might well induce the opioid-mediated process discussed above, would as well allow eating of more calories for less distension.

6.6 Stress and Convenience Foods ?

Finally, a factor which should not be overlooked in an investigation of food choices during stress is time pressure. Lack of time in which to buy, prepare, and eat meals, is a frequent accompaniment to stress. Data from the naturalistic study suggest that this is the case - participants reported that work interfered with their home life

more during periods of high work stress (that is, they had less time in which to carry out work and home duties). Lack of time may in some cases be the driving force behind increased consumption of highly energy dense snack foods in some stressed individuals. It is, however, difficult to replicate the influence of this factor in laboratory studies, and can only really be assessed in free living environments in which individuals are obtaining their own food.

6.7 Summary and future research

What do the findings of this thesis tell us about stress-eating and food choice? An effect of stress on eating is reported by 80% of an undergraduate sample, of whom about half report eating less and half report eating more during stress. By and large, stress-eaters can be characterised as emotional eaters; gender and restraint differences are not strongly apparent, and in any case may be secondary to differences in gender and dieting tendencies among emotional eaters. Results from the questionnaire, interview and laboratory studies suggest that stress-eaters tend preferentially to increase their intake of highly palatable snack foods. These foods tend to be energy dense and high in fat and sugar, especially among subjects reporting emotional eating tendencies.

It would seem that the self report data are consistent with the effects of an acute stressor upon food choice in a laboratory setting where the real purpose of the experiment was concealed from the subjects. The preponderance of emotional eaters amongst stress-eaters is to be expected given that the DEBQ emotional eating scale essentially paraphrases the concept of stress-eating. Also implicit in the concept of

emotional eating is the concept of "comfort eating", which itself implies that the foods chosen during emotional distress provide some sort of reward or reinforcement. This could even be *negative* reinforcement - meaning the removal of punishment - and a cognitive example of this has been proposed by Spitzer, Marcus and Rodin (1980) and also Heatherton & Baumeister (1991) in the sense that eating food might simply distract from an aversive emotional state. However, such a process would not, on the face of it, imply changes in food preference in response to stress - merely eating. Nevertheless, if the relief from aversive emotions obtained from eating is quite acute, and negative feelings such as guilt return postprandially, as indeed the evidence does suggest (Macdiarmid & Hetherington, 1995) then perhaps "comfort foods" are selected for the strength of their relief by distraction in that acute period. That is, stress-eaters should be expected to choose highly "salient" foods, however that may be characterised.

Alternatively, or indeed as well, foods selected during stress might have inherently positively rewarding characteristics, whether sensory or postingestional. This would seem to be supported by the evidence here that sweet, fatty foods are preferentially selected by stressed emotional eaters. At a sensory level, such foods are known to be highly attractive to both humans and rats alike, even innately (Steiner, 1974, Pfaffmann, 1977; Drewnowski, 1995); moreover, they have been shown to alleviate stress via release of endogenous opioids (Blass et al, 1989). The energy-dense nature of such foods can also provide two reasons for their selection during stress: first, energy-rich foods powerfully condition preferences for flavours associated with the postingestive caloric delivery (Johnson, McPhee & Birch, 1991;

Sclafani, 1995). Second, a smaller weight of such food may be eaten for a given amount of calories; this may appeal to stressed individuals whose gut motility and gastric secretion has been inhibited by a stress-induced increase in sympathetic tone (Bech, 1989; Gue et al, 1989). All these characteristics of a comfort food can be found in abundance in the snack food, chocolate. As mentioned, chocolate even has unique sensory properties that very likely add to its salience and palatability (Morgan, 1994). The fact that chocolate is so often cited as the comfort food *par excellence* among emotional eaters (Hill & Heaton-Brown, 1994) further supports the above mechanisms for reinforcement of the observed effect of stress on food choice.

Thus it can be appreciated that there are many influences acting on food choice during stress. Nevertheless, a consistent pattern has emerged from the findings in this thesis, and it is argued that this pattern is supported by other evidence for mechanistic processes relating stress and food choice. The task of further research is to confirm the mechanisms by which each of the many factors exert their effects, on which individuals, and to assess the potential impact of these effects upon health in the longer term.

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Appendix 1

STRESS AND EATING QUESTIONNAIRE

We are studying the effects that stress has upon people's health, in particular their appetite and eating habits. It would be a great help if you could answer the following short questionnaire .

1) When you are feeling under stress, how is the overall amount of food that you eat affected ? (tick whichever box(es) apply to you):

I eat much less than usual	I eat less than usual	I eat same amount as usual	I eat more than usual	I eat much more than usual
❒	❒	❒	❒	❒

2)When you are feeling under stress, how is the amount that you eat of these particular foods, affected ? (please answer for **all** the foods listed; or indicate if you are vegetarian)

	I eat much less than usual	I eat less than usual	I eat same as usual	I eat more than usual	I eat much more than usual
a) Bread	❒	❒	❒	❒	❒
b) Meat /fish	❒	❒	❒	❒	❒
c) Fruit & vegetables	❒	❒	❒	❒	❒
d) Biscuits & cakes	❒	❒	❒	❒	❒
e) Sweets & chocolate	❒	❒	❒	❒	❒
f) Savoury snacks	❒	❒	❒	❒	❒

3a) When you're feeling stressed, how does your intake of snacks compare to usual ? (tick all that apply)

I eat far fewer snacks than usual	I eat slightly fewer snacks than usual	I eat the same number of snacks as usual	I eat slightly more snacks than usual	I eat many more snacks than usual
❒	❒	❒	❒	❒

3b) When you are stressed, do you tend to eat snacks (tick all that apply).....

Instead of proper meals	As well as proper meals	I don't snack when I'm stressed
❒	❒	❒

4) Are you currently trying to lose weight ? YES ❒ NO ❒

5) Would you describe yourself as:

very underweight	slightly underweight	correct weight	slightly overweight	very overweight
❒	❒	❒	❒	❒

6) How old are you ? .....yrs

7) Are you MALE ❒ FEMALE ❒

8) What is your ethnic origin ? (please tick)

White ❒ Afro-Caribbean ❒ Asian (Indian/ Pakistani/ Bangladeshi) ❒
Chinese ❒ Other (please indicate) ❒ .....

Appendix 2 - Instructions for speech performance task given to subjects in stress group (from Kapczinski et al,1994)

You are required to make a 4-minute speech about a controversial topic which you will select from the list provided. The speech should have two parts.

IN THE FIRST PART (2 minutes) you should:

1. DEFINE your chosen topic
2. Explain WHY IT IS CONTROVERSIAL

IN THE SECOND PART (2 minutes) you should:

1. Present two or three important FACTS about your topic
2. Give your PERSONAL OPINION about it.

Your performance will be recorded and subsequently rated for content, verbal fluency and `audience appeal'. Please keep talking throughout the video recording without stopping.

List of topics:

1. Racism
2. War
3. Homosexuality
4. Death sentence
5. Religion
6. Exploitation of animals
7. Social Classes in the UK
8. Abortion
9. Feminism
10. The political system in the UK

Appendix 3

POSITIVE AND NEGATIVE AFFECT SCHEDULE

Name: .....

Date: ..... **Record Number:** .....

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent* .....

Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	*a little*	*moderately*	*quite a bit*	*extremely*

.....interested
.....distressed
.....excited
.....upset
.....strong
.....guilty
.....scared
.....hostile
.....enthusiastic
.....proud
.....irritable
.....alert
.....ashamed
.....inspired
.....nervous
.....determined
.....attentive
.....jittery
.....active
.....afraid

*Insert appropriate time instructions above from page 27

Appendix 4 State-Trait Anxiety Inventory (Spielberger et al, 1983)

A number of statements which people use to describe themselves are given below. Read each statement and then tick the box to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to best describe how you generally feel.

	Almost never	Sometimes	Often	Almost always
1. I feel pleasant.				
2. I feel nervous and restless.				
3. I feel satisfied with myself.				
4. I wish I could be as happy as others seem to be.				
5. I feel like a failure.				
6. I feel rested.				
7. I am "calm cool and collected".				
8. I feel that difficulties are piling up so that I cannot overcome them.				
9. I worry too much over something that really doesn't matter.				
10. I am happy.				
11. I have disturbing thoughts.				
12. I lack self-confidence.				
13. I feel secure.				
14. I make decisions easily.				
15. I feel inadequate.				
16. I am content.				
17. Some unimportant thought runs through my mind and bothers me.				
18. I take disappointments so keenly that I can't put them out of my mind.				
19. I am a steady person.				
20. I get in a state of tension or turmoil as I think over my recent concerns and interests.				

Appendix 5

ROSENBERG SELF-ESTEEM SCALE

Name: .....

Date: ..... **Record Number:** .....

Here is a list of statements dealing with your general feelings about yourself. If you **agree** with the statement, circle A. If you **strongly agree**, circle SA. If you **disagree**, circle D. If you **strongly disagree**, circle SD. Thank you.

	1 Strongly agree	2 Agree	3 Disagree	4 Strongly disagree
1. On the whole, I am satisfied with myself.	SA	A	D	SD
2. At times I think I am no good at all.	SA	A	D	SD
3. I feel that I have a number of good qualities.	SA	A	D	SD
4. I am able to do things as well as most other people.	SA	A	D	SD
5. I feel I do not have much to be proud of.	SA	A	D	SD
6. I certainly feel useless at times.	SA	A	D	SD
7. I feel that I'm a person of worth, at least on an equal plane with others.	SA	A	D	SD
8. I wish I could have more respect for myself.	SA	A	D	SD
9. All in all, I am inclined to feel that I am a failure.	SA	A	D	SD
10. I take a positive attitude toward myself.	SA	A	D	SD

Appendix 6 Food Choice Questionnaire (Steptoe et al, 1995)

Factors that influence your choice of food

Several different factors influence our choice of food. For every person, there will be a different set of factors that is important. In the next set of questions, we are interested in finding out what factors influence *your choice of food*. Listed below are a series of factors that may be relevant to your choice of foods. Read each item carefully and decide how important the item is to you. Put a tick in the box that best reflects your feelings. Remember, there are no right or wrong answers - we are interested in *what is important to you*.

	It is important to me that the food I eat on a typical day:	*Not important at all*	*A little important*	*Moderately important*	*Very important*
1	is easy to prepare				
2	contains no additives				
3	is low in calories				
4	tastes good				
5	contains natural ingredients				
6	is not expensive				
7	is low in fat				
8	is familiar to me				
9	is high in fibre and roughage				
10	is nutritious				
11	is easily available in shops and supermarkets				
12	is good value for money				
13	cheers me up				
14	smells nice				
15	can be cooked very simply				
16	helps me cope with stress				
17	helps me control my weight				
18	has a pleasant texture				
19	is packaged in an environmentally friendly way				
20	comes from countries I approve of politically				
21	is like the food I ate when I was a child				
22	contains lots of vitamins and minerals				
23	contains no artificial ingredients				

It is important to me that the food I eat on a typical day:		*Not important at all*	*A little important*	*Moderately important*	*Very important*
24	keeps me awake and alert				
25	looks nice				
26	helps me relax				
27	is high in protein				
28	takes no time to prepare				
29	keeps me healthy				
30	is good for my skin/teeth/hair/nails etc				
31	makes me feel good				
32	has the country of origin clearly marked				
33	is what I usually eat				
34	helps me to cope with life				
35	can be bought in shops close to where I live or work				
36	is cheap				

Please make sure you have answered every item

Appendix 7 Dutch Eating Behaviour Questionnaire (DEBQ) (van Strien et al, 1986)

Listed below are a series of questions about factors that are relevant to eating habits. Please tick the column that best applies to you.

	Never	Seldom	Sometimes	Often	Very Often
If you have put on weight, do you eat less than you usually do?					
Do you have a desire to eat when you are irritated?					
If food tastes good to you, do you eat more than you usually do?					
Do you try to eat less at meal times than you would like to eat?					
Do you have a desire to eat when you have nothing to do?					
Do you have a desire to eat when you are fed up?					
If food smells and looks good, do you eat more than you usually do?					
How often do you refuse food or drink offered because you are worried about how much you weigh?					
Do you have a desire to eat when you are feeling lonely?					
If you see or smell something delicious, do you have a desire to eat it?					
Do you watch exactly what you eat?					
Do you have a desire to eat when somebody disappoints you?					
If you have something to eat, do you eat it straight away?					
Do you deliberately eat foods that are slimming?					
Do you have a desire to eat when you are cross?					
Do you have a desire to eat when you are expecting something unpleasant to happen?					

	Never	Seldom	Sometimes	Often	Very Often
If you walk past the baker do you have a desire to buy something delicious?					
When you have eaten too much, do you eat less than usual on the following days?					
Do you get a desire to eat when you are anxious, worried or tense?					
If you walk past a snack bar or cafe, do you have a desire to buy something delicious?					
Do you deliberately eat less in order not to become heavier?					
Do you have a desire to eat when things are going against you or when things have gone wrong?					
If you see others eating, do you also have a desire to eat?					
How often do you try not to eat between meals because you are watching your weight?					
Do you have a desire to eat when you are frightened?					
Can you resist eating delicious foods?					
How often in the evening do you try not to eat because you are watching your weight?					
Do you have a desire to eat when you are disappointed?					
Do you eat more than usual when you see others eating?					
Do you think about how much you weigh before deciding how much to eat?					
Do you have a desire to eat when you are upset?					
When you see someone preparing a meal, does it make you want to eat something?					
Do you have a desire to eat when you are bored or restless?					

Appendix 8 Perceived Stress Scale (Cohen et al, 1983)

Feelings and thoughts over the past week

These questions ask about your feelings and thoughts during the past week. Please indicate how often you felt or thought this way over the past week. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question.

In the past week:	Never	Seldom	Sometimes	Often	Very Often
How often have you been upset because of something that happened unexpectedly?					
How often have you felt that you were unable to control the important things in your life?					
How often have you felt nervous and stressed?					
How often have you felt confident about your ability to handle your personal problems?					
How often have you felt that things were going in your way?					
How often have you found that you could not cope with all the things that you had to do?					
How often have you been able to control irritations in your life?					
How often have you felt that you were on the top of things?					
How often have you been angered because of things that were outside your control?					
How often have you felt difficulties were piling up so high that you could not overcome them?					

Appendix 9

GENERAL HEALTH QUESTIONNAIRE

We should like to know if you have had any medical complaints and how your health has been in general, *over the past few weeks.* Please answer ALL the questions below simply by ticking the answer which you think most nearly applies to you. Remember that we want to know about present and recent complaints, not those that you had in the past.

	HAVE YOU RECENTLY				
A1	been feeling perfectly well and in good health?	**Better than usual**	**Same as usual**	**Worse than usual**	**Much worse than usual**
A2	been feeling in need of a good tonic?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
A3	been feeling run down and out of sorts?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
A4	felt that you are ill?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
A5	been getting any pains in your head?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
A6	been getting a feeling of tightness or pressure in your head?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
A7	been having hot or cold spells?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
B1	lost much sleep over worry?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
B2	had difficulty in staying asleep once you are off?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
B3	felt constantly under strain?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
B4	been getting edgy and bad-tempered?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
B5	been getting scared or panicky for no good reason?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
B6	found everything getting on top of you?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**
B7	been feeling nervous and strung-up all the time?	**Not at all**	**No more than usual**	**Rather more than usual**	**Much more than usual**

	HAVE YOU RECENTLY				
C1	been managing to keep yourself busy and occupied?	More so than usual	Same as usual	Rather less than usual	Much less than usual
C2	been taking longer over the things you do?	Quicker than usual	Same as usual	Longer than usual	Much longer than usual
C3	felt on the whole you were doing things well?	Better than usual	About the same	Less well than usual	Much less well
C4	been satisfied with the way you've carried out your task?	More satisfied	About same as usual	Less satisfied than usual	Much less satisfied
C5	felt that you are playing a useful part in things?	More so than usual	Same as usual	Less useful than usual	Much less useful
C6	felt capable of making decisions about things?	More so than usual	Same as usual	Less so than usual	Much less capable
C7	been able to enjoy your normal day-to-day activities?	More so than usual	Same as usual	Less so than usual	Much less than usual
D1	been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
D2	felt that life is entirely hopeless?	Not at all	No more than usual	Rather more than usual	Much more than usual
D3	felt that life isn't worth living?	Not at all	No more than usual	Rather more than usual	Much more than usual
D4	thought of the possibility that you might make away with yourself?	Definitely not	I don't think so	Has crossed my mind	Definitely have
D5	found at times you couldn't do anything because your nerves were too bad?	Not at all	No more than usual	Rather more than usual	Much more than usual
D6	found yourself wishing you were dead and away from it all?	Not at all	No more than usual	Rather more than usual	Much more than usual
D7	found that the idea of taking your own life kept coming into your mind?	Definitely not	I don't think so	Has crossed my mind	Definitely has

THANKYOU FOR HELPING WITH THIS STUDY