Studies on the relationship between perimenstrual food craving, negative mood and serotonergic functioning

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Declaration

The research described in this thesis was the unaided work of the author, except where acknowledgement is made by reference. No part of this work has previously been accepted for any other degree, nor is any part of it being concurrently submitted in candidature for another degree.

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Abstract

This thesis examined the relationship between perimenstrual negative affect and food craving, and assessed potential factors influencing mood changes observed following satisfaction of cravings.

Findings from both retrospective report and daily diary ratings confirmed a strong relationship between cycle-related food craving and negative affect. The majority of women reported either premenstrual or perimenstrual symptoms, with very few reporting symptoms to be confined to the menstrual phase of the cycle. Structural equation modelling of data obtained from a large questionnaire study (n=686) confirmed premenstrual negative affect and a range of emotional health variables, including history of depression, perceived stress and current emotional state to be predicted by a latent variable, proposed to reflect neuroticism. As this variable relates to both increased risk of major depressive episodes and long-term outcome, it constitutes a vital variable in examining perimenstrual negative affect. Food craving by contrast was not directly related to this variable but was mediated by premenstrual negative mood and to a lesser extent, by emotional eating. It was initially hypothesised that craving might simply reflect a propensity to comfort eat. A subsequent study however, suggested this unidirectional hypothesis to be overly simplistic. Food craving was found to be associated with lowered energy intake, and findings from both this study and retrospective reports suggested that food craving may at times exacerbate negative affect through the effect of restraining intake or as a consequence of increased guilt following satisfaction of cravings.

Qualitative analysis of food craving suggested intake of craved foods, 90% of which were reported to be for carbohydrate-rich foods, to produce transient improvement in mood in a majority of subjects. This appeared primarily to be linked to the taste of foods. Negative mood following intake was related to eating restraint and dissatisfaction with body image.

Two studies assessed the hypothesis that increase in serotonergic functioning may contribute to improvement in mood following satisfaction of cravings. Results from the initial study supported the suggestion that carbohydrate-rich protein-poor foods may produce small increments in serotonergic activity. A subsequent double-blind study assessed mood following intake of protein-rich and carbohydrate-drinks taken in response to cravings and compared this to mood change observed following intake of craved foods. Findings confirmed retrospective reports suggesting the most striking effect on mood to relate to psychological factors associated with intake of foods, and indicated no differential effects of test drinks on mood. It is concluded that improvement in mood observed following intake of craved foods is unlikely to be a product of substrate driven increase in serotonergic activity.

Chapter 1 - General introduction and review of the literature

1.1   Introduction

The creation of a single diagnostic category, premenstrual syndrome (PMS), has had a questionable benefit for either the understanding or treatment of women who experience cycle-related symptoms. Instead, a more beneficial approach to research in this field would be to identify and investigate individual cycle-related symptoms in terms of their relationship to menstruation, to hormonal variation, and to factors that influence their reporting (Bancroft, 1993).

Perimenstrual negative mood is the single most likely cause for women to seek medical help for PMS (Bancroft, Williamson, Warner, Rennie & Smith, 1993) and is associated with increased lifetime risk of depressive illness (Bancroft, Rennie & Warner, 1994; Graze, Nee & Endicott, 1990; Warner, Bancroft, Dixson & Hampson, 1991). Recently, interest in the relationship between perimenstrual negative mood and food cravings has arisen from the observed association between the two symptoms in a number of medical complaints including premenstrual syndrome (Smith & Sauder, 1969; Tobin, Schmidt & Rubinow, 1994; Wurtman, Brzezinski, Wurtman & Laferrere, 1989), seasonal affective disorder (Kräuchi & Wirz-Justice, 1988; Kräuchi, Wirz-Justice & Graw, 1990; Rosenthal et al., 1989), and bulimia (Blouin et al., 1992; Jansen, van den Hout & Griez, 1989). There is also a potential biochemical link between negative mood and food cravings, which are anecdotally reported to be for carbohydrate-rich foods. As both carbohydrate intake and mood state are thought to be regulated by serotonergic functioning in the central nervous system, it has been proposed that these two symptoms of PMS may be products of a common, neuroregulatory dysfunction (Wurtman et al., 1989).

Further to this proposal, improvement in mood following carbohydrate intake has been observed in women with premenstrual depression (Sayegh et al., 1995; Wurtman et al., 1989). As carbohydrate intake is reported to increase the synthesis and release of serotonin, carbohydrate craving may reflect an attempt to counteract the potential adverse effects of reduced serotonergic functioning on mood by increasing carbohydrate intake and thereby alleviating negative mood state (Wurtman et al., 1989).

Despite these proposals, relatively little is known about the nature or experience of food craving per se, or its relationship to negative mood across the menstrual cycle. It is unknown whether food cravings result in intake of foods that are sufficiently rich in carbohydrates to increase central serotonergic activity, nor if mood is improved following

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satisfaction of a craving. If changes in mood do occur, it remains to be assessed whether improvement is due to increased serotonergic activity, to other biological factors proposed such as increased blood glucose (Benton & Owens, 1993), or to suggested psychological factors such as the contentment derived from eating preferred foods (Drewnowski, 1987; Hetherington & MacDiarmid, 1993; Rodin, Mancuso, Granger & Nelbach, 1991; Rozin, Levine & Stoess, 1991; Schlundt, Virts, Sbrocco, Pope-Cordle & Hill, 1993).

This thesis therefore has several aims. First to elucidate the nature and experience of cycle-related food craving and its relationship to negative mood; secondly, to examine the effect that satisfaction of cravings has on mood and to explore possible mechanisms to account for such mood effects; thirdly, to examine precise temporal relationships between food craving, negative mood and macronutrient intake across the menstrual cycle, and finally to examine the impact of food cravings on such factors as diabetic control.

In this chapter the aim is to define food craving, give a background to the clinical and biochemical associations between the symptoms of cycle-related negative mood and food craving, introduce theories proposed for the effect of carbohydrate intake on mood, and summarise the aims and objectives of this thesis. Literature pertaining to each experimental chapter will then be discussed in the relevant introductions to those chapters.

1.2   Food craving

1.2.1   Definition of the concept

Research into food cravings has been carried out both in random sample populations (Hill & Heaton-Brown, 1994; Hill, Weaver & Blundell, 1991; Rodin et al., 1991; Rozin et al., 1991; Weingarten & Elston, 1991) and in subpopulations who report frequent experience of food cravings. Studies examining specific subpopulations have included cravings related to hormonal variation (i.e. pregnancy, Bowen, 1992; Fairburn, Stein & Jones, 1992, and PMS, Bancroft, Cook & Williamson, 1988; Cohen, Sherwin & Fleming, 1987; Dye, Warner & Bancroft, 1995; Pliner & Fleming, 1983; Rogers & Jas, 1994; Smith & Sauder, 1969; Tomelleri & Grunewald, 1987) to eating disorders (i.e. obesity, Lieberman, Wurtman & Chew, 1986; Schlundt et al., 1993; Wurtman, 1988, and bulimia, Jimerson, Lesem, Kaye, Hegg & Brewerton, 1990; van der Ster Wallin, Norring & Holgrem, 1994), and to 'food addiction' (Hetherington & MacDiarmid, 1993; Macdiarmid & Hetherington, 1995). Yet despite this research, the word craving has until lately remained both contentious (Hill et al., 1991) and poorly defined (Weingarten & Elston, 1990). Many have

advocated the abolition of the word (see Weingarten & Elston, 1990), yet it continues to capture well the sense of irresistibility and compulsivity surrounding the concept.

Weingarten & Elston (1990) suggest that 'it is rare to find an individual that does not have some intuitive sense of the meaning of the term and one which is generally consistent with cravings as a strong desire for some object'. However, the use of additional explanations such as 'strong urge or desire' appears to be an important adjunct. In a study questioning the understanding of the word craving, half of the ninety nine respondents agreed that the word craving best fitted the meaning 'strong desire'. Thirty six of the subjects however, defined it as any urge or desire, even a weak one (Koslowski, Mann, Wilkinson & Poulos, 1989). Koslowski et al. therefore proposed that the word craving ought to be avoided as a sole means of evaluating subjective desires and suggested the necessity both to define the term (i.e. as a strong urge) and to measure the intensity of cravings.

1.2.2   Cycle-related food craving

Craving for sweet foods has been anecdotally described as one of the most frequently reported symptoms of premenstrual syndrome (Dalton, 1964; Wurtman et al., 1989). Abraham (1984) described four subgroups of PMS, of which one was characterised by increased appetite premenstrually, craving for sweets (mainly chocolate) and ingestion of large amounts for refined sugar. Unfortunately, the majority of studies to date have either merged the symptoms of increased appetite and food craving (Endicott, Nee, Cohen & Halbreich, 1986; Hurt et al., 1992; Schechter, Bachmann, Vaitukaitis, Phillips & Saperstein, 1989), or have discussed premenstrual symptoms in terms of total symptom scores (Ainscough, 1990; Gise, Lebovits, Paddison & Strain, 1990; Schnurr, 1988), making it difficult to examine incidence rates of individual symptoms such as food craving.

In the few studies on premenstrual symptomatology that have examined incidence of food cravings, one early study observed cravings for sweets to be noted by 37% of subjects who reported premenstrual symptoms (Morton, Additon, Addison, Hunt & Sulivan, 1953). In more recent studies, higher rates of between 60% (Bancroft & Rennie, 1993; Bancroft et al., 1993) and 75% (Mortola, Girton, Beck & Yen, 1990; Warner & Bancroft, 1990) of subjects reporting premenstrual symptoms have included perimenstrual cravings. Of these studies two noted cravings to be for sweet-tasting foods (Bancroft & Rennie, 1993; Cawood, Bancroft & Steel, 1993) which would support previous anecdotal reports on the type of food commonly craved (Dalton, 1964; Smith & Sauder, 1969; Wurtman et al., 1989). A further study noted 70% of women reporting symptoms of PMS to report increased intake of sweet foods in the premenstrual phase of the cycle (Corney & Stanton,

1991). However, despite the high prevalence of cycle-related food craving, no research has provided a detailed analysis of actual foods craved and only one study has reported carbohydrate intake to be increased in the premenstrual phase of the cycle in women reporting premenstrual cravings (Wurtman et al., 1989).

By contrast, the majority of studies using random sample populations have reported cravings, particularly in female subjects, to be most commonly for chocolate (Hill & Heaton-Brown, 1994; Hill et al., 1991; Rodin et al., 1991; Rozin et al., 1991; Waterhouse, 1995; Weingarten & Elston, 1991). Of studies examining changes in food preference across the cycle, increased preference for sweet tasting foods has been reported in the premenstrual phase of the cycle (Bowen & Grunberg, 1990; Pliner & Fleming, 1983) as has increased preference for chocolate during menses (Tomelleri & Grunewald, 1987).

Interestingly, several studies reporting chocolate to be the most common food craved in random samples have also reported a premenstrual increase in food cravings. In two studies, 32% (Weingarten & Elston, 1991) and 57% (Rozin et al., 1991) of the female samples questioned noted cravings to be related to the menstrual cycle. Similarly, in studies that examined food cravings prospectively, Cohen et al. (1987) reported food craving to be more severe in the 10 premenstrual than the 10 postmenstrual days of the cycle, and Hill & Heaton-Brown (1994) observed the number of cravings reported to increase by 66% in the premenstrual week as compared with the remainder of the cycle. In the latter study, approximately two thirds of the cravings were reported to be for chocolate-containing, or sweet tasting foods. Weingarten & Elston (1991) also noted that women who reported cravings to be cycle-related were also more likely to report chocolate as the food most commonly craved.

Food craving therefore appears to be a relatively common phenomenon both in women who report PMS and in random sample populations, with evidence from both groups suggesting cycle-related cravings to be specifically for sweet-tasting, carbohydrate and fat-rich foods, such as chocolate.

1.3   Clinical observation of a link between food craving and negative mood

Both food cravings, and intake of carbohydrate-rich foods, are reported to occur more frequently during negative mood states. Lyman (1982) noted 'junk' foods (foods typically high in carbohydrate and fat content) to be preferred more when subjects imagined themselves in negative, than in positive mood states. Similarly, both Hill et al. (1991) and Macdiarmid & Hetherington (1995) have noted negative emotional tone to be present prior to food cravings. To a certain extent, craving in itself constitutes a negative mood state - it

entails a desire for something that has not yet been fulfilled and therefore single observations may not say much about the relationship between craving and mood. However, further to these individual observations, food cravings appear common to a number of medical conditions which are also characterised by negative mood state.

PMS, as suggested above, is characterised by a number of emotional, physical and behavioural symptoms, including negative mood and food craving (Bancroft, 1993; Mortola, 1992; Smith & Sauder, 1969; Wurtman et al., 1989). Few studies however, have examined temporal relationships between the two symptoms in women reporting PMS. Of those that have, Bancroft et al. (1988) reported no difference in severity of food cravings between those subjects reporting mood changes, and those not. However, as the sample had been selected to include a subset of subjects who reported food cravings but no mood changes, this is perhaps unsurprising. Similarly, Cohen et al. (1987), noted no evident correlation between the two symptoms, but as the sample was selected to exclude those subjects who reported experiencing premenstrual symptoms correlations might be expected to be low.

More recently, Hill & Heaton-Brown (1994) noted a positive correlation between the number of premenstrual symptoms reported and the proportion of food cravings occurring premenstrually. Similarly, in another study examining subjects with prospectively confirmed premenstrual syndrome, positive correlations were observed between food craving and depression, (r=0.6), anxiety, (r=.5), and irritability (r=.6) in the week before menstruation, suggesting a possible link between negative mood and food craving in women reporting PMS (Tobin et al., 1994).

The link between food craving and negative mood is common to other mental health problems. Bulimic binges include carbohydrate-rich, fat-rich foods (van der Ster Wallin et al., 1994) and have been attributed to cravings in approximately 70% of subjects (Mitchell, Hatsukami, Eckert & Pyle, 1985). Many studies have reported a link between dysphoric mood state and bingeing (Cooper & Bowskill, 1986; Davis, Freeman & Garner, 1988; Johnson & Larson, 1982; Walsh, Gladis & Roose, 1987). Mitchell et al. (1985) observed that the majority of bulimic patients noted tension (83% of the sample) or unhappiness (67% of the sample) to be the most common causes for their binge eating.

So too, patients with seasonal affective disorder report craving for carbohydrate-rich foods during winter months when depression is most severe (Kräuchi & Wirz-Justice, 1988; Kräuchi et al., 1990; Rosenthal, Genhart, Jacobsen, Skwerer & Wehr, 1987; Rosenthal et al., 1989) and increase their intake of carbohydrate during this time period (Kräuchi & Wirz-Justice, 1988; Kräuchi et al., 1990).

Besides the observed association between food craving and negative mood across a number of medical conditions, the conditions themselves appear to have similarities. All appear to be more prevalent in females than in males. Over 80% of patients presenting to clinics with bulimia are females, as are those presenting with seasonal affective disorder (Blouin et al., 1992; Mitchell et al., 1985; Rosenthal et al., 1987).

There also appears to be an interesting overlap amongst conditions. Retrospective reports suggest a greater perceived likelihood of binge eating in bulimics during winter months, and a correlation between actual frequency of bingeing and number of dark hours has been observed (Blouin et al., 1992). Similarly, a modest but significant increase in reporting of bulimic behaviours in the premenstrual phase of the cycle has been observed in bulimic patients (Gladis & Walsh, 1987). Previous failure to detect this relationship (Leon, Phelan, Kelly & Patten, 1986) may have been due to a number of factors, the most important of which were inclusion of subjects taking medication and inappropriate analysis of the data, as discussed by Gladis & Walsh (1987).

1.4 Biochemical theory for a link between food craving and negative mood

From the observed association between negative mood and food cravings in predominantly female populations, many researchers have postulated a common biochemical link between symptoms, focusing on the role of serotonin (5HT) in the regulation of appetite for carbohydrates and mood (Bancroft et al., 1993; Christensen, 1993; Kräuchi et al., 1990; Lieberman et al., 1986; Møller, 1992; Rosenthal et al., 1987; Rosenthal et al., 1989; Wallin & Rissanen, 1994; Wurtman, 1988; Wurtman, 1990; Wurtman et al., 1989).

As will be explained in the following sections, lowered 5HT is associated with both negative mood and carbohydrate intake. This link has become more interesting in the light of recent studies reporting an association between dietary restriction and altered 5HT functioning in females (Anderson, Parry-Billings, Newsholme, Fairburn & Cowen, 1990; Cowen, Clifford, Williams, Walsh & Fairburn, 1995; Goodwin et al., 1990; Goodwin, Fairburn & Cowen, 1987; Walsh, Oldman, Franklin, Fairburn & Cowen, 1995). As this association is not apparent in males, it serves as a potential explanation for the preponderance of conditions characterised by food craving and negative mood in female populations, given the higher incidence of dieting in this group (see Davis, Durnin, Gurevich, Le Maire & Dionne, 1993; McAllister & Caltabiano, 1994). Before discussing the role of serotonin in the regulation of mood and carbohydrate intake, the synthesis of serotonin is described.

1.4.1 Synthesis of serotonin (5HT)

As shown in Figure 1.1, serotonin or 5-hydroxytryptamine (5HT) is an inhibitory neurotransmitter, synthesised in the brain from the essential amino acid, tryptophan (Grahame-Smith, 1970). As both tryptophan hydroxylase and aromatic l-amino acid decarboxylase are unsaturated with substrate at normal plasma concentrations (Huether et al., 1992), increases in brain tryptophan result in increases in brain serotonin (Fernstrom & Wurtman, 1971; Fernstrom & Wurtman, 1972). This is fundamental to the theories linking tryptophan availability to carbohydrate's neurobiological effects.
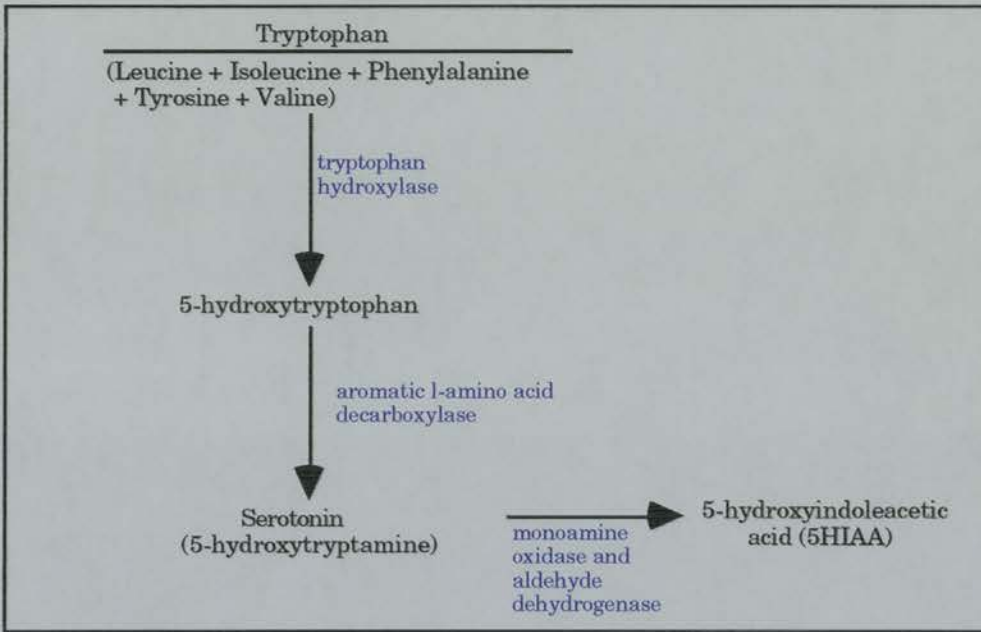
Figure 1.1 - Synthesis of serotonin.

In order for tryptophan to travel from the peripheral blood supply into the brain however, it has to compete with other large neutral amino acids (LNAAs) for transport across the blood-brain barrier on a non-specific transporter system (Oldendorf & Szabo, 1976). These competing amino acids include leucine, isoleucine, valine, phenylalanine and tyrosine. The correlation between brain tryptophan and the ratio of plasma tryptophan to the five competing amino acids has been reported in rats as r=0.95, whereas the correlation between plasma tryptophan and brain tryptophan is much lower (r=.66, Fernstrom & Wurtman, 1972). This emphasises the importance of all six amino acids in determining brain tryptophan. In human experiments, where direct measures of central serotonin are

not feasible, the tryptophan to competing amino acid ratio (T:LNAA) is commonly taken as a measure of central serotonergic activity.

1.4.2.   The role of serotonin in the regulation of mood.

Depression undoubtedly involves an interaction of psychological and biological factors and it remains unknown whether biological abnormalities observed are state markers of the illness or trait markers of predisposition to the illness (Cowen & Wood, 1991). Whilst the suggestion that dysfunction of the serotonergic system contributes to the psychopathology of depression was proposed over 30 years ago, it remains controversial (Deakin, Pennell, Upadhyaya & Lofthouse, 1990; Young, 1993). Despite this, the balance of studies have noted several abnormalities of serotonergic functioning in depressed patients.

Measurement of neuroendocrine response to the infusion of tryptophan and serotonergic agonists for example, which is now well established as a means of assessing central serotonergic functioning (Cowen, 1993), has provided evidence of abnormal serotonergic activity in patients with depression. Several studies have noted blunted endocrine responses to infusion of L-tryptophan (Cowen & Charig, 1987; Deakin et al., 1990; Heninger, Charney & Sternberg, 1984; Price, Charney, Delgado & Heninger, 1991) which is known to produce increase in plasma prolactin and growth hormone levels in healthy subjects (Charney, Heninger, Reinhard, Sternberg & Hafstead, 1982). In line with this, the majority of findings to date would suggest prolactin release in depressed patients to be blunted in response to fenfluramine, a serotonin releaser and reuptake inhibitor (Coccaro, Siever, Klar & al., 1989; Lopez-Ibor, Saiz-Ruiz & Moral Ingesias, 1989; Mitchell & Smythe, 1990; Siever, Murphy, Slater, de la Vega & Lipper, 1984; Weizman, Mark, Gil-ad, Tyano & Laron, 1988), although others remain contradictory (Asnis et al., 1988). These findings are slightly problematic in that fenfluramine is not a clean serotonergic agonist. However, in the single study using the more selective acting isomer, *d*-fenfluramine[1], a similar blunted prolactin response was noted (O'Keane & Dinan, 1991), suggesting the prolactin response to be specific to serotonergic manipulations.

Further evidence for the role of serotonin in the regulation of mood comes from acute tryptophan depletion challenge tests, which cause rapid lowering of plasma tryptophan. In patients being treated with anti-depressants, acute tryptophan depletion was observed to cause a relapse in depressive mood state in a majority of patients (Delgado et al., 1991). A more recent study of non-medicated patients noted a less consistent response to this manipulation, with no changes in mood observed whilst tryptophan was being depleted (Delgado et al., 1994). On the day following treatment however, whilst tryptophan levels

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[1] As opposed to fenfluramine, the racemic mixture of *d*- and *l*- fenfluramine which also alters dopamine transmission (Invernizzi, Berettera, Garatinni & Samanin, 1986)

were being repleted, 37% of the patients reported feeling significantly better, suggesting involvement of 5HT systems in at least some cases of depressive illness.

Other reports suggesting an abnormality of serotonergic functioning in depressed patients include decreased plasma tryptophan and decreased tryptophan to competing amino acid ratio (Deakin et al., 1990; Russ, Ackerman, Banay-Schwartz, Schindledecker & Smith, 1990), reduced cerebrospinal fluid 5-hydroxyindoleacetic acid levels, decreased platelet 5HT uptake and increased 5HT2 receptor concentrations in the cortex of suicide patients, (see Deakin et al., 1990 and Delgado et al., 1994 for a review of this literature). There is therefore evidence to implicate serotonergic dysfunction in the aetiology of depression.

1.4.3   The role of serotonin in the regulation of carbohydrate intake

Initial studies examining the effect of 5HT functioning on carbohydrate intake employed the serotonergic agonists fluoxetine and *d*-fenfluramine. In rats, it was discovered that whilst 5HT agonists had no effect on protein intake, they selectively decreased the percentage of nutrients consumed as carbohydrate (Wurtman & Wurtman, 1979). More recently, the majority of replicate studies in rats have also shown selective decreases in intake of carbohydrate at between one and two hours following injection of *d*-fenfluramine and fluoxetine (Kim & Wurtman, 1988; Lawton & Blundell, 1993a; Lawton & Blundell, 1993b; Luo & Li, 1991), although some earlier studies reported a decrease in all macronutrients consumed, not purely carbohydrate (Orthen-Gambill, 1985; Orthen-Gambill & Kanarek, 1982; Peters, Bellissimo & Harper, 1984)

In humans, studies have more frequently examined intake of macronutrients following tryptophan administration. The majority of these studies have failed to note any selective effect of tryptophan (2-3 grams) on macronutrient intake (Hrboticky, Leiter & Anderson, 1985a; Hrboticky, Leiter & Anderson, 1985b; Rogers, Binnes, McArthur & Blundell, 1979; Silverstone & Goodall, 1984). One study did however note that as little as one gram of tryptophan, when given with a high protein meal, produced a significant decrease in subsequent carbohydrate intake at the following meal (Blundell & Hill, 1987). Hence, although an interaction effect may be apparent when protein and tryptophan are consumed simultaneously, there is little evidence to suggest that tryptophan has any unique, selective effect on carbohydrate intake in random sample populations.

In populations reporting food cravings however, treatment with serotonergic drugs appears beneficial in reducing craving. D-fenfluramine, a selective serotonin releaser and reuptake blocker, decreases carbohydrate intake in obese carbohydrate cravers (Wurtman, Wurtman, Reynolds, Tsay & Chew, 1987; Wurtman et al., 1981; Wurtman, Wurtman,

Mark, Tsay & Growdon, 1985) and reduces carbohydrate craving in women with premenstrual depression (Brzezinski et al., 1990). A trend towards lower food craving scores in subjects receiving tryptophan (2g/ day) than in those receiving placebo was also observed before discontinuation of the study was enforced following warnings of a potential association between tryptophan administration and eosinophilia-myalgia syndrome (Brzezinski, Shalitin, Ever-Hadani & Schenker, 1990).

Similarly, in a placebo-controlled study, patients with seasonal affective disorder demonstrated significant reduction in carbohydrate craving after four weeks on d-fenfluramine (O'Rourke, Wurtman, Wurtman, Chebli & Gleason, 1989). Binge frequency among patients with bulimia has also been noted to decrease following treatment with monoamine oxidase (MAO) inhibitors (see Walsh et al., 1987). It may therefore be that manipulation of the serotonergic system does not alter carbohydrate intake in random sample populations, but could affect the desire to eat carbohydrate in specific subpopulations. Whether this effect is direct, or results from an improvement in mood remains to be elucidated. Brzezinski et al. (1990) observed an improvement in mood in women with premenstrual symptoms concomitant with a decrease in food cravings following treatment with d-fenfluramine. By contrast, (Bancroft et al., unpublished observation) noted that whilst treatment with d-fenfluramine decreased carbohydrate craving, it had little effect on perimenstrual negative mood. Similarly, reduction of binge eating in bulimics following treatment with 5HT agonists appears unrelated to the presence of pre-treatment depression (see Walsh et al., 1987).

1.4.4   Abnormality of 5HT function in women reporting PMS

From the above evidence, it would appear that serotonergic functioning has a potential role to play both in the regulation of negative mood and may affect desire for carbohydrate in certain populations. In addition to this theoretical, biochemical association between cycle-related negative mood and carbohydrate craving, there are also several findings to suggest decreased serotonergic functioning in the perimenstrual phase of the cycle which may account for the emergence of these two symptoms at this time point.

Reduced platelet uptake of serotonin has been reported in the week before menstruation in women with PMS (Ashby, Carr, Cook, Steptoe & Franks, 1988; Taylor, Mathew, Ho & Weinman, 1984) which does not appear to be evident in controls at this time (Ashby et al., 1988). Plasma serotonin has also been reported to be lower in the premenstrual phase as compared to the postmenstrual phase in women suffering from PMS (Taylor et al., 1984) and whole blood serotonin levels have been observed to be significantly lower in women

with PMS than in controls during the ten days before onset of menses (Rapkin et al., 1987). This latter finding however appears due to an increase in levels of whole blood serotonin in control subjects premenstrually, rather than a decrease in premenstrual levels of serotonin in women with PMS.

Despite these differences in serotonergic functioning between women with PMS and controls, Rapkin, Reading, Woo & Goldman (1991) reported similar tryptophan to competing amino acid ratios to be present in women with and without PMS, with no difference in ratio noted between the follicular and luteal phases of the cycle in either group.

More direct evidence of central serotonergic dysfunction is however available from a study examining the neuroendocrine response to infusion of L-tryptophan. As noted on page 8, tryptophan infusion, which increases central 5HT release in animals (Sharp, Bramwell & Grahame-Smith, 1992), also produces an increase in plasma prolactin and growth hormone levels in healthy subjects (Charney et al., 1982). The finding that prolactin and growth hormone release are enhanced by pre-treatment with clomipramine (a selective 5HT reuptake inhibitor) would suggest that their release following tryptophan administration is mediated by 5HT pathways (Anderson & Cowen, 1986). In a study examining the effect of tryptophan in both pre- and postmenstrual phases of the cycle, blunted growth hormone responses were observed in subjects with premenstrual depression as compared with controls in both cycle phases (Bancroft, Cook, Davidson, Bennie & Goodwin, 1991). Interestingly, the authors also noted an effect of cycle phase on prolactin response to L-tryptophan infusion, with blunted responses observed in both groups in the premenstrual phase of the cycle. These findings suggest that women who report premenstrual depression may have some biochemical abnormality throughout the cycle that makes them particularly vulnerable to naturally occurring variations in biochemical functioning in the premenstrual phase of the cycle.

The involvement of serotonin in premenstrual symptomatology is also suggested by the effect of acute tryptophan depletion on symptom severity. Challenge tests have noted acute tryptophan depletion to result in aggravation of premenstrual depression approximately ten hours after ingestion of a tryptophan-free amino acid mixture (Menkes, Coates & Fawcett, 1994). This is a less rapid response to that observed in depressed patients (Delgado et al., 1991). In Menkes et al.'s study, aggravation of irritability was most pronounced, with changes in ratings of depression and food cravings just failing to reach statistical significance, ($p < 0.08$, n=16). These findings are in contrast to the lack of effect on mood observed in healthy female volunteers up to five hours following acute

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tryptophan depletion (Oldman, Walsh, Salkovskis, Laver & Cowen, 1994) although it remains unclear whether effects may have been observed had the time-scale of monitoring mood been extended, as in Menkes et al.'s study.

Studies reporting effective treatment of premenstrual depression with serotonin reuptake inhibitors (fluoxetine and clomipramine) also suggest dysfunction of the system in this phase of the cycle (Menkes, Taghavi, Mason, Spears & Howard, 1992; Steiner et al., 1995; Stone, Pearlstein & Brown, 1991; Sunblad, Modigh, Anderesch & Eriksson, 1992; Wood, Mortola, Chan, Moossazadeh & Yen, 1992). In those studies which examined appetitive changes specifically, Stone et al. (1991) noted a significant reduction in reporting of premenstrual increases in appetite following treatment with fluoxetine and Brzezinski et al. (1990) noted significant decreases in both carbohydrate craving and intake following *d*-fenfluramine treatment.

In line with evidence supporting serotonergic dysfunction in women with PMS, similar dysfunction of the serotonergic system has also been reported to occur in other disorders where food cravings and negative mood are apparent including bulimia (Jimerson et al., 1990; McBride, Anderson, Khait, Sunday & Halmi, 1991) and seasonal affective disorder (Rosenthal et al., 1987).

1.5   Mood change following intake of craved foods

In addition to the proposed biochemical association between food craving and negative mood, several studies have noted beneficial effects on mood following intake of carbohydrate (as further discussed in Chapter 6) and following satisfaction of food cravings. Hill et al. (1991) reported six of ten subjects to experience positive shifts in mood following intake of craved foods, the majority of which were for chocolate. As mood questionnaires were completed at set time points throughout the day, no exact time scale for improvement in mood following intake was discernible. In a more recent study this finding has been replicated, with improvement in mood noted immediately following intake (Hill & Heaton-Brown, 1994). Weingarten & Elston (1991) similarly noted positive shifts in mood in over 57% of female subjects, and 87% of male subjects, when questioned retrospectively about mood change following intake of craved foods, although again no time scale for mood change was given. So too Macdiarmid & Hetherington (1995) in their study of chocolate addicts, reported both addicts (n=20) and controls to rate contentment as higher immediately after eating chocolate, although no significant changes in ratings of depressed mood were reported. Unfortunately, as no further ratings of mood were taken, it is unknown for how long these alterations in mood were apparent. Other studies have

also noted an association between chocolate craving and intake in response to negative moods states (Schuman, Gitlin & Fairbanks, 1987), and an association between frequency of intake of sweet foods and their emotional meaning (Prätälä & Keinonen, 1984).

In light of these findings, and those which suggest improvement in mood following carbohydrate intake (see Chapter 6), three theories for mood change following satisfaction of a craving have been proposed. The first of these concentrates on changes in serotonergic functioning, the second on changes in blood glucose, and the third on psychological factors. The first suggests that carbohydrate craving may act as a sort of self-medicating system for alleviating negative mood and proposes that food craving results in an overconsumption of carbohydrate which in turn produces an increase central serotonergic functioning, thereby alleviating negative mood (Wurtman et al., 1989). The evidence for this is discussed below.

1.6   Biochemical theories for mood changes observed

1.6.1   The effect of carbohydrate intake on serotonin in rats

As described on page 7, brain serotonin is dependent on both plasma levels of tryptophan and competing amino acids. These amino acids are essential as they cannot be synthesised by the human body and are only obtainable through dietary protein (Wurtman, Hefti & Melamed, 1981). The suggestion that serotonin could be altered by dietary intake arose from the observation that infusion of insulin lowered most of the amino acids in plasma, but increased concentrations of plasma tryptophan (Fernstrom & Wurtman, 1971). In a study examining the response of tryptophan to increases in insulin produced by carbohydrate intake, levels of plasma tryptophan were observed to rise by 65% two hours following consumption of a carbohydrate meal (Fernstrom & Wurtman, 1971).

The reason for this insulin mediated increase in central levels of tryptophan is that once released, insulin enhances penetration of most amino acids into peripheral muscle tissue (Teff, Young & Blundell, 1989a; Teff, Young, Marchand & Botez, 1989b). As most tryptophan is found bound to serum albumin (McMenamy & Oncley, 1958) increases in insulin have little effect on plasma levels. Hence there is an increased proportionate amount of tryptophan to competing amino acids in the blood stream. This in turn is available for transport into the brain because the blood-brain barrier transport system has

Basal blood levels of amino acids

○ Competing amino acids
◉ Tryptophan
● Albumin

Carbohydrate intake

Broken down into simple sugars

Causes release of insulin

Promotes entry of competing
amino acids into muscle tissue

Serves to change the balance of
amino acids in the blood stream

Relatively more tryptophan available
for transport in to the brain

Transporter molecule

Blood-brain barrier

Increase in levels of
brain tryptophan

Increase in levels
of brain serotonin

Figure 1.2 - Proposed effect of carbohydrate intake on tryptophan to brain serotonin

a higher affinity for tryptophan than does albumin (Fernstrom & Fernstrom, 1993). Figure 1.2 on page 14 shows a diagrammatic explanation of this process.

Following their initial observation that carbohydrate intake increased brain tryptophan, Fernstrom & Wurtman (1972) hypothesised that protein ingestion ought also to produce this effect as it would elevate plasma tryptophan both by inducing insulin secretion and by providing new tryptophan. This hypothesis proved unfounded. When a protein meal was consumed, concentrations of plasma tryptophan increased by 60% above those of fasted controls, whilst levels of brain tryptophan concentrations remained unchanged (Fernstrom & Wurtman, 1972).

Fernstrom & Wurtman (1972) hypothesised that the failure to increase brain tryptophan levels was due to raised levels of the other competitor amino acids. As all dietary proteins are richer in other LNAAs than tryptophan (comprising only 1-1.5% of total protein), consumption of a high-protein meal would cause a decrease in the ratio of plasma tryptophan to competing amino acids and thus a decrease in tryptophan uptake by the carrier molecules. To test this, Fernstrom & Wurtman (1972) gave rats two meals. The first contained both carbohydrate and a casein-like protein. The second meal was similar to this but omitted the five amino acids thought to share a common transport system with tryptophan. Although both diets significantly increased plasma tryptophan levels, increases in brain tryptophan were noted only when competing amino acids were omitted from the diet. Hence protein blocks the carbohydrate mediated increase in the proportion of tryptophan available to the brain by introducing a over-abundance of new competitor amino acids to the blood stream.

1.6.2   The effect of carbohydrate intake on serotonergic functioning in humans

Since this early research, many other studies carried out in humans have provided evidence to support the theory that carbohydrate intake increases the relative amount of tryptophan available to the brain. Research to date suggests that meals very high in carbohydrate and low in protein content (<2%), produce a significant increase in the tryptophan to competing amino acid (T:LNAA) ratio. Despite small subject samples, the majority of studies that have examined the effect of carbohydrate intake on the T:LNAA ratio have noted significant increases in the T:LNAA ratio at two hours post-consumption, after as little as 100 Kcal carbohydrate meal. Table 1.1 on page 16 summarises these studies, giving the weighted mean of the increase from baseline at two hours post consumption as 23%.

Table 1.1 - Summary of published literature on the effect of nutrient intake on tryptophan to competing amino acid (T:LNAA) ratio.   [*]obese subjects; [ϕ]bulimic subjects.

	n	% protein in meal	Kcal	% T:LNAA from baseline at 2 hours	P-value
≤2% protein containing meals					
(Martin-Du Pan et al., 1982)	6	0	100	122	.05
	6		200	118	.05
(Lyons & Truswell, 1987)	10	0	480 (sugar)	123	.05
	10	0	480 (starch)	111	ns
(Caballero et al., 1988)	8	0	120	116	.05
	9[*]			105	ns
(Teff et al., 1989a)	10	0	400	126	.05
(Teff et al., 1989b)	5	0	375	147	ns
(Turner et al., 1991)	16	0	1200	116	.05
	13[ϕ]	0	1200	122	.05
(Davis et al., 1992)	10	0	-	129	not given
(Sayegh et al., 1995)	n	0	200	129	.05
(Lieberman et al., 1986)	6	<1	650	111	.05
(Rosenthal et al., 1989)	32	<1	800	131	not given
(Spring et al., 1989)	7	<1	780	142	.05
(Ashley et al., 1982)	8	1.6	500	114	ns
(Ashley et al., 1985)	6	1.6	500	113	.04
Total	140				
Weighted mean				123[2]	
≥4% protein containing meals					
(Teff et al., 1989a)	10	4	400	109	ns
	10	6		98	ns
	10	8		93	ns
	10	12		92	ns
(Christensen & Redig, 1993)	9	6	650	110	not given
	5	10		109	
	6	50		83	
(Caballero et al., 1988)	8	15	400	97	ns
	9[*]			113	not given
(Lyons & Truswell, 1987)	10	20	480	52	.05
(Ashley et al., 1982)	8	20	500	98	ns
(Ashley et al., 1985)	6	20	500	82	.04
(Sayegh et al., 1995)	n	33	200	98	ns
(Lieberman et al., 1986)	6	50	650	72	.01
(Rosenthal et al., 1989)	32	50	800	63	.01
(Spring et al., 1989)	7	54	780	55	.05
(Teff et al., 1989b)	7	75	250	75	ns
(Møller, 1985)	6	100	24	72	.001

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[2] Sayegh et al . (1995)were omitted from this analysis due to lack of reported n. The obese population in Lieberman et al. (1986) and bulimic population in Turner et al. (1991) were also omitted.

This increase appears to be independent of the calorific value of the meal, with 25g of glucose observed to be as effective as 50g in increasing the T:LNAA ratio (Martin-Du Pan, Mauron, Glaeser & Wurtman, 1982). Increase in the T:LNAA ratio may however be dependent on the glucose response produced by different carbohydrate types, as Lyons & Truswell (1987) noted less increase in both the glucose response and the T:LNAA ratio following starch meals than those observed following intake of sucrose meals (see Table 1.1).

By contrast, meals high in protein content (>50%) appear to cause significant decreases in the T:LNAA ratio (Lieberman, Caballero & Finer, 1986; Møller, 1985, see Table 1.1). Recently however, Sayegh et al. (1995) noted no significant change in T:LNAA ratio following ingestion of a meal containing 33% protein, which would suggest that meals containing relatively large quantities of protein are required before consistent decreases the T:LNAA ratio are observed. Variability amongst studies observed might also reflect the importance of type of protein (i.e. relatively rich or poor in tryptophan) in determining change in the amino acid ratio.

Of interest to the theory that mood changes following satisfaction of cravings may result from a change in 5HT activity however, is whether commonly craved foods are likely to induce an increase in the T:LNAA ratio. Chocolate bars, commonly reported as craved in random sample populations, contain approximately 5% protein[3] (see Appendix 1). Therefore, how much protein included in a meal is sufficient to block the increase in T:LNAA ratio following carbohydrate intake? Only two studies have assessed the impact of relatively low protein-containing meals (<10%) on the T:LNAA ratio, and of these Teff et al. (1989a) noted 4% protein in a meal to be sufficient to block any significant increase in T:LNAA ratio caused by carbohydrate intake, in a sample of males (see Table 1.1, p16). From this, Teff et al. concluded that it is only at extreme levels of macronutrient ingestion i.e. when either pure carbohydrate or protein are ingested, that significant changes in the tryptophan ratio will occur. As noted previously however, dietary induced changes in serotonergic functioning may be more pronounced in females than in males and more recently, using a female sample population, Christensen & Redig (1993) noted increases in the T:LNAA ratio of 10% and 9% following intake of meals containing 6% and 10% of protein, respectively. Unfortunately, this study is marred by the fact that no measurement of tyrosine was taken and very small sample sizes included (see Table 1.1). Hence, it remains unclear then whether small quantities of protein in carbohydrate-rich meals are sufficient to block the rise in T:LNAA ratio produced by carbohydrate intake

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[3] 5.3% as calculated from nutritional lists of the 48 types of chocolate bar manufactured by Mars Confectionery and Cadbury Ltd.

and therefore whether changes in mood following satisfaction of food cravings could result from such biochemical alterations.

1.6.3   The effect of blood glucose on mood

An alternative factor that may be of interest in examining the effect of intake on mood is that of blood glucose. Studies have observed a relationship between mild hypoglycaemia and both irritability (Linnoila & Virkkunen, 1991) and aggression (Benton, Kumari & Brain, 1982). So too in insulin dependent diabetics, a tendency for low blood glucose to be associated with negative mood and high blood glucose with positive mood has been observed (Gonder-Frederick, Cox & Bobbitt, 1989). And recently, consistent relationships between increased blood glucose and decreased tension were observed across a series of experiments (Benton & Owens, 1993). Hence some improvement in mood following satisfaction of a craving might relate to changes in this variable, rather than to changes in serotonergic activity.

1.7   Psychological theories for mood change following satisfaction of a craving

One problem inherent in any biochemical theory concerning mood change is that of the time scale for mood change given by women. Anecdotal reports from women attending the Edinburgh PMS clinic would suggest improvement in mood following satisfaction of a craving to be immediate and therefore to occur well before any biochemical changes take place. This time scale is similar to that reported by other researchers looking at mood change following satisfaction of cravings (Hill & Heaton-Brown, 1994; Macdiarmid & Hetherington, 1995). In contrast to biological theories of food craving, several theorists have proposed that cravings may reflect a desire for preferred tastes, or other sensory cues, rather than a need for physiological effects (Drewnowski, 1987; Hetherington & MacDiarmid, 1993; Rodin et al., 1991; Rozin et al., 1991; Schlundt et al., 1993). Improvement in mood following satisfaction of a craving may simply result from the pleasure derived from eating a preferred food.

Certainly, sweet food appears to be preferred from a very young age (Bartoshuk & Beauchamp, 1994), and is often associated with celebration (Lyman & McCloskey, 1989) and reward (Waterhouse, 1995), positive events which may come to be related to intake of sweet-tasting foods, making the experience more pleasurable. Sweet, high-fat foods are also highly palatable (Drewnowski & Greenwood, 1983) and by this standard chocolate has been proposed to be 'hedonically ideal' (Schuman et al., 1987). Furthermore, it is the sensory properties of craved foods that are often cited as the reason for their appeal.

Hetherington & MacDiarmid (1993) for example, noted chocolate cravers to report the sensory aspects of chocolate (i.e. taste, smell, texture) as its most alluring feature.

In support of this, Hill, Magson & Blundell (1984) found that feelings of relaxation and contentment reported at one and two hours after intake of preferred foods were not reported following intake of non-preferred foods, despite the similar macronutrient contents of each. In line with this, both Rodin et al. (1991) and Weingarten & Elston (1990) have noted that foods which contain similar macronutrient profiles to craved foods are often not desired. This challenges both the hypothesis that cravings reflect some need to correct bodily deficits (i.e. by restoring the 5HT deficiency) and the suggestion that effects on mood may be biochemically mediated.

Other theorists have suggested a marriage between biochemical and psychological theories. Waterhouse (1995), in her recently published book entitled 'Why women need chocolate', proposes that 'the psychological experience is as much involved as is the biological phenomenon' and suggests that 'taste, habit, emotional attachment, and cultural influences also define the foods we crave'. Similarly, Weingarten & Elston (1990) have noted that the 'explanations of craving based on [biological] need or sensory stimulation may not be independent'. It is possible that both the reason as to why particular foods are craved and their effect on mood may be a product of both psychological and biochemical factors.

1.8   Summary

There are many reasons, both from observed association and potential biochemical abnormalities, to suggest that food craving and negative mood may be linked in women reporting cycle-related symptoms. Yet relatively little research has examined food craving per se, nor is much known about the exact temporal relationship between perimenstrual negative mood and food craving. Similarly, although it has been observed that mood often improves following satisfaction of cravings it remains unknown whether these effects are due to psychological gratification or to biochemical changes produced by intake of carbohydrate-rich foods. These questions are examined further in the relevant chapters contained within this thesis.

1.9   Aims and objectives

The purpose of this thesis is to elucidate the nature of perimenstrual food craving and to examine the relationship between this symptom and perimenstrual negative mood. It also

aims to examine the effect of intake of craved foods on mood and to assess the likely causes for any mood changes observed in relation to current theories.

Hence, Chapter 2 elucidates the relationship between food craving and negative mood and examines the psychosocial factors relating to these symptoms. Chapter 3 confirms prospectively the relationship observed between food craving and negative mood and examines their temporal relationship to menstruation. Chapter 4 examines the qualitative experience of cycle-related food craving, including the type of foods craved and perceived mood changes following intake whilst Chapters 5 and 6 directly test Wurtman's proposal that carbohydrate may alleviate negative mood state by increasing serotonergic activity. Hence, in Chapter 5 the effect on mood of drinks differing in both protein content and impact on the T:LNAA ratio are examined, whilst in Chapter 6 the effect of carbohydrate-rich, protein-poor drinks and protein-rich drinks taken in response to food cravings are assessed and compared to mood change following intake of actual craved foods. Chapter 7 examines the association between negative mood, food craving and carbohydrate intake across the cycle and Chapter 8 looks at the effect of food craving on the control of Type 1 Diabetes Mellitus.

Chapter 2 - Relationship between premenstrual food craving and negative mood: psychosocial factors influencing their reporting

2.1 Introduction

The aim of this study was to assess the relationship between cycle-related food craving and negative mood and to examine the impact of psychosocial factors on reporting of these symptoms. Factors thought to be associated with symptom reporting are discussed below.

2.1.1 Factors associated with reporting of premenstrual symptoms

2.1.1.1 Contraception

It is often assumed that ovulation, and the subsequent development of a corpus luteum with increase in progesterone, are prerequisites for development of physical and emotional symptoms in the premenstrual phase of the cycle (Bancroft, 1993; Walker & Bancroft, 1990). As ovulation is blocked by oral contraceptive use, it would be assumed that their action would ameliorate symptoms. Several early reports noted a beneficial effect of oral contraceptive use on reporting of premenstrual symptoms (Grant & Pryse-Davies, 1968; Kutner & Brown, 1972; Moos, 1968). Many of these however, referred to oral contraceptives which contained much higher steroidal doses than are currently available and are therefore of limited validity in determining the effect of current oral contraceptives on symptom reporting (Bancroft, 1993; Graham & Sherwin, 1993).

In more recent studies including new, lower steroidal dosages, women using oral contraceptives have been observed not to report fewer symptoms, but to report lower severity of certain symptoms (Bancroft & Rennie, 1993; Bancroft, Williamson, Warner, Rennie & Smith, 1993; Corney & Stanton, 1991; Graham & Sherwin, 1987; Walker & Bancroft, 1990) and to report symptoms to occur closer to onset of bleeding than those using non-steroidal forms of contraception (Corney & Stanton, 1991; Graham & Sherwin, 1987). In essence, the largest differences appear to relate to physical symptoms. Breast tenderness, has been noted in several studies to be less severe in oral contraceptive (o.c.) users than in non-o.c. users (Bancroft & Rennie, 1993; Bancroft et al., 1993; Corney & Stanton, 1991; Walker & Bancroft, 1990) whilst a difference in severity of negative mood has been observed in only one study (Graham & Sherwin, 1987)[1]. These findings support reports from a small scale study (Walker, 1987) in which anovular cycles were noted to be

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[1] Although several studies have noted persistence of negative mood in the menstrual phase to be more common in oral contraceptive users (Bancroft, 1993; Walker & Bancroft, 1990; Warner & Bancroft, 1988)

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associated with lower breast tenderness than ovular cycles, and another larger study which assigned subjects with PMS to one of two treatments (triphasic pill or placebo). The authors reported significant reductions in breast pain and bloatedness in the group using triphasic as compared with placebo preparations, but observed no differences in affect between the two groups (Graham & Sherwin, 1992)[2]. Of the two studies to examine appetitive changes specifically, one noted o.c. users to be less likely to report appetitive changes (Corney & Stanton, 1991), whilst another reported no differences in severity of perimenstrual food craving between o.c. users and non-o.c. users (Bancroft & Rennie, 1993).

2.1.1.2   Age

Contrary to the common assumption that premenstrual symptoms increase with age, many studies have observed no relationship (Cumming, Fox & Cumming, 1995; Friedman & Jaffe, 1985; Gannon, Luchetta, Pardie & Rhodes, 1989), or a weak negative relationship between these variables (Freeman, Rickels, Sondheimer & Polansky, 1990; Freeman, Rickels, Schweizer & Ting, 1995; Freeman, Sondheimer & Rickels, 1988). Others have noted no relationship between age and premenstrual negative mood but report weak negative relationships between age and premenstrual and menstrual pain (Wood, Larsen & Williams, 1979; Woods, Dery & Most, 1982). By contrast, only one study observed a positive relationship between age and premenstrual anxiety (Andersch, Wendestam, Hahn & Öhman, 1986) but noted no relationship between age any other symptom. And in the only longitudinal and relatively small scale study of symptom reporting (n=9), little change in severity of either physical or emotional symptoms was observed across an eight year follow-up period, in a sample of women with PMS (Metcalf, Braiden & Livesey, 1992).

Perception of increased severity of symptoms with age might result from the tendency for psychosocial load to increase with age. Warner & Bancroft (1990) noted that when this was controlled for, there was little effect of age on reporting of PMS.

2.1.1.3   Parity

As with age, in contrast to the many anecdotal reports from women suggesting that symptoms either begin or worsen after childbirth (Corney & Stanton, 1991; Pearlstein, 1995; Warner & Bancroft, 1990), there is little evidence to suggest increased reporting of symptoms in parous as compared with non-parous women. Two studies observed no relationship between parity and reporting of premenstrual symptoms (Andersch et al.,

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[2]It is noteworthy in this study that all subjects reported an improvement in symptoms. Only differential effects are discussed here.

1986; Cumming et al., 1995), whilst several others noted no association between parity and negative mood but found weak negative associations between menstrual cramps and parity (Lee & Rittenhouse, 1991; Wood et al., 1979; Woods et al., 1982). By contrast, only one study reported there to be a modest effect of parity on the prevalence of PMS (Warner & Bancroft, 1990).

Increased family size may however affect symptom reporting. A recent study reported women with PMS to have had a greater number of pregnancies than low symptom controls (Mitchell, Woods & Lentz, 1994; Woods, Mitchell & Lentz, 1995)[3], whilst a further study observed a significant correlation between number of children and symptom severity (Freeman et al., 1988). The latter study suggested that whilst this link might be due to biological factors associated with pregnancy, it might also be due to the increased stress associated with larger family size. Warner & Bancroft (1990) also noted that when only parous women were examined, there was a marked effect of family size (up to three children) on prevalence of PMS and remarked upon the potential link between number of children and increase in perceived stress. The idea that increased stress accounts for the relationship between number of children and severity of symptoms accords with a further report which observed an association between reported severity of symptoms and problems with children (Futterman, Jones, Miccio-Fonseca & Quigley, 1992)

2.1.1.4 Relationship status

Similar to parenthood problems, happiness of a relationship rather than the presence of a relationship itself may be linked to reporting of perimenstrual symptoms. Wood et al. (1979) found no difference between married and non-married women in terms of affective symptoms, whilst Lee & Rittenhouse (1991) observed single women to report more depression and crying episodes premenstrually than married women. By contrast, many studies have observed a relationship between lowered marital satisfaction and premenstrual complaint (Clare, 1983; Coughlin, 1990; Siegel, 1986; Stout & Steege, 1985; Winter, Ashton & Moore, 1991). Warner & Bancroft (1990) reported PMS to be related to unhappiness of relationship in cohabiting women, although no association was observed in women who were not living with their partners. Two further studies reported higher marital conflict within families of women reporting PMS, than in those of non-PMS controls (Futterman et al., 1992; Kuczmierczyk, Labrum & Johnson, 1992).

The causal connection between happiness of relationship and symptom reporting remains unclear. Two studies observed women to blame premenstrual symptoms for marital

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[3] It should be noted that number of confirmed pregnancies may not be equivalent to number of children in all instances.

problems. Keye, Hammond & Strong (1986) noted women reporting premenstrual symptoms to have comparative scores on the Locke Marital Adjustment Scale to a sample of women seeking sex and marital therapy. Many of these subjects reported their symptoms to be a source of their marital problems. In a similar study, 37% of subjects noted relationship problems, and 55% estimated premenstrual symptoms to have an adverse effect on their relationship with their spouse (Corney & Stanton, 1991).

In a recent study, Dye, Warner & Bancroft (1995) reported the effect of happiness of relationship on food craving to be slight when severity of depression was controlled. By contrast, ratings of depression in each cycle phase were strongly associated both with severity of food cravings and with happiness of relationship.

2.1.1.5 Stress

Aside from specific stresses associated with families, many studies have reported a relationship between non-specific, accumulated stress and reporting of premenstrual symptoms. In one study, approximately 20% of women reported onset of PMS to be associated with general stress in life (Corney & Stanton, 1991). Many other researchers have noted associations between reported levels of stress and premenstrual symptomatology. Where stress was measured in a fairly crude way (none or some), Warner & Bancroft (1990) noted a relationship between perceived stress and reporting of premenstrual symptoms, in particular reporting of emotional symptoms. Two further studies (Cumming et al., 1995; Dinning & Guptill, 1992) observed scores on a life events survey to contribute significantly to the prediction of premenstrual symptom reporting as did a third study (Woods et al., 1995), which also observed subjects with PMS to report more stress related to family matters and personal issues than those reporting low severity of symptoms. Again, in the only study to examine premenstrual craving and negative mood specifically, Dye et al. (1995) reported an effect of stress (a great deal, some, none) on reporting of negative mood, but found premenstrual food craving across all cycle phases not to be affected by stress when the effect of depressed mood was controlled.

The effect of stress on symptom reporting appears to be relatively minor however, when examined in isolation. In one study, stress was reported to account for no more than 7% of the variance in premenstrual symptoms in a community sample population (Woods et al., 1982). Similarly, although Gannon et al. (1989) noted stress to be the largest and most consistent predictor of perimenstrual symptoms, it accounted for only 3-15% of the variance in symptom reporting. In a population of women experiencing PMS Beck, Gevirtz & Mortola (1990), who defined stress as the number of undesirable events experienced daily and measured daily symptoms and stress over three cycles, noted stress

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to account for only 6% and 10% of premenstrual negative mood and physical discomfort, respectively. Indeed, approximately one third (9/25) of the subjects reported most severe dysphoric mood in the month when their stress was least severe.

Rather than a change in frequency of stressors, some women may become more vulnerable to stressors in the premenstrual phase of the cycle. In a recent study, no increase in the actual number of reported stressful incidents was observed across the cycle, but subjects with premenstrual mood change appraised stressors as more stressful, changeable and undesirable premenstrually than postmenstrually (Fontana & Palfai, 1994). The authors suggested that self-reporting of increased stress premenstrually may be a result of state-dependent changes in perception, rather than increased exposure to actual stressors, as noted previously (Brown & Lewis 1993). Premenstrual negative affect may be linked not only to the actual number of stressful events, but also to the way in which these events are perceived.

2.1.1.6   Exercise

Other lifestyle variables thought to affect symptom reporting include exercise. Two retrospective questionnaire studies have noted slight associations between level of exercise and premenstrual symptoms, with greater symptom reporting associated with less exercise (Freeman et al., 1988; Gannon et al., 1989). In a six month controlled trial, moderate exercise training was observed to reduce premenstrual symptom reporting in those training, whilst no difference in reporting was observed in sedentary controls (Prior, Vigna, Alojado & Schulzer, 1987).

2.1.2   Factors associated with the reporting of negative mood

2.1.2.1   Emotional health

Similar to the link between stress and premenstrual symptomatology, evidence based largely on retrospective reports would suggest an association between premenstrual negative mood changes and depressive illness. In one study, history of past depression, as defined by treatment with antidepressants, was associated with prolonged reporting of depressive mood through the menstrual phase of the cycle, with symptoms persisting at times into the first few postmenstrual days (Warner, Bancroft, Dixson & Hampson, 1991).

In a follow-up of this study, history of treated depression was similarly associated with a pattern of prolonged depression in the premenstrual and menstrual weeks, with mild depression also more prevalent in the postmenstrual week of the cycle (Bancroft, Rennie & Warner, 1994). In this study, severity of negative mood in all three cycle phases was

associated with a history of depression.   A more recent prospective study by this group failed to replicate these findings (Bancroft & Rennie, 1995).

Other findings however support a link between depressive illness and premenstrual negative mood. History of post-natal depression has been associated both with severity (Kennerley & Gath, 1989) and in duration of symptoms (Warner et al., 1991). Yet the causal link between perimenstrual depression and history of depression remains unclear. One study for example, noted a history of premenstrual depression to predict future major depressive episodes in a 3-4 year follow-up study (Graze, Nee & Endicott, 1990), suggesting cycle-related mood changes to have a 'kindling effect' for more chronic depressive illness.   By contrast, it has been suggested that an underlying 'vulnerability factor' could increase propensity to both chronic and premenstrual depression (Bancroft 1993) and hence as such would suggest that neither directly influences the other.

As with history of depression, current emotional state is also associated with reporting of cycle-related changes.   Several studies have noted associations between the General Health Questionnaire, a measure which gauges characteristics of anxiety and depression, and severity of premenstrual symptom reporting (Clare, 1979; Cumming et al., 1995; Mira, Vizzard & Abraham, 1985).

In summary, stress, marital discontent, history of depression and current emotional state, appear to be associated with reporting of perimenstrual negative affect. It might be that reporting of cycle-related negative mood is linked to all these factors by a common 'vulnerability factor', as suggested by Bancroft (1993). It has been hypothesised that this factor may influence the way in which individuals react to and cope with cycle-related symptoms.   Such a vulnerability factor might however, also reflect differences in individual's ability to cope with external stressors, including marital problems. As such, the association between stress and premenstrual reporting could be mediated by this vulnerability factor.   As this vulnerability factor has been postulated to underlie the relationship between past history of depression and premenstrual negative affect, it may also underlie the relationship between current emotional state and premenstrual negative affect.

2.1.2.2 Perimenstrual pain

A further factor of importance in the reporting of perimenstrual negative affect is that of physical pain. Several studies have noted an association between dysmenorrhea and premenstrual tension (Coppen & Kessel, 1963; Steege, Stout & Rupp, 1985; Wood et al., 1979). More recently, severity of period-type pain was reported to be associated with severity of reported depression in both the premenstrual and menstrual phases of the cycle (Bancroft & Rennie, 1995; Bancroft et al., 1993). The association appeared to be particularly strong in the premenstrual phase of the cycle. Bancroft & Rennie (1995) postulated from this observation that processes involved in the build up of the endometrium causing pain, might in some way contribute to negative mood in the premenstrual phase of the cycle.

2.1.3   Factors associated with reporting of food craving

2.1.3.1 Weight

Several studies have noted an association between increased weight and food craving, although none have specifically examined cycle-related cravings. Seasonal affective disorder (SAD) has been reported to be associated with carbohydrate craving and weight gain (Wehr et al., 1991). Indeed in some instances, extent of carbohydrate craving and weight gain has been used to quantify the severity of SAD (Dilsaver, Qamar & del Medico, 1992). In line with this, Wurtman (1988, 1990) has suggested that carbohydrate craving may explain weight problems in some obese individuals. Other studies by contrast have reported no association between food craving and BMI (Hill, Weaver & Blundell, 1991; Rodin, Mancuso, Granger & Nelbach, 1991).

2.1.3.2 Attitudes towards eating

Despite the suggestion that dietary restraint may lead to exacerbation of food craving (Streigel-Moore, Silberstein & Rodin, 1986; Wardle, 1987; Wardle, 1990), several research groups have failed to find any relationship between food craving in general, and dietary restraint (Hill et al., 1991; Rodin et al., 1991; Weingarten & Elston, 1991). High eating restraint has however been related to the number of menstrual symptoms reported by subjects (Bowen & Grunberg, 1990). These authors suggested that this might reflect a propensity to 'hold back' from consuming sweet foods, thereby not gaining the positive effects of intake on mood in this cycle phase.

By contrast, both emotional eating (a tendency to eat in response to negative emotional states) and external eating (defined as a propensity to eat in response to external food

cues), which are strongly related to one another (van Strein & Schippers, 1995), have been positively associated with both frequency and intensity of reported food cravings (Hill et al., 1991).

In summary, it would be expected that several factors, including stress, dissatisfaction with personal relationship, history of depression and emotional state may be associated with perimenstrual symptom reporting, and in particular with premenstrual negative affect. These variables may be predicted by a common vulnerability factor which reflects the way in which individuals cope with undesirable events. By contrast, from the limited information available, food craving does not appear to be directly related to these factors, but may be associated with certain attitudes towards eating, and with high body mass index.

2.1.4   Population subgroups chosen to examine

One criticism of large retrospective questionnaire studies examining premenstrual symptoms is that they recruit populations who specifically report PMS and therefore represent self-selected populations likely to yield a majority of women who are 'desperate for help' (Corney & Stanton, 1991). These self-selected populations have been reported to differ from random community samples, having higher incidence of psychosocial morbidity (Corney & Stanton, 1991). By selecting sample populations in several different ways in the following study, it was possible to determine whether a self-selected sample population, predicted to report more severe perimenstrual symptoms, could be distinguished from other populations on variables that might be related to reporting of premenstrual symptoms, such as stress and history of depression.

In the following study, subjects were therefore recruited in several ways. An initial population was selected by advertising through magazines and articles for women experiencing premenstrual symptoms. This is a method used by a large number of similar studies into PMS (Corney & Stanton, 1991; Dye et al., 1995; Keye et al., 1986; Warner & Bancroft, 1990; Woods et al., 1995) and is referred to as a self-selected sample population. A second group represented a community sample population, recruited from a local family planning clinic, from several industrial workplaces and from two GP patient register lists. Whilst not representing a random sample population, it was expected that this population would report less severe perimenstrual symptoms than the self-selected population. Our final sample population comprised of women with insulin-dependent diabetes mellitus. There were several reasons for recruitment of this sample.

Firstly, insulin-dependent diabetics are an interesting population to examine in the context of Wurtman et al's (1989) proposal that women overconsume carbohydrate in an attempt to alleviate negative mood by increasing central 5HT activity. As discussed in Chapter 1, the effects of carbohydrate on the tryptophan to competing amino acid ratio are mediated via insulin. In insulin-dependent diabetic women this system will not operate, as no endogenous insulin is released following carbohydrate intake. Hence, the connection between negative mood and food craving might be expected to be less strong in this population. Similarly, given the necessary restraint on intake imposed by type 1 diabetes, it might be expected that food cravings would be both less prevalent and less strongly related to both emotional and external eating. Finally, it has been suggested that food craving may in part explain loss of diabetic control observed around the time of menstruation (Cawood, Bancroft & Steel, 1993). The effect of food craving on diabetic control was examined using the questionnaire described in this Chapter and is discussed in Chapter 8.

2.1.5   Aims

The principal aim of this study was to elucidate the relationship between perimenstrual negative affect and food craving and to examine factors that influence reporting of these symptoms. It was hypothesised that the associations amongst cycle-related negative affect, perceived stress, emotional well being, history of depression and happiness of relationship could be explained by a common underlying 'vulnerability factor'. Premenstrual negative affect was also expected to be predicted by premenstrual physical discomfort. Cycle-related food craving was not expected to be directly linked to this 'vulnerability factor' but it was hypothesised that a tendency to eat during negative mood states (i.e. emotional eating) and in response to external cues (external eating) would predict severity of food craving. Perimenstrual negative affect was also expected to predict severity of food craving because of the preponderance of studies suggesting onset of cravings to occur during negative mood states (see section 1.3, Chapter 1).

2.2   Method

2.2.1   Subjects

In order to look for robustness of relationships among psychosocial factors and the reporting of perimenstrual food cravings and negative affect, several sample populations were identified.

2.2.1.1   Community sample population

Of four GP practices approached, two, both advised as spanning a wide range of socio-economic groups, permitted access to their age/sex registers. Another sample population were recruited via the Family Planning Clinic, Dean Terrace, Edinburgh. Concurrent with this, boxes of questionnaires and return envelopes were sent to several industrial work places (Marks & Spencer, Ethicon, the Employment service and Queen Margaret College). Of samples in which the total population was known (i.e. family planning and G.P. samples), 318 of 520 (61%) subjects completed and returned the initial questionnaire. Of all community sample populations, 542 completed and returned the first questionnaire and 323 (60%) returned the second questionnaire.

2.2.1.2   Self-selected sample population

A further sample population was recruited via articles and advertisements placed in a variety of magazines and newspapers (The Guardian, Edinburgh Herald & Post, The Big Issue and Living magazine) asking for help with a study into PMS. All articles emphasised changes in mood and appetite as being of particular interest. In this population, both questionnaires were posted out to the subjects together. From an original 312 women to whom questionnaires were sent, 253 (81%) completed and returned both questionnaires.

2.2.1.3   Diabetic subjects

Women with diabetes were recruited from the Department of Diabetes, Royal Infirmary of Edinburgh. All patient records were checked to exclude women with major medical complaints (i.e. blindness, Down's syndrome) and those patients who had non-insulin dependent diabetes mellitus. Women who had not been treated at the clinic within the last two years were excluded as it was not known whether the contact addresses given would be correct. Of the 370 questionnaires sent out, 14 were returned as unknown at the address given. Hence the total sample population of women with diabetes is 356. Of this population, 292 (82%) returned the first questionnaire, and 214 (60%) completed and returned both questionnaires.

2.2.1.4   Total questionnaires

Questionnaires with missing data were not included for purposes of analysis. Of 1087 first questionnaires, 973 (90%) contained complete information. Of those subjects who returned both questionnaires, 686 of 790 (87%) contained complete information.

2.2.2   Measures

2.2.2.1   Development of the questionnaire[4]

One aim of the questionnaire was to assess the relationship between premenstrual negative mood and food craving and to determine the psychosocial factors relating to the reporting of these symptoms. The questionnaires also aimed to elicit information about the experience of food craving, including types of food craved and mood changes following satisfaction of cravings. These data will be described in Chapter 4. The final aim of the questionnaire was to assess the impact of food craving on diabetic control. These data are discussed in Chapter 8.

2.2.2.2   Questionnaire design

As length of questionnaire is known to affect response rate (Oppenheim, 1993) two questionnaires were developed so that initial information on as large a proportion of the sample population as possible could be gained. Both questionnaires are available in Appendix 2.

The initial questionnaire consisted of 17 questions. In principle, this questionnaire was aimed at assessing the incidence of cycle-related negative mood and food craving and gaining some demographic information about the sample populations. Information was requested primarily about age, weight, height, marital status, occupation, parity, and satisfaction with body image. A final section also asked about regularity of cycle, contraceptive use, presence of PMS, and severity of common symptoms associated with PMS.

The second questionnaire was split into four sections, containing a total of 55 questions. The first section asked about attitudes towards eating, the second about a wide range of symptoms associated with PMS, the third about the experience of food craving and the fourth about previous and current emotional state. A supplementary section, consisting of 6 questions asking about diabetic control, was included in the questionnaires sent to women with diabetes. Only those sections pertaining to assessment of the relationships amongst food craving, negative affect and the psychosocial variables outlined in the

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[4] This questionnaire was developed jointly by the author and by Dr L. Dye who worked with the MRC for ten months from October 1992, and who was responsible for the recruitment of the industry and Guardian samples (n=337).

introduction to this chapter are described here. Questions relating to the experience of food craving, and impact of food craving on diabetic control are detailed in relevant chapters.

2.2.2.3   Severity of cyclical symptoms

Questions relating to severity of symptoms were based on the Menstrual Health Questionnaire (Warner & Bancroft, 1990). Women were asked to rate the severity of each symptom listed for the week before, during, and the week following their last period. They were also asked to rate severity of the symptom for the remainder of their last menstrual cycle. Ratings were given on a 6 point scale from 0 (no symptom) to 5 (very severe).

2.2.2.4   Eating behaviour questionnaire

The Dutch Eating Behaviour Questionnaire (van Strein, Frijters, Bergers & Defares, 1986) was used to examine attitudes towards eating, primarily because the factors of emotional and external eating included in this scale had previously been reported to be associated with food craving (Hill et al., 1991). The scale contains 33 items of which 10 relate to eating restraint, 10 to external eating and 13 to emotional eating. All questions are answered on a five point scale (from never to very often). Scores were obtained by dividing the total scores on each scale by ten (thirteen in the case of emotional eating). A further option of 'not applicable' was available to subjects. For purposes of analysis, where subjects took this option no rating was given and the total score for the factor was divided by n-1. Pilot work with a group of 15 women with diabetes suggested that all the questions contained within the scale were pertinent to diabetics.

2.2.2.5   Current emotional state

The emotional state of subjects for the month previous to questionnaire completion was assessed using the five-item version of the Mental Health Inventory (Berwick et al., 1991). This produces a potentially wide range of scores (5-30) and has been found to be equally as reliable as the longer 18-item inventory MHI and the 30-item version of the General Health Questionnaire in detecting clinical affective disorders (Berwick et al., 1991). The questionnaire requested subjects to indicate as to how much of the time in the past month they had felt nervous, down in the dumps, downhearted/low, happy and calm, on a six point scale (from all of the time to none of the time). Questions relating to nervousness, being down in the dumps and downhearted were reversed. Hence low scores were associated with good mental health and high scores with poor mental health.

2.2.2.6   Past history of depression

Post-natal depression and history of depression were asked about using similar questions to those used by Warner & Bancroft (1990). Subjects thus responded to the question 'Did you suffer from any mood changes after the birth of any of your children' by ticking one of the answers on a five point scale from 1 (no depression at all) to 5 (very depressed for a week or more and saw a doctor). General depression was asked about using the question 'Have you ever suffered from depression (excluding post-natal depression)?' Subjects again responded by ticking the appropriate boxes (no, yes in the past, yes at present) and 'If yes, are you being treated, or were you treated with antidepressants? (yes/no).

2.2.2.7   Stress and happiness of relationship

Stress and happiness of relationship were examined using identical questions to those developed by Warner & Bancroft (1990) and reported in a previous study on food craving (Dye et al., 1995). Subjects were therefore asked to indicate 'Over the last three months, how much stress would you say you have been under? on a four point scale from 1 (a great deal of stress) to 4 (no stress). Responses were then reversed, so a high scores denoted high levels of stress. Similarly, to the question 'How happy is the relationship between you and your partner'? subjects responded from 1 (Very happy) to 4 (Not at all happy).

2.2.3   Procedure

2.2.3.1   Questionnaires sent by post to GP and diabetic clinic samples

Subjects were told in a covering letter sent out with Questionnaire 1 that the study aimed to examine general and menstrual health in women, or where applicable, in women with diabetes.   Reminder letters were sent to all subjects who failed to return the questionnaires after one month as this is known to optimise response rate (Oppenheim, 1993). Second questionnaires were sent out on return of first questionnaires. Again reminder letters were sent to those who failed to return the questionnaire within one month.

2.2.3.2   Family planning clinic

Women waiting for appointments at the Family Planning Clinic were approached by the investigator and asked if they would complete Questionnaire 1. Questionnaires were returned by women before leaving the clinic. Second questionnaires were subsequently sent to those subjects who expressed a willingness to complete a second questionnaire, and reminder letters were sent out as described above.

2.2.3.3   Industrial sample

Industrial sample populations were recruited via the health and personnel managers within each organisation. Questionnaires were left with managers along with boxes in which completed questionnaires could be left. Second questionnaires were sent out as described for other population samples noted above.

2.2.3.4   Self-selected sample

Letters were sent to women who expressed an interest in the study after reading advertisements or articles in newspapers or magazines. Both questionnaires were sent together as subjects were presumed to be more motivated to complete the study. A covering letter again expressed the author's interest in cycle-related changes in mood and appetite. Reminder letters were sent to those individuals who did not return the questionnaires within one month.

2.2.4   Statistical analysis

Examination of differences between subject groups (i.e. diabetic, community, self-selected) for nominal variables (i.e. relationship status, parity, employment, social class, reporting of PMS) were assessed using Chi square tests. Differences in age, BMI, attitudes towards eating and current emotional state (MHQ) were assessed using analysis of variance, with group (3 levels) as a between subjects factor. Comparison of symptom severity across the cycle in subjects completing either one or both questionnaire was using analysis of variance. Post hoc comparisons were carried out using unrelated t-tests. Principal components analysis with oblique rotation was used to determine factors for the DEBQ and to assess symptom factors. Pearson r correlations were calculated to evaluate relationships between food craving and other variables of interest. All of these analyses were carried out using the Statview 4.02 statistical analysis program for Apple Macintosh.

2.2.5   Structural equation modelling[5]

Models of the association between variables were tested using the EQS structural equations package for IBM (Bentler, 1995). As this is a relatively new technique, it is explained in detail in this section. Structural equation modelling is really a combination of the well-known techniques of multiple regression, principal components analysis and path analysis. Primarily, it requires a hypothetical model containing proposed associations amongst all variables of interest to be created, before analysis of data. The

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[5] I am grateful to Ian Deary and to Joyce Willock for their helpful explanations of the processes involved in this technique and to two papers which led a path through this method of analysis (Deary et al., in press; Deary, Hepburn, MacLeod & Frier, 1993).

program allows for specification of putatively causal relationships between variables (i.e. directional hypotheses). It also permits specification of latent variables (i.e. variables not measured but postulated to have direct effects on the reporting of measured variables). The model is then tested for its goodness of fit to the data. The advantage of this method over conventional multiple regression is that it allows an assessment of an overall model and examination of mediating variables within the model. It also tests for other models that would fit the data better. Although this technique cannot confirm causality, it confirms that the specified model is the best fit for that data set.

2.2.5.1   Building a model

Models are built by writing a series of linear equations to represent relationships between variables. When representing a model diagramatically, independent variables (predictor variables) generally occupy the left side of the diagram, with dependent variables (outcome variables) on the right, and mediating variables in the centre. Direction of arrows shown in the diagram give the predicted direction of the relationship between two variables. The program assumes that where no relationship is specified, there is no direct association between variables.

2.2.5.2   Testing a model

The program evaluates the adequacy of the model in two different ways, Initially it calculates both the expected strength of association between variables based on the hypothetical model specified, and then calculates the actual strength of association between variables, using the covariance matrix for all variables of interest[6]. Strength of associations are called parameter estimates, which may be thought of as similar to beta weights in multiple regression. Standardised parameters when squared, give the percentage of variance shared by two variables. The remaining variance (i.e. residual variance) for each variable included in the model is assumed to reflect both error variance and variance specific to the variable. The first method of model fit checks that the residual covariances left after relationships expressed in the model have been taken into account are low; in other words, that most of the association amongst variables is accounted for by the model.

An overall goodness-of-fit of the model to the data is then assessed using the Chi square and Bentler-Bonnett fit indices. The chi-square likelihood ratio test assesses whether the unexplained covariance is significantly greater than zero. A non-significant chi-square indicates that the model has a good fit to the data (i.e. that the hypothesised and observed parameters are not significantly different). However, a non-significant chi square is rarely

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[6] All covariance matrices used for analyses were taken to five places after the decimal. Raw data may also be used for analysis puposes.

obtained when sample sizes are large (Bentler & Bonett, 1980) as relatively trivial discrepancies between observed and hypothesised parameters may lead to significant X^2 values (Dunn, Everitt & Pickles, 1993). Hence the Bentler-Bonett indices assess goodness of fit in a practical sense. Indices range from 0-1, with values above 0.9 indicating the data to be a good fit for the model. Three indices are given: the normed fit index (NFI), the non-normed fit index (NNFI) and the comparative fit index (CFI). Basically, the NNFI gives a fit for the data of interest, the NFI takes into account the sample size in the model. The CFI takes into account both the degrees of freedom for the model (i.e. the number of covariances between variables that are assumed to be zero) and the sample size. There are therefore several indices reflecting model fit, and the more they accord with one another, the greater the robustness of the model.

2.2.5.3   Testing for alternative models

Two final tests are vital for ensuring the optimal structural model is achieved. The Lagrange Multiplier test indicates any fixed parameters (associations between variables not specified are assumed to be fixed at zero) that might be freed in order to give a better fit to the data; in other words, whether any associations between variables could be added to the model to give a better fit. The Wald test by contrast checks for parameters that may be dropped without a significant decrease in the fit of the model, thereby giving a more economical model that fits the data just as well. Whilst structural equation modelling is therefore often assumed to be confirmatory, it frequently involves exploratory components in searching for better models.

2.2.5.4   Multi-sample analysis

Multisample analysis tests whether components of the central model are invariant across different population groups. It does this by constraining parameters within the model to be equal across all sample populations. The Lagrange multiplier test is then used to indicate any constraints that should be released to improve the fit of the model.

2.3   Results

The following results are split into six major sections. The first two (2.3.1 and 2.3.2) refer to data from the initial questionnaire. In 2.3.1 incidence of food craving and negative mood in each phase of the cycle is determined. 2.3.2 examines the severity of symptoms in each cycle phase and assesses whether subjects from the community and diabetic sample populations were more likely to respond to both questionnaires if they experienced severe cyclical symptoms. The final five sections relate to data from subjects who responded to both questionnaires. 2.3.3 details principal components analysis for the DEBQ and symptom ratings which was carried out in order to produce relevant factors for further analysis. 2.3.4 examines the relationship between food craving, negative affect and physical discomfort. 2.3.5 then determines factors other than severity of symptom reporting that differentiate the self-selected sample population from the remaining two populations. 2.3.6 examines associations amongst symptom reporting and other variables of interest and 2.3.7 outlines structural models that account for the relationship amongst premenstrual negative affect, food craving and other associated variables.

2.3.1   Incidence of cycle-related food craving and negative mood

2.3.1.1   Food craving

Food craving appeared to be most prevalent in the premenstrual phase of the cycle. Of those subjects reporting at least moderate food cravings (n=502) in either the premenstrual or menstrual phases of the cycle, 43% of subjects reported a predominantly premenstrual pattern (i.e. craving reported at moderate or severe only in the premenstrual phase of the cycle) and a further 47% of subjects reported moderate or severe cravings in both phases of the cycle. By contrast, only 10% reported a predominantly menstrual pattern, (i.e. craving reported at moderate or severe only in the menstrual phase of the cycle). Only 4% of all subjects reported food craving at moderate or severe levels in the postmenstrual phase of the cycle.

Table 2.1 shows the reported incidence of cravings in the premenstrual phase of the cycle. Over half of both diabetic (57%) and non-diabetic (52%) sample populations reported no premenstrual cravings. Of the remaining subjects, over 75% noted these cravings to be at least moderate. In terms of cyclicity of reporting, 94% (95% of diabetics) reported a decrease in ratings from the premenstrual to the postmenstrual phase of the cycle, reflecting the strong cyclical nature of reporting. When the self-selected sample population was examined, incidence of reporting was far higher than in the other two sample populations, with 82% reporting moderate or severe premenstrual cravings.

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However, in line with the other sample populations, 97% of those subjects reporting food cravings reported a decrease in severity from the premenstrual to postmenstrual phase of the cycle.

Table 2.1 - Percentage of subjects reporting food craving in the premenstrual phase of the cycle, split by severity of ratings in the postmenstrual phase of the cycle.

Ratings in Postmens.	Ratings in the premenstrual phase of the cycle											
	Community (n=466)				Diabetic (n=265)				Self-selected (n=226)			
	Sev.	Mod.	Mild	None	Sev.	Mod	Mild	None	Sev.	Mod.	Mild	None
None	13	14	10	52	14	12	8	57	38	15	6	9
Mild	4	3	2	0	3	3	2	0	16	4	2	1
Moderate	1	0	0	0	1	0	0	0	8	1	0	0
Severe	1	0	0	0	0	0	0	0	0	0	0	0
Total	**19**	**17**	**12**	**52**	**18**	**15**	**10**	**57**	**62**	**20**	**8**	**10**

2.3.1.2 Incidence of cycle-related negative mood

Similar to food craving, both depression and irritability were most prevalent in the premenstrual phase of the cycle. 448 (46%) subjects reported moderate or greater depression in the premenstrual or menstrual phase of the cycle. 658 (68%) reported irritability. 49% of these subjects (46% for irritability) noted a predominantly premenstrual pattern whilst only 7% noted a menstrual pattern (6% for irritability). A further 44% and 48% reported depression or irritability (at least moderate or severe) in both cycle phases. Only 5% of subjects reported these symptoms to be moderate or severe in the postmenstrual phase of the cycle.

Tables 2.2a and 2.2b show the reported incidence of both depressed mood and irritability in the premenstrual and postmenstrual phases of the cycle. As shown below, 37% of the community and diabetic samples reported no premenstrual depression and 18% reported no irritability premenstrually. Of the remaining subjects, 70% reported at least moderate irritability premenstrually, and 58% moderate or greater depression. Incidence was again higher in the self-selected sample population with 61% reporting moderate depression and 81% irritability. As with food craving, over 90% of subjects reporting symptoms in each group showed a decrease in ratings from the premenstrual phase to the postmenstrual phase of the cycle.

Table 2.2a - Percentage of subjects reporting depressed mood in the premenstrual phase of the cycle, split by severity of ratings in the postmenstrual phase of the cycle.

Ratings in Postmens.	Ratings in the premenstrual phase of the cycle											
	Community (n=466)				Diabetic (n=265)				Self-selected (n=226)			
	Sev.	Mod.	Mild	None	Sev.	Mod	Mild	None	Sev.	Mod.	Mild	None
None	11	16	25	37	11	12	23	35	16	23	18	16
Mild	3	3	1	1	6	3	4	1	9	6	3	1
Moderate	1	1	0	0	2	2	0	0	5	0	1	0
Severe	1	0	0	0	1	0	0	0	1	1	0	0
Total	**16**	**20**	**26**	**38**	**20**	**17**	**27**	**36**	**31**	**30**	**22**	**17**

Table 2.2b - Percentage of subjects reporting irritability in the premenstrual phase of the cycle, split by severity of ratings in the postmenstrual phase of the cycle.

Ratings in Postmens.	Ratings in the premenstrual phase of the cycle											
	Community (n=466)				Diabetic (n=265)				Self-selected (n=226)			
	Sev.	Mod.	Mild	None	Sev.	Mod	Mild	None	Sev.	Mod.	Mild	None
None	23	21	21	19	22	18	22	16	34	23	9	6
Mild	5	3	3	1	7	6	2	1	13	6	2	1
Moderate	2	1	0	0	3	1	0	0	3	1	1	0
Severe	1	0	0	0	2	0	0	0	1	0	0	0
Total	**31**	**25**	**24**	**20**	**34**	**25**	**24**	**17**	**51**	**30**	**12**	**7**

2.3.2   Differences between subjects completing one or both questionnaires

Data in this section relates only to diabetic and community sample populations and was included to examine whether subjects were more likely to complete the second questionnaire if they experienced premenstrual symptoms. No difference in prevalence of reported PMS was observable between those subjects completing either one or both questionnaires (X^2= 3.04, df=6 p<.39) with approximately one third of all subjects reporting PMS (see Table 2.3). Differences were however apparent in reporting of certain individual symptoms. Significant time by group interactions were observed for irritability ($F_{3,722}$=12.01, p<.0001) and food craving ($F_{3,722}$=2.81, p<.04, see Figure 2.1, overleaf). This reflected the slightly higher ratings given in the premenstrual phase of the cycle by those subjects completing both questionnaires (t=3.70 p<0.001 for irritability and t=2.08 p<.04 for food craving in this cycle phase). An interaction was also observed for pain ($F_{3,722}$=5.75, p<.0007), reflecting marginally higher ratings given in the menstrual phase of the cycle by those completing both questionnaires (t=2.43 p<.02 in this cycle phase).

Subjects who completed both questionnaires were also older (t=4.26, p<.0001), more likely to be living with a partner (X²= 6.85, df=4 p<.04), more likely to be parous (X²= 18.13, df=2, p<.0001) and less likely to be in paid employment (X²= 8.96, df=2, p<.003) than those responding to only the first questionnaire (see Table 2.4). By contrast, no significant differences were noted in social class (X²= 3.68, df=8, p<.46) or in body mass index (t =.95, p<.35).

Table 2.3 - Self-reported PMS

	Qu1 only (%) n=246	Both Qu.(%) n=485
No	35	32
Don't know	10	8
Maybe	26	25
Yes	29	35

Table 2.4 - Characteristics of subjects responding to either one or both questionnaires

	Qu. 1 only (%) n=246	Both qu. (%) n=485
Social class		
One	10	12
Two	32	36
Three	38	36
Four & Five	8	6
Not paid work	12	10
Relationship		
Single	25	24
In relationship	22	15
Married/ living with partner	53	62
Working	93	85
Parous	34	50
Age ± s.e.	31.2±.48	33.6±.32
BMI ± s.e.	24.3±.23	24.6±.18
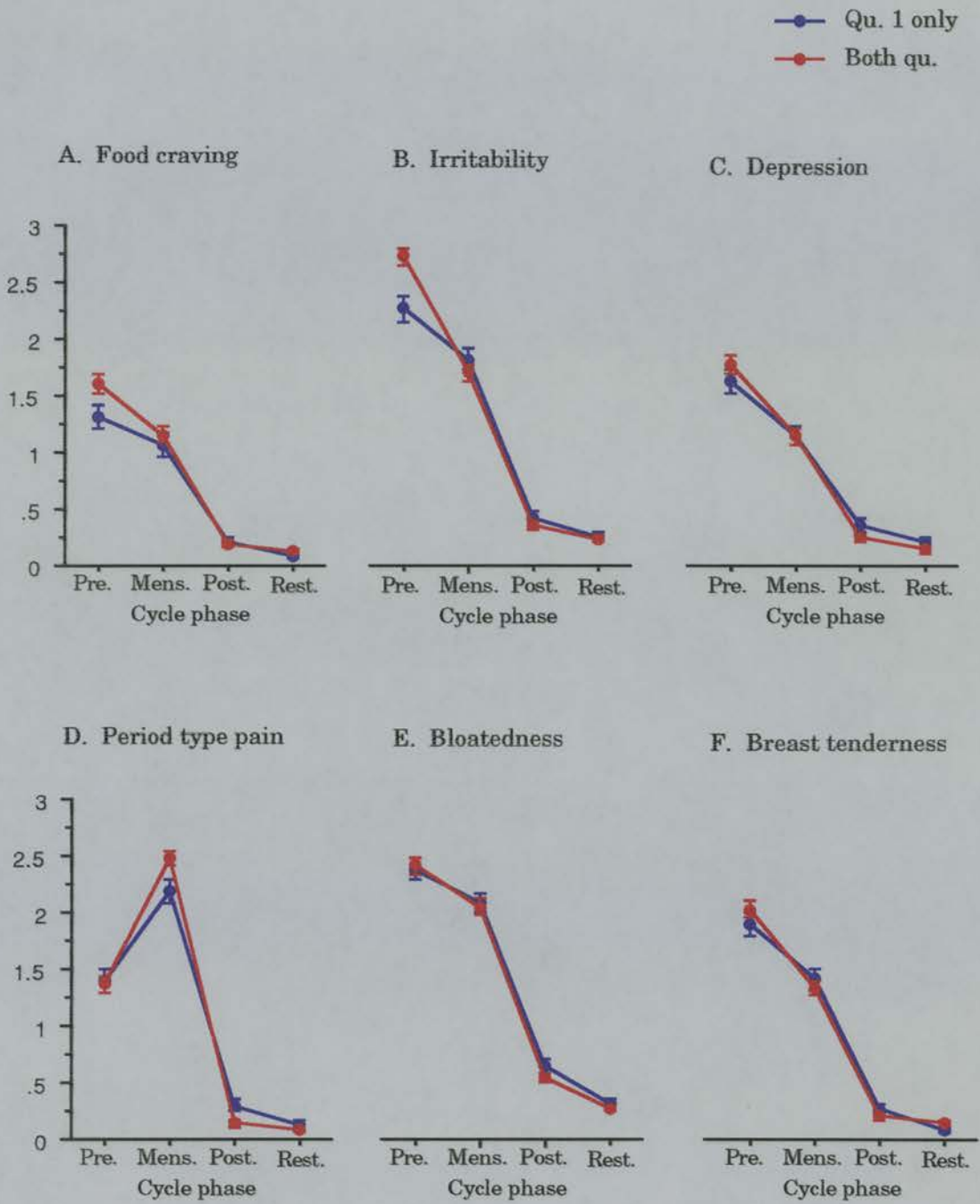
Figure 2.1 - Mean ratings given across cycle phases for individual symptoms.

The two preceding sections confirmed both negative affect and food craving to be most prevalent in the premenstrual or perimenstrual (i.e. premenstrual and menstrual) phase of the cycle, and to be most severe in the premenstrual phase of the cycle. The latter section also revealed a propensity for women responding to the second questionnaire to experience more severe premenstrual symptoms than those who responded only to the initial questionnaire. The remaining sections concentrate on data pertaining to both questionnaires.

2.3.3   Principal components analysis

2.3.3.1   Dutch eating behaviour questionnaire

Principal components analysis of the Dutch Eating Behaviour Questionnaire yielded five factors with eigen values greater than unity, explaining 59% of the variance. The scree plot of factors suggested a three factor solution to be appropriate (54% variance explained). Table 2.5 (page 43) gives the results of the rotated three factor solution for each cycle phase examined. All questions loaded at >0.35 on the factor accorded by the DEBQ. Thus the first factor reflected emotional eating, accounting for 21% of the variance, the second reflected eating restraint and accounted for 18% of the variance and the third reflected external eating and accounted for 15% of the variance. All factors displayed good internal consistency, as shown by the high Cronbach alpha indices.

The factor structure outlined above held in both diabetic and non-diabetic populations, with all but three of the questions loading on same factor for each population (see Appendix 3). Only questions 2, 4 and 8 displayed loadings on two factors (external and emotional eating) and this was evident only in the self-selected population (see Appendix 3). To determine whether the omission of these questions made a significant impact on overall emotional eating scores, the correlation between the average of the thirteen questions and ten questions (omitting questions 2, 4 and 8) was determined. Due to the exceptionally high correlation between the two (r=.984 for the self-selected sample population), it was elected to include all thirteen questions in the measurement of emotional eating in order to make results comparable with previous literature. Hence, all questions loading on the emotional eating factor were averaged to produce a score for emotional eating. Similarly, questions loading on both the restraint factor (n=10) and the external eating factor (n=10) were averaged to produce relevant factor scores.

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Table 2.5 - Principal components analysis of the Dutch Eating Behaviour Questionnaire. Bold type indicates loadings of ≥.35 on factors at p<0.01, using the Burt-Banks formula, (Childs, 1990).

	Oblique rotation			
	Factor 1	**Factor 2**	**Factor 3**	**Cronbach alpha**
Do you have the desire to eat when:				
2. You have nothing to do	**.35**	.05	.34	
4. You are depressed or discouraged	**.55**	.06	.16	
8. You are bored or restless	**.42**	0	.30	
10. You are irritated	**.64**	.05	0	
15. You are cross	**.69**	-.02	-.05	
16. Something unpleasant is about to happen	**.67**	0	-.06	.94
19. Somebody lets you down	**.64**	-.04	.12	
21. You are anxious, worried or tense	**.73**	-.03	-.05	
24. Things are going against you	**.68**	.04	.07	
27. You are disappointed	**.69**	0	.07	
29. You are emotionally upset	**.71**	.0	-.02	
31. You are feeling lonely	**.46**	.03	.22	
33. You are frightened	**.61**	-.14	-.04	
3. How often do you try not to eat between meals because you are watching your weight?	.04	**.74**	-.03	
7. If you have put on weight, do you eat less than you usually do?	-.13	**.76**	0	
9. Do you eat less at mealtimes than you would like to eat?	.05	**.64**	0	
12. How often do you refuse food or drink because you are worried about your weight?	.01	**.76**	-.10	
14. Do you watch exactly what you eat?	-.03	**.54**	-.24	.91
17. Do you deliberately eat foods that are slimming?	.04	**.67**	-.03	
20. When you have eaten too much, do you eat less than usual the following day?	-.10	**.68**	.06	
23. Do you deliberately eat less in order not to become heavier?	-.09	**.84**	.01	
26. How often in the evening do you try not to eat because you are watching your weight?	.01	**.69**	.04	
30. Do you take into account your weight with what you eat?	0	**.78**	-.12	
1. When preparing a meal are you inclined to eat something?	.06	.03	**.39**	
5. If you walk past a cafe, do you have the desire to eat something delicious?	0	-.04	**.62**	
6. If food tastes good to you, do you eat more than usual?	-.02	-.06	**.63**	
11. If you have something to eat, do you eat it straight away?	.10	-.09	**.47**	
13. If food smells and looks good to you do you eat more than usual?	-.01	-.09	**.65**	.85
18. If you walk past the baker do you have the desire to eat something delicious?	-.06	-.02	**.64**	
22. If you see others eating do you also have the desire to eat?	0	-.01	**.59**	
25. Do you eat more than usual when you see others eating?	.12	.02	**.52**	
28. If you see or smell something delicious do you have the desire to eat it?	-.10	-.03	**.72**	
32. Can you resist eating delicious foods?	0	.16	**.57**	

2.3.3.2   Cycle-related symptoms

Symptom scores for each cycle phase were also subjected to principal components analysis. Analysis for each cycle phase yielded three factors with eigen values greater than unity. The scree plot of factors also suggested a three factor solution to be appropriate. The principal component extracted explained approximately 40% of the observed variance in each cycle phase (43%, 41%, 40% and 35% in the premenstrual, menstrual, postmenstrual and remainder of the cycle, respectively). This reflected a general factor of negative symptom reporting, as shown by the positive loading of all symptoms but smoking and alcohol intake on this component.

Table 2.6 (pages 45-46) shows the results of the three factor solution following oblique rotation, for all phases examined. Factor 1 reflected negative affect with all mood adjectives loading at .7 or above in both cycle phases examined and accounting for approximately 30% of variance in each cycle phase (30%, 32%, 30% and 30% in the premenstrual, menstrual, postmenstrual and remainder of the cycle, respectively). Factor 2 reflected physical discomfort with symptoms of breast tenderness, pain, nausea and headaches all loading highly on this factor. This factor accounted for 14% of variance in the premenstrual phase of the cycle and 11%, 13% and 10% in the menstrual, postmenstrual and remainder of the cycle, respectively). The third factor appeared to reflect a general indulgence factor, with cycle-related change in nicotine and alcohol intake loading on this factor (accounting for 7-10% of variance across all cycle phases). Symptoms showing lower and less consistent loadings on factors included food craving, weight gain, fatigue, sleep disturbance and flushes/sweats. Food craving loaded poorly on both factors in the premenstrual phase of the cycle, but in the remaining phases loaded on the factor reflecting negative affect. For purposes of analysis, and because individual symptom loadings were similar, all mood symptoms (mood swings, feel bad about self, depressed, angry, lack self-control, easily upset, tense) were averaged to produce a negative affect rating for each phase of the cycle. Similarly, the four symptoms noted to load consistently on factor 2 (breast tenderness, pain, nausea and headaches) were averaged to produce an overall score for physical discomfort. Cronbach alpha indices indicated good internal consistencies for both measures of physical discomfort and negative affect. Ratings for food craving were examined separately. Symptoms failing to show consistent loadings were not included in subsequent analyses.

Table 2.6 - Symptom loadings on factors for each cycle phase. Bold type indicates significant loadings of ≥.35 on factors at p<0.01, using the Burt-Banks formula, (Childs, 1990).

	First Principal Component	Oblique rotation			Cronbach alpha
		Factor 1	Factor 2	Factor 3	
Premenstrual phase					
Mood swings	**.82**	**.72**	-.03	.03	
Feel bad about self	**.79**	**.65**	.01	.07	
Depressed	**.81**	**.65**	.02	.08	
Angry	**.81**	**.73**	-.04	.01	**.93**
Lack self-control	**.77**	**.62**	.02	.08	
Easily upset	**.84**	**.74**	-.03	.04	
Tense	**.83**	**.65**	.05	.07	
Feel tired	**.71**	**.37**	.33	-.06	
Weight gain	**.64**	**.35**	.31	-.11	
Food craving	**.66**	.34	.28		
Tender breasts	**.50**	.19	**.47**	-.32	
Headache	**.49**	0	**.57**	-.06	**.62**
Nausea	**.44**	-.07	**.53**	.09	
Aches/ pains	**.60**	.15	**.45**	.05	
Flushes/ sweats	**.52**	-.04	**.54**	.16	
Disturbed sleep	**.55**	0	**.44**	.33	
Smoke more	.28	-.03	0	**.68**	
Drink more alcohol	.33	.05	0	**.61**	
Menstrual phase					
Mood swings	.78	**.69**	-.06	0	
Feel bad about self	.78	**.64**	0	.03	
Depressed	.80	**.73**	-.08	-.02	
Angry	.80	**.75**	0	-.12	.93
Lack self-control	.73	**.58**	.16	-.07	
Easily upset	.83	**.72**	0	-.03	
Tense	.83	**.66**	.10	-.01	
Feel tired	.67	**.36**	.10	.23	
Weight gain	.65	**.46**	-.04	.17	
Food craving	.63	**.40**	.08	.14	
Tender breasts	.54	-.08	**.39**	.24	
Headache	.48	.12	**.54**	-.14	.62
Nausea	.40	-.13	**.66**	.06	
Aches/ pains	.57	.11	**.48**	.10	
Flushes/ sweats	.50	-.03	.29	**.46**	
Disturbed sleep	.52	.04	.13	**.58**	
Smoke more	.37	.02	0	**.54**	
Drink more alcohol	.33	.06	-.21	**.64**	

Table 2.6 (cont.) - Symptom loadings on factors for each cycle phase. Bold type indicates significant loadings of ≥.35 on factors at p<0.01, using the Burt-Banks formula, (Childs, 1990).

	First Principal Component	Oblique rotation			Cronbach alpha
		Factor 1	Factor 2	Factor 3	
Postmenstrual phase					
Mood swings	.74	**.65**	-.01	0	
Feel bad about self	.73	**.68**	-.09	.03	
Depressed	.79	**.68**	0	-.02	
Angry	.81	**.67**	.04	0	**.91**
Lack self-control	.71	**.59**	-.07	.15	
Easily upset	.81	**.66**	0	.07	
Tense	.74	**.61**	.01	.07	
Feel tired	.63	**.47**	.18	-.10	
Weight gain	.66	.31	.25	.15	
Food craving	.63	**.49**	.09	-.01	
Tender breasts	.52	.20	**.35**	0	
Headache	.45	.02	**.66**	-.19	**.62**
Nausea	.47	-.05	**.62**	.02	
Aches/ pains	.64	.27	**.36**	.05	
Flushes/ sweats	.40	-.13	**.57**	.14	
Disturbed sleep	.53	0	**.36**	**.38**	
Smoke more	.39	0	.14	**.44**	
Drink more alcohol	.33			**.83**	
Remainder of cycle					
Mood swings	.72	**.65**	-.15	0	
Feel bad about self	.74	**.55**	.06	0	
Depressed	.73	**.56**	-.04	.07	
Angry	.76	**.73**	-.11	-.11	.90
Lack self-control	.73	**.58**	.07	-.08	
Easily upset	.80	**.58**	.10	0	
Tense	.80	**.66**	-.07	.02	
Feel tired	.61	.30	.31	0	
Weight gain	.52	.06	.26	**.36**	
Food craving	.62	**.49**	.01	-.02	
Tender breasts	.46	.20	**.36**	-.09	
Headache	.42	-.04	**.57**	.07	.50
Nausea	.27	-.12	**.64**	-.06	
Aches/ pains	.56	.08	**.40**	.25	
Flushes/ sweats	.32	-.19	.28	**.51**	
Disturbed sleep	.52	.14	.09	**.41**	
Smoke more	.21	0	-.09	**.40**	
Drink more alcohol	.29	-.09	-.10	**.70**	

2.3.4   Relationship between food craving, negative affect and physical discomfort

As expected from the high loadings of all symptoms on the principal component, food craving, negative affect and physical discomfort correlated positively with one another across each phase of the cycle (see Table 2.7). Negative mood was shown to be strongly related to physical discomfort and food craving across all cycles phases, with weaker associations observable between physical discomfort and food craving.

Table 2.7 - Pearsons r correlations between symptoms in each phase of the cycle examined. Correlations between each symptom pair have the effects of the third symptom partialled out. Zero order correlations are shown in brackets (Correlations >.10 are significant at p<0.01)

	Correlations between symptoms in each cycle phase		
Phase of cycle	Food craving / negative affect	Food craving / physical discomfort	Negative affect / physical discomfort
Premenstrual week	.41 (.56)	.21 (.47)	.43 (.58)
During menses	.41 (.54)	.15 (.41)	.45 (.57)
Postmenstrual week	.24 (.36)	.20 (.40)	.30 (.40)
Remainder of cycle	.45 (.54)	.07 (.35)	.45 (.54)

2.3.5   Differences between sample populations

As outlined in the introduction, the self-selected sample population was expected to report more severe symptoms than either the community or diabetic populations. This analysis intended to confirm this and to determine distinctive factors that might differentiate this group from the other two populations and therefore potentially be associated with symptom reporting.

2.3.5.1   Demographic characteristics

In terms of demographic differences between sample populations, women with diabetes were more likely to be in social class four or five (X^2=24.72, df=8, p<0.002), were less likely to be working (X^2=42.61, df=2, p<0.0001) and were more likely to have children (X^2=17.14, df=2, p<0.03) than were either of the non-diabetic population samples (see Table 2.8, page 49). They also had a higher mean body mass index than either the self selected sample (Sheffé, p<0.003) or community sample populations (Sheffé, p<0.0001). In terms of age, the self-selected sample population was significantly older than the diabetic (Scheffé p<0.01), but not the community sample (Scheffé p<0.13, see Table 2.8). Significantly fewer self-selected subjects reported using oral contraceptives (X^2=13.80, df=2, p<0.001).

2.3.5.2   Symptom ratings

The self-selected sample were also more likely to report PMS (X^2=52.51, df=6, p<0.0001, see Table 2.8), which was reflected in the ratings for perimenstrual food cravings, physical discomfort and negative mood, all of which were significantly higher than either the community or diabetic populations, (Scheffé tests all significant at p<0.0001 between the self-selected sample and the other two groups in the premenstrual and menstrual phases of the cycle, see Figure 2.2). No differences were observable between community and diabetic samples in terms of symptom reporting.
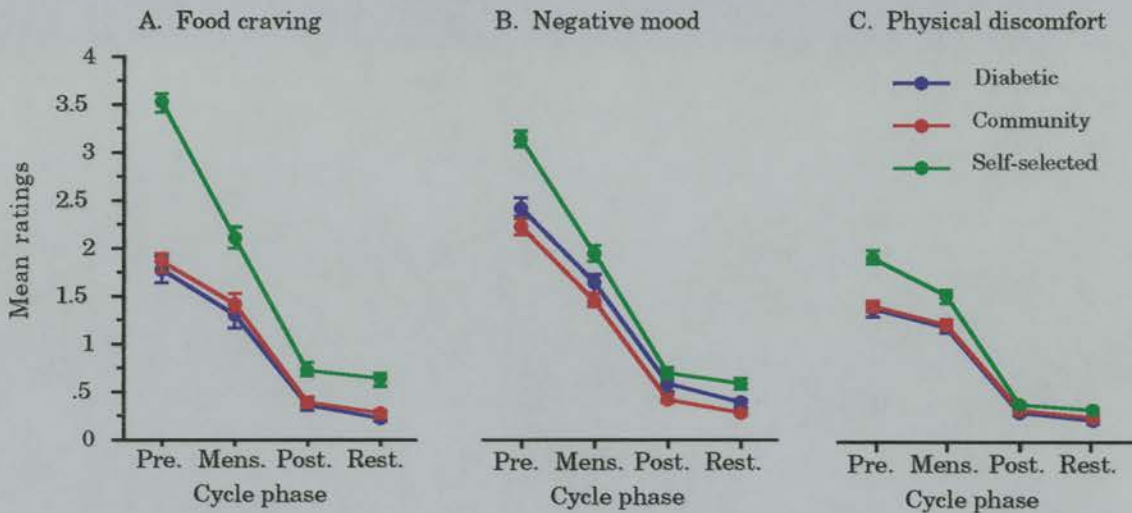
Figure 2.2 - Mean ratings given across cycle phases for individual symptoms, split by population.

2.3.5.3   Emotional health

In terms of emotional health, self selected subjects differed from the other population groups, being more likely to report themselves as under a great deal of stress (X^2=16.61, df=4, p<0.003), to report both a past history of depression (X^2=40.04, df=2, p<0.0001) and antidepressant treatment (X^2=13.93, df=2, p<0.0009), and to have higher ratings on the MHQ scale than either the diabetic or community sample populations (Scheffé test p<0.0003 and p<0.0001, respectively, see Table 2.8). Similarly, when only those in a relationship were examined (n=559), the self-selected sample were less likely to report their relationships as very happy than were the other two sample populations (X^2=18.03, df=4, p<0.002). An observable trend was apparent for severity of post-natal depression with the self-selected sample reporting higher ratings than either of the other populations ($F_{2,342}$=2.73, p<0.07). Again, no differences were apparent between the community and diabetic populations.

Table 2.8 - Characteristics of sample populations. (Nominal data are given as percentages).

	Diabetic (n=190)	Community (n-270)	Self-selected (n=226)	Total (n=686)
Demographic				
Social class				
One	7	13	14	13
Two	36	39	45	40
Three	36	48	23	31
Four & Five	9	3	6	6
Not paid work	11	8	12	10
Relationship				
Single	23	23	24	23
In relationship	12	17	13	15
Married/ living	65	60	63	62
Working	73	94	85	85
Parous	57	45	51	50
Age ± s.e.	33.0±.47	33.9±.46	35.3±.56	34.12±.29
BMI ± s.e	25.7±.30	23.8±.21	24.4±.27	24.55±.15
PMS				
No	33	31	11	25
Don't know	11	6	7	7
Maybe	22	27	24	25
Yes	34	36	58	43
Oral contraceptive use	29	31	17	26
DEBQ				
Eating restraint	2.9±.06	2.8±.05	3.0±.06	2.88±.03
Emotional eating	2.5±.06	2.46±.05	2.85±.06	2.60±.03
External eating	2.6±.05	2.9±.04	3.1±.04	2.90±.04
Emotional Health				
Stress				
A little	30	24	15	23
Some	47	50	49	**49**
A great deal	23	26	35	28
Happy relationship				
Very	64	60	43	55
Fairly	29	30	44	35
Not very	7	10	13	10
MHQ	13.8±.32	13.5±.25	15.48±.27	14.25±.16
History of depression	31	24	51	35
Treated with antideps.	15	11	23	16
Sev. of post-nat. dep.	2.59±.14	2.38±.12	2.81±.13	2.59±.08

2.3.5.4   Attitudes towards eating

Self-selected subjects rated emotional eating and external eating as significantly higher than either diabetic or community sample populations (Scheffé test significant at <0.0004 for all comparisons, see Table 2.8). No significant differences were observed for eating restraint ($F_{2,685}=2.30$, p<0.11). In terms of differences between the diabetic and community samples only on the external eating factor were scores found to be lower in the diabetic population (Scheffé, p<0.02).

Overall, the self-selected sample were observed to have higher symptom ratings, particularly in the premenstrual phase of the cycle. They also reported higher perceived stress and incidence of depression than did the other two population groups, noted higher ratings for emotional and external eating, and were less likely to report being in a very happy relationship. These latter mentioned variables have all previously been observed to be associated with reporting of cycle-related symptoms. The apparent association between symptom reporting and these variables held when the population was examined as a whole, as discussed below.

2.3.6   Relationship between symptom reporting and psychosocial variables

Due to the observation that symptoms were reported to be most severe in the premenstrual phase of the cycle, this was the phase concentrated on in the following section. Similarly, as all but 13 subjects reported either no symptoms, or a cyclical pattern of either food craving or negative affect (i.e. a decrease in severity of symptoms from pre- to postmenstrual phase of the cycle)[7] all subjects were included in subsequent analyses.

When correlations between eating restraint, age, number of children and BMI were examined no strong associations with food craving and negative mood were observed (see Table 2.9). By contrast, stress, happiness of relationship, current emotional state (MHQ), severity of post-natal depression, emotional and external eating all correlated positively with reporting of premenstrual symptoms (see Table 2.9). When the effects of negative mood were controlled, there appeared little correlation between food craving and these variables, but significant associations were observed between food craving and both external and emotional eating. As emotional and external eating have been noted to be highly intercorrelated in previous studies (van Strein et al., 1995) and were found to be so in this study (r=.54, p<0.0001), partial correlations were carried to examine their

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[7] For negative affect ratings were categorised <1=none, <3=mild, 3=moderate, >3=severe.

relationships to food craving.   Partial correlations between food craving and these variables were r= .27, p<0.001 for emotional eating and r= .05, p=n.s. for external eating, suggesting the important relationship to be between food craving and emotional eating.

As shown in Figure 2.3, history of depression was also associated with higher severity of symptoms in all cycle phases (p<0.001 for all symptoms). By contrast, oral contraceptive use was associated with lower reporting of symptoms in the premenstrual phase of the cycle only (p<0.0001 for all symptoms, see Figure 2.4).

Table 2.9 - Pearson r correlations among key variables[8]. Correlations at >.10 are significant at p<0.01 All correlations with symptoms have the effects of other symptoms partialled out. Raw correlation are given in brackets. N=686 for all correlations, except those concerning happiness of relationship (n=559) and history of post-natal depression (n=341)[9].

| | Food craving | Premenstrual | |
		Negative affect	Physical discomfort
Age	.07 (.10)	-.06 (.04)	.11 (.13)
BMI	.03 (.11)	.03 (.13)	.10 (.16)
No. children	.03 (.08)	.02 (.08)	.05 (.09)
Exercise	-.06 (-.04)	-.01 (.04)	.06 (-.01)
Eating restraint	.04 (.10)	.08 (.13)	.01 (.09)
MHQ	-.06 (.25)	.48 (.54)	-.06 (.26)
Post-natal depression	.03 (.25)	.19 (.37)	.17 (.35)
Stress	.01 (.18)	.18 (.29)	.06 (.22)
Happiness of relationship	.05 (.14)	.13 (.19)	-.02 (.11)
Emotional eating	.22 (.34)	.15 (.30)	-.05 (.17)
External eating	.14 (.22)	.08 (.18)	-.03 (.11)

To summarise, reporting of premenstrual negative affect appeared to be associated with perceived stress, current emotional state, happiness of relationship and past history of depression. The following section aimed to assess whether these symptoms could all be predicted by a common 'vulnerability factor', as suggested in the introduction. Food craving was found in the previous section to be positively correlated with emotional eating and was also expected to be predicted by premenstrual negative affect.

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[8]Non-parametric correlations between symptom ratings and stress and happiness of relationship give identical results to those shown above.

[9] These variables are included in this table despite different sample sizes, as correlations between other variables are similar for n=559 and n=341.

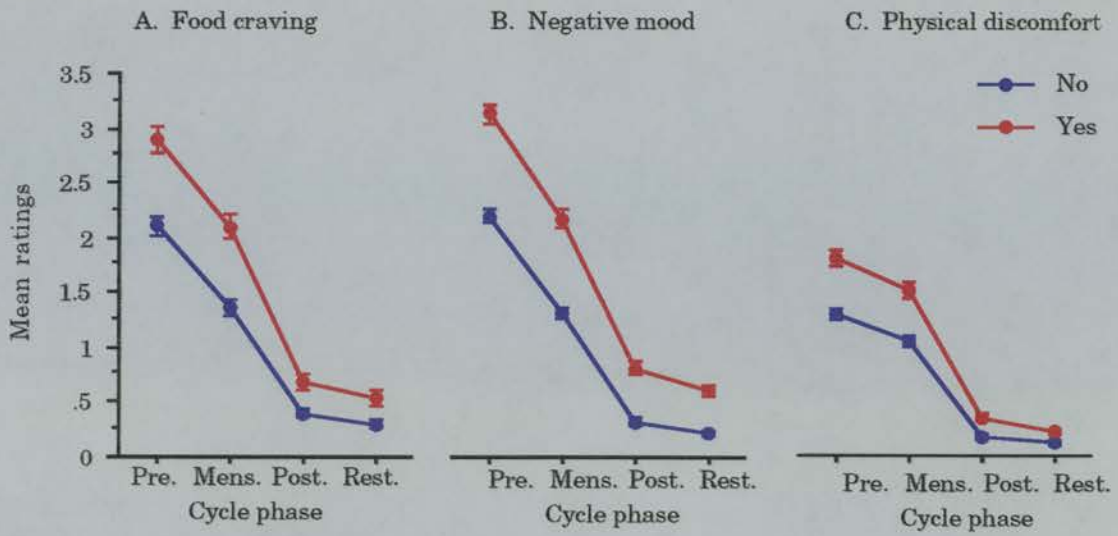**Figure 2.3** - Mean ratings given across cycle phases symptoms, split by whether subjects reported a history of depression.
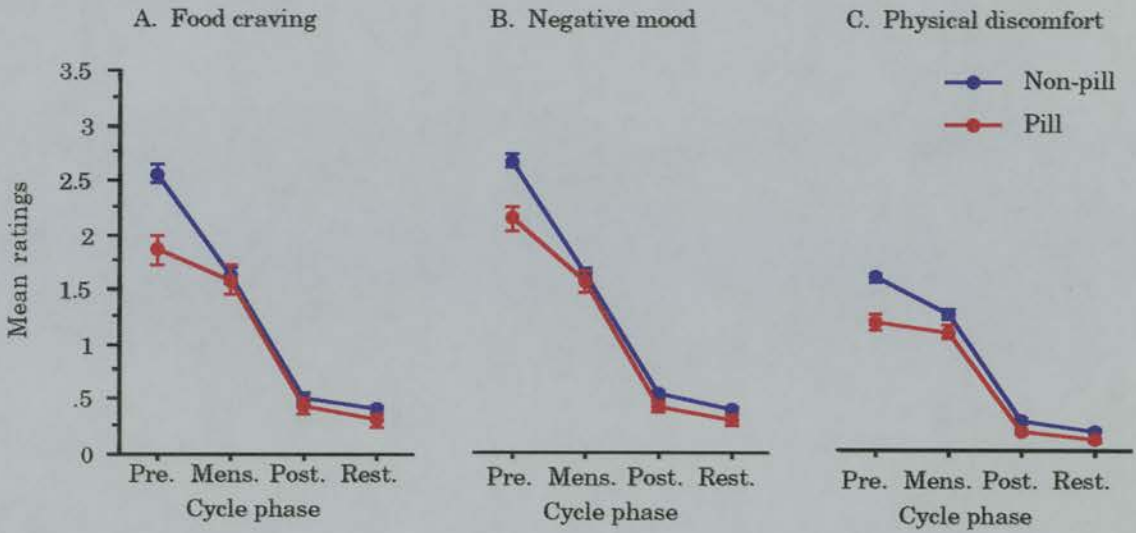

Figure 2.4 - Mean ratings given across cycle phases for symptoms, split by whether subjects used oral contraceptives.

2.3.7   Structural equation modelling of key variables associated with premenstrual food craving and negative mood

The first hypothetical model that was tested is shown in Figure 2.5. This model proposed both past and present emotional state and premenstrual reporting of negative mood to be predicted by a single latent variable (F). Negative affect was proposed also to be predicted by physical discomfort. It was also postulated that severity of premenstrual food craving would be predicted by premenstrual negative affect and emotional eating. This model however had a relatively poor fit to the data as measured by the Chi-squared test and the Bentler-Bonett indices, all of which were ≤.85.
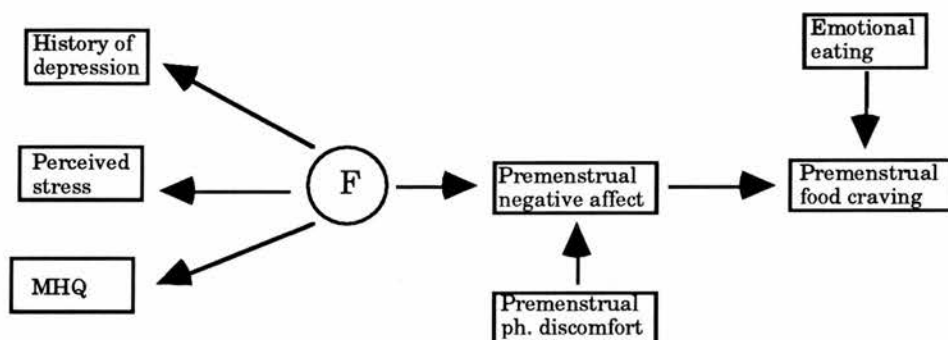
Figure 2.5 - Initial hypothesised model of factors influencing reporting of premenstrual symptoms

The model with the best fit to the data is shown in Figure 2.6. This model proposed a latent factor (F) to predict reporting of both premenstrual negative affect and physical discomfort and to predict increased incidence of depression[10], greater perceived stress, lower current emotional state and higher scores on the emotional eating scale. By contrast food craving showed a weak negative relationship to this variable, but was predicted by both reporting of cycle-related negative affect and emotional eating. Goodness of fit data for the total sample population was adequate according to the Bentler-Bonett indices, as shown in Table 2.11.

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[10] This variable was divided by both whether the subjects reported depression, and whether they reported treatment with anti-depressants. Both gave similar results when included in the model. To optimise numbers in categories, reported history of depression(n=239) rather than treatment with antidepressants (n=112) was included in subsequent analyses.
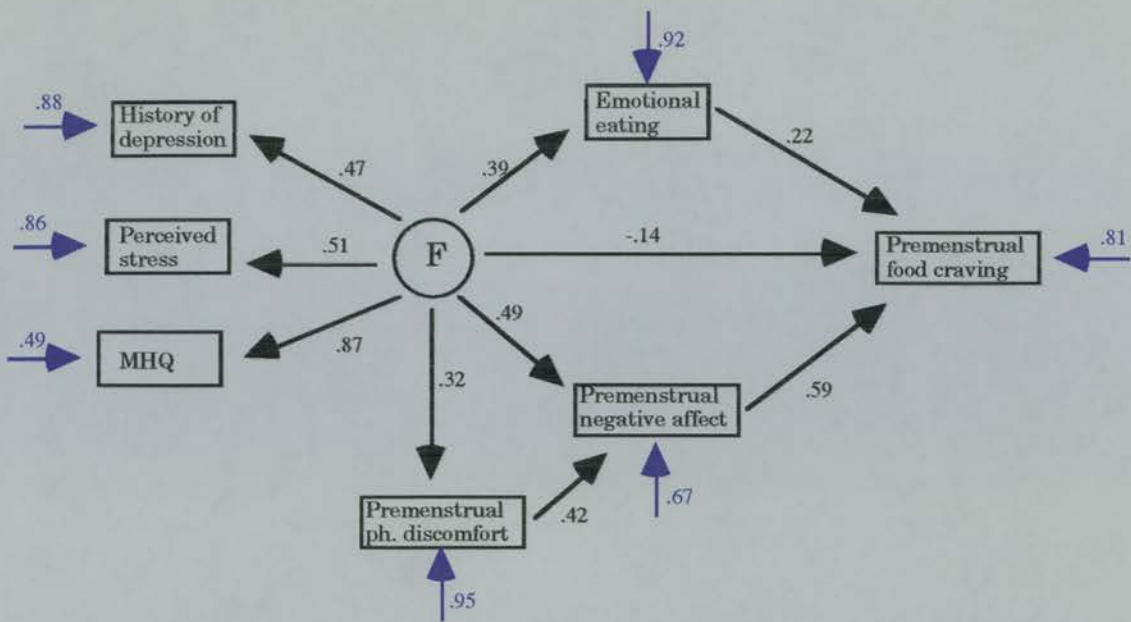
Figure 2.6 - Best fit model of factors influencing reporting of premenstrual symptoms. Blue arrows show residual variances and black arrows show standardised parameter estimates.

Table 2.11 - EQS goodness of model fit for factors influencing reporting of premenstrual symptoms.

	Summary statistics (n=686)
Average off-diagonal standardised residuals	.034
Chi-square (df, p value)	58.62 (df=11, p<0.001)
Bentler-Bonett non-normed fit index	.927
Bentler-Bonett normed fit index	.954
Comparative fit index	.962
Wald test (for dropping parameters)	not significant
Lagrange M. test (for adding parameters)	not significant

2.3.7.2   Multi-sample analysis

When goodness of fit of the proposed model was assessed in individual sample populations, the model was observed to fit the data well in all population samples, as shown in Table 2.12. Multi sample analysis was undertaken to assess whether parameter estimates between variables were invariant across different sample populations. As shown in Figure 2.7 estimates were equivalent amongst groups, with the exception of those between F and stress and between F and negative affect. Both estimates were slightly lower in the self-selected sample populations than in the remaining two sample groups. The Lagrange multiplier test for multisample analysis indicated that these two

constraints ought to be freed. Goodness of fit when these constraints were freed is shown in Table 2.12. Parameter estimates were therefore equivalent across all sample populations with the exception of those between F and stress and F and premenstrual negative affect.
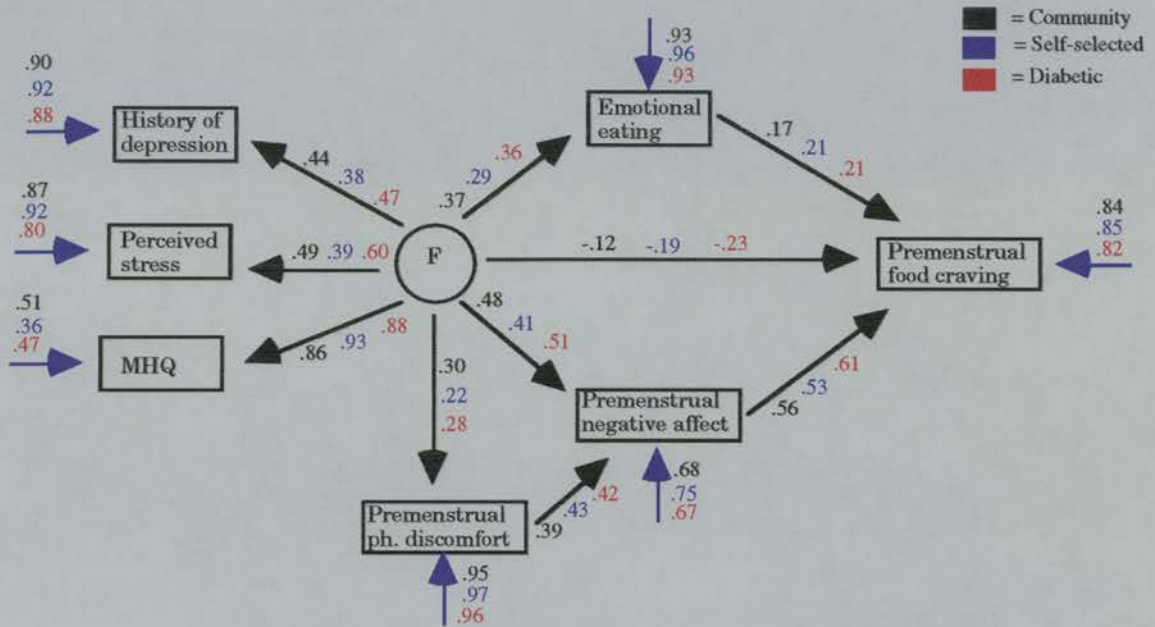
Figure 2.7 - Best fit model of factors influencing reporting of premenstrual symptoms in each sample.

Table 2.12 - EQS goodness of model fit for factors multi-sample analysis.

	Summary statistics			
	Community (n=270)	Self-selected (n=226)	Diabetic (n=190)	Overall
Average off-diag. standardised residuals	.032	.037	.037	
Chi-square , df=11 (p value)	32.96 (<.001)	20.77 (<.04)	19.72 (<.05)	81.07 (df=51, p<.005)
Bentler-Bonett non-normed fit index	.927	.934	.951	.965
Bentler-Bonett normed fit index	.903	.932	.946	.927
Comparative fit index	.949	.966	.974	.972
Lagrange M. test (Parameters to free)	Premens. neg. affect and perceived stress on F			

2.3.7.3   Structural equation modelling for happiness of relationship and post-natal depression

308 women, both parous and currently in a relationship, were included in this analysis. Our initial model suggested both happiness of relationship and reported severity of post-natal depression to be predicted by the latent variable (F) postulated in the previous model. However, when post-natal depression was included in the model, parameter estimates were observed to be relatively low (.15) between the latent variable F and post-natal depression and the fit of the model was substantially decreased (see Table 2.13). When this latter variable was excluded from the analysis, the model adequately fitted the data, as shown by the Bentler-Bonett indices (see Table 2.13). One further alteration to our model was the lack of a significant estimate between food craving and the latent variable F (see Figure 2.8), which was unsurprising given the smaller n.
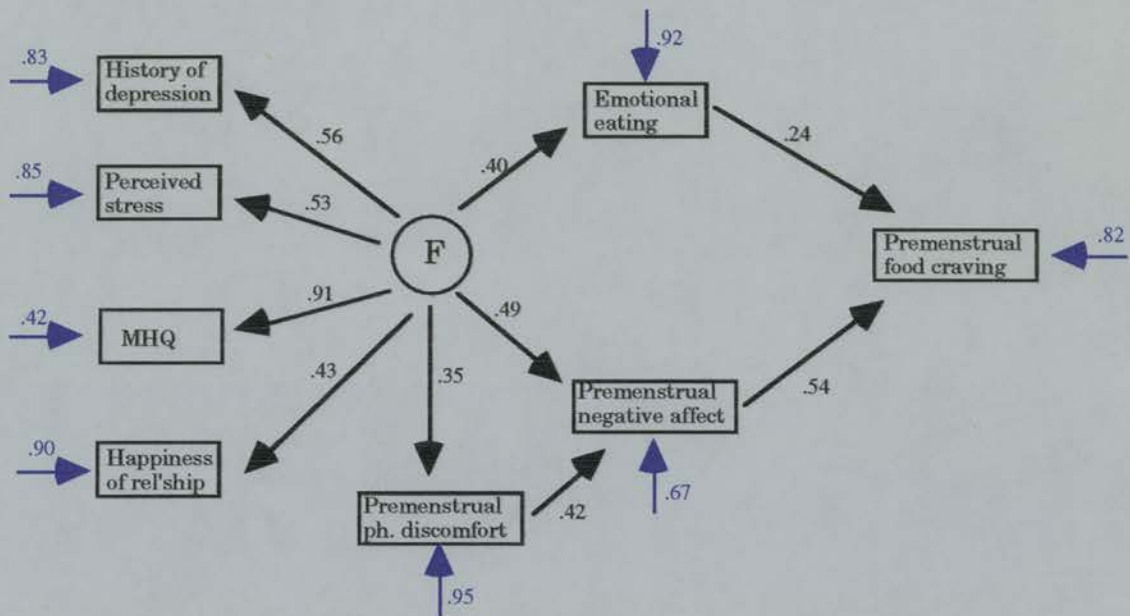
Figure 2.8 - Best fit model of factors influencing reporting of premenstrual symptoms in women who were both parous and in a current relationship

Table 2.13 - EQS goodness of model fit for factors influencing reporting of premenstrual symptoms.

	Including postnatal dep. Total (n=308)	Excluding postnatal dep. Total (n=308)
Average off-diagonal standardised residuals	.054	.042
Chi-square (df, p value)	104.11 (24,p<0.001)	48.29 (17, p<0.001)
Bentler-Bonett non-normed fit index	.844	.923
Bentler-Bonett normed fit index	.871	.931
Comparative fit index	.896	.954
Wald test (for dropping parameters)	not significant	not significant
Lagrange M. test (for adding parameters)	not significant	not significant

2.4   Summary discussion

Whilst the main aim of this study was to observe the relationships amongst premenstrual negative affect, food craving and potential psychosocial factors that influenced their reporting, several other findings are of interest and are discussed before findings relating to the structural models presented in the results section. In line with many early studies which assessed incidence of PMS in community populations (see Clare, 1979), around one third of the community and diabetic sample populations reported experiencing PMS. Incidence in women with diabetes was somewhat lower than the 47% reported in a previous study (Cawood et al., 1993), but may simply reflect different recruitment procedures. Whereas the study by Cawood et al. (1993) recruited subjects via an article in *Balance* magazine which specifically concentrated on cycle-related changes, our sample probably reflected a less self-selected sample population in that subjects were recruited from an entire clinic population and many more general health questions were asked, making the focus of our interest less specific. 58% of the self-selected sample reported PMS, which is similar to the 62% reported in another self-selected sample population (Warner & Bancroft, 1990)

As noted by Bancroft, Cook & Williamson (1988), food craving was found to be most common in the premenstrual phase of the cycle, with many women reporting a perimenstrual pattern and only a small proportion of women noting food craving to be confined to the menstrual phase of the cycle. Of subjects reporting premenstrual food cravings, around 95% of all three sample populations reported a decrease in the postmenstrual phase of the cycle, reflecting the strong cyclical nature of this symptom. Similarly, cycle-related depression and irritability showed a strong cyclical pattern and were most commonly reported in the premenstrual or perimenstrual phase of the cycle.

Principal components analysis of the symptoms in the second questionnaire related well to previous findings from two studies that prospectively examined symptom reporting (Schechter, Bachmann, Vaitukaitis, Phillips & Saperstein, 1989; York, Freeman, Lowery & Strauss, 1989). In these studies, two predominant factors of negative affect and physical discomfort emerged following factor analysis. Several other studies examining factor structure both retrospectively and prospectively have previously also observed a factor of negative affect (Condon, 1993; Monagle, Chatterton, DeLeon-Jones & Hudgens, 1986; Moos, 1969; Morse & Dennerstein, 1988; van der Ploeg, 1990; York et al., 1989), although several have noted two components of physical discomfort (water retention and pain) to comprise separate factors (Monagle et al., 1986; Moos, 1969; van der Ploeg, 1990).

The lack of differentiation of these components in this study may well have reflected the fact that fewer symptoms were included in the questionnaire used in this study.

Principal components analysis of the Dutch Eating Behaviour Questionnaire yielded three factors identical to those reported previously (van Strein et al., 1986; van Strein & Schippers, 1995). This is the first study to examine the factor structure of the DEBQ in a diabetic sample population, and compare it to a non-diabetic community sample. External eating was the only variable that differed in diabetic as compared with the non-diabetic populations, a finding unsurprising given the constraints on intake that are necessarily associated with maintaining good diabetic control. Interestingly, diabetics had equivalent restraint scores to the non-diabetic populations, suggesting worry about weight and restriction of intake to be as prevalent in women with diabetes as in non-diabetic women. This may be an important factor to evaluate in the management of diabetics. Differences between diabetic and non-diabetic populations in terms of marital status and parity are perhaps also unsurprising, given that women with diabetes are encouraged to have children early in order to avoid complications associated with increased age.

In terms of the relationship amongst symptoms, food craving and negative affect were observed to be strongly related to each other in all phases of the cycle. By contrast, physical discomfort was less strongly related to food craving, but was strongly associated with negative affect. The structural equation model proposed physical discomfort to predict severity of negative affect, in line with the suggestion that the association between pain and negative affect in the premenstrual phases of the cycle might result from discomfort associated with processes involved in the build-up and shedding of the endometrium (Bancroft & Rennie, 1995). It also accords with recent research in cancer patients noting a causal effect of discomfort on propensity towards depression (Speigel, Sands & Koopman, 1994). However, in order to confirm the causality of these symptoms in the premenstrual phase of the cycle, time-lagged analysis of symptom reporting would be necessary.

In terms of variables associated with severity of symptom reporting, several psychosocial factors were found to be related to severity of symptoms in the premenstrual phase of the cycle. These associations were first evident in differences observed amongst subject populations. Sample populations differed primarily in severity of symptom reporting and emotional health variables, such that the self-selected sample population reported more severe premenstrual and menstrual symptomatology and were more likely to report higher levels of stress, history of depression, poorer current mental health (as measured by the MHQ) and higher emotional eating scores. They were also less likely to report their

relationship as being very happy than the other populations and tended to report higher severity of post-natal depression than the other two sample populations. These observations align with previous literature suggesting self-selected sample populations to report a high incidence of psychosocial morbidity (Corney & Stanton, 1991).

In the population as a whole, no association was observed between age and reporting of premenstrual symptoms as suggested by the literature outlined in the introduction (Cumming et al., 1995; Friedman & Jaffe, 1985; Gannon et al., 1989; Metcalf et al., 1992). Nor was any relationship observed between symptom reporting and exercise or number of children. The lack of relationship between both eating restraint and food craving, and food craving and body mass index aligns with previous observations (Hill et al., 1991; Rodin et al., 1991). The finding concerning BMI however lies in contrast to the suggestion by Wurtman that food cravings may lead to weight problems in certain individuals (Wurtman, 1988; Wurtman, 1990).

The variables of most interest in terms of their association with reporting of cycle-related symptoms were those encompassing general emotional health and included perceived stress, reported history of depression, current emotional health (MHQ), happiness of relationship and emotional eating. The structural equation modelling confirmed that both these variables and premenstrual negative mood were predicted by the latent variable F. This is in contrast to the concept that variables such as perceived stress, propensity towards depression and marital discontent exacerbate reporting of premenstrual symptoms, or alternatively that premenstrual negative affect may exacerbate reporting of these variables.

The factor (F) that underlies all our emotional variables has been referred to as a 'vulnerability' factor. This factor probably reflects 'negative affectivity' or neuroticism, which has been defined as a propensity to experience negative emotions and is related to reporting of various health complaint scales (Watson & Pennebaker, 1989). There are several reasons to assume that this might be the case. Current emotional state has been shown known to be strongly associated with scores on the neuroticism scale in a large sample population (r=.48, n=5585; Cramer, 1991) and in this study MHQ scores were found to be most strongly associated with the factor F. In fact, scores on the MHQ, which gauge current anxiety and depression, could be thought of as state markers of a trait disposition towards negative affectivity.

In line with the suggestion that the latent factor observed may reflect negative affectivity, several other of the variables loading on this factor have been associated with this variable. In a large scale study (n=1052) depressive symptoms were shown to be

associated with trait neuroticism scores (Fergusson, Horwood & Lawton, 1989). Liability to major depression (Kendler, Kessler, Neale, Heath & Eaves, 1993) and duration of depressive episode have also been noted to be correlated with premorbid ratings of neuroticism (Scott, Eccleston & Boys, 1992; Scott, Williams, Brittlebank & Ferrier, 1995), and high neuroticism scores have been associated with poor outcome and chronicity of depressive illness (Lee, Duggan & Murray, 1992). It has recently been suggested from a longitudinal twin study that the relationship between neuroticism and liability to major depression can largely be explained by genetic risk factors (Kendler, Neale, Kessler, Heath & Eaves, 1993).

Similarly, neuroticism is often included as a predictor variable in studies examining reported stress (Deary et al., in press). Emotional eating has also been associated with emotional distress (van Strein & Schippers, 1995) and with feelings of inadequacy, low self-esteem and social anxiety (van Strein & Bergers, 1988; van Strein, Fritjers, Roosen, Knuiman-Hill & Defares, 1985).

Furthermore, several researchers have noted an association between cycle-related symptom reporting and measures of neuroticism, such that women reporting cycle-related symptoms tend also to report higher levels of neuroticism (Bancroft et al., 1993; Coppen & Kessel, 1963; Hallman, Oreland, Edman & Schalling, 1987; Lewis & Horn, 1991; Mira et al., 1985). Recently, it has been reported that this relationship is particularly strong for negative affect (Bancroft et al., 1993). By contrast, reporting of food craving appears only weakly related to neuroticism (Bancroft et al., 1993). Unfortunately, in this study no measure of neuroticism was taken, but our model would fit with the assumption that the latent factor F probably reflects some measure of this. Moreover, the good fit of the model in the three independent subpopulations would suggest it to be a robust model for further research.

Food craving was not directly related to the underlying factor F, but was predicted both by negative mood and less strongly, by a propensity to eat when feeling low, as has been noted previously (Hill et al., 1991). The relationship between food craving and negative affect would align with both anecdotal reports and previously observed associations of a strong relationship between the food craving (Hill & Heaton-Brown, 1994; Tobin, Schmidt & Rubinow, 1994). However, it is not discernible from this study whether the relationship between food craving and negative affect reflects a biochemical dysfunction, such as an alteration in 5HT activity.

Despite the relationship between negative affect and food craving, almost two thirds of the variance in food craving remained unexplained by the model. This deficit can in part be

explained by error variance but may in part reflect variance specific to food craving. Hence, this symptom appears likely to be at least partly independent of negative mood, which supports observations that the symptom can and does occur at times without the presence of negative mood (Bancroft et al., 1988). In view of both the strong cyclical nature of food craving and its partial independence from negative affect and negative affectivity, this variable may be a good indicator of hormonal changes associated with the ovarian cycle, as suggested by Bancroft (Bancroft, 1993; Bancroft et al., 1993). This is examined further in the following chapter.

It is concluded from this study that both food craving and negative mood show a predominantly premenstrual or perimenstrual pattern, with only a small proportion of individuals reporting either to be confined to the menstrual phase of the cycle. Structural equation modelling confirmed that rather than examining the effects of individual factors on symptom reporting, it may be of greater usefulness to look at interactive models such as the one outlined in this chapter. Negative affect was strongly predicted by the latent variable proposed to reflect neuroticism, or negative affectivity. Given that this factor has been reported to predict both susceptibility to major depressive illness and prognosis, further longitudinal studies examining the relationship between premenstrual negative affect and neuroticism are warranted. Whilst there is clearly a strong relationship between food craving and negative mood in all cycle phases, a proportion of the variance observed in the premenstrual phase of the cycle appears specific to food craving itself.

Chapter 3 - Prospective confirmation of the relationship between food craving and negative affect and examination of their temporal relationship to the menstrual cycle

3.1 Introduction

Questionnaire studies examining cycle-related symptoms are frequently criticised for basing findings and conclusions solely on retrospective reporting of symptoms (Gallant, Popiel, Hoffman, Chakraborty & Hamilton, 1992a; Hart & Russell, 1986; Rubinow et al., 1986). In this study prospective assessment of both the cyclical nature of food craving and its relationship to negative affect was examined.

3.1.1 Confirmation of retrospective reports

A large number of reports have observed that retrospective reporting of cyclical symptoms is often not validated by subsequent prospective studies (Abplanalp, Donnelly & Rose, 1979; Ainscough, 1990; Cook et al., 1990; Endicott & Halbreich, 1983; Gallant et al., 1992a; Gise, Lebovits, Paddison & Strain, 1990; McCance, Luff & Widdowson, 1937; Schnurr, 1988; Slade, 1984). Much of this literature relates to failure to confirm severity of retrospective ratings given. To a certain extent, many of the studies noting failure of subjects to confirm retrospective reports are unsubstantiated. McCance et al. (1937) for example, are often quoted as showing lack of prospective confirmation, yet, rather than showing no cyclicity of symptoms in the random sample population studied, they merely noted less apparent incidence of cyclical symptoms than other retrospective reports had implied.

In many other studies, analysis of data appears questionable. Gise et al. (1990) reported only 20% of their study sample to have a diagnosis of premenstrual syndrome prospectively confirmed. However, included in the 80% of non-confirmers were all subjects who failed to complete the study (63%). Hence, if the 37% of subjects who completed the study are examined, in fact 60% confirmed retrospective ratings of premenstrual syndrome. In another such study, Cook et al. (1990) reported no consistent confirmation of retrospectively reported increase in premenstrual anxiety. Yet eleven of the nineteen subjects reported increases of >30% in anxiety, in at least one of two cycles examined. This compares with fifteen who retrospectively reported increase in anxiety premenstrually, giving a confirmation rate of approximately 70%. Similarly, Schnurr (1988) reported that of fifty subjects attending a PMS clinic, only 12 subjects displayed a consistent cyclical pattern of mood change when the six premenstrual days were compared

with the six postmenstrual days, for two menstrual cycles. However, 34 (68%) women show cyclicity in at least one cycle.

In contrast to the studies discussed above, many others have noted confirmation of retrospective reports in populations of subjects reporting PMS (Hart & Russell, 1986; van der Ploeg & Lodder, 1993). In studies examining single symptoms, high confirmation rates of retrospective ratings have also been observed. In a study looking at prospective confirmation of food cravings, 72% of subjects confirmed retrospective ratings across two cycles (Bancroft et al., 1988). So too, in studies examining retrospective reporting of cycle-related depression, prospective confirmation was noted in approximately two thirds of the sample populations (Coleman et al., 1988; Warner et al., 1991). Lack of higher confirmation rates is unsurprising, given the large between-cycle variability noted by other authors (Hart, Coleman & Russell, 1987; van Keep & Lehert, 1981). Yet despite these studies, criticism remains over the use of retrospective data, and it would appear useful to confirm reporting of symptoms in a large questionnaire survey, both in terms of their relationship to the menstrual cycle, and their relationship to one another. Daily diaries are an effective tool in the confirmation of retrospective reporting of symptoms. It is the assessment of cyclical change that is often the source of conflict.

3.1.2   Assessment of cycle phases

Prospective assessment of symptoms involves rating symptoms on a daily basis, using either visual analogue scales (Abraham, 1984; Rubinow et al., 1986; van der Ploeg & Lodder, 1993) or likert scales (Abplanalp et al., 1979; Ainscough, 1990; Bancroft et al., 1988; Coleman et al., 1988; Cook et al., 1990; Endicott, Nee, Cohen & Halbreich, 1986; Gallant et al., 1992a; Hart & Russell, 1986; Hurt et al., 1992; Warner et al., 1991). The definition of cycle phase has been more problematic. The premenstrual phase of the cycle for example, has been used to refer to varying numbers of days, from fourteen days preceding menstruation (Dalton, 1964), to twelve (Rubinow et al., 1986), ten (Morse, Dennerstein, Varnavides & Burrows, 1988), nine (Bäckström & Hammarbäck, 1991), seven (Hart & Russell, 1986) six (Gise et al., 1990; Hurt et al., 1992; Schnurr, 1988), five (Abplanalp et al., 1979; Cook et al., 1990; Endicott et al., 1986; Slade, 1984), and four (Bancroft et al., 1988; Gallant et al., 1992a). Halbreich & Endicott (1985) have advocated changing the length of the premenstrual phase dependent of the group of individuals being studied. As one aim of this study was to assess exact temporal relationship of symptoms to the menstrual cycle, it was decided to examine changes in severity of ratings on a day-to-day basis in this study. In order to accommodate factor analysis, data were divided into five day sections, as outlined in the method section.

3.1.3   Definition of cyclical change

As with the problems associated with definition of cycle phase, there is as yet no agreed upon definition of what constitutes a cyclical pattern of symptom change. In those studies attempting to separate 'cyclical' from 'non-cyclical' subjects, Dalton's (1964) original criteria of PMTS restricted the phenomenon to symptoms which occurred only in the premenstrual period, thereby omitting any individuals reporting mild symptoms for the remainder of the cycle. Other researchers seeking to determine cyclical patterns have used a change of 30% between pre- and post-menstrual phases (Rubinow et al., 1986; van der Ploeg & Lodder, 1993) as was suggested by the NIMH PMS research group (Rubinow et al., 1986). A change of >30 points on the Moos MDQ between follicular and luteal phases has also been used (Morse et al., 1988) and others have used similar point changes (Bancroft et al., 1988; Halbreich & Endicott, 1985). Bancroft et al. (1988) for example, used a change of at least one point per day on average in the premenstrual week as compared with the post menstrual week to determine cyclicity of food craving in their sample population. Recently, it has been noted that the criteria used to define cyclical change within sample populations can dramatically alter the percentage of sample observed as showing cyclical patterns (Hurt et al., 1992). Further, all criteria used thus far to determine 'cut-off' points for cyclicity of symptoms have been arbitrary and consequently are of limited validity in studies aiming to assess cyclicity of symptoms in a non-clinic population (Warner & Walker, 1992).

3.1.4   Number of cycles chosen to observe

Large inter cycle variability between cycles (Hart et al., 1987; van Keep & Lehert, 1981) may account for differences observed between retrospective and prospective ratings, which would advocate the use of examining multiple cycles. Endicott et al. (1986) have observed however that it may be difficult to interpret data collected for more than one cycle. The tendency is to average cycles and then to take mean change scores between pre- and post-menstrual periods, demanding presence of symptoms across two cycles. As this is frequently reported not to occur, this method may decrease reported incidence of symptoms. Further, several studies have noted a high attrition rates with prolonged assessment of symptoms (Bancroft et al., 1988; Walker & Bancroft, 1990; Warner et al., 1991). Hence this study assessed data collected from one cycle.

In sum, the principle aim of this study was to prospectively confirm retrospective reports of cyclical food craving given in the questionnaire study and to assess the timing of cravings in relation to both the menstrual cycle and to negative mood. Collection of data also allowed confirmatory analysis of symptom factors found in Chapter 2.

3.2   Method

3.2.1   Subjects

Subjects for this study were contacted following completion of the questionnaire study (Chapter 2) if they met the necessary inclusion criteria: 1) Reports of food craving with a drop of at least two points from the premenstrual phase to the post-menstrual phase of the cycle as measured on the 0-6 point scale outlined in Chapter 2) Not currently being treated with any form of medication for the alleviation of premenstrual symptoms 3) Menstrual cycles of between 21 and 35 days 4) Living within the Edinburgh area[1].

From a total of 89 women who had been asked to participate, 59 subjects completed daily diaries. Of these, 4 were excluded due to incomplete information (>2 consecutive days of missing data). A further three subjects had insufficient data to allow comparison of a pre- and post-menstrual phase.   16 subjects who completed the questionnaire study (see Chapter 2) and food intake study (see Chapter 7) and who had sufficient data to allow comparison of pre- to post-menstrual phases were also included in this analysis. The procedure for these subjects is detailed in Chapter 7. Information from 68 subjects is therefore included in this analysis. Mean retrospective ratings for food craving in the premenstrual, menstrual and postmenstrual phases and remainder of the cycle were 4.02±0.97, 2.52±1.66, 0.78±1.08 and 0.62±1.08, respectively.

3.2.2   Measures

3.2.2.1   Daily diaries

Daily diaries were used to monitor changes in symptoms across the cycle (see Appendix 4). Eleven symptoms were included to be rated on a six point scale from 0 (not at all) to 5 (very severe). Items included 6 physical symptoms (food craving, bleeding, bloatedness, breast tenderness, period type pain and fatigue) and 5 emotional symptoms (tension, depression, anger, irritability and mood swings). Two positive items (cheerfulness and energy) were also included.

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[1] It was orignially planned to incude these subjects in the study described in Chapter 5.

3.2.2.2 Assessment of cycle phase

Data were taken from each woman's daily diaries for the 10 days preceding menstruation and 14 days following the onset of bleeding. In only 19 cases was information available for two pre- to post-menstrual phases. The second cycle for these subjects was not included in the analysis.

To allow factor analysis, data were also split into 4 phases, with day 1 referred to as the first day of bleeding. 1) early premenstrual: -10 to -6 days before onset of bleeding, 2) late premenstrual: the five days before onset of bleeding, 3) menstrual: all days of bleeding, 4) postmenstrual: the five days following the menstrual phase. The mean rating for each of these phases was then computed for each cycle.

3.2.3 Procedure

Subjects who met the inclusion criteria and had agreed to be contacted were sent a letter inviting them to participate. Willing subjects were subsequently sent daily diaries and asked to complete these for a period of eight weeks. All were requested to complete the diaries before going to bed at night, by rating how they had felt on average throughout the day for each symptom. Diaries were returned at two weekly intervals in freepost envelopes supplied to each participant. As knowledge of study aims has been noted to increase reporting of symptoms, in particular change in appetite in subjects (Ruble, 1977), subjects were not informed as to the exact nature of the study, but were told it was designed to assess their physical and emotional state prior to participation in the study outlined in Chapter 5[2].

3.2.4 Statistical analysis

Principal components analysis of symptoms was conducted using an oblique rotation. Pearsons r correlations and partial correlations were calculated to examine relationships amongst symptoms in each cycle phase. Change in severity was analysed across time using a repeated measures ANOVA design. All analyses were performed using the Apple Macintosh Statview 4.02 statistical package.

3.3 Results

3.3.1 Principal components analysis

Rather than assessing the timing of each individual symptom separately, principal components analysis was carried out using ten symptoms included in the daily diaries.

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[2] Due to problems outlined in Chapter 5, only 5 of these subjects consequently participated in the study.

The first principal component extracted explained over half of the observed variance in each cycle phase (57% for days -10 to -6, 56% for days -5 to -1, 59% for menstrual days, and 51% for the postmenstrual phase), reflecting a general factor of negative symptom reporting.

Following rotation, two factors had eigen values greater than unity. These explained approximately 70% of the variance in each cycle phase (67%, 69%, 70% and 68% for days 10 to -6, days -5 to -1, days of menses and 5 postmenstrual days, respectively). The scree plot of factors also suggested a two factor solution to be appropriate. Table 3.2 shows the results of the solution, for each cycle phase examined. Of the two rotated factors, the first reflected a negative affect factor, with symptoms of anger, depression, irritability, tension and mood swings all loading at .7 or above in all cycle phases examined. The second, in contrast reflected physical discomfort, with symptoms of breast tenderness, bloatedness and period type pain all loading at .6 or more on this factor. These factors exhibited high internal consistencies in each phase, as shown by the cronbach alpha indices (see Table 3.2).

The only two symptoms showing lower and less consistent loadings on factors were food craving, and fatigue. Craving tended to load on both factors in all but the menstrual phase of the cycle, where it loaded on the factor reflecting physical discomfort. Fatigue displayed inconsistent loading on the negative affect factor and was excluded from further analysis.

3.3.2 Confirmation of relationship between food craving and negative affect

Food craving and negative mood were strongly associated with one another in all cycle phases, particularly in the late premenstrual phase of the cycle (see Table 3.1). When the effects of negative mood were controlled, the relationship between food craving and physical discomfort was somewhat less strong in both premenstrual phases.

Table 3.1 - Correlations amongst symptoms in each phase of the cycle examined. Correlations between each symptom pair have the effects of the third symptom partialled out. (Zero order correlations are shown in brackets). *p<.05, **p<.004, ***p<0.0001)

	Correlations between symptoms in each cycle phase		
Phase of cycle	Food craving / negative affect	Food craving / physical discomfort	Negative affect / physical discomfort
Days -10 to -6	.42** (.57)	.21 (.46)	.41** (.56)
Days -5 to -1	.45*** (.55)	.23 (.41)	.29* (.45)
Menstrual days	.30* (.50)	.33* (.51)	.40** (.55)
5 postmenstrual days	.42** (.49)	.46*** (.53)	.04 (.29)

Table 3.2 - Symptom loadings on factors for each cycle phase. Bold type indicates significant loadings of ≥.35 on factors at p<0.01, using the Burt-Banks formula, (Childs, 1990).

	First Principal Component	Oblique rotation Factor 1	Factor 2	Cronbach alpha
Days -10 to -6				
Anger	.83	.55	.30	
Depression	.80	.81	-.05	
Irritability	.88	.74	.13	.93
Mood swings	.85	.82	.01	
Tension	.87	.75	.10	
Fatigue	.76	.47	.3$	
Food craving	.71	.36	.40	
Bloatedness	.67	.09	.69	
Breast tenderness	.43	-.03	.55	.63
Period type Pain	.60	-.01	.72	
Days -5 to -1				
Anger	.89	.73	.05	
Depression	.76	.79	-.16	
Irritability	.91	.75	.05	.95
Mood swings	.88	.76	-.01	
Tension	.89	.72	.05	
Fatigue	.75	.27	.47	
Food craving	.70	.32	.36	
Bloatedness	.63	-.07	.76	
Breast tenderness	.40	-.16	.62	.65
Period type Pain	.48	-.07	.59	
Mens. days				
Anger	.86	.68	-.03	
Depression	.75	.73	-.18	
Irritability	.93	.63	.08	.95
Mood swings	.90	.64	.05	
Tension	.87	.66	.01	
Fatigue	.80	.40	.24	
Food craving	.64	.10	.43	
Bloatedness	.68	-.10	.70	
Breast tenderness	.64	.01	.54	.75
Period type Pain	.52	-.26	.74	
5 postmens. days				
Anger	.85	.73	.26	
Depression	.82	.84	.01	
Irritability	.91	.87	.09	.93
Mood swings	.90	.89	.04	
Tension	.82	.85	-.05	
Fatigue	.76	.77	-.01	
Food craving	.66	.40	.51	
Bloatedness	.28	-.07	.70	
Breast tenderness	.42	.06	.72	.54
Period type Pain	.38	-.03	.80	

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3.3.3   Confirmation of retrospective reporting and timing of symptom reporting

Repeated measures analysis of variance revealed a significant effect of time on severity of food craving, ($F_{23,44}$= 16.95, p<0.0001), with ratings peaking in the three days before menses, as shown in Figure 3.1. Significant effects of time were also observed for negative mood ($F_{23,44}$= 13.03, p<0.0001) and physical discomfort ($F_{23,44}$= 149.85, p<0.0001).

Food craving appeared to be more strongly associated with the premenstrual phase of the cycle than either physical discomfort or negative affect, with severity of ratings decreasing considerably on the first day of bleeding.   As expected, physical discomfort peaked on the first day of bleeding, reflecting increased pain.

For comparison with published literature, NIMH and Bancroft et al's (1988) criteria were used to define cyclical food craving. In this sample, 41 subjects (60%) reported a decrease of ≥1 point per day from premenstrual to postmenstrual phase of the cycle, and 46 (68%) reported an increase in severity of >30% in the premenstrual as compared with the postmenstrual phase of the cycle.
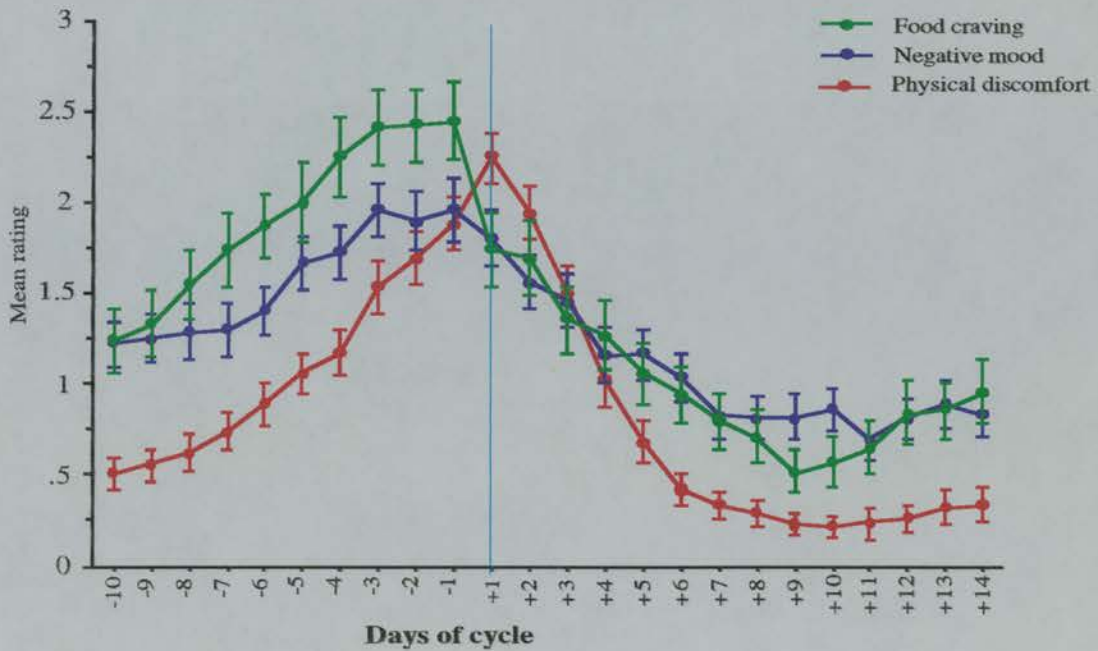
Figure 3.1 - Reported severity of symptoms across the cycle (day 1 denotes first day of bleeding).

3.3.4   Differences in timing between oral contraceptive users and non-o.c. users

Given the different hormonal profiles of oral contraceptive users from the remainder of the population, these groups were compared. No differences in timing of symptoms, or in severity of symptoms were observed between oral contraceptive users (n=21) and non-o.c. users (n=47) as shown in Figure 3.2 (for food craving, negative mood and physical discomfort, $F_{1,44}$=.164, .515, .142, respectively. All p <0.48).

A Food craving
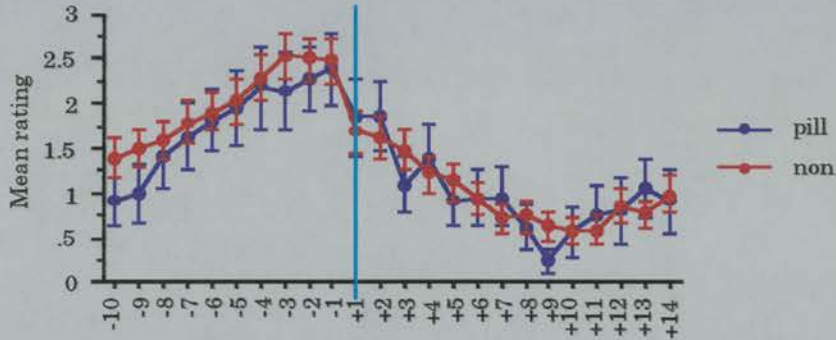
B Negative affect
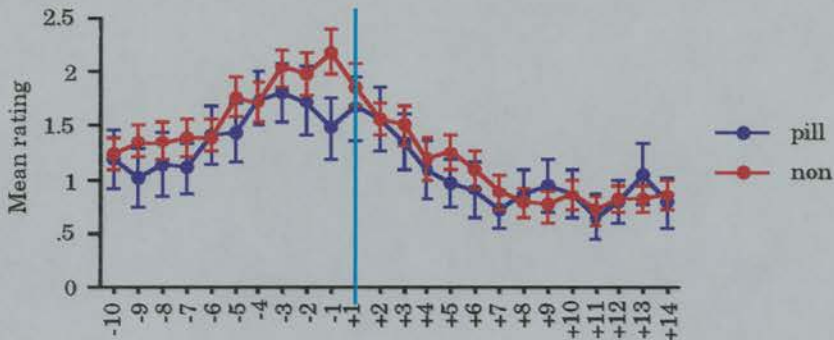
C Physical discomfort
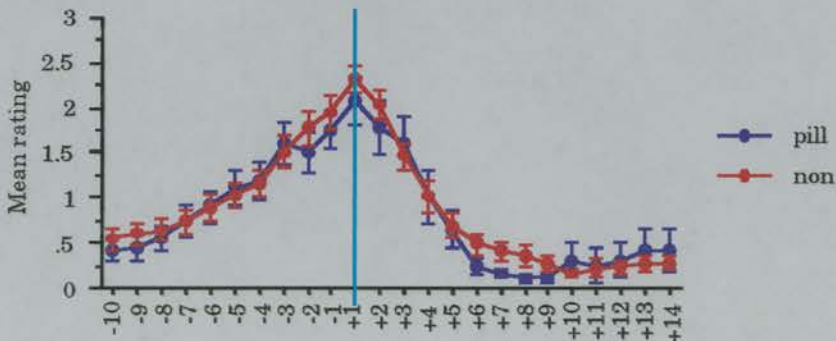
Figure 3.2 - Mean severity ratings across cycle phase given by oral contraceptive and non-o.c. users (day 1 denotes first day of bleeding)

3.4   Summary discussion

A clear cyclical pattern of food craving was observed in our sample population, although severity was somewhat less than retrospective reports had suggested. It could be that retrospective reports amplify the cyclical pattern by reflecting the worst days in the premenstrual and menstrual phases, rather than an average of all days in each of these phases. When results were compared using Bancroft et al's (1988) criteria and NIMH criteria, 60% and 68% confirmation rates were observed, in line with previous studies examining individual symptoms (Bancroft et al., 1988; Coleman et al., 1988; Warner et al., 1991). Higher confirmation rates would not have been expected due to large inter-cycle variability noted in symptoms (Hart & Russell, 1986; van Keep & Lehert, 1981). The observation that food craving reached its peak in the final three days prior to menstruation fits with previous findings reporting craving to peak in the three to four days before menses (Bancroft et al., 1988; Rozin, Levine & Stoess, 1991).

Factor analysis of the four cycle phases produced the factors of physical discomfort and negative affect observed in Chapter 2. These factors were also noted by Schechter, Bachmann, Vaitukaitis, Phillips & Saperstein (1989), although in this study fatigue and food cravings comprised individual factors. This differentiation is probably due to the larger number of questions asked about each symptom (i.e. fatigue, sleep more, want to nap and craving, appetite). As only one question about food craving was asked in the study reported here, factor analysis would not be expected to produce a separate factor. The strong relationship between food craving and negative mood in each phase of the cycle accords with findings from Chapter 2, where approximately one third of variance observed in both symptoms was shared.

Given the consistency of reports noting food craving to peak in the 3-5 days prior to menses, possible mechanisms for this are worth considering. In terms of the effects of steroids on symptom reporting, no difference in severity of reporting of food craving between pill and non-pill users would have been expected given that the sample was specifically selected to include women with cyclical patterns of food craving. The lack of difference in timing is however of interest, given that the two steroid cycles are somewhat different between groups. As noted, food craving appears to increase rapidly from approximately five days prior to bleeding and peaks in the three days prior to bleeding in both oral contraceptive (o.c.) and non-o.c. users. A rapid decrease in steroid levels similarly occurs in those experiencing a natural menstrual cycle in the five days prior to menses (Asso, 1988; Backström, 1992; Illingworth, Reddi, Smith & Baird, 1990). The time course of decrease in hormonal levels is somewhat later in women taking the pill where bleeding usually occurs within three days of hormone withdrawal (McNeill, 1992).

However, occurrence of some follicular development in women using the new low dose oral contraceptive has been reported. In one study, residual cyclical oestrogen production was noted all subjects using this type of oral contraception (McNeill, 1992). Therefore, an endogenous infradian rhythm could explain the appearance of food craving at similar time periods in pill users and non-pill users. If so, it would however suggest an effect of oestrogen on food craving, as no cyclical pattern of progesterone is apparent in women taking the pill (McNeill, 1992). Only one study has thus far sought to examine the relationship between oestrogen and food craving. In this, subjects had blood samples taken in the luteal phase of the cycle and were questioned about food cravings for the two weeks prior to this. No relationship was observed between oestradiol levels and number of cravings. Given the large time period included in the question regarding food craving, the results hold little validity, as noted by the authors (Rodin, Mancuso, Granger & Nelbach, 1991). Future studies should therefore measure both variables concurrently.

The role of oestrogen in onset of food craving would accord with animal studies reporting food intake to increase when oestrogen levels are low and to decrease when estrogen levels are high (Blaustein & Wade, 1976; Czaja, 1975; Czaja & Goy, 1975). Similarly, evidence of a link between food craving and oestrogen comes from reports noting that whilst ovarectomy in rats increases intake, oestrogen administration decreases this (see Cohen, Sherwin & Fleming, 1987 and Pliner & Fleming, 1983 for a review of this literature), although caution should be taken when comparing a rat oestrous cycle (where oestrogen acts as the dominant hormone) and the human menstrual cycle (where progesterone dominates the luteal phase of the cycle).

Given the consistency among studies noting food craving to peak in the three to four days prior to bleeding, this would be of interest to examine further in relation to hormonal changes occurring at this time. Food craving may well in part reflect change in ovarian function and in oestrogen production. However, it is not clear why food craving should decrease following onset of menstruation, when oestrogen levels remain low.

In summary, this study confirmed both the factor structure of symptom reporting outlined in Chapter 2 and the strong relationship observed between food craving and negative affect in all phases of the cycle. It also clarified the timing of food cravings in women reporting a cyclical pattern, and found in line with previous research that craving increases from five days prior to bleeding and peaks in the final three days before onset. Its relation to oestrogen remains of interest to examine further.

Chapter 4 - Qualitative analysis of cycle-related food craving.

4.1   Introduction

Chapters 2 and 3 confirmed the relationship between reporting of cycle-related food craving and negative mood. The study described in this Chapter assessed the nature of cycle-related food craving and evaluated potential psychosocial factors governing mood change observed following intake of craved foods.

4.1.1   Types of foods craved

As discussed in Chapter 1, little is known about the qualitative experience of cycle-related cravings although several reports have suggested sweet-tasting foods to be particularly craved (Abraham, 1984; Bancroft & Rennie, 1993; Cawood, Bancroft & Steel, 1993; Dalton, 1964; Morton, Additon, Addison, Hunt & Sulivan, 1953; Wurtman, Brzezinski, Wurtman & Laferrere, 1989). In line with this, studies using random sample populations frequently report food cravings, particularly in females, to be for carbohydrate and fat-rich foods, notably chocolate (Hill, Weaver & Blundell, 1991; Rodin, Mancuso, Granger & Nelbach, 1991; Rozin, Levine & Stoess, 1991; Tomelleri & Grunewald, 1987; Waterhouse, 1995; Weingarten & Elston, 1991) and several have noted food cravings to peak premenstrually (Cohen, Sherwin & Fleming, 1987; Hill & Heaton-Brown, 1994; Rozin et al., 1991). Preference for chocolate has also been reported to increase during menstruation (Tomelleri & Grunewald, 1987) and cravings for chocolate have been noted to be slightly more likely to be reported by women who note cravings to be related to their menstrual cycle (Weingarten & Elston, 1991).

Unfortunately, the majority of these studies have categorised foods by taste, rather than by macronutrient content (Hetherington & MacDiarmid, 1993; Hill & Heaton-Brown, 1994; Rodin et al., 1991; Weingarten & Elston, 1991) and whilst some authors have concentrated on the carbohydrate element, others have highlighted the fat content (Drewnowski, 1987; Drewnowski & Greenwood, 1983; Hill & Heaton-Brown, 1994; Rozin et al., 1991) and protein content (Hill & Heaton-Brown, 1994; Young, 1991) of commonly craved foods. It would therefore be of interest to examine the macronutrient similarities between different types of foods craved in women who report cycle-related cravings. The protein content of foods is of particular interest because if mood change is mediated in any way by increased serotonergic activity as proposed by Wurtman et al. (1989), protein content would be hypothesised to be minimal in these foods, as protein is known to block the increase in tryptophan to competing amino acid, as discussed in Chapter 1 (see Table 1.1, page 16).

4.1.2   Potential factors influencing mood following satisfaction of cravings

In terms of relationship to mood, both food cravings and intake of carbohydrate-rich foods, as discussed in Chapter 1, are reported to occur more frequently during negative mood states (Cooper & Bowskill, 1986; Davis, Freeman & Garner, 1988; Hetherington & MacDiarmid, 1993; Hill & Heaton-Brown, 1994; Hill et al., 1991; Lyman, 1982; Macdiarmid & Hetherington, 1995). In line with this, several studies have noted immediate beneficial effects on mood following satisfaction of food cravings. Unfortunately, as data used in these studies were collected either from retrospective questionnaires (Schuman, Gitlin & Fairbanks, 1987; Weingarten & Elston, 1991) or immediately following intake (Hill & Heaton-Brown, 1994; Hill et al., 1991; Macdiarmid & Hetherington, 1995), the duration this improvement is unknown. Part of the improvement noted is likely to result from relief of the craving state. Other psychosocial and biochemical theories for change in mood state have already been discussed in Chapter 1.

Mood change in response to a craving is however likely to be governed by many other factors besides contentment derived from pleasurable tastes or potential change in biochemical activity, as will be discussed. Indeed not all intake results in an improvement in mood and psychosocial factors are undoubtedly of interest in attempting to determine the diversity of mood change reported in previous studies following satisfaction of cravings. In one study for example, improvement in mood was noted in the majority of cases whilst subjects were eating the craved foods (Hetherington & MacDiarmid, 1993). Shortly after intake however, improvement was noted in approximately half of the subjects whilst the other half noted negative affect. Similarly, Hill et al. (1991) noted that of ten subjects who completed mood questionnaires before and after satisfaction of cravings, those who intermittently restrained from eating in response to a craving were more likely to note negative mood following intake than those subjects who always ate in response to all cravings. It has also been reported that men are more likely to report positive responses to satisfying a craving than are women (Weingarten & Elston, 1991).

One factor that would account for the difference between females and males is the potential link between the tendency for women to be less satisfied with their body shape (Fallon & Rozin, 1985; Thompson & Dolce, 1989) and their tendency to report higher ratings of guilt in response to eating under certain conditions than men (Dewberry & Ussher, 1994). It is likely that individuals who are less contented with their body shape will also be more likely to feel guilty after eating in response to cravings. This link between body satisfaction and guilt may be particularly important in women who report

cycle-related craving, as body dissatisfaction is known to increase in the premenstrual phase of the cycle and to be associated with reporting of perimenstrual symptoms (Carr-Nangle, Johnson, Bergeron & Nangle, 1994). Further, depressed mood is known to induce concern with body shape in women who place high value on weight or shape (Cohen-Tovée, 1993).

Mood changes observed following satisfaction of cravings are also likely to be influenced by eating restraint. High-restraint subjects are known to report more guilt about eating in certain situations (Dewberry & Ussher, 1994), with one study reporting high-restraint teenagers to report more guilt in response to eating fattening foods (Wardle & Beales, 1986). Possible predictors for change in mood such as attitudes towards eating and body dissatisfaction would therefore be of interest to examine with regard to mood changes reported.

In terms of information regarding other factors associated with food cravings, cravings have been reported to occur more frequently in the evening (Hetherington & MacDiarmid, 1993; Hill et al., 1991) and afternoon (Hill & Heaton-Brown, 1994) and to be more likely to occur at home (Hill & Heaton-Brown, 1994). A weak association between taste and liking of foods have been noted (Rozin et al., 1991) and Hetherington & MacDiarmid (1993) observed that subjects frequently commented on the taste of the foods as the reason for their craving. This is in contrast to seasonal affective disorder patients who frequently highlight the energising effect of carbohydrates as their most appealing feature (Rosenthal et al., 1989).

The aim of this study was therefore to gain qualitative information about the type of foods craved in women reporting perimenstrual craving, the most and least liked aspects of craved foods, and any specific factors such as time of day or place that might be associated with cravings. Similarly, it aimed to examine the prevalent mood states associated with cravings, the time course of improvement in mood following intake, and potential psychosocial predictors of mood changes observed, such as attitudes towards eating.

Within the subject population that took part in this study was included a sub-population of women with diabetes, as previously outlined in Chapter 2. Women with diabetes are constrained in their intake of energy, not only by concerns about weight, but by worry about the loss of diabetic control that accompanies excess intake of carbohydrate. It was therefore expected that women with diabetes would show restraint more often and when they did eat in response to a craving, would eat less than the non-diabetic sample population.

4.2   Method

4.2.1   Subjects

Of the subjects who completed the questionnaires described in Chapter 2, 549 reported that they noticed cycle-related craving. 501 questionnaires contained complete data for Part III of the questionnaire, which included specific questions about cycle-related food cravings. 28 subjects (6%) were excluded from further analysis because no cycle-related changes could be determined, (equivalent ratings for severity and frequency of cravings were noted across all cycle phases). Of the remaining 473 subjects for which there was complete information, 104 were diabetic.

4.2.2   Measures

These data were collected concurrently with the data discussed in Chapter 2 (see Appendix 2, section III). Open-ended questions were included to gain information about the type of food most frequently craved, the amount usually eaten, the place where food cravings were most likely to occur and the aspects subjects liked most and least about the foods craved. Questions about mood state at several time intervals during a craving were also included: when the craving was first noticed, whilst the food was being eaten, shortly after and two hours after intake of food, and if the food was not eaten. Again these questions were designed to be open-ended, in order to assess the factors that subjects found to be most strongly associated with food intake, without biasing response. A final section requested subjects to rate on 6 point scales, the frequency and strength of the craving, the difficulty in ignoring the craving, and the percentage of time the craving was satisfied across four cycle phases (week before period, during period, week after period, and rest of cycle).

Measures described in Chapter 2 were also used in this section as predictors of mood following intake. These included body mass index (Kg/ m^2) and measures of eating restraint, emotional eating and external eating, as measured by the Dutch Eating Behaviour Questionnaire (van Strein, Frijters, Bergers & Defares, 1986).

Perceived body image and ideal body image were assessed using nine figure drawings originally developed by Stunkard, Sorenson & Schulsinger (1983) and used in previous studies (Fallon & Rozin, 1985; Thompson, 1991). Dissatisfaction with current body shape was measured by subtracting current body shape from ideal body shape.

4.2.3 Coding

4.2.3.1 Content analysis of mood state across the course of a food craving

Relevant portions of questionnaires containing open-ended questions were photocopied so both questions and answers were available to coders. Subject number was noted at the top of each page. Adjectives given by subjects in the section regarding mood during the course of a craving are summarised in Table 4.1.

An initial coding scheme was formulated based on about 50% of the data. The initial 13 categories (see Table 4.1) were based as far as possible on the mood dimensions of the UWIST mood adjective checklist (Matthews, Jones & Chamberlain, 1990) with any words not fitting into these categories being assigned a new category. Reliability of this coding scheme was then tested as follows, using guidelines set by Krippendorf (1980)[1]. The initial coding scheme was piloted by an independent coder, using about 30% of the data. The independent coder had a background in psychology and knew the aim of the coding process. Problems were then discussed and coding schemes refined on this basis. One problem for example was the decision to code 'contented' and 'satisfied' into the 'happy' category rather than into the 'relaxed' category. Placement into the latter category was based on UWIST categorisation of these adjectives.

The author and another independent coder given detailed instructions as to the coding procedure then categorised all responses into the initial 13 categories. All data were assigned to a category. Where subjects had given two adjectives, both were coded and entered into the data set. However, for purposes of analysis the first adjective given was taken as the predominant emotion. An inter-rater reliability of 0.96 was found, well above the normally accepted limit of 0.8 (Krippendorf, 1980, p147). Discrepancies were discussed with another 3 colleagues and a majority judgement used as to which categories to assign these adjectives.

As the main objective of this procedure was to detect change in mood following a food craving, the initial 13 categories were further refined to 3 final categories (see Table 4.1). Again, two independent coders then categorised the 13 initial categories into 3 final categories. Coding of other open-ended questions were categorised using similar guidelines to those outlined above.

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[1]I am very grateful to Dr Sue Widdicombe for advice given regarding content analysis of this data.

Table 4.1 - Content analysis of open-ended mood questions relating to how subjects felt when responding to a craving. Both first and second responses of subjects noting more than one adjective were coded.

Adjectives	Freq.	Initial categories	Final categories
Relaxed/ Calm/ Relieved	54	Relaxed	
Increases energy	6	Energetic	
Happy	230		
Satisfied/ satisfaction	123		
Enjoyment/ Pleasure	62		
Better frame of mind	35		**Positive**
Contented	32	Happy	
Cared for / Comforted	17		
Full	14		
Excited/ Eager	5		
Satisfies craving	4		
Pleased with myself/ Proud/ Smug/ Virtuous	82	Feel good about behaviour	
NPFM/ Nothing in particular	457		
Fine/OK/ Not bothered	57	Neutral	**Neutral**
Forgotten/ Feeling passes	34		
Sad/ Unhappy/ Low/ Miserable/ Upset	87		
Depressed	52		
Hungry	24		
Fed up/ Resigned	21	Unhappy	
Bored	20		
Dissatisfied	14		
Denied/ Deprived/ Disappointed	12		
Tense/ Unrelaxed/ On edge	64		
Frustrated	39		
Restless/Twitchy	30		
Anxious	22	Tense	
Agitated	15		
Can't concentrate	5		
Jittery	4		
Must have it/ Craving worse/ Crave it	124		**Negative**
Keep thinking about it	14	Craving	
Rush/ Frantic to eat it	8		
Irritable/ Grumpy	74	Irritable	
Angry/ Annoyed	15		
Tired	52	Tired	
Sick/ Unwell	25		
Bloated	17	Unwell	
Headache	3		
Guilt	207		
Annoyed with self/ Weak	62		
Regret/ Wish I hadn't	50		
Self-disgust	15	Self deprecation	
Fat	15		
Greedy	8		
Worried about blood sugar	4		
Worried about my weight	4		
Always eat the food	47	Always eat food	
Total n	2365		

4.2.3.2   Categorisation of craved foods

Groupings for the food categories are shown in Table 4.2. Categories were based on both the macronutrient content of the foods and their taste. The decision to create carbohydrate categories was based on the observations that all foods were higher in carbohydrate content than in fat or protein in terms of weight and with the exception of chocolate, chips and crisps, carbohydrate also contributed most in terms of the energy derived from each food source. In contrast, although many of the foods contained moderate or high fat content, others contained relatively little fat (pasta, potatoes, bread, sweets).

4.2.3.3   Calorific intake per craving episode

The number of calories usually consumed in response to cravings were calculated by converting reported quantities into weights using the Ministry of Agriculture, Fisheries & Food's guide 'Food Portion Sizes' (Crawley, 1992). As very few of the subjects specified the brand names of foods craved, calorific values of foods were estimated from popular brand names (i.e. Digestive biscuits, Cadbury's Dairy Milk, Scottish cheddar cheese).

4.2.4   Statistical analysis

Differences between diabetic and non-diabetic populations were analysed using various techniques. To assess differences between groups for types of food craved, average amount eaten and most and least liked aspects of craved foods, Chi-square tests were carried out. Changes in strength and frequency of cravings across cycle phase between diabetic and non-diabetic subjects were assessed using two way analysis of variance, group (2 levels) x time (4 levels), with the latter as a repeated measures factor. Finally, analysis of covariance (ANCOVA) was used to determine differences in percentage of time subjects satisfied cravings in each phase of the cycle, using percentage of time satisfied as the dependent variable and the sum of frequency and strength in each cycle phase as a covariate.

Pearson r correlations were used to determine associations between measures of attitudes towards eating (eating restraint, emotional eating and external eating) and percentage of time that subjects satisfied their cravings. These were also used to determine intercorrelations between strength, frequency, difficulty in ignoring cravings and percentage of time subjects satisfied their cravings. Logistic regression analysis using binary dependent variables was employed to determine variables that predicted self deprecating responses following satisfaction of cravings.

Table 4.2 - Categorisation of craved foods. Where applicable, both first and second foods reported by subjects were coded.

Food	Freq.	Final categories
Chocolate	322	**Chocolate**
Chocolate biscuits	10	
Biscuits	31	
Cakes	44	**Carbo. (sugar)**
Ice-cream	11	(high carbohydrate / low
Sweets	24	protein /variable fat)
Sugar	2	
Bread/ Toast	42	
Pasta	9	
Potatoes	1	**Carbo. (starch)**
Crisps	45	(high carbohydrate / low
Corn flakes	1	protein /variable fat)
Chips	10	
Cheese	32	
Cream	2	**Dairy**
Yoghurt	5	(high fat / variable protein
Milk shake	1	/variable carbohydrate)
Meat	10	
Curry	2	**Protein**
Chinese	1	(high protein / variable carbohydrate/
Fish	1	variable fat
Fruit	3	
Pickles	6	**Fruit/ veg**
Tinned peach	1	(high fibre / high fructose)
Salad/ Tomatoes/ vegetables.	4	
Nuts	7	**Nuts**
Miscellaneous	5	**Miscellaneous**
Total	632	

4.3   Results

4.3.1   Type of food craved

Of the 473 subjects who competed this section of the questionnaire, 104 were diabetic. and the remaining 369 non-diabetic. Foods craved were grouped into seven categories, according to both taste and nutritional composition. Any second foods reported by subjects (n=159) were also noted (see Table 4.3 below).

As expected, chocolate was the most frequently reported food, accounting for around 60% of craved foods in both diabetic and non-diabetic sample populations. Of all foods noted, 90% were for carbohydrate-rich foods with the majority of these also containing high proportions of fat and low protein content. Only 2% of the sample population noted cravings for protein-rich foods.

Differences between sample populations were evident (X^2=11.10 df=4 p<0.03)[2] with the diabetic population more likely to report dairy foods as being craved than were the non-diabetic sample, in particular cheese which was noted in 10 of the 12 cases (see Table 4.3)

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Table 4.3 - Foods craved.

Type of Food	Non-diabetic % (n)	Diabetic % (n)	Total (%)	Second food noted % (n)
Chocolate	66 (244)	59 (61)	64	18 (29)
Carbohydrate (sugar) (biscuits, cakes,sweets, pudding)	13 (48)	9 (9)	12	33 (53)
Carbohydrate (starch) (bread, crisps. potatoes,chips, pasta)	11 (40)	14 (15)	12	33 (52)
Dairy (cheese, cream,milk, yoghurt)	4 (15)	11 (12)	6	8 (13)
Protein (meat, fish)	2 (8)	1 (1)	2	3 (5)
Fruit/ vegetables	2 (7)	1 (1)	1	4 (6)
Nuts	1 (4)	3 (3)	1	1 (1)
Miscellaneous	1 (3)	3 (2)	1	-

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[2] To increase cell counts, the final four categories (protein, fruit/veg, nuts, miscellaneous) were collapsed.

4.3.2   Average energy intake in response to a craving

In terms of reported calories consumed in response to a craving, the modal energy intake was between 200-300 Kcal per craving episode (see Figure 4.1). Almost half (49%) of the non-diabetic sample and 37% of the diabetic sample reported intake within this range. The high proportion of the population falling within this category reflected the large number of subjects who reported that they were most likely to eat one chocolate bar in response to a craving (39% of the sample, n=168).

In order to examine differences between sample populations, intake was grouped into three categories; <200 Kcal, 200-300 Kcal and >300 Kcal. Clear differences were observable between sample populations ($X^2 = 31.91$ df=2, p<0.0001), with the diabetic sample more likely to report calorific intake of less than 200 Kcal (46% of diabetics v 16% of non-diabetics), and the non-diabetic subjects twice as likely to report intake of more than 300 Kcal than subjects with diabetes (34% of non-diabetic v 17% of diabetic subjects).
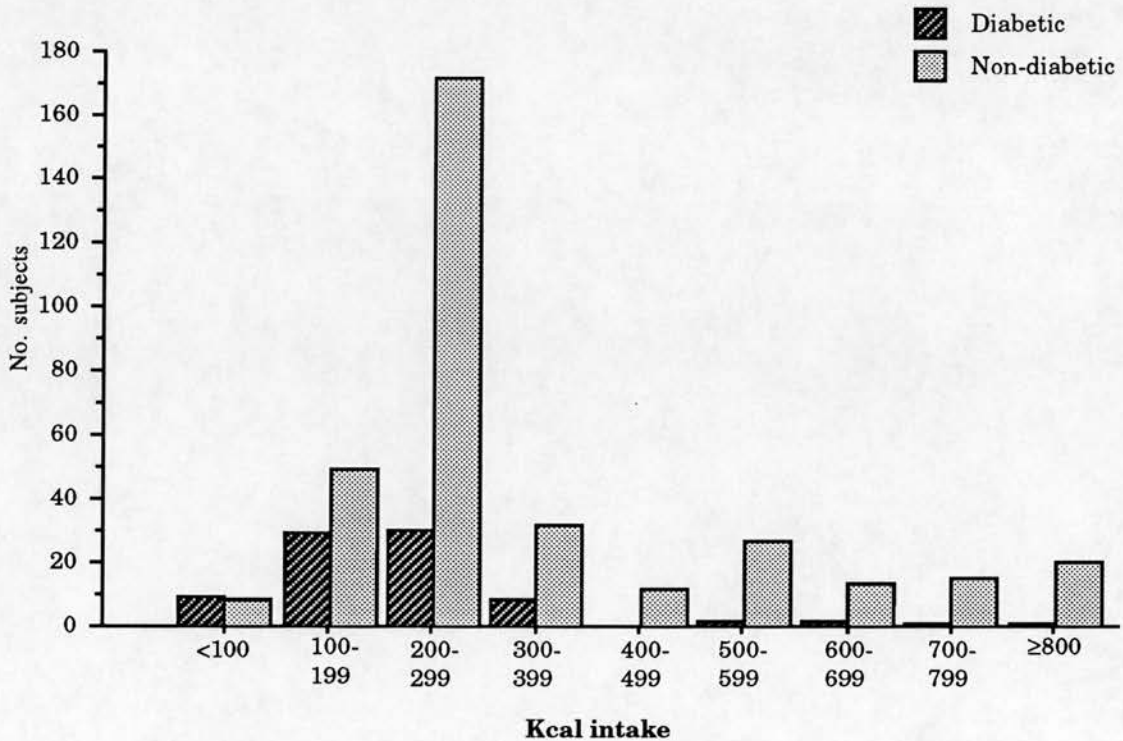

Figure 4.1 - Frequency distribution of typical calorific intake in response to a craving.

4.3.3   Most pleasant and least pleasant aspects of food

Approximately 50% of subjects reported taste to be the most pleasant aspect of the food craved (see Table 4.4), with the pleasure or satisfaction derived from eating the food mentioned by approximately another third of the sample population.   Whilst no differences in response between diabetic and non-diabetic populations were observable for the most pleasant aspects of the foods, diabetic subjects were less likely to note any aspects of foods that they disliked (X^2=47.20 df=3, p<0.0001), and also less likely to note worry about effect of intake on weight than were the non-diabetic sample population, (see Table 4.4).   They were however slightly more likely to report feelings of self deprecation (mainly guilt) than were the non-diabetic subjects[3].

Table 4.4 - Favourite and least favourite aspects of foods craved.

Response	Non-diabetic %	(n)	Diabetic %	(n)	Total %
<u>Favourite aspects</u>					
Taste	49	(182)	50	(52)	49
Satisfaction	18	(67)	13	(13)	17
Pleasure	11	(40)	15	(16)	12
Nothing in particular	9	(35)	12	(12)	10
Comforting	5	(17)	4	(4)	4
Increase in energy	3	(12)	3	(3)	3
Texture	3	(11)	2	(2)	3
Calming effect	1	(5)	2	(2)	1
<u>Least favourite aspects</u>					
None	31	(113)	41	(43)	33
Weight concern	36	(131)	21	(22)	32
Self deprecation	12	(46)	20	(21)	14
Physically unwell	10	(36)	7	(7)	9
Not healthy	10	(37)	3	(3)	8
Effect on blood glucose	0	(0)	8	(8)	2
Effect on mood	2	(6)	0	(0)	1

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[3] To increase cell counts the final four categories (unwell, not healthy, effect on blood glucose and mood) were collapsed.

4.3.4   Location and time of day associated with food cravings

Many subjects (45%) reported that food cravings could occur anywhere (see Table 4.5). Of those subjects reporting specific locations, home was the place most frequently noted with cravings at work found to be less common. In addition to specific locations, 11% of the sample noted cravings to start when around food.

Table 4.5- Reported location of food cravings.

	Non-diabetic		Diabetic		Total
	%	(n)	%	(n)	(%)
Location					
Anywhere	41	(153)	57.	(59)	45
Home	26	(97)	24	(25)	26
Around food	12	(46)	7	(7)	11
Work	12	(46)	3	(3)	10
When relaxing	6	(23)	6	(6)	6
Miscellaneous	1	(4)	4	(4)	2

As with location, many subjects reported that cravings could occur at any time of day (41% across all cycle phases). Of those who did report specific times, evening appeared to be most common and was noted by 32% of subjects across all cycle phases. As shown in Figure 4.2, cravings were more likely to be noticed as occurring at specific times when they occurred in the premenstrual phase of the cycle, and were also more likely to be reported as occurring all day in this phase.
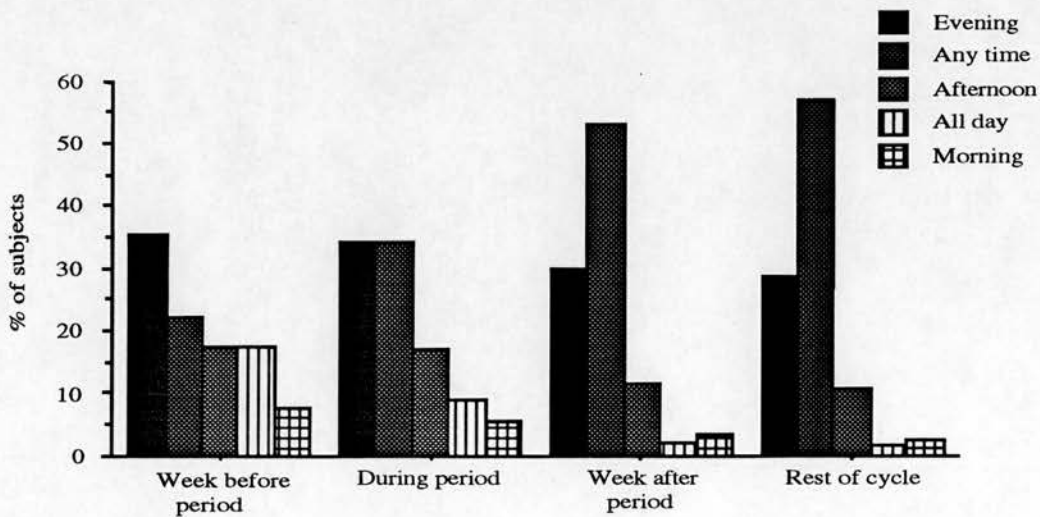
Figure 4.2 - % of food cravings reported at varying time of day, in each phase of the cycle examined.

4.3.5 Frequency and intensity and of cravings

In accordance with subjects being more likely to report food craving as occurring all day in the premenstrual phase of the cycle, both strength and frequency of cravings were found to be highest in this phase (see Figure 4.3). Strength and frequency correlated highly both with one another (r=.82, p<0.0001), and with difficulty in ignoring the craving in this phase of the cycle, (r=.82 and .74 for strength and frequency, respectively). Similar intercorrelations were noted in all other phases of the cycle examined (all r>0.72, p<0.0001).

Group by time interactions were observed between diabetic and non-diabetic subjects for both frequency ($F_{3,465}$=6.22, p<0.0003) and strength ($F_{3,465}$=8.08, p<0.0001) of cravings across cycle phases. This reflected the slightly lower ratings reported by the diabetic subjects in all but the menstrual phase of the cycle. Post hoc comparisons revealed significant differences between diabetic and non-diabetic populations (p<.001) for the premenstrual phase and remainder of the cycle, for both frequency and strength of cravings.
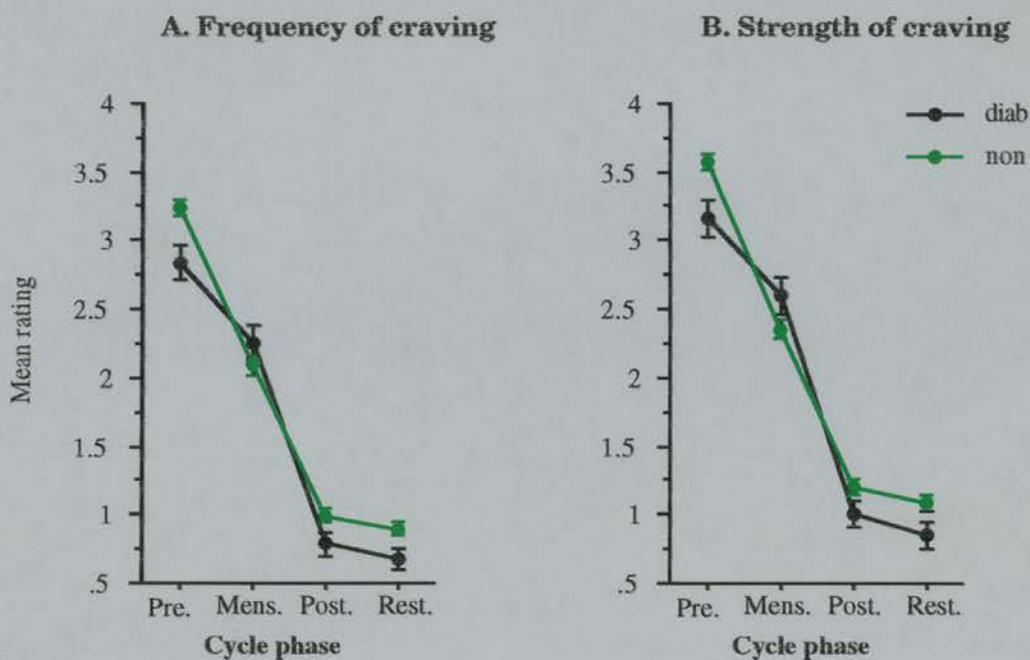

Figure 4.3 - Frequency and strength of food craving in each phase of the cycle ± standard errors.

4.3.6   Satisfaction of cravings

The percentage of time that subjects satisfied their cravings also correlated highly with strength, frequency, and difficulty in ignoring the craving in the premenstrual phase of the cycle (r=.66, .65, .68, respectively, all p<0.0001). Again, similar intercorrelations were noted in all other cycle phases (all r>.64, p<0.0001).

As diabetic and non-diabetic subjects differed in reported frequency and strength of cravings analysis of covariance was carried out to determine differences in percentage of time each group satisfied their cravings, using total scores for frequency and strength of cravings as a covariate in each cycle phase. Whilst no differences between groups were observed in the premenstrual and menstrual phase of the cycle ($F_{1,472}$=.223, p<.64 and $F_{1,472}$=2.75, p<.16), there was a slight tendency for diabetics to satisfy their cravings less in the postmenstrual phase and throughout the remainder of the cycle ($F_{1,472}$=3.51, p<.06 and $F_{1,472}$=4.52, p<.04).

When controlling for the intensity of craving[4], analysis showed that the amount of time subjects satisfied their cravings in any phase of the cycle correlated only weakly with external eating and eating restraint. Similarly a positive correlation between percentage of time subjects satisfied their cravings and emotional eating was observed only in the premenstrual phase of the cycle (see Table 4.6). It would seem that the percentage of time subjects satisfied their cravings was relatively independent of attitudes towards eating, but strongly dependent on intensity of the cravings as measured by their frequency and strength.

Table 4.6 - Pearson r correlations between percentage of time subjects satisfied cravings in each cycle phase, eating restraint and emotional eating. Correlations have intensity of craving partialled out. (*p<0.05 after Bonferroni correction for multiple correlations).

	Eating Restraint	Emotional Eating	External eating
% sat. in premens. phase	-.13*	.15*	.12*
% sat. in mens. phase	-.09	.10	.16*
% sat. in postmens. phase	-.13*	.10	.22*
% sat. in rest of cycle	-.12*	.07	.21*

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[4]Using the average score for strength and frequency of the craving.

4.3.7   Mood state across the course of a food craving

As described in the method section, the open-ended responses to the questions concerning mood state before, during and after food cravings were split into thirteen major categories, and then down to a final three; positive, neutral and negative. As no differences in responses were observed between diabetic and non-diabetic subjects, analyses are given for the total sample population. The responses given at each time point are described to show the general shift in mood state across time.

4.3.7.1   When craving first noticed

As shown in Table 4.7, many subjects (42%) reported being in no particular mood when cravings were first noticed. However, a cumulative 51% of the sample noted some type of negative emotion, of which 21% noted this as due to feeling down or low, and 17% to feeling tense or irritable. By contrast, only 7% of the total sample reported tending to feel in a positive emotional state when cravings started.

4.3.7.2   Whilst eating the food

In contrast to the 7% of subjects noting positive emotional tone when cravings were first noticed, 72% reported feeling positive whilst they were eating the food. By contrast, only 17% (n=82) noted low emotional tone whilst eating the food and in the majority of these cases (n=53) this reflected feelings of guilt.

4.3.7.3   After eating the food

Following satisfaction of food cravings, the number of subjects who reported feeling guilty increased from 11% of the sample population whilst eating the food to 38% shortly after intake and remained at 25% at two hours following intake. In contrast, compared with the 72% of subjects reporting positive emotional tone whilst eating the food, 35% reported this to be the case shortly after intake, with only 9% noting this two hours following intake.

From this descriptive analysis, it would appear that positive changes in emotional tone were most pronounced whilst subjects were eating the foods craved. Whilst feelings of guilt may have accounted for the decrease in reporting of positive mood at shortly after intake, it did not account for the decrease in reporting of positive mood at two hours post consumption. At this time point, subjects tended to report being in no particular frame of mind, or reported a return of food cravings at this time point. However, relatively fewer subjects reported feeling low, tense, irritable or tired than had done when cravings were initially noticed (11% v 44% of the sample). Figure 4.4 shows the change in mood across time in subjects who reported tending to feel negative when cravings were first noticed.

Table 4.7 - Reported mood throughout the course of a food craving. (Numbers given are percentages of the total population, rounded to the nearest 1%).

|	First notice	Whilst eating	Shortly after eating	Two hours after eating	If not eat
Mood					
Positive	**6**	**71**	**35**	**9**	**18**
Happy	6	65	31	7	1
Relaxed	<1	6	4	1	-
Energetic	-	<1	1	<1	-
Pleased with self	-	-	-	-	17
Neutral	**43**	**11**	**12**	**38**	**12**
Negative mood	**51**	**17**	**53**	**53**	**60**
Feel low/ down	21	2	5	5	15
Tense	13	4	-	2	20
Irritable	4	-	1	1	13
Tired	6	<1	-	3	17
Physically unwell	-	<1	5	4	<1
Craving	5	<1	3	13	9
Self deprecation	2	11	39	25	1
Always eat food					10
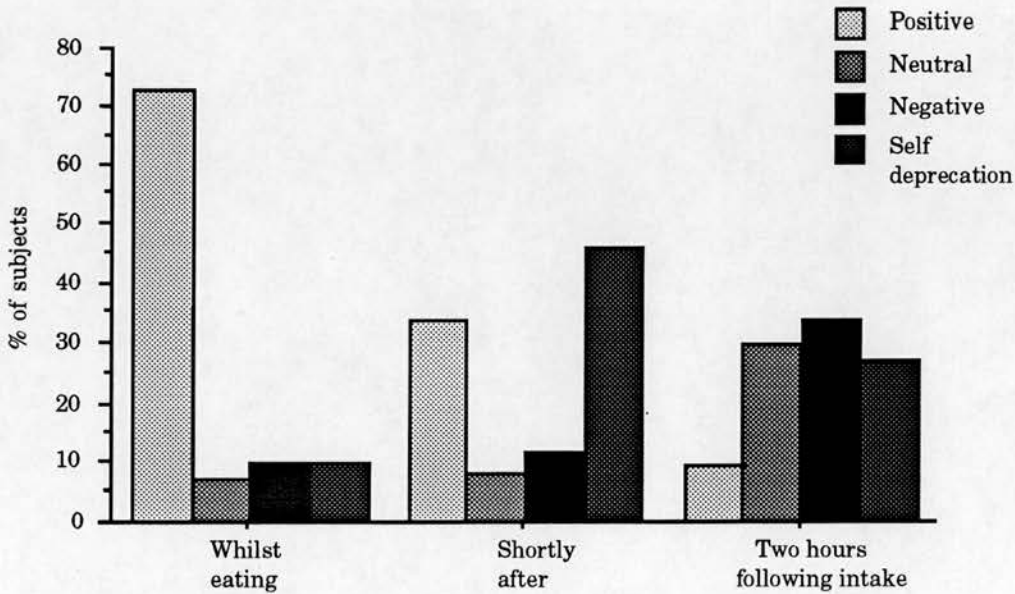
Figure 4.4 - Moods of subjects who reported negative emotional tone when cravings first noticed.

4.3.7.4   Following restraint

In response to the question of how subjects felt when they restrained from eating the food, 10% of subjects stated that they always ate food in response to a craving. Of the remaining subjects, two thirds (67%) reported tending to feel in a negative emotional state, with over half (55%) of these subjects reporting feelings of tension or irritability. This is in contrast to the prevailing feelings of negative mood when cravings were first noticed, where the most common emotion reported was feeling low or down. Of the remaining subjects, a further 19% reported positive emotional tone as being due to feeling pleased with themselves over showing restraint.

4.3.8   Psychological predictors of mood in response to cravings

Due to the prevalence of emotional states that related to behaviour (i.e. guilt following intake and feeling pleased when restraint was shown), the effect on mood of attitudes towards eating, body mass index, usual calorific intake and dissatisfaction with body image were assessed. Logistic regression analysis on a binary dependent variable (Self deprecation/ not) indicated measures of eating restraint to be the only significant predictor of self deprecation shortly intake (see Table 4.8). Two hours following intake both measures of emotional eating and eating restraint predicted self deprecation, as did body dissatisfaction. Eating restraint was similarly the only predictor of reporting feeling pleased with self due to restraining intake in response to cravings (see Table 4.8).

Table 4.8 - Logistic regression showing predictors of self deprecation following intake of foods and self congratulation following restraint (n.s. = not significant)..

	Shortly after intake		Two hours after intake		Following restraint	
	Wald	p	Wald	p	Wald	p
Eating restraint	20.13	<.0001	11.39	<.0007	14.89	.0004
Emotional eating	2.03	n.s.	6.62	.009	1.63	n.s.
Body dissatis.	.003	n.s.	5.48	.02	.17	n.s.

4.4   Summary discussion

As expected from the findings of chapter 3, frequency and severity of cravings were highest in the premenstrual phase of the cycle. Similarly, in line with much of the published literature, chocolate was reported as the food most frequently craved (Hill & Heaton-Brown, 1994; Hill et al., 1991; Rodin et al., 1991; Rozin et al., 1991; Tomelleri & Grunewald, 1987; Waterhouse, 1995; Weingarten & Elston, 1991). Of the remaining foods craved, the vast majority were similar to chocolate in macronutrient content in that all were relatively carbohydrate-rich, fat-rich foods such as crisps, cakes and chips. However, what linked the majority of different foods together appeared to be their relatively high carbohydrate content. Not all of the carbohydrate-rich foods were also fat-rich (i.e. bread, pasta, sweets), which might suggest carbohydrate to be the important determining factor of foods craved. More importantly however is the fact that the bulk of foods reported were also relatively low in protein content, suggesting the possibility that foods might be craved, at least in part for their biochemical effects. However, several other findings suggest this to be unlikely.

In women with diabetes, whose carbohydrate intake is essentially controlled, over 80% reported commonly craving foods that were carbohydrate-rich. In this group, no insulin is be released following carbohydrate intake and therefore biochemical changes in T:LNAA ratio will not occur. On the other hand, it is conceivable that diabetics would see carbohydrate-rich foods as treats and therefore mood changes could result from contentment derived from the experience of eating 'forbidden' foods. This idea would align with the observation that subjects tended to focus on taste as the most pleasing aspect of the foods, as noted by Hetherington & MacDiarmid (1993). Further evidence for the idea that mood change might be driven primarily by psychological factors comes from the observation that the most substantial improvement in mood appeared to occur whilst foods were being eaten, suggesting factors associated with intake itself (i.e. taste) to have the most striking effect on mood. Similarly, at two hours following intake, a not inconsiderable portion of subjects (13%) noted a tendency for cravings to recur, which would also appear to conflict with the time scale of change in the T:LNAA ratio.

However, when only those subjects who noted a tendency towards negative mood at craving outset were considered, sustained improvement in mood remained observable in approximately 40% of this population. The potential causes for this improvement include relief of cravings, contentment derived from taste of the food and potential biochemical effects such as increased T:LNAA ratio. These potential factors cannot be teased apart in this study, but are examined in Chapters 5 and 6.

In terms of factors which might predict response to food cravings, the weak relationship between eating restraint and percentage of time subjects reported satisfying their cravings is perhaps predictable, when the prevalence of negative mood state when cravings are first noticed is borne in mind. Overeating in restrained eaters following negative mood induction is a well known phenomenon (Cools, Schotte & McNally, 1992; Frost, Goolkasian, Ely & Blanchard, 1982).

As suggested from previous studies, eating restraint was the only predictor of self deprecating emotions (most of which were guilt) shortly following intake. The wide reporting of guilt observed in this study accords with the findings of Dewberry & Ussher (1994) and Hetherington & MacDiarmid (1993). At two hours following intake eating restraint, emotional eating and dissatisfaction with body shape all predicted self deprecating remarks. As eating restraint is associated with worry about intake, this might be expected to have the most immediate impact on mood following intake. Similarly, if thoughts regarding the effect of intake as unnecessary (emotional eating) and as fattening (body dissatisfaction) are less immediate, then it is unsurprising that these variables influence mood only at later time points, but of particular interest that they are picked up in a retrospective questionnaire study.

In terms of differences in response to cravings between sample populations, in line with previous findings (Cawood et al., 1993) diabetics tended to report their cravings as less severe than non-diabetics. This is probably due to the sample selection as discussed in Chapter 2.   Whilst diabetic women were recruited from a total clinic population, approximately half of the non-diabetics were targeted by advertising for women who noticed cyclical changes in appetite and mood.

Similarly, differences between diabetic and non-diabetic sample populations in terms of calorific intake in response to cravings are relatively unsurprising, given the effects of carbohydrate intake on diabetic control, and their experience with controlling their diet on a daily basis. The fact that diabetic subjects tended to satisfy their cravings less in the post-menstrual week and the remainder of the cycle than did the non-diabetic population is also likely to relate to concern over diabetic control. So too, the more frequent reporting of guilt as the factor most disliked about intake of craved foods in the diabetic sample is unsurprising, given that women with diabetes not only have the concerns associated with intake of 'unhealthy' foods but also have the additional concerns related to the effect of intake of carbohydrate on their diabetic control.

In conclusion, craved foods appear to be for specifically carbohydrate-rich protein-poor foods although the majority are also high in fat content. As suggested by Hetherington &

MacDiarmid (1993) taste appears to be an important aspect of cravings as opposed to the energising effect following intake that is noted by patients with seasonal affective disorder. However, around 40% of women who noted cravings to start during negative mood states also reported relatively sustained improvement in mood at two hours intake. Whether this is due in any part to increased serotonergic activity cannot be excluded and is studied further in the following two chapters. Factors related to intake, such as eating restraint have little impact on the amount of time that women satisfy their cravings but appear to be strong predictors of mood following intake.

Chapter 5 - The effect of carbohydrate intake on plasma tryptophan ratio and on mood

5.1 Introduction

As noted in Chapter 4, foods craved appear to be predominantly for carbohydrate-rich foods. This study aimed to examine the effect of three carbohydrate drinks which varied in protein content on both mood and the T:LNAA ratio, using a single-blind design. Literature on the effects of carbohydrate intake on mood is firstly reviewed.

5.1.1 Long-term effects of macronutrient intake on mood

Of studies examining the long-term effects of macronutrient intake on mood, several have noted beneficial effects of carbohydrate intake. Keith, O'Keefe, Blessing & Wilson, (1991) noted that when students were given high, medium or low carbohydrate containing diets for a period of one week each, the low carbohydrate diet produced increases in reported levels of tension, depression, and anger, as compared with the other two diets. So too, Deijen, Heemstra & Orlebeke (1989), noted increased anger in subjects fed low-carbohydrate, high-protein breakfasts for a period of three weeks, as compared with controls. However, the authors noted that the unpleasant taste of the high protein meals could have resulted in this effect, highlighting the problems associated with manipulating diet using familiar foods.

Several other studies have also noted beneficial effects of carbohydrate intake on mood. De Castro (1987), reported significant negative correlations between the proportion of energy consumed as carbohydrate and reported levels of depression over a nine day period and Jansen, van den Hout & Griez (1989) similarly noted a positive relationship between intake of carbohydrate and positive mood over a seven day period in a group of control subjects, although no relationship was observed in bulimic patients. Further, in a study including women experiencing premenstrual symptoms, Dalton & Holton (1992) noted that changing to a three-hourly starch diet appeared beneficial to symptoms in 74% of women over a 3-5 month period. By contrast, only one study has reported no difference in mood when comparing high-carbohydrate with low-carbohydrate diets over a three-day period (Prusaczyk, Dishman & Cureton, 1992). One further study has reported a positive association between high proportionate intake of carbohydrate (i.e. higher percentage of energy ingested as carbohydrate) and negative mood (Johnson, Carr-Nangle & Bergeron 1995).

5.1.2   Short-term effects of carbohydrate intake on mood in random sample populations

Comparatively, many more studies have examined the short-term effects of carbohydrate intake on mood following single test meals. Table 5.1, on page 96, gives a summary of this literature with the type of mood measures used and the overall findings for each study. Due to several methodological differences amongst these studies findings cannot simply be summarised by calculating overall effect sizes for each of the mood dimensions measured. These differences are considered before discussion of the findings on mood.

5.1.2.1   Test meals used

The majority of studies examining the effect of carbohydrate intake on mood used natural sugar-based (i.e. biscuits, sorbet, cereal, sweet drinks) or starch-based foods (i.e. rice, bread, or pasta), leaving results subject to possible expectancy effects and potential biases produced by familiar or preferred foods. Few studies used placebo, control meals (see Table 5.1).

Studies also varied widely in terms of calorific content (100-1200 Kcal) and differed in terms of whether main effects of carbohydrate intake or interaction effects of different macronutrients on mood were examined. Hence, six studies contrasted the effects of protein-rich meals (i.e. turkey breast, ham) with carbohydrate-rich meals (Christensen & Redig, 1993; Hartmann, Spinweber & Fernstrom, 1977; Rosenthal et al., 1989; Smith, Leekam, Ralph & McNeill, 1988; Spring et al., 1989; Spring, Maller, Wurtman, Digman & Cozolino, 1982/83), with a further five contrasting the effect of carbohydrate with calorie-free drinks (Benton & Owens, 1993; Blouin et al., 1991; Brody & Wolitzky, 1983; Reid & Hammersley, 1995; Turner et al., 1991), and a final study examining interaction effects amongst carbohydrate-rich, balanced and fat-rich meals (Lloyd, Green & Rogers, 1994). Two further studies used no control meal (Thayer, 1987; Wurtman, Brzezinski, Wurtman & Laferrere, 1989). Differences in the types of test meals could conceivably have affected expectancy effects, as could calorific content, discussed later.

Similarly, there were differences in study design. Whilst some studies contrasted the effects of different meals on mood using between subject designs (Benton & Owens, 1993; Christensen & Redig, 1993; Reid & Hammersley, 1995; Spring et al., 1982/83) others employed within subject designs (Blouin et al., 1991; Hartmann et al., 1977; Lloyd et al., 1994; Rosenthal et al., 1989; Smith et al., 1988; Spring et al., 1989; Turner et al., 1991).

5.1.2.2   Measurement of mood

As shown in Table 5.1, studies also differed in their measurement of mood with many studies using single, validated mood questionnaires (Benton & Owens, 1993; Blouin et al., 1991; Brody & Wolitzky, 1983; Hartmann et al., 1977; Reid & Hammersley, 1995; Smith et al., 1988; Thayer, 1987) some using multiple questionnaires (Christensen & Redig, 1993; Rosenthal et al., 1989; Spring et al., 1989; Spring et al., 1982/83; Wurtman et al., 1989), and two analysing single adjectives (Lloyd et al., 1994; Turner et al., 1991).

But perhaps the largest potential problem to calculating an overall effect size for mood change, exists in the timing of mood measurement. The majority of studies examined the effects of meals on mood for approximately two hours post-consumption, using repeated measures analysis to compare change from baseline. Several studies however, two of which included extremely large sample populations, used different designs. Spring et al. (1982/83) used no baseline, simply comparing mood at two hours post-consumption, between groups. Hence, actual change in mood following intake was not measured, a factor which undoubtedly reduced the power of the study by failing to control for potential baseline differences between groups and may consequently have resulted in non-significant results. Benton & Owens (1993) on the other hand, observed the effects of meals for only 15 or 30 minutes following intake, as did Hartmann (1977)[1]. Similarly, both Blouin et al. (1991) and Reid & Hammersley (1995) examined mood for only 60 minutes post-consumption. This shorter period of examination, especially in Benton and Owen's (1993) study, may conceivably have altered the expected results, as will be discussed below.

5.1.2.3   Changes in reported energy following intake

Despite the methodological differences outlined above, many studies noted a decrease in reported energy levels following consumption of test meals. Overall, seven found a decrease in reported energy on at least one mood scale, following intake of test meals (Christensen & Redig, 1993; Hartmann et al., 1977; Rosenthal et al., 1989; Smith et al., 1988; Spring et al., 1982/83; Thayer, 1987; Wurtman et al., 1989).

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[1] Hartmann et al. (1977) also measured mood at four hours post-consumption.

Table 5.1 - Summary of literature on the effect on mood of nutrient intake in random sample populations Figures in normal type indicate a main effect of intake on mood. Figures in bold type indicate meal by time interactions, with meal condition showing effect given in brackets below. Only main effects, or meal*time interactions are noted in this table.   Sex and time of day interactions are noted in the text. POMS=Profile of Mood States; AD ACL= activation/deactivation adjective checklist.   SSS= Stanford Sleepiness Scale; VAMS= Visual analogue mood scales. NIMHMS= National Institute of Mental Health mood scale Dec.= decrease in mood dimension. cho. =carbohydrate-rich meal; prot. =protein-rich meal; fat =fat-rich meal; plac. =0 Kcal.; - = not significant; *, p<.05; **, p<0.01; ***, p<0.001.

	n	Meals	Kcal	Mood measures	Effect of meals on mood			
					Energy	Tens.	Dep.	Anger
Thayer (1987)	18	cho.	220	AD ACL	dec.*	inc.*		
Wurtman et al (1989)	14	cho.	560	POMS	dec*	-	-	-
				VAMS	-	-	-	-
				SSS	-			
Turner et al. (1991)	16	cho. v plac.	1200	VAMS	-	-	-	-
Blouin et al. (1991)	12	cho. v plac.	100	POMS	inc.* (cho)	-	-	-
Benton & Owens (1993)								
Exp. 1:	354	cho. v plac.	200	AD ACL	inc.*	-		
Exp. 2:	53				inc.*	-		
Exp. 3:	91				-	-		
Brody & Wolitzky (1983)	53	cho. v plac. v saccharin	400	NIMHMS	-			
Reid & Hammersley (1995)	60	cho. v plac. v saccharin	140	POMS	-	-	-	-
Hartmann et al. (1977)	12	cho. v prot.	600	SSS	dec.* (cho)			
Spring et al. (1982/83)	184	cho. v prot.	260	POMS	-	-	-	-
				VAMS	-	-	-	
				SSS	-			
Smith & Leekam (1988)	11	cho. v prot.	700	VAMS	dec.*	-	-	
Rosenthal et al (1989)	16	cho. v prot.	800	POMS	dec.*	-	-	-
				VAMS	dec.*	-	-	
				SSS	dec.*			
Christensen & Redig (1993)								
Exp. 1:	26	cho. v prot. v fast.	650	POMS	dec.**	dec.**	dec.**	dec.**
				AD ACL	-	dec.**		
				SSS	-			
Exp. 2:	38	cho. v prot. v fast.		POMS	dec.**	-	dec.**	dec.**
				AD ACL	-	-		
				SSS	dec.**			
Spring et al. (1989)	7	cho v fasted v prot v balanced	780	POMS	dec.* (cho)	-	-	-
				VAMS	-	-	-	
				SSS	-			
Lloyd et al. (1994)	18	cho. v fat v balanced	700	VAMS	dec.*** (fat)	dec.** (cho)	-	-

By contrast, only two studies noted carbohydrate to increase energy (Benton & Owens, 1993, Exp. 1 & 2; Blouin et al., 1991), and there could be several reasons for this; for example the use of a much shorter time-scale than others studies. In contrast to the 120 min post-intake measured by the majority of other researchers, Benton & Owens observed only 15-30 min following intake, and Blouin et al, only 60 mins following intake. As Thayer (1987) also reported a short-term increase in energy followed by a decrease, it is probable that the shorter time course employed in these studies could account for their difference in results. Alternatively, the lower calorific content used may account for the difference in outcomes as Craig & Richardson (1989), examining the general effect of lunch on mood, found energy to decrease following a heavy lunch and increase following a light lunch. This differential effect may also account for the non-significant findings in the studies by Reid & Hammersley (1995), and Spring et al. (1989), both of whom used relatively low calorie meals (see Table 5.1).

In terms of interaction effects, of the five studies including protein-rich meals, three observed no difference between these and carbohydrate-rich meals (Christensen & Redig, 1993; Rosenthal et al., 1989; Smith et al., 1988). However, a further two (Hartmann et al., 1977; Spring et al., 1989) reported carbohydrate to have a more sedative effect than protein. Spring et al. (1989) suggested increase sedation following carbohydrate intake to result from differential increases in the tryptophan to competing amino acid ratio. These authors had previously also noted carbohydrate intake to have a more sedative effect than protein (Spring et al. 1982/83), but this finding was apparent only in females, and on only one of the three mood measures used in the study (the Stanford Sleepiness Scale). So too, in Lloyd et al' s study subjects reported feeling more drowsy following a fat-rich, than a carbohydrate-rich meal. However, no difference between meals was apparent for reported tiredness, energy, or liveliness, all of which were analysed separately.

It seems in general then, that energy decreases following intake, but transient increases in energy may be apparent before this decrease becomes apparent. Further, decrease in energy may depend on the calorific content of the meal with only those meals high in calorific content producing an effect on reported energy levels. In terms of differential effects of macronutrient intake on mood, studies have reported conflicting results, with some noting carbohydrate to have a more sedative effect on mood than protein-rich meals whilst others observed no difference. Reasons given for the differential effect of carbohydrate on energy levels have included the carbohydrate mediated increase in availability of tryptophan to the brain, as tryptophan administration is known to decrease

sleep latency in individuals (see Spring, Chiodo & Bowen, 1987 for a comprehensive review of this literature).

5.1.2.4 Changes in tension, depression and anger.

In contrast to the general trend apparent in energy levels following intake of carbohydrate, changes in other mood dimensions are less clear. Of the eight studies measuring changes in tension, four studies noted no effect of intake (Blouin et al., 1991; Reid & Hammersley, 1995; Spring et al., 1989; Turner et al., 1991) with only one reporting a main effect (Christensen & Redig, 1993). Three studies however noted meal by time interactions. In Spring et al's (1982/83) study, males reported feeling less tense after a carbohydrate-rich than a protein-rich meal, and older subjects reported feeling less tense following a carbohydrate-rich meal, when given at breakfast. Similarly, Benton & Owens (1993) reported subjects to feel less tense following a carbohydrate than a placebo breakfast, and suggested this effect to result from increased blood glucose levels, reporting significant correlations in each of their studies between blood glucose levels and reported tension (p<.002). Lloyd et al. (1994) also noted subjects to feel less tense following a carbohydrate-rich meal than a fat-rich meal or a 'balanced' meal. However, no changes were noted on three of the other analogue scales associated with tension (i.e. jittery, placid, or calm).

In terms of changes in other mood dimensions, only one study noted a main effect of intake on reported levels of depression and anger (Christensen & Redig, 1993) although another found a decrease following intake of the first meal, irrespective of content (Rosenthal et al., 1989). Rosenthal et al. (1989) suggested that this might be a result of habituation to the environment, and in particular adaptation to intravenous lines used in the study. Whilst this would also explain the findings of Christensen & Redig (1993) in Exp. 1, it would not explain the identical findings in Exp. 2, when blood samples were not taken (see Table 5.1).

In summary, it would appear that there is a general tendency towards a decrease in energy following intake, although it remains unclear whether this effect is more pronounced following intake of carbohydrate than protein. The effect of intake on other dimensions of mood would suggest a possible beneficial effect of carbohydrate intake on reported levels of tension, with no observable effect of intake on reported levels of anger or depression. However, the lack of controlled blinded studies fails to preclude the possibility that effects observed may have been due either to expectancy effects or to preferred tastes associated with carbohydrate intake.

5.1.3   Mood change following macronutrient intake in populations who report carbohydrate cravings

Of studies examining populations reporting craving for carbohydrate-rich foods, some have reported the effects on mood following carbohydrate intake to be more pronounced than those observed in random sample populations.

In the first study of this kind, Lieberman, Wurtman & Chew (1986b) found obese carbohydrate cravers to report feeling significantly less depressed two hours following a carbohydrate-rich meal (6 biscuits, 800 Kcal) as compared to baseline, whilst subjects who craved for non-carbohydrate foods felt more depressed. Non-carbohydrate cravers also felt significantly less alert following intake, whilst carbohydrate cravers reported no significant difference in energy levels. The authors concluded that these differences in affect were unlikely to be due to the taste of the test meal as mood was measured two hours after the meal had been consumed. They suggest that the apparent antidepressant qualities of the carbohydrate-rich meal might be due to biochemical changes such as those seen following tryptophan administration.

There are however several other explanations that might account for the alterations observed in mood state. The food consumed was evidently rich in carbohydrate, leaving open the possibility that the changes in mood observed in the carbohydrate-cravers were due to expectancy effects or perhaps due to the contentment derived from eating a highly preferred food, as discussed in Chapters 1 and 4. Conversely, the decline in mood observed in the non-carbohydrate cravers may have been due to the unappealing nature of the food: eating six biscuits for lunch may have been unappetising.

More recently, two further studies examined the effects of carbohydrate intake in women experiencing premenstrual mood change, (Sayegh et al., 1995; Wurtman et al., 1989). In Wurtman et al.'s study, subjects were tested twice, once in the follicular phase of the cycle and once in the luteal. The carbohydrate test-meal was composed of cornflakes (560Kcal). Although no mood change was observed in the follicular phase of the cycle, in the luteal phase PMS subjects reported decreases in tension, anger, depression, confusion and fatigue at two hours post-consumption, in contrast to the increase in fatigue observed in control subjects. Again however, these authors included no control meal therefore leaving open the possibility that the observations made may have been a result of subjects expectations of the food.

In a following study, the effects on mood of a high-protein drink, a carbohydrate-rich drink, and a carbohydrate-control drink[2] were examined (Sayegh et al., 1995). Results showed non-significant changes in mood at 30 and 90 min post-adsorption, but revealed meal by time interactions at 180 min post-adsorption, with the carbohydrate-rich meal producing greatest decreases in depression and anger.

In contrast to the three studies above, all of which observed clear, beneficial effects of carbohydrate intake on affect, three further studies have observed fewer effects of intake on mood. Rosenthal et al. (1989), compared the mood of patients with seasonal affective disorder (SAD) to that of controls[3] following both a carbohydrate-rich and protein-rich meal. The protein meal consisted of turkey breast and mayonnaise (800 Kcal), whilst the carbohydrate meal was identical to that of Lieberman et al. (i.e. six biscuits). The authors noted substantial effects of sequence on mood with all subjects reporting decreases in tension, depression and anger during their first visit. However, they also noted a group-by-time-by-meal interaction, with a decrease in energy observed in control subjects following carbohydrate intake but no effect of intake on the patient group. By contrast, Blouin et al. (1991) noted an intravenous glucose tolerance test (25g) to produce a group by time interaction with decreased ratings of fatigue in controls, but increased fatigue in patients with bulimia in the first hour post-consumption. It is unclear however whether these constituted a significant change from baseline in each individual group. Another study examining change in mood in bulimic patients following carbohydrate drinks (1200 Kcal) reported no effect on mood (Turner et al., 1991).

In sum, of the six studies described above, only one found increased energy and decreased tension following intake of carbohydrate-rich meals (Wurtman et al., 1989) whilst three of the six reported decreases in depression (Lieberman, Caballero & Finer, 1986; Sayegh et al., 1995; Wurtman et al., 1989). Of those studies finding positive effects of intake on mood (Lieberman et al., 1986; Sayegh et al., 1995; Wurtman et al., 1989) all suggested these effects to result from increased serotonergic functioning. Yet of these three studies, all carried out by the same research group, none measured mood concurrent with the tryptophan to competing amino acid ratio (a measure thought to indicate serotonergic activity, see Chapter 1). The study by Lieberman et al. has already been criticised (Christensen, 1993) as T:LNAA ratio has been reported not to change following intake of sucrose in obese individuals (Caballero, Finer & Wurtman, 1988). Similarly, it has been reported that the carbohydrate-rich meal used by Wurtman et al, (1989) contained

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[2] Which had no effect on the T:LNAA ratio.

[3] Described in the previous section.

sufficient protein (4%) to block the carbohydrate mediated rise in the T:LNAA ratio (Teff, Young & Blundell, 1989a; Young, 1991).

In view of the lack of apparent evidence linking changes in mood following carbohydrate intake to change in the T:LNAA ratio, the following study was designed to test the hypothesis that subpopulations who report craving for carbohydrate foods may overconsume carbohydrate in an attempt to alleviate negative mood state, by increasing serotonergic activity. Firstly, the hypothesis was examined in this chapter, by

1) Evaluating the change in T:LNAA ratio following carbohydrate-rich meals, varying in protein content.

2) Assessing differential effects on mood change in the three hours following consumption of the meals.

It was initially intended to examine these changes in two populations of subjects; one sample of subjects who reported no cycle-related symptoms and another sample who reported premenstrual food craving and negative mood. However inherent problems encountered in the measurement of mood within a laboratory situation became apparent during the course of this study, as discussed later in this chapter. Examination of the differential mood changes following drinks containing varying protein content were therefore evaluated in women reporting premenstrual mood changes and food cravings in a revised study which is described in Chapter 6.

5.2   Method

5.2.1   Design

The effects on mood following consumption of two carbohydrate drinks containing 0% and 5% protein, were assessed in the luteal phase[4] of the menstrual cycle, using a repeated-measures, single-blind design.

5.2.2   Subjects

18 subjects completed this study, of mean age 28.0±4.7 years, (range 19-36), and BMI 23.4±3.11 (19.7-29.2).   Nine were using oral contraceptives[5].   Six subjects reported perimenstrual food craving and negative mood.   As no different patterns of mood change or change in T:LNAA ratio were found between these six subjects and the remaining subjects either in terms of mood change or amino acid analysis (all Anova values p>.10), both groups are described together in the analysis section.

5.2.3   Measures

5.2.3.1   Test drinks

Test meals were devised from drink powders primarily because it is more difficult for subjects to gauge the composition of drinks than foods.   Macronutrient content is also easier to manipulate than would have been the case in using natural foodstuffs and it is easier to standardise quantities when using powders.   Drinks would also be expected to produce similar satiety levels to meals as gastric-emptying rates are equivalent following liquid and solid meals (Carbonnel, Lémann, Rambaud, Mundler & Jian, 1994),   Duocal, Maxijul and Maxipro drink powders were therefore obtained from Scientific Hospital Supplied Ltd, for this purpose[6].

Both drinks contained 560 Kcal, similar to that used by Wurtman et al. (1989): quantities are shown in Table 5.2. Drink A (0% protein) contained a mixture of Duocal and Maxijul, and Drink B (5% protein) contained a mixture of Duocal, Maxijul and Maxipro.   Both contained substantial fat content, primarily because foods that are commonly craved are known to contain high proportions of fat content (see Chapter 4) and also because fat is known to delay gastric emptying[7].

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[4] Within ten days of menses.

[5] These subjects were included as oral contraceptive use has been reported not to alter the T:LNAA ratio (Maes et al., 1992)

[6] I would like to thank Dr Fred Pender, Department of Dietetics and Nutrition, Queen Margaret College for help in the design of test drinks.

[7] My thanks to Dr R.C.Heading, Centre for Liver and Digestive Disorders, Royal Infirmary of Edinburgh, for this advice.

Table 5.2 - Composition of test drinks.

	Energy (Kcal)	Fat (g)	Fat (%Kcal)	Carbohydrate (g)	Carbohydrate (%Kcal)	Protein (g)	Protein (%Kcal)
Drink A	560	18.6	30	98	70	0	0
Drink B	560	18.6	30	91	65	7	5

Drinks were served in covered beakers to prevent olfactory information and therefore decrease the perceived intensity of the taste. The drinks were also chilled before serving as temperature is known to affect the perceived intensity of sweet-tasting substances.

5.2.3.2 Mood

The UWIST mood adjective checklist (Matthews, Jones & Chamberlain, 1990) was chosen because of its well defined factor structure and its sensitivity in measuring short-term changes in mood (Matthews & Ryan, 1994). It contains a list of 29 adjectives to be rated on a four point scale (definitely, slightly, slightly not, definitely not), yielding three mood dimensions; hedonic tone, tense arousal, and energetic arousal. A sub-scale of anger, which correlates with low hedonic tone, was also included. In addition to this, two adjectives (hungry and full) were included to assess satiety following intake. Visual analogue mood scales were also completed. These consisted of four 10cm lines marked at either end with the adjectives Happy/Sad, Tense/Relaxed, Alert/Tired, Angry/Calm. At the top of each scale were the words, 'Please rate how you feel at the moment by placing a vertical mark on each of the lines below'.

5.2.4   Procedure

Subjects consumed both drinks in randomised order, at two day intervals. Subjects were asked to eat similar lunches on test days and were requested to abstain from eating for four hours prior to participating so as to ensure similar baseline glucose levels. On arrival, each subject had a cannula inserted into the anticubital fossa. Baseline blood samples and mood ratings were taken at 30 and 60 minutes following cannulation. Drinks were consumed 5 mins later, at 6pm. Subjects were requested to consume the drink within ten minutes, but not to drink it rapidly[8]. Mood ratings were completed and plasma samples taken at half hourly intervals, starting at 6.30pm (30 minutes after starting the drink) and continuing until 9pm.

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[8]Where drinks are gulped, rapid transfer from stomach to small bowel can result in incomplete digestion of macronutrients (personal communication, Dr R.C. Heading, Centre for Liver and Digestive Disorders, Royal Infirmary of Edinburgh).

Before each test day, it was discussed with the subjects what they would like to do throughout the study period. This was to keep subjects from watching or reading anything that might alter their mood, whilst at the same time allowing them to establish their own level of arousal, very much as they would do if they were in their own home environment.

5.2.5   Plasma analysis

5.2.5.1 Collection and storage: Samples were collected in heparinized containers, centrifuged immediately, and plasma collected for measurement of glucose, insulin and amino acids, in separate alliquots. Plasma was subsequently frozen and stored at -20°C until analysis.

5.2.5.2 Glucose was determined by hexokinase procedure (Sigma Chemicals U.K.) and measured spectrophotometrically.

5.2.5.3 Insulin was measured using a standard radioimmunoassay kit (Coat-A-Count, Diagnostic Products Corporation, C.A., U.S.A.)

5.2.5.4 Amino acid analysis was performed by Bioflux Ltd, Glasgow.
Apparatus: Separation was achieved with reversed phase 'high pressure' liquid chromatography with fluorescence detection (Jarrett, Cooksy, Ellis & Anderson, 1986, revised method). A Phillips gradient PU 4100 liquid chromatographic system, with Gilson automatic sample injector and Gilson 401 dilutor was used to quantify amino acids in conjunction with Phillips PU 6000 integration software. Separation was carried out on a 5µm C8 Ultracarb column (Phenomenex). The fluorescence intensity of the OPA-amino acid derivatives were detected with a Jasco Intelligent Spectrofluorometer (excitation wavelength = 230nm; emission wavelength= 455nm).

Materials: Crystalline samples of amino acids were obtained from Sigma Chemicals U.K. A standard mixture of 8 amino acids was prepared to a concentration of 25µM with distilled water and stored at -20°C before using. OPA reagent was prepared by dissolving 50mg of anhydrous o-phthalaldehyde in 1ml of methanol and then adding 10mls of 0.2M borate buffer and 40µl of 2-mercaptoethanol.

Procedure: Plasma samples were initially deproteinized by adding to 40µl volume of plasma sample, 160µl ice-cold methanol, and then centrifuging at 14000min^{-1} for 4 minutes. One volume (100 µl) of supernatant was then drawn into the automatic sample

injector and placed in an empty vial, followed by one volume of OPA reagent. Plasma sample and OPA reagent were mixed in the needle and left for 1 minute before injection into the column. This method is reproducible with time accuracy to avoid unreliable results in recording the fluorescence intensity of the OPA- amino acid derivatives. Resolution of the peaks was achieved using a gradient elution, starting with a mobile phase (sodium acetate buffer) and a increasing a second mobile phase (methanol) gradually to 100% after 35 minutes. The elution order of the amino acid derivatives is dependent on the polarity of the amino acids. The tryptophan to competing amino acid (T:LNAA) ratio was then calculated by dividing the values of tryptophan at each time point by the sum of the values for valine, leucine, isoleucine, phenylalanine, and tyrosine.

5.2.5.5   The measurement of total as opposed to free tryptophan

As most of plasma tryptophan (70-80%) is in complex with serum albumin (Wurtman, Hefti & Melamed, 1981) it has been questioned as to whether total tryptophan gives the correct value of tryptophan available for transport to the brain. However, as the affinity for tryptophan of the blood brain barrier transport system, estimated from its V_{max}/K_m ratio, is greater than the affinity for tryptophan of albumin, the effect of albumin binding on tryptophan available to the brain is small (Etienne, Young & Sourkes, 1976; Fernstrom & Fernstrom, 1993). Due to this we opted to measure total tryptophan.

5.2.6   Statistical analysis

The effect of test drinks on mood were assessed using three way analysis of variance, drink (2 levels) x order of visit (2 levels) x time (7 levels), with time as a repeated measures factor. Post hoc comparisons were carried out using related t-tests. The effects of drink on plasma measures were analysed using a two way analyses of variance, drink (2 levels) x time (7 levels). Analysis were performed for the 0% and 5% protein drinks, where n=18. Identical analyses were then performed to include the results from a third drink (see below), where n=13, although sequence was not included in the analyses of varaince due to the time lapse between this test condition and the other two drink conditions. All analyses were carried out using the Statview 4.02 package, for Apple MacIntosh.

5.2.7   Method 2

Following completion of this study and analysis of the results, it was decided to examine the effects of a further drink, and of no drink, on the T:LNAA ratio.

5.2.7.1   Subjects

Of the 18 subjects who participated in the initial experiment, 13 were available to take part in the drink experiment. Of the remaining 5, one had moved to London, one was pregnant, two were on courses antidepressants and one further subject had participated in another research study and did not wish to participate in any further studies. The mean age of the 13 subjects who participated in the drink condition was 26.4 ± 4.4 (19-36) and the BMI 23.0 ± 3.4 (19.7-290.3). Nine of these subjects also took part in the no drink experiment, of mean age 25.2 ± 1.86 (range 23-28) and BMI 22.5 ± 3.2 (range 19.7-29.2). Findings from all experiments are incorporated together in the following results section.

5.2.7.2   Procedure

Procedure and measurements for the drink condition were identical to those outlined above. The test meal consisted of Duocal, Maxijul and Maxipro, and contained 15% protein, 30% fat, and 55% carbohydrate.

In the no meal condition, subjects fasted as outlined above, and had two blood samples taken at 6pm and 9pm. No mood measures were taken as it was assumed that hunger ratings would be substantially higher in this condition, possibly confounding any mood ratings given.

5.3   Results

5.3.1   Change in tryptophan to competing amino acid (T:LNAA) ratio following intake of test drinks

There was a trend towards a meal by time interaction on the T:LNAA ratio following consumption of the 0% and 5% protein-containing drinks ($F_{3,28}=2.75$, $p<0.07$). As can be seen from Figure 5.1a, the 5% protein drink resulted in a delayed, but more prolonged, increase in the T:LNAA ratio. By two hours, the 5% protein drink had produced an increase of 11% in the T:LNAA ratio as compared with the 20% increase observed following the 0% protein drink. By three hours post consumption however, 0% and 5% protein drinks had produced similar increases in the T:LNAA ratio (22% and 21%, respectively).

When these drinks were compared with the 15% protein drink (for n=13), no significant interaction was observable ($F_{3,27}=1.53$, $p<0.23$) although again the 15% protein drink produced a slower but more prolonged rise in the tryptophan ratio with an increase in T:LNAA ratio of 1% and 13% respectively, at 2 and 3 hours post consumption (see Figure 5.1b).
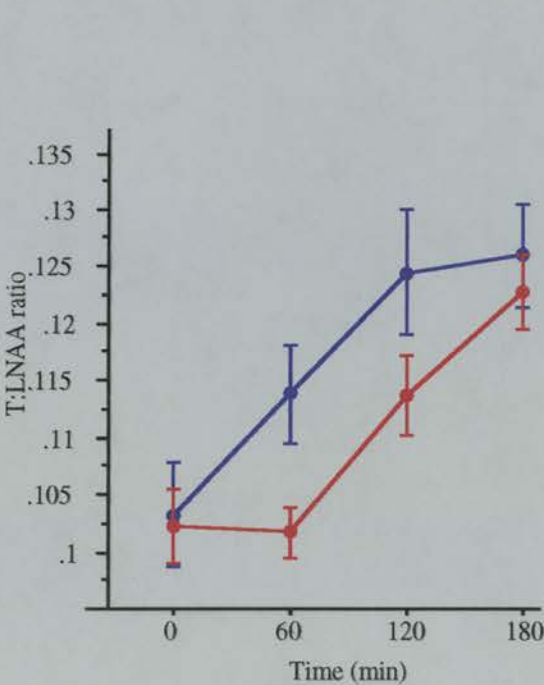
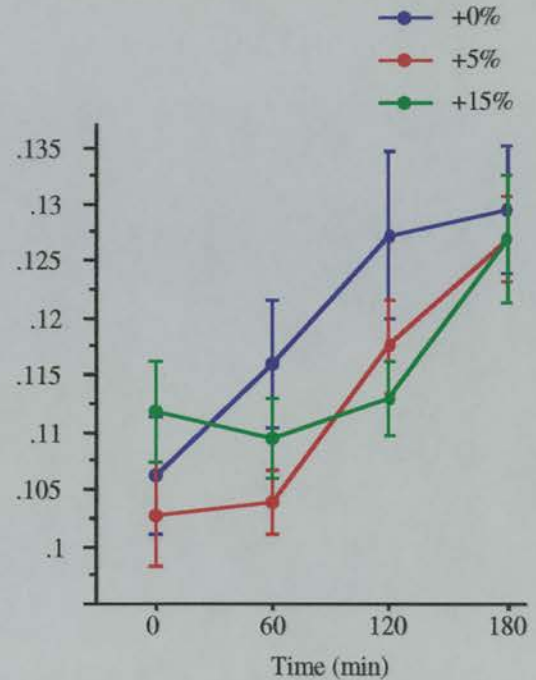**Figure 5.1a** - Effect of 0% and 5% protein drinks on the T:LNAA ratio, (n=18).

Figure 5.1b - Effect of 0%, 5% and 15% protein drinks on the T:LNAA ratio, (n=13).

As a significant effect on the T:LNAA ratio was observed following each of the test drinks ($F_{3,14}=12.14$, p<0.0001 for 0% protein; $F_{3,14}=21.70$, p<0.0001, for 5% protein, and $F_{3,9}=5.26$, p<0.02 for 15% protein) plasma samples from nine fasted subjects, taken at 6pm and 9pm, were examined to ensure that the increases observed were not due to any diurnal variation in the T:LNAA ratio (i.e. any naturally occurring changes in the T:LNAA ratio throughout the course of the evening). No effect of time on the T:LNAA was evident (baseline T:LNAA ratio = .121, 180 min =.126), suggesting that the increases observed following drink conditions were a direct result of consumption of the drinks, rather than attributable to diurnal variation.

5.3.2 Effect of meals on glucose and insulin levels

Analyses are presented here for those subjects who completed all three test drinks (n=13) as no interactions were observed between 0% and 5% protein drinks (n=18). As expected, there was a main effect of time on glucose levels ($F_{6,18}= 14.61$, p<0.0001) with glucose peaking at 60 min following the 0% and 5% drinks and at 90 min following the 15% protein drink (see Figure 5.2a). No meal by time interactions were observable among drink conditions.

Similarly, there were no differences amongst drinks in resulting insulin levels although again a significant effect of time was apparent ($F_{6,18}= 20.61$, p<0.0001) with levels peaking at 120 min after all three drinks (see Figure 5.2b).
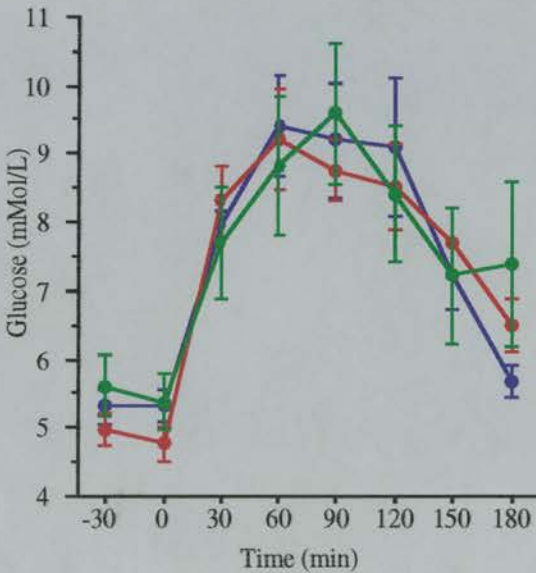

Figure 5.2a - Effect of 0%, 5% and 15% protein drinks on blood glucose, (n=13).
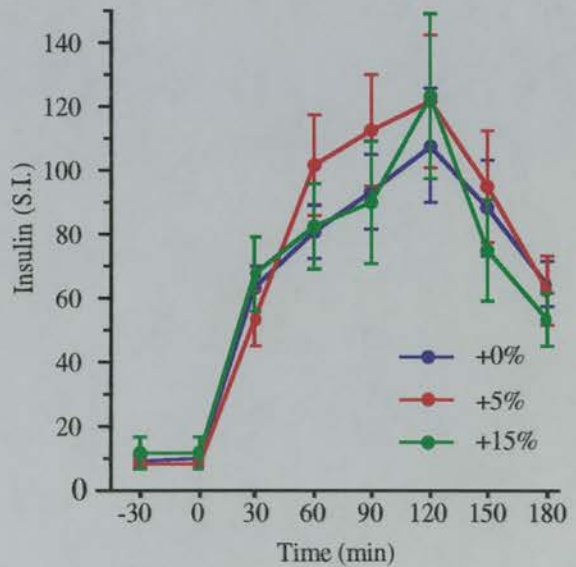
Figure 5.2b - Effect of 0%, 5% and 15% protein drinks on insulin, (n=13).

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5.3.3   Effects of test meals on mood

5.3.3.1 Energy

When 0% and 5% protein drinks were compared a significant meal by time interaction was observed on the energetic arousal scale ($F_{6,22}$=2.75, p<0.05, see Fig. 3a). This appeared due to the maintenance of energy following intake of the 0% protein drink in the 60-90 minutes post-consumption, as compared with the decrease in energy reported following the 5% protein drink. Post hoc comparisons revealed significant differences between drink conditions at 60 minutes (t=3.18, p<.001) and 90 minutes (t=2.93, p<.001). A trend towards differences between drinks was observable on the Alert/ Tired VAS ($F_{6,22}$=3.42, p<0.08) although no interaction was observed (Figure 5.3b). Again, this appears to be due to the more rapid decline in energy reported following intake of the 5% protein drink. No effect of sequence of drink on energy levels was observed.

When the effect of the 15% protein drink on energy was compared with these, no significant interactions were observed for either energetic arousal ($F_{12,18}$=1.36, p=n.s.) or the Alert/ Tired VAS (F=.89, p=n.s.).
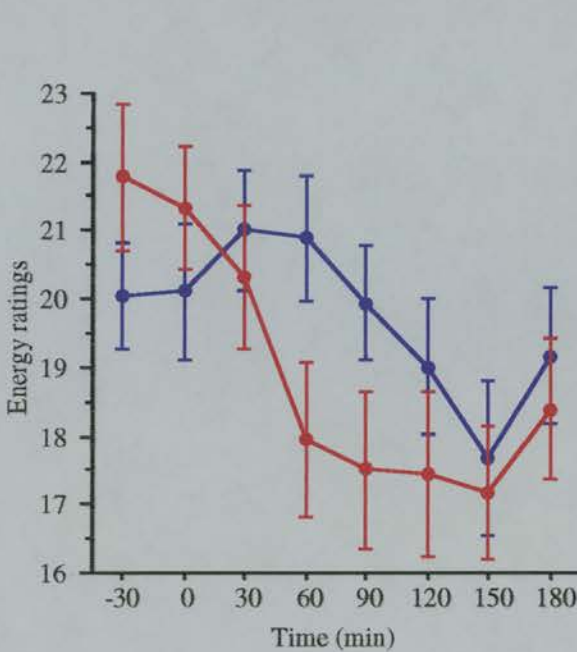

Figure 5.3a - Effect of 0% and 5% protein drinks on energetic arousal, (n=18).
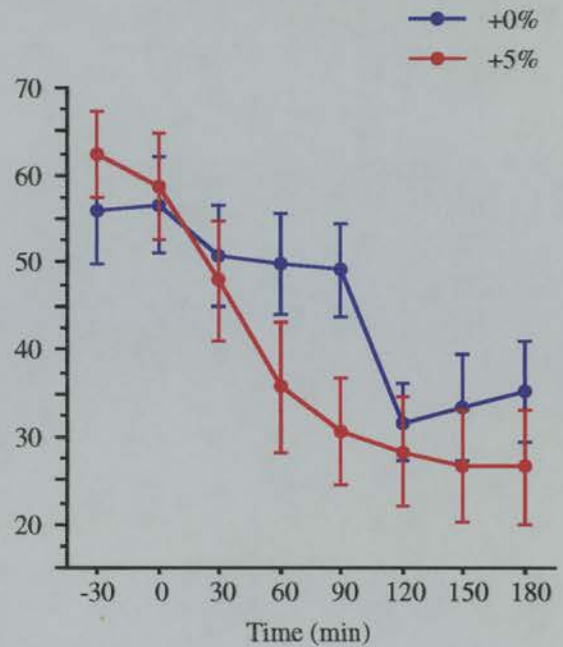
Figure 5.3b - Effect of 0% and 5% protein drinks on alertness (VAS) , (n=18).

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5.3.3.2   Tension

When all three drink conditions were compared, no differential effects of test meals on levels of tension were apparent on either the Tense Arousal scale or the Tense/ Relaxed visual analogue scale (see Figures 4a & 4b). Both however showed a main effect of time on reported levels of tension ($F_{6,18}=18.72$, $p<0.0001$, and $F_{6,18}=27.87$, $p<0.0001$, respectively) with the most apparent decrease in perceived ratings of tension reported in the first hour after each drink.

As can be seen from the graphs, this decrease in tension was apparent before the test drinks were consumed (i.e. between the two baselines measures at -30 and 0 minutes). However, when the 0% and 5% protein drinks were analysed using three way analysis of variance, no effect of sequence on reported levels of tension was found for either scale ($F_{1,14}=.44$ p=n.s., for tense arousal; and $F_{1,14}=.30$ p=n.s., for Tense/ Relaxed VAS), nor were any sequence by time interactions observable ($F_{6,14}=.40$, p=n.s. for tense arousal; and $F_{6,14}=.14$,p=n.s. for Tense/ Relaxed VAS), suggesting comparable declines in tension following both the first and second meal conditions.
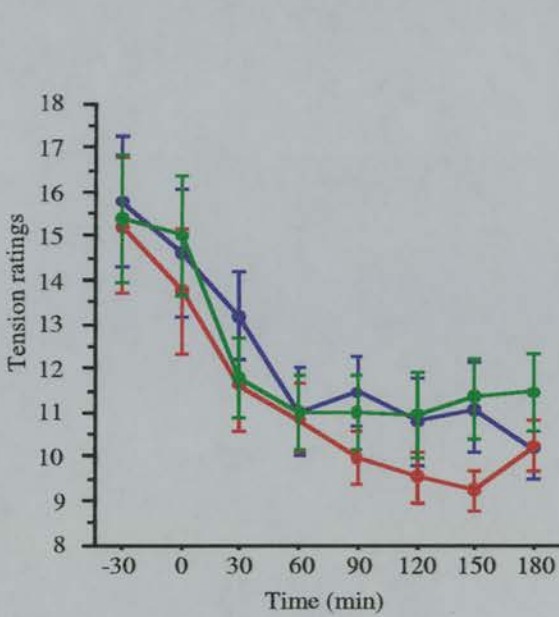

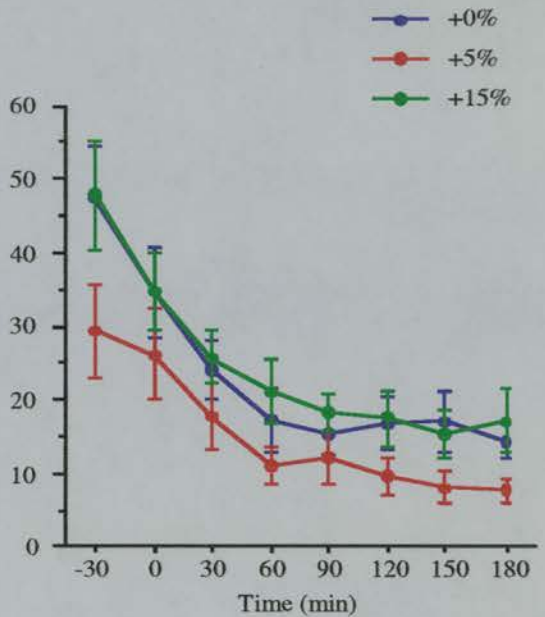**Figure 5.4a** - Effect of 0%,5% and 15% protein drinks on tense arousal, (n=13).

Figure 5.4b - Effect of 0%, 5% and 15% protein drinks on tension (VAS) , (n=13).

5.3.3.3   Hedonic tone

Similar to the change observed in reported levels of tension following intake of the three test drinks, ratings of perceived happiness increased across time, as measured by the UWIST hedonic tone scale ($F_{6,18}$=8.69, p<0.0002) and the Happy/ Sad visual analogue scale ($F_{6,18}$=3.41, p<0.03). This effect was less striking than that seen for reported tension, with ratings of happiness showing a more gradual increase throughout the entire test period. A trend towards significant differences amongst drinks on the visual analogue scale reflected differences in baseline measures ($F_{2,18}$=3.04, p<0.08), with no meal by time interactions observable.

Similar to ratings for tension, improvement in hedonic tone was observable before subjects were given the test drinks (i.e. between the two baseline measures). When analyses of variance were carried on on data from the 0% and 5% drink conditions, no effect of sequence on mood was found when comparing first and second visit ($F_{1,14}$=.15 p=n.s., and $F_{1,14}$=.54 p=n.s., for UWIST and VAMS, respectively), nor was any sequence by time interaction observable ($F_{6,14}$=1.02 p=n.s., and $F_{6,14}$=1.41 p=n.s. for UWIST and VAMS, respectively).
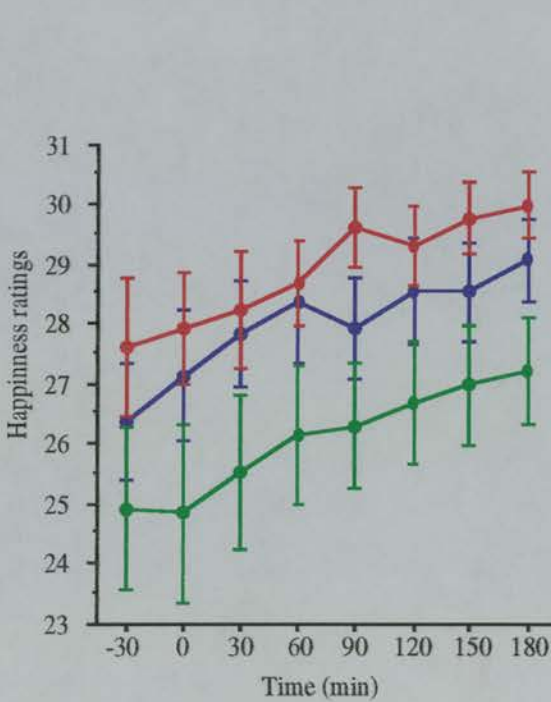

Figure 5.5a - Effect of 0%,5% and 15%
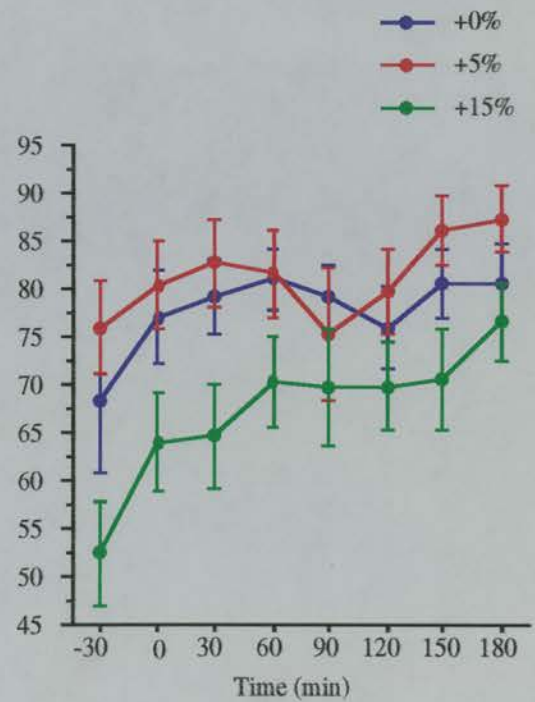protein drinks on hedonic tone, (n=13).

Figure 5.5b - Effect of 0%, 5% and 15%
protein drinks on happiness (VAS) , (n=13).

5.3.3.4   Anger

As with other mood dimensions, reported anger decreased significantly across the test periods, on both the UWIST MAC and the visual analogue anger scale ($F_{6,18}=14.68$, $p<0.0001$, and $F_{6,18}=11.75$, $p<0.0001$, respectively). Again, this reflected a gradual decrease across the entire time period, rather than the 'tailing off' effect seen in reported levels of tension. Differences observed amongst drinks in the UWIST MAC anger subscale ($F_{2,18}=6.71,p<0.02$) reflected differences in baseline scores with no interaction effects observed.

As with all other mood dimensions, when the 0% and 5% protein drinks were compared to include effect of sequence, no order effect was observed on either UWIST MAC anger scale or the visual analogue scale ($F_{1,14}= .02$ p=n.s. and $F_{1,14}= .32$, p=n.s., respectively), nor were any time by sequence interactions observable ($F_{6,14}= 1.17$ p=n.s. and $F_{6,14}= .85$ p=n.s., respectively).
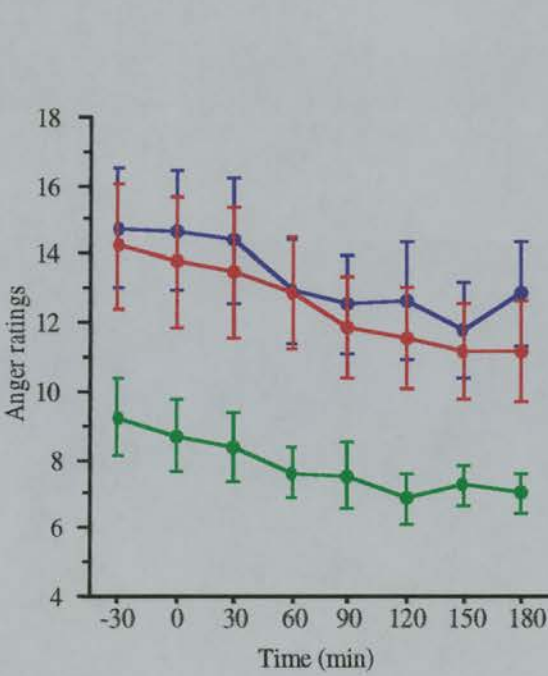

Figure 5.6a - Effect of 0%, 5% and 15% protein drinks on anger (UWIST MAC), (n=13).
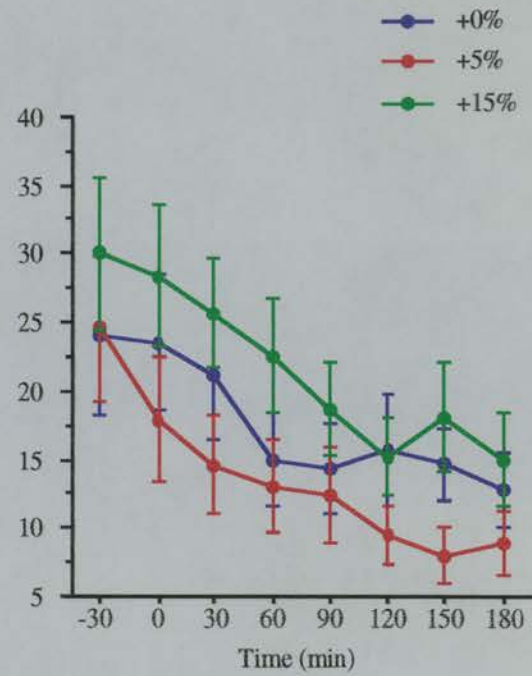
Figure 5.6b - Effect of 0%, 5% and 15% protein drinks on anger (VAS) , (n=13).

5.3.3.5   Hunger

As expected, there was a significant effect of test meals on feelings of hunger ($F_{6,22}= 9.20$, p<0.0009). However, despite the identical calorific content of all three drinks, inclusion of small quantities of protein had a significant effect on perceived levels of hunger with significant differences amongst drinks reflecting the greater satiating effect of the 15% protein meal ($F_{2,18}= 6.05$, p<0.02).
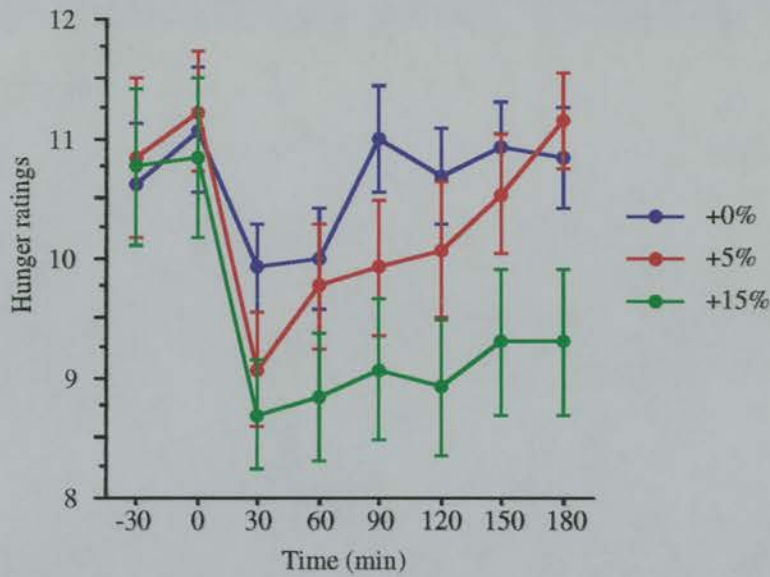

Figure 5.7 - Effect of 0%, 5% and 15% protein drinks on ratings of hunger, (n=13).

5.4   Summary discussion

The T:LNAA ratio was observed to increase following the carbohydrate-rich, 0% protein meal by a similar amount (20% at two hours) to that reported in previous studies (average=23%, see Table 1.1 in Chapter 1, page 16). In contrast to the findings of Teff et al. (1989a) significant increases in the T:LNAA ratio were also observed following intake of carbohydrate-rich drinks containing 5% and 15% protein, although in both instances these increments were observed to occur later than those following intake of the 0% protein drink. Such differences in findings may be due to several factors, the first of which is the longer time period of observation included in this study. Had only two hours post-consumption been examined, as in the study by Teff et al. (1989a), changes in the T:LNAA ratio following the 5% protein-containing drink (11% at two hours) would have been comparable to that seen following the 4% protein meal (9% at two hours) used by Teff et al (1989a).

Another factor which might explain differences between studies lies in the type of protein used in test meals as this has been reported to affect the resulting change in the T:LNAA ratio in rats. Yokogoshi & Wurtman (1986) for example, reported high quality protein (i.e. casein, containing low proportions of tryptophan) to have a stronger blocking effect on the carbohydrate-mediated rise in the T:LNAA ratio than proteins rich in tryptophan. Therefore, it is probable that the protein used in this study, containing approximately twice the proportionate tryptophan content of that used by Teff et al. (1989a) could explain the greater increment in T:LNAA ratio observed[9].

Similarly, differences in glucose response might explain the larger increases reported in this study, as compared with that of Christensen & Redig (1993), who reported no further increase in the T:LNAA (10%) after 60 minutes post consumption. In our study glucose peaked at 60 minutes post-consumption, increasing by a factor of two from baseline at this time-point. By contrast, Christensen & Redig (1993) noted glucose to peak at 30 minutes following consumption of test meals and also noted a lesser increase in glucose levels (60%) at this time point. If the T:LNAA ratio is mediated by insulin, which is in turn mediated by the glucose, then differences in the glucose response between studies might explain differences in the magnitude of change observed. Indeed, Lyons & Truswell (1987) noted this to occur when they examined the effects of starch and sucrose intake on the resulting rise in T:LNAA ratio, and noted starch to produce both a lower glycemic index and less change in the T:LNAA ratio. However, as so few studies have been carried out to

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[9] Analysis of protein used by Teff et al. (1989a) was supplied by Bariatrix Products Inc., Canada. Relative tryptophan content was calculated by dividing total quantity of tryptophan by the sum of competing amino acids contained in the protein.

date, more work in this area is needed if the possible factors outlined above, as determinants of the resultant increase in the T:LNAA ratio, are to be elucidated.

In terms of satiety, differential effects of test drinks on ratings of hunger accords with much, although not with all (de Graaf, Hulshof, Westsrate & Jas, 1992) of the previous research reporting protein to have a greater satiating effect than carbohydrate (Hill & Blundell, 1986; Hill & Blundell, 1990; Rolls, Hetherington & Burley, 1988). Interestingly, this observation conflicts with the theory that energy intake and appetite are related to central serotonergic activity, in that the meals producing least change in the T:LNAA ratio also have the greatest effect on satiety.

The significant decrease in energy observed following intake of test drinks mirrors much of the previous research in random sample populations, of which half reported decreases in energy following intake of test meals (Christensen & Redig, 1993; Hartmann et al., 1977; Rosenthal et al., 1989; Smith et al., 1988; Spring et al., 1982/83; Thayer, 1987; Wurtman et al., 1989). The delayed decrease in energy following the protein free drink as compared with the 5% protein initially appeared similar to those studies in subpopulations reporting carbohydrate cravings, where carbohydrate intake was reported to sustain energy for longer than intake of protein (Lieberman et al., 1986; Rosenthal et al., 1989). However, whereas these studies used protein-rich meals, the protein drink used in this study contained very small quantities of protein and was therefore still relatively carbohydrate-rich.

Certainly the interaction effect observed between the 0% and 5% protein drink is unlikely to result from increase in blood glucose, as no differences were noted between drinks. In contrast, differential effects of drinks on the T:LNAA ratio were apparent after the first hour post consumption. Whilst the increased T:LNAA ratio observed following intake of the protein-free drinks might explain the maintenance of energy observed in this condition after the first hour post consumption, more work on this is required if this possible explanation is to be considered. It should be borne in mind however, that despite the apparent energising effect of carbohydrate mediated increases in tryptophan observed in patients with seasonal affective disorder (Rosenthal, 1989), this theory runs contrary to the many reports linking increases in tryptophan to sleep (see Spring et al, 1987). Another explanation that seems equally as likely for the more rapid decrease in energy following the protein-containing drink is that protein is requires more energy to digest than does carbohydrate. Therefore the digestive processes themselves may well result in differences in perceived energy observed.

In terms of change in other mood dimensions following intake, decreases in tension, anger and depression observed in this study accord with the findings of Christensen & Redig (1993), but conflict with the majority of other studies noting no change in mood. There are several potential reasons for this anomaly. One reason might be the use of I.V. lines used in this study. However, several other researchers drew blood samples throughout experiments, without noting changes in these mood dimensions (Blouin et al., 1991; Turner et al., 1991; Wurtman et al., 1989). Satisfaction of hunger might also have resulted in improved mood, although this fails to explain the mood change between baseline periods. A more likely explanation might be that despite the fact that no differences in mood change between first and second visits were apparent, habituation to the environment could have occurred each time the subjects were tested. Another likely explanation for the mood changes observed is the nature of the study environment itself. As all of the subjects either worked or looked after young children, and as many subjects came to take part in the study directly from work, changes in mood observed across the evening may have been due to a general 'relaxation factor' induced by a quiet environment. Hence, our findings, although similar to those noted by Christensen & Redig (1993), serve to highlight the problems of measurement of mood in laboratory situations.

In conclusion, in contrast to Teff et al.'s suggestion (1989a), meals containing 5% protein can produce similar although more delayed increases in the T:LNAA ratio as carbohydrate-rich meals containing 0% protein. Whilst this supports the theory that mood changes following intake of test meals could be mediated in part by changes in central serotonergic functioning, this study observed no evidence to suggest distinct effects on mood dimensions resulting from differential effects of test drinks the T:LNAA ratio. Failure to detect any potential T:LNAA mediated effects on mood however may have been a result of the inherent problems of measuring subtle effects of intake on mood in laboratory conditions. The study described in the following chapter was therefore designed to counter these problems.

Chapter 6 - Premenstrual food cravings: change in mood following intake of craved foods, carbohydrate-rich, and protein-rich drinks.

6.1   Introduction

This study was a continuation of Chapter 5 and aimed to control for the confounding effects of the laboratory environment in examining the effects of macronutrient intake on mood.   It also aimed to confirm the retrospective reports concerning the qualitative experience of craving that were described in Chapter 4.

In this study, the effect on mood following intake of craved foods was compared to that following intake of substitute drinks. Half of these drinks were carbohydrate-rich, protein free drinks which from results in Chapter 5 were postulated to be likely to increase the T:LNAA ratio following intake. The remaining drinks contained relatively high levels of protein (40%) and would therefore have been extremely unlikely to cause any increase in the T:LNAA ratio (see Chapters 1 and 5 for a discussion of related literature). Hence, if the effects on mood of intake are in fact due in any way to biological changes in the T:LNAA ratio as suggested by Wurtman et al. (1989), then the carbohydrate-rich test drinks would be expected to produce a more beneficial effect on mood than the 40% protein drinks.

6.2   Method

6.2.1   Design

Effect on mood following satisfaction of a craving by intake of craved foods, carbohydrate-rich and protein-rich drinks was assessed using a double-blind design.

6.2.2   Subjects

42 subjects, aged between 20-45, were recruited for this study through placement of an advertisement in a local paper. All reported premenstrual food cravings and negative mood change, and noted regular menstrual cycles. Of these, 30 women agreed to participate although only 15 women completed the study, of which one set of data were unusable. In 4 further cases, information was available only on mood change following intake of craved foods. The fourteen subjects for which data were available were of mean age 32.9±7.4 (range 23-48) and of BMI 23.5±3.6 (range 19-29).

6.2.3   Materials and measures

6.2.3.1   Drinks

Test drinks were packaged in individual containers, in powder form. The carbohydrate-rich, protein-free drinks contained 60% carbohydrate and 40% fat and comprised 200 Kcal. The protein-rich drinks contained 60% carbohydrate and 40% protein and comprised 160Kcal[1]: quantities are given in Table 6.1. Each drink was diluted in 150-200 ml water by the subjects directly before consumption.

Drink powder containers were numbered 1-10 for each subject. Each set included 5 carbohydrate-rich, protein-free drinks, and 5 protein-rich drinks. Randomisation of order was carried out by an independent coder and coding sheets only supplied once data had been entered into the computer.

Table 6.1 - Macronutrient composition of test drinks

	Energy (Kcal)	Fat (g)	Fat (%Kcal)	Carbohydrate (g)	Carbohydrate (%Kcal)	Protein (g)	Protein (%Kcal)
Drink A	200	9	40	30	60	0	0
Drink B	160	0	0	23.7	60	15.5	40

6.2.3.2   Symptom diaries

Daily diaries were used to monitor changes in symptoms across the cycle. Eleven symptoms were included to be rated on a six point scale from 0 (not at all) to 5 (very severe). Items included 6 physical symptoms (food craving, bleeding, bloatedness, breast tenderness, period type pain and fatigue) and 5 emotional symptoms (tension, depression, anger, irritability and mood swings). Two positive items (cheerfulness and energy) were also included (see Appendix 4). Subjects were requested to complete the diaries before going to bed at night by circling one number on the 0-5 scale for each symptom that best described how they had felt, on average, throughout the day. From this, information on day of cycle for each craving record was available.

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[1] Protein-rich drinks contained fewer calories than the protein-free drinks as results from Chapter 5 suggested protein to have a more satiating effect than carbohydrate.

6.2.3.3   Craving records

Mood was recorded on craving records at several intervals: when the craving was first noticed, during consumption of a craved food or test drink, and at one and two hours following consumption, or at one and two hours after noticing the craving if restraint was shown. Measurement of mood is noted below. Craving records also requested information about the food craved, the time of day, the strength of the craving (as measured on a 5 point scale, from not at all strong to extremely strong) and recorded any food eaten between mood assessments.

Mood was assessed using visual analogue scales, similar to those described in Chapter 5. From pilot work (n=7) it was observed that visual analogue scales produce a far greater compliance rate than did the UWIST Mood Adjective Checklist. Results from Chapter 5 also suggested these to produce comparable results to the UWIST Mood Adjective Checklist. Visual analogue mood scales used therefore consisted of six 10cm lines marked at either end with the adjectives Happy / Sad, Tense / Relaxed, Alert / Tired, Angry / Calm, Proud / Guilty, and Hungry / Full. At the top of each scale were the words, 'Please place a vertical mark on each of the lines below, to describe how you are feeling now'. An example was also given on the first page of each record (see Appendix 5).

6.2.4   Procedure

Following agreement to participate, subjects were visited at home and given daily symptom diaries, craving records and a set of ten drink powders in separate, numbered containers. Subjects were asked to complete daily symptom diaries each evening, for a period of three months, and to complete craving records on occasions that they noticed craving for a particular food. Subjects were given the option of consuming the food craved on any particular occasion or taking a test drink in response to the craving, but were requested to refrain from eating anything for a further two hours following satisfaction of a craving.

6.2.5   Statistical analysis

One way analysis of variance was used to determine differences in pleasantness of taste amongst food and carbohydrate-rich and protein-rich drinks. Two way analysis of variance was used to determine differential effects on mood of food and drinks, response (3 levels) x time (4 levels), with the latter as a repeated measures factor. Post hoc Scheffé tests were used to examine differences amongst conditions at specific time points. Pearsons r correlation's were also calculated to assess the relationship between pleasantness of taste and reported mood. All analyses were carried out using the Statview 4.02 statistical package for Apple MacIntosh.

6.3   Results

6.3.1   Qualitative analysis of food cravings

121 craving records were completed and returned. Of these, 14 subjects reported instances where they ate the actual food craved in response to an episode, whilst only 10 of these subjects also reported instances where test drinks (both carbohydrate and protein) were consumed in response to cravings. On average, subjects recorded four instances in which they responded to a craving by eating the food (range 2-6) and on average twice when taking carbohydrate, or protein drinks in response to the cravings (range 2-5, see Table 6.2). Only four subjects recorded instances when they restrained from eating anything in response to the craving.

Table 6.2 - Number of craving episodes recorded for each condition.

Response	Subjects (n)	Craving records (n)	Ave. no. records / sub.
Food	14	62	4.4±3.0
Cho drink	10	23	2.3±1.4
Prot drink	10	25	2.5±1.3
Restraint	4	11	2.8±1.7

Severity of cravings reported ranged from 2 (slightly strong) to 5 (extremely strong) and were of mean 3.6±0.83. No differences in strength of craving were found between instances in which drinks or foods were taken in response to the cravings, or restraint shown ($F_{3,106} = 1.10$, p<0.35). There were however significant differences between conditions in terms of pleasantness of taste ($F_{2,98} = 72.8$, p<0.0001) with craved food noted as significantly more pleasant than either the carbohydrate or protein drinks (mean ratings of pleasantness = 83±18, 27±19 and 36±28, respectively).

The most common item of food reported as being craved during an reported episode was chocolate, which was noted in approximately 50% of records (see Table 6.3). A further 44% of cravings reported were for carbohydrate-rich foods. This was reflected in the macronutrient profiles of foods eaten in response to cravings. In these 62 instances, the average proportion of carbohydrate, fat and protein content contained in the foods consumed was 56.2±18%, 38.3±18%, and 6.0±4%, respectively, and the average calorific consumption per craving episode, 356±208 Kcal. Only one episode resulted in intake of foods containing >10% protein.

Table 6.3 - Type of food craved during each episode

Type of food craved	Frequency	(%)
Chocolate	53	48
Sweets	28	25
Biscuits/ cake/ pudding	8	7
Potatoes/ Chips/ Crisps	13	12
Cheese/ bread	3	3
Other	5	5
Total	110	

Table 6.4 - Number of craving episodes recorded throughout the day

Time of day	No. cravings recorded	% of total
9-11 am	24	20
12-2pm	25	21
3-5pm	29	24
6-8pm	32	26
9-11pm	11	9

In terms of timing, cravings were most commonly reported in the 3 days prior to menstruation (see Figure 6.1). In contrast to the findings in Chapter 4 where cravings were noted to occur most frequently in the evening, cravings were interspersed evenly throughout the day (see Table 6.4).
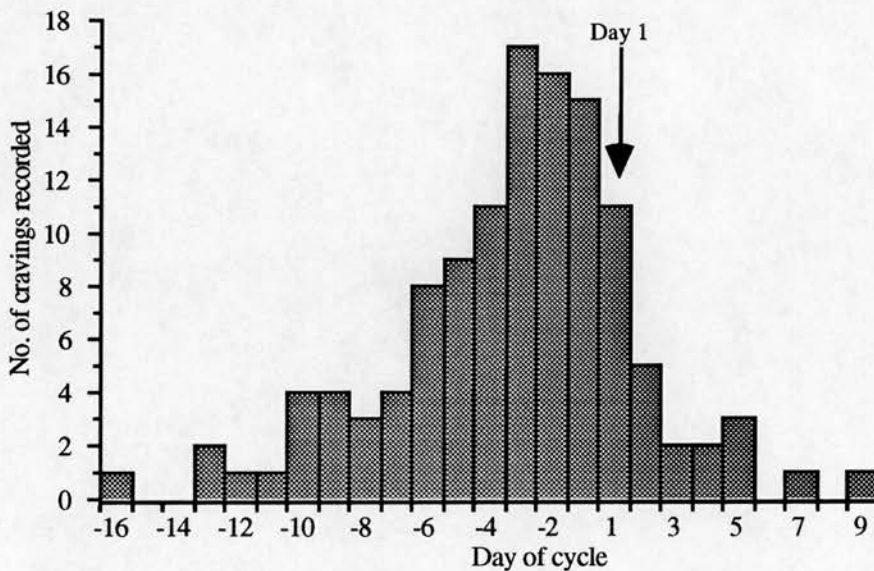

Figure 6.1 - Number of craving episodes recorded on each day of the cycle

In order to examine the effects of intake on mood, data for each response condition (i.e. food, protein-free drink, protein-rich drink) were averaged for each subject. Hence fourteen subjects were included in the analysis of mood change following intake of craved foods, with only 10 subjects who consumed both carbohydrate-rich and protein-rich drinks included in the analysis of all three conditions. Unfortunately, due to the small numbers of subjects who reported restraint in response to a craving (n=4), effects of mood following restraint could not be analysed.

6.3.2   Effect of craved foods on mood

Consumption of food in response to a craving produced an immediate and significant increase in self-rated happiness ($F_{3,13}$=6.88, p<0.003, see Figure 6.2), and decrease in tension ($F_{3,13}$=6.93, p<0.004), Similarly, a significant effect on hunger was observed with subjects noting an instant decrease in hunger whilst eating the food ($F_{3,13}$=7.01, p<0.004). No effects of intake were however apparent for the dimensions of alertness ($F_{3,13}$=1.25, p<.31), anger ($F_{3,13}$=1.19, p<.32), or guilt ($F_{3,13}$=1.27, p<.29).
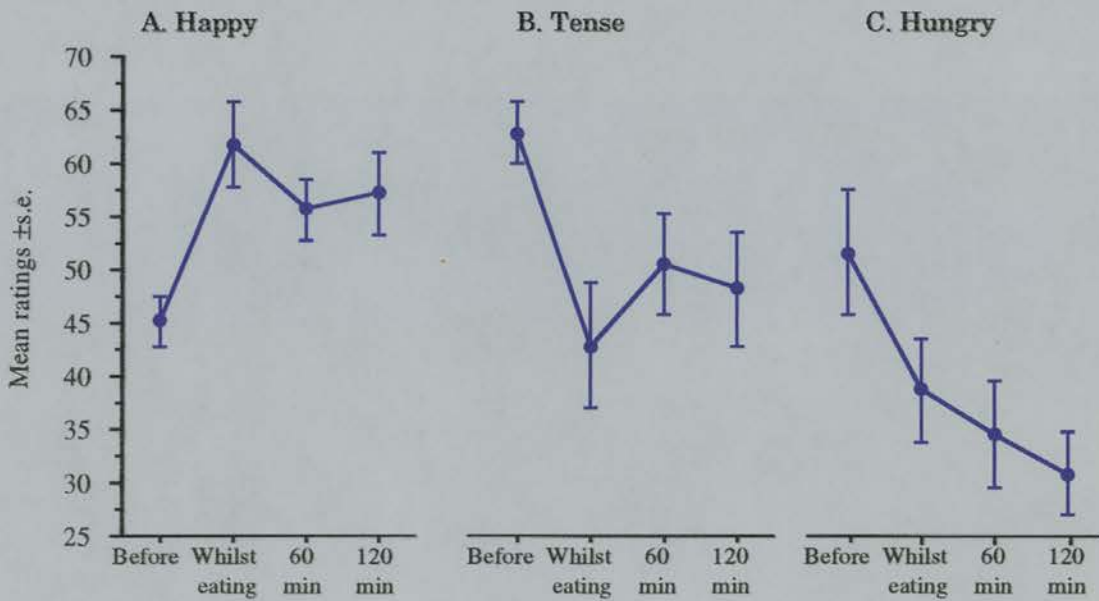

Figure 6.2- Changes in reported happiness, tension and hunger from first noticing a craving to 120 min. post consumption of craved foods (n=14).

When mood change following intake of craved foods was compared with the effects on mood following intake of carbohydrate-rich or protein-rich drinks (n=10), significant interactions were observed for the dimensions of both happiness ($F_{6,18}$=3.62, p<0.04) and tension ($F_{6,18}$=4.22, p<0.02). In both cases, post hoc comparisons revealed significant differences between both drink conditions and the food condition whilst subjects were eating (p<.001 for all comparisons). This reflected the immediate improvement in mood observed following intake of craved foods that was not apparent when subjects took substitute drinks in response to the craving (see Figure 6.3a and 6.3b).

In contrast to the decrease in hunger following intake of craved foods, no significant effect of time was observed when the three conditions were analysed together ($F_{3,13}$=1.21, p<0.31). This appeared to be a result of the less satiating effects of the drink conditions, which aligns with the lesser number of calories in these as compared to the average energy in foods consumed.
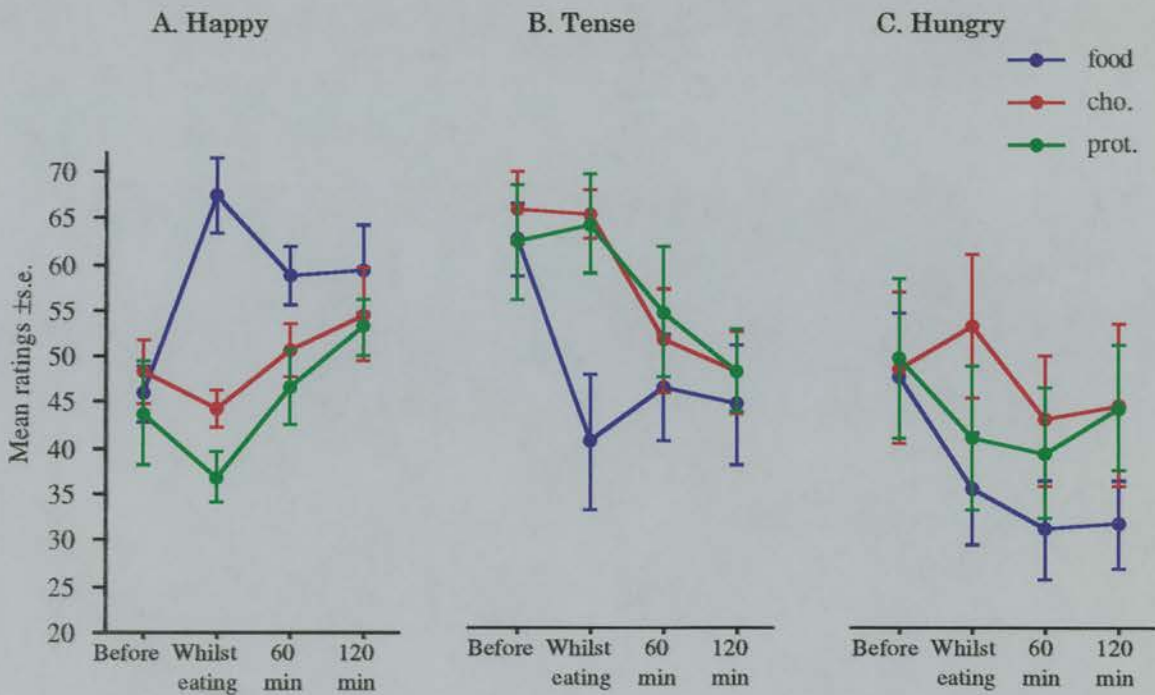

Figure 6.3- Changes in reported happiness, tension and hunger from first noticing a craving to 120 min. post consumption (n=10).

Despite the immediate, and pronounced improvement in mood following intake of craved foods, self-reported guilt was higher at all time-points when subjects consumed the food craved, rather than one of the drink powders ($F_{2,18}$=7.52, p<0.02, see Figure 6.4a).

In contrast, no interactions were observed amongst conditions for reported levels of energy, although this dimension did show an overall variation across time points ($F_{3,18}$=6.19, p<0.006, see Figure 6.4b). This appeared to be due to a transient increase in alertness whilst consuming the foods or drinks. Again no effect of intake of reported anger was evident ($F_{3,18}$=1.64, p<0.23).
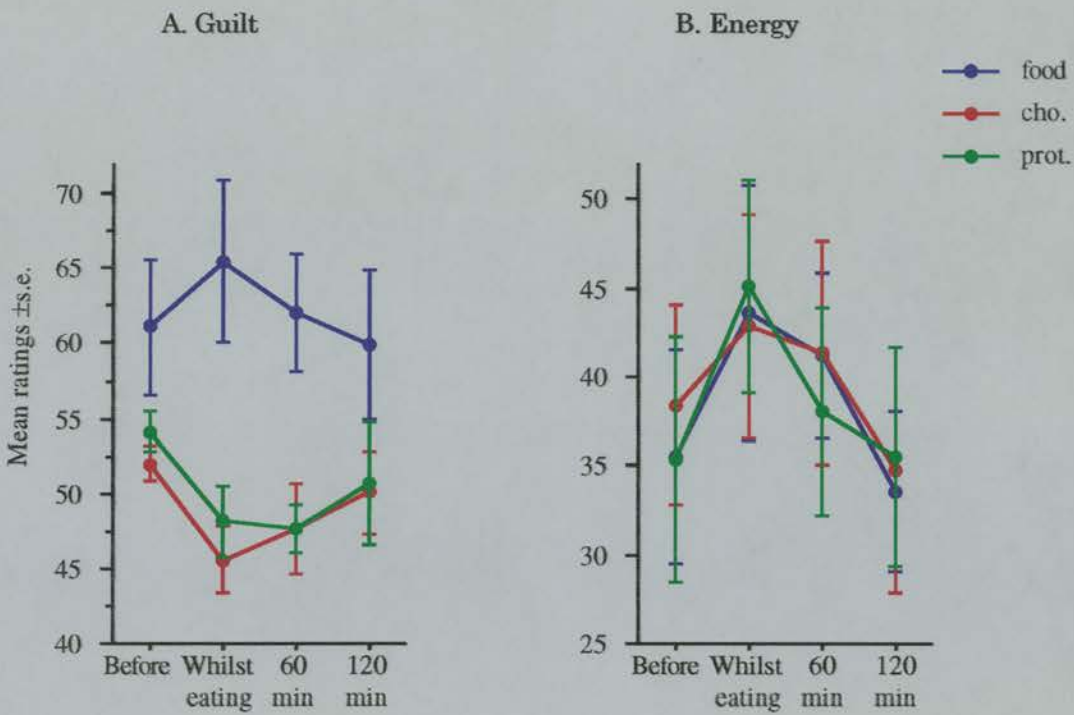

Figure 6.4 - Changes in reported energy and feelings of guilt from first noticing a craving to 120 min. post consumption (n=10).

6.3.3   Importance of taste in determining mood change

To determine whether taste was associated with mood reported whilst subjects were eating or drinking, Pearson r correlation's were calculated for each craving episode (n=101) between reported pleasantness of taste and mood. To control for the possible expectancy effects associated with intake of craved foods, correlations were also carried out for the 'food only' condition.

Strong positive correlations were noted between reported happiness and pleasantness of taste, whilst negative correlations were reported between tension and taste. These were apparent both when total craving records were examined and when only those including satisfaction of a craving with food were examined (see Table 6.5). Hence it would appear that the dimensions of happiness and tension were directly linked to the taste of the foods, with more pleasant tastes associated with lower tension and higher reported hedonic tone. Anger similarly displayed a negative correlation with taste, although this was not as strong as those noted for happiness and tension, and failed to reach significance when the 'food only' condition was examined.

Reported guilt whilst eating also showed a positive association with pleasantness of taste when all conditions were included in the analysis. However, as significant differences between food and drinks were noted in terms of taste and guilt, the observed association is likely to be a result of the higher feelings of guilt associated with eating actual foods craved and not actual taste per se. This appears likely as no correlation was observed between the two when food only condition was examined.

Table 6.5- Pearson r correlations between mood dimensions measured and ratings of taste. (*p<0.01; **p<0.001).

	Pleasantness of taste	
Mood dimension	**All conditions**	**Food only**
Happiness	.59**	.52**
Tension	-.47**	-.41**
Guilt	.38**	.18
Alertness	.17	.16
Anger	-.27*	-.18
Hunger	-.10	.03

6.4   Summary discussion

The timing of cravings accords with much previous research. Rozin et al. (1991) noted number of foods craving episodes to peak in the three days premenstrually, and Bancroft, Cook & Williamson (1988) noted food cravings to be most severe in the four days premenstrually. Similarly, in Chapter 3 cravings were noted to be most severe in the 3-4 premenstrual days. However, in contrast to previous findings suggesting food craving to occur most commonly in the evening (Hill et al., 1991; see also Chapter 4), results from this study would suggest that cravings are also relatively common in the morning and afternoon.

In terms of type of food craved, over 90% of food cravings were reported to be for carbohydrate-rich foods, which is similar to the findings observed in Chapter 4. Preference for carbohydrate-rich foods was also apparent when the macronutrient content of foods consumed in response to a craving was examined: foods were observed to contain relatively high proportions of carbohydrate and fat, with much smaller proportions (6%) of protein. Indeed, only one reported food eaten in response to a craving contained >10% protein. Whilst these results accord with findings suggesting cravings to be for carbohydrate-rich foods, they also accord with the suggestion by Drewnowski (1987), that foods craved often contain high proportions of fat. This is perhaps unsurprising, as the most common item of food reported to be craved was chocolate, in line with the findings of many other researchers (Hill et al., 1991; Rodin, Mancuso, Granger & Nelbach, 1991; Rozin et al., 1991; Waterhouse, 1995; Weingarten & Elston, 1991), and with the observations made in Chapter 4. As Wurtman & Lieberman (1987) noted, it is the carbohydrate content of foods that affects the change in T:LNAA ratio observed following intake, and therefore it is this macronutrient that is important in determining the biological effects following intake. As the foods consumed in this study contained high proportions of carbohydrate, and on average only 6% protein, it is probable, extrapolating from the findings reported in chapter 5, that T:LNAA ratio is affected following intake of at least some craved foods.

In terms of mood change following satisfaction of a craving however, the most substantial improvements were noted whilst foods were actually being eaten. In contrast, no immediate effects were observed following intake of substitute drinks. This differential improvement in mood associated with intake of foods occurred in spite of the high levels of guilt associated with food intake, as noted previously (Macdiarmid & Hetherington, 1995) The immediacy of this effect on reported happiness and tension following intake of food would strongly suggest psychological rather than biochemical factors to be producing

changes in mood at this time point. In accordance with this, the strong positive correlations between ratings of happiness and perceived pleasantness of taste, would suggest taste to be an important factor in influencing mood, as observed by other researchers (Hetherington & MacDiarmid, 1993; Rodin et al., 1991; Rozin et al., 1991). This explanation also fits well with the lack of change in mood following intake of substitute drinks which were rated on the lower end of the taste scale. Yet the findings on intake of craved foods do not preclude the possibility that change in the T:LNAA ratio could be affecting mood at later time points. What did suggest that the T:LNAA ratio was unlikely to be contributing to mood changes observed were the lack of differences between the two test drinks.

At one and two hours following consumption, evident decreases in tension were noted following all test conditions. However, there appeared no apparent difference between the two substitute drinks in their ability to influence mood, despite the likelihood that they were affecting the T:LNAA ratio in different ways. Given previous findings that as little as 100 Kcal can influence the T:LNAA ratio (Martin-Du Pan, Mauron, Glaeser & Wurtman, 1982), the protein-free drink ought to have caused this to occur in at least some instances. By comparison, it is extremely unlikely that drinks containing 40% protein would have caused any increase in the T:LNAA ratio (see Chapter 1, Table 6.1 for a summary of this literature). It is therefore unlikely that changes in the T:LNAA ratio following the carbohydrate drink contributed to the mood changes observed. Possible reasons for improvement in mood could include psychological factors such as placebo effects, general relief following satisfaction of the craving irrespective of taste, or satisfaction of hunger. This lack of difference in mood change following drinks, is in contrast to the findings of Sayegh et al. (1995), who noted differential effects of carbohydrate and protein drinks in reported depression at three hours post-consumption and suggested this as due to the differential effects of drinks on serotonergic functioning. It does however align with their findings of no difference between drinks at 90 minutes post consumption, when the T:LNAA ratio was shown to have increased.

Before summarising these findings, constraints on conclusions should be noted. The principal problem of the study was one of poor response rate. Although 30 subjects started the study, half failed to complete any craving records within the three month period. Of these, only two noted time constraints as reasons for not continuing in the study. Of the remaining subjects, five either noted practical problems with completing the records (i.e. they were in meetings or out shopping when the cravings occurred), or reported having no cravings within the time period (n=3). About one quarter of the sample (n=8) noted failure

to recognise cravings until the food had actually been eaten, suggesting food craving and intake to be almost subconscious in some instances. Due to these problems, our completion rate is fairly low and results may fail to reflect a representative sample population. Similarly, our final sample population is small and so any conclusions reached are tentative. However, these problems also highlight the difficulties in recognition and recording of cravings for researchers wishing to examine this phenomenon in detail.

In summary, from the relatively small subject sample who participated in this experiment, it would appear that the most striking mood changes following intake of craved foods are immediate, and are therefore likely to be associated with psychological factors such as taste, rather than biological alterations occurring as a result of intake. Similarly, later improvements in mood following intake of drinks are unlikely to be due to effects of intake on the T:LNAA ratio, as no differential effects were evident between low protein and protein-rich drinks at the later time points examined.

Chapter 7 - Premenstrual food craving and negative mood: relationship to energy intake across the menstrual cycle.

7.1   Introduction

Findings from Chapter 6 suggested intake of carbohydrate-rich snacks to increase in the premenstrual phase of the cycle in women reporting cycle-related food cravings. This study aimed to assess how food cravings related to both total energy intake and to carbohydrate intake in the across the cycle, and how all three of these factors relate to negative mood.

7.1.1   Change in energy intake across the menstrual cycle

Research in non human primates has reported increased energy intake in the premenstrual, as compared with the postmenstrual phase of the cycle (Czaja, 1975; Czaja, 1978; Czaja & Goy, 1975). Intake is similarly reported to be increased in this phase of the cycle in humans. Of thirteen studies published, ten have shown intake to be significantly increased in the premenstrual phase of the cycle, with a further two reporting non-significant changes in this direction (see Table 7.1, overleaf). Unfortunately, due to the lack of reported variances in studies, overall effect size could not be calculated. However the weighted mean of the difference[1] between average daily energy intake in the pre- and postmenstrual phases is 182 Kcals. This consistency of findings is somewhat surprising, when variability in methodology and study aims is considered.

7.1.1.1   Divergent aims of studies assessing change in intake

The first methodological difference exists in the divergent aims of the studies, few of which were designed exclusively to examine cycle-related change in intake. Several included restriction of dietary choice which might conceivably have constrained any spontaneous change in intake across the cycle. For example, both Lissner, Stevens, Levitsky, Rasmussen & Strupp (1988) and Martini, Lampe, Slavin & Kurzer (1994), analysed data from women who were participating in an experiment in which their diets were being manipulated, (either by changing fat content, or by giving fibre or flaxseed supplements).

Food choice was also restricted in the study by Fong & Kretsch (1993), the principal aim of which was to validate a new, computerised dietary intake recording method. Subjects lived within the research unit for the duration of the study (52 days) and had all exercise

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[1]Weighted means calculated by $\Sigma n_i \, y_i / \Sigma n_i$, as in Armitage & Berry, (1994), pp208.

supervised. Likewise, energy intake of subjects in the study carried out by Wurtman et al., (1989) was monitored over 2 days in each cycle phase, whilst subjects stayed within the confines of the research centre. Both studies offered restricted menus, as in Lissner et al. and Martini et al's studies, but also included supervised meals, which may conceivably have affected energy intake and could explain their lack of significant findings[2].

Table 7.1 - Average energy intakes per day ± s.d. in the pre- and post-menstrual phases of the cycle.

	n.	Daily intake (Kcals) Premens.	Postmens.	Diff. (Pre.- Post.)	cycles observed	p-value
Dalvit (1981)	8	1940	1440	500	2	.0001
Pliner & Fleming (1983)	33	2013	1790	223	1	.05
Manocha et al. (1986)	11	1612	1298	313	2	.0001
Lissner et al (1988)	23	2335	2248	87	1	.006
Gong et al. (1989)	7	2040	1833	207	1	.044
Lyons et al (1989)	18	2150	2012	138	1	.05
Wurtman et al.(1989)[3]	9	2085	2022	63	1	ns
Tarasuk & Beaton (1991)	14	1912	1822	90	1-4	.033
Fong & Kretch (1993)	9	2501	2360	141	1	ns
Johnson et al. (1994)	26	1704	1867	163	1	.05
Martini et al. (1994)	18	1908	1749	159	4-6	.003
Barr et al (1995)[3]	29	2229	1926	303	1	.0001
Piers et al (1995)	13	1702	1701	1	5	n.s
Total	**218**					
Weighted means		2037 ± 244	1855 ± 290	182 ± 131		.02

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[2]Although lack of significant findings may also have reflected small sample size.

[3] Sub-groups in studies examining specific menstrual phemomena, ie:non-ovulatory cycles (Barr et al (1995), and subjects with PMS (Wurtman et al, 1988), have been excluded from this analysis.

7.1.1.2   Number of days assessed in each cycle phase

Studies also differed in their definition of the pre- and post-menstrual phases of the cycle and in the number of days assessed in each. In the study by Dalvit (1981), average energy intake in the ten pre-menstrual days was compared with intake in the ten postmenstrual days of the cycle. This method was used as standard by Lissner et al. (1988), Manocha et al. (1986) and Tarasuk & Beaton (1991)[4]. In all of these studies however, the postmenstrual phase included the days of menstruation which may have confounded results, given the findings from studies seeking to separate the menstrual, from the post-menstrual phase of the cycle. In these studies, although observing approximately ten days in the pre- and post-menstrual phases, Gong et al. (1989), Lyons et al. (1989) and Fong & Kretsch (1993) also assessed intake in the menstrual and ovulatory phases of the cycle and reported no difference between luteal and menstrual phases of the cycle. Therefore, including days of bleeding in the 'post-menstrual phase' may have decreased the magnitude of the difference between pre- and post-menstrual phases, as observed in Lissner et al. and Tarasuk & Beaton's studies.

Similarly, observing shorter 'windows' of time may have accounted for lack of significant findings. Piers et al. (1995), Martini et al. (1994), Wurtman et al.(1989) and Pliner & Fleming (1983) calculated the average intake of five, three, two and one pre- and post-menstrual days, respectively, of which two studies reported non-significant results (see Table 7.1).

7.1.1.3   Within and between cycle variation

Studies also varied in whether information was compared within cycle (i.e. pre to post-ovulation: Fong & Kretsch, 1993; Gong et al., 1989; Lissner et al., 1988; Martini et al., 1994; Piers et al., 1995; Wurtman et al., 1989; Johnson, Corrigan & Lemon, 1994) or between cycles (i.e. from the premenstrual phase of one cycle to the post-menstrual phase of the next: Barr et al., 1995; Tarasuk & Beaton, 1991). Other studies used either between or within-cycle data dependent on which were available for individual subjects (Dalvit, 1981; Lyons et al., 1989; Manocha et al., 1986; Pliner & Fleming, 1983). This difference may conceivably account for variance in findings, in that 3 of the 6 studies observing from pre- to post-ovulation found non-significant differences between pre- and post-menstrual phases, whilst all studies observing between the premenstrual phase of one cycle and the postmenstrual phase of the next noted significantly decreased intake in the postmenstrual phase of the cycle.

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[4] In this study, daily energy intake was recorded across 365 consecutive days as part of a large dietary study, with retrospective information on menstrual dates requested only after completion of the study.

7.1.1.4   Measurement of energy intake

A final way in which studies varied was in their measurement of food intake. Least precise, with the obvious disadvantage of memory loss, was the 24-hour recall method employed in the early studies of Dalvit (1981) and Pliner & Fleming (1983), in which subjects recounted intake for the previous day to the experimenter. More often, estimated food intake diaries were used (Barr et al., 1995; Manocha et al., 1986; Martini et al., 1994; Piers et al., 1995; Tarasuk & Beaton, 1991; Johnson et al., 1994). These involved subjects recording food intake after eating by estimating quantities of intake from household measures such as spoons and cups. Measures were then converted to weights by the experimenter.

More accurate methods using weighed intakes were employed by the remaining research groups with either subjects (Lissner et al., 1988) or experimenters (Fong & Kretsch, 1993; Gong et al., 1989; Lyons et al., 1989; Wurtman et al., 1989) pre-weighing all food consumed. This method tends to pose greater demands on subjects with the potential for higher rates of discontinuation. More importantly however, where food is pre-weighed by experimenters, bias may occur in the amount selected by subjects and again this may explain the non-significant findings in two of the studies employing this method (Fong & Kretsch, 1993; Wurtman et al., 1989).

There are therefore several reasons that may have contributed to the variance in findings amongst studies, with non-significant differences possibly being due to observing subjects in restricted environments where food was weighed by experimenters, looking at shorter 'windows' of time, or observing within rather than between-cycle variances. However, although such disparities in design and methodology of the studies outlined above serve to explain possible reasons for the variance in the size of difference between pre- and post-menstrual phases reported by different studies, they also highlight the robustness of the observed phenomenon.

7.1.2   Change in energy intake across the cycle in women with premenstrual symptoms

This phenomenon of increased energy intake in the premenstrual phase of the cycle has been reported to be of larger magnitude in women who experience premenstrual mood changes. Both-Orthman et al. (1988) for example, found increased appetite[5] in the premenstrual phase of the cycle to be more apparent in women who experienced premenstrual mood changes, than in controls. Indeed, a significant relationship was found to exist between appetite and mood in the pre-menstrual phase of the cycle in women reporting premenstrual mood change, (r=0.82, p<0.001; n=21), whereas no relationship was found for the control subjects (n=13). However, as indirect measures of intake such as hunger and appetite do not always correlate with actual intake (Mattes, 1990) it is not certain that the increased appetite noted in this study actually reflected an increase in intake in the premenstrual phase of the cycle.

Similarly, another study by Goei, Ralston & Abraham (1982), although describing increased intake in women with premenstrual syndrome, also contains methodological ambiguity. This study restrospectively assessed symptoms of PMS and estimated intake of nutrients over one month. Subjects reporting premenstrual symptoms were observed to consume 30% more calories than a control group, although this difference failed to reach significance due to large intra-group variances. What is not clear however, is whether this difference between groups reflected general differences in intake, or possibly reflected differences specific to the premenstrual phase of the cycle.

In a study that did observe change in intake across the cycle, women reporting more severe symptoms of PMS also reported greater increases in energy intake in the ten days premenstrually, compared with the ten days postmenstrually (Giannini, Price, Loiselle & Giannini, 1985). In accordance with this, Wurtman et al. (1989) directly assessed food consumption in women experiencing premenstrual changes (n=19), and in a group of control subjects (n=9), during two days in each of the follicular and luteal phases of the cycle. Whilst a non-significant increase in intake of 63 Kcals was observed in control subjects between follicular and luteal phases, subjects experiencing premenstrual depression were found to significantly increase their calorific intake by an average of 500 Kcals per day in the luteal phase of the cycle. Wurtman et al. (1989) suggested that this difference between groups resulted from the carbohydrate cravings associated with premenstrual negative mood change and proposed that women with premenstrual syndrome may overconsume carbohydrates in an attempt to improve dysphoric mood by increasing serotonergic functioning (see Chapter 5 for a review of related literature).

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[5] As measured on a 6 point scale.

7.1.3   Change in macronutrient intake across the menstrual cycle

In line with the theory outlined above, Wurtman et al. (1989) observed that the greater energy intake in the premenstrual phase of the cycle in women experiencing premenstrual mood change, could be largely accounted for by a specific increase in carbohydrate intake (an increase of 24% in meals and 43% in snacks from the follicular to the luteal phase). Goei et al. (1982) similarly noted patients with PMT to report greater intake of refined sugar than controls, although again it is not clear whether this reflected a general difference or was specific to differences in the premenstrual phase of the cycle.

Both increased craving for carbohydrate foods (Cohen, Sherwin & Fleming, 1987) and increased carbohydrate intake (Dalvit-McPhillips, 1983) have however been observed in women experiencing no premenstrual mood changes, in this phase of the cycle. Dalvit-McPhillips (1983) reported that the increased calorific intake observed in subjects (Dalvit, 1981) could be accounted for by an increase in carbohydrate consumption of almost 100% in the ten days prior to menses, as compared to the ten days following the onset of menses. Johnson et al. (1994) similarly found intake of carbohydrate to increase significantly in the premenstrual phase of the cycle and Gong et al. (1989) reported a tendency for sucrose intake to be greater in the luteal, than in the follicular phase (mean difference = 45 Kcals), although this difference was not significant. Cyclical fluctuations in carbohydrate intake were also found by Fong & Kretsch (1993), although highest carbohydrate intake was reported in the menstrual phase of the cycle and was attributed to the significant increase in consumption of sweets, mainly chocolate coated, during this phase of the cycle. Similarly, in a study examining taste preferences across the cycle, Bowen (1992) found that subjects tested in the luteal phase of the cycle ate significantly more sweet tasting foods (i.e. coffee cake, chocolate, sweets) than those tested in the follicular phase of the cycle.

Findings of increased premenstrual intake of carbohydrate also accords with information gained from questionnaire studies. Students (n=83) given craving sheets at weekly intervals over a period of eight weeks reported an increased preference for chocolate during the menstrual phase of the cycle (Tomelleri & Grunewald, 1987). Chocolate was similarly found to be far the most commonly craved item by women, and in particular by those who reported their cravings to be cyclical in nature (Weingarten & Elston, 1991). Smith & Sauder (1969) also noted a specific increase in appetite for chocolate in the premenstrual phase of the cycle.

By contrast, Tarasuk & Beaton (1991) found increased calorific intake to be due to a disproportionate rise in the quantity of fat consumed in the luteal phase of the cycle (p<0.01), a finding consistent with that of Gallant, Short & Turkki (1987) in their study in women experiencing premenstrual symptoms.[6]   Johnson et al. (1994) and Wurtman et al. (1989) similarly found intake of fat, as well as carbohydrate, to increase significantly in the premenstrual phase of the cycle. Since chocolate contains a large proportion of fat, both Tomelleri & Grunewald's (1987) and Weingarten & Elston's (1991) studies suggest that females preferences for high carbohydrate, high fat foods increase around the time of menstruation.

The details of exactly how macronutrient intake changes across the cycle therefore remains unclear. Whilst the majority of studies agree on increased carbohydrate intake in the luteal and menstrual phases of the cycle, fat intake may also increase at this time.

In summary, there appears to be a robust phenomenon of increased food intake in the premenstrual phase of the cycle, which may be explained in part by increased carbohydrate intake. This increase appears to be of greater magnitude in women who experience premenstrual mood change, although to date only two studies have examined this in detail. Of these, Wurtman et al.(1989) have suggested that the greater increase in premenstrual energy intake apparent in this sub-population may result from the carbohydrate cravings associated with premenstrual negative mood. However increased carbohydrate intake has also been observed in sample populations not spontaneously reporting premenstrual symptomatology.

In view of these findings it was hypothesised that premenstrual food craving would be associated with both negative mood and with energy intake in the premenstrual phase of the cycle. Furthermore, that increased intake would be largely accounted for by an increased intake of carbohydrate in this cycle phase.

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[6] These authors also noted increased intake of protein in the luteal phase of the cycle.

7.2   Method

7.2.1   Design

Energy intake and cyclical symptoms were assessed in the premenstrual, menstrual and postmenstrual phases of the cycle, using a repeated-measures design.

7.2.2   Subjects

Subjects for this study were contacted following completion of the questionnaire study (Chapter 2) if they met the necessary inclusion criteria: 1) Premenstrual cravings for carbohydrate-rich foods 2) Retrospectively reporting a decrease in severity of cravings of at least two points from the premenstrual phase to the post-menstrual phase of the cycle, as rated on the six point scale in the questionnaire. 3) Regular menstrual cycles 4) BMI of <30 (i.e. not defined as clinically obese). 5) Not using anti-depressants or other forms or steroidal medication[7] likely to affect carbohydrate metabolism (other than the contraceptive pill).

Of 69 women contacted, 35 subjects agreed to take part and 30 completed the study. The average age of the subjects was 34.7±1.4 years (range 22-48) and the average BMI (in Kg/m^2) 22.7±0.4. (range 18.7-29.1). Two women were using oral contraceptives. A further 3 women smoked, all <15 per day.

7.2.3   Measures

7.2.3.1   Symptom diaries

Daily diaries were used to monitor changes in symptoms across the cycle, as described in Chapter 3. Eleven symptoms were included to be rated on a six point scale from 0 (not at all) to 5 (very severe). Items included 6 physical symptoms (food craving, bleeding, bloatedness, breast tenderness, period type pain and fatigue), and 5 emotional symptoms (tension, depression, anger, irritability and mood swings). Two positive items (cheerfulness and energy) were also included. Subjects were requested to complete the diaries before going to bed at night, by circling one number on the 0-5 scale for each symptom that best described how they had felt, on average, throughout the day.

Factor loadings from Chapter 3 were used to group symptoms. The ratings for tension, anger, depression, irritability and mood swings were therefore averaged to obtain a daily measure for negative mood. Daily ratings for bloatedness, breast-tenderness and period-type pain were averaged to obtain an overall measure for physical discomfort. Ratings for

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[7]i.e. Treatment for certain forms of asthma.

food craving were analysed separately. Daily ratings describing severity of negative mood, physical discomfort and food craving were therefore available for each subject.

7.2.3.2   Food intake diaries [8]

Diaries included two pages per day for recording daily intakes and three columns on each page in which to record time of eating, and type and amount of food or drink consumed. Subjects noted the day and date at the top of each page.

Instructions were given to write down food intake in as much detail as possible, giving details of cooking methods, brand names and ingredients of homemade meals. Subjects estimated intake by using household measures (i.e. teaspoons, tablespoons) or by estimating size (i.e. size of matchbox, egg). Guidelines as to how to estimate quantities and a single example of how to record information was given at the beginning of each booklet (see Appendix for example). The importance of maintaining usual intakes was emphasised to all subjects.

7.2.4   Procedure

Subjects were sent a letter, along with information sheet, inviting them to take part in the study. Following agreement to participate, subjects were sent food intake diaries and daily symptom diaries. Subjects were asked to complete food diaries immediately after eating and not from memory at the end of the day, and to complete daily diaries before going to bed. Subjects were contacted at fortnightly intervals during the study. On completion of the study, diaries were returned in freepost envelopes provided.

To control for any effects of time on accuracy of diary keeping, subjects were started in the study at two different time points of the menstrual cycle as shown Figure 7.1, overleaf. Group 1 (n=14) was therefore asked to complete diaries from day one[9] of the cycle to day one of the next cycle and Group 2 (n=16) to complete diaries from day 14 of the cycle to day 16 of the following cycle. Hence comparisons of energy intake were within-cycle for Group 1 and between-cycle for Group 2.

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[8]Food diaries were supplied by Dr Fred Pender, Dept. of Dietetics, Queen Margaret's College, Edinburgh.
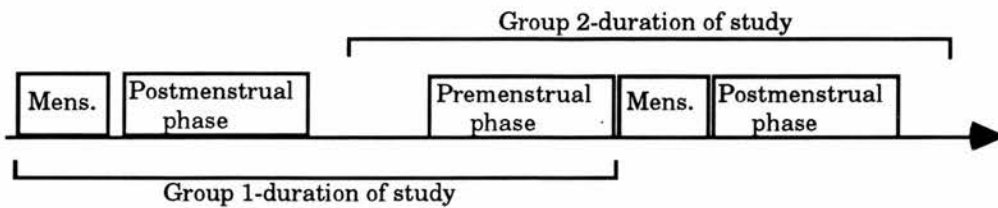[9]Regarded as first day of bleeding.

Figure 7.1 - Study design

7.2.5 Coding of food diaries

7.2.5.1 Meals and snacks

Foods consumed were coded either as meals or as snacks, according to the following. Meals were regarded as those foods consumed at times of the day normally associated with regular eating, i.e. breakfast, lunch and dinner. These times varied between subjects but showed habitual patterns within subjects. Meals often had lengthier preparation times than did snack foods. Snacks were regarded as those foods eaten between regular meal-times. These foods were often pre-packaged (i.e. crisps or sweets), singular (i.e. pieces of fruit), or simple to prepare (i.e. toast). Reliability of coding was checked by an independent coder.

7.2.5.2 Measurement of energy intake

Various methods for recording food intake were discussed in the introduction to this chapter. Although weighed intake provides the most accurate estimation of energy intake, several studies have reported differences in intake of less than 10% when comparing weighed and estimated intakes (Cade, 1988; Edington, Thorogood, Geekie, Ball & Mann, 1989; Fehily & Hopkinson, 1993; Ralph, Massie, McNeill, Vint & James, 1990). These differences are less within females who tend to estimate intake more accurately than do males (Cade, 1988). In Cade's study, total calorific intakes for females were estimated within 2% of weighed intake. Accuracy also appears to be unrelated to body mass index of the subjects (Ralph, Massie, McNeill, Vint & James, 1990).

As food intake was recorded for a minimum period of 24 days in this study, it was decided that completion rates would be optimised, and accuracy of measurement not significantly compromised, if estimated intakes rather than weighed intakes were requested.

7.2.6   Analysis of food diaries

Estimated intakes were converted into weights (grams) using the Ministry of Agriculture, Fisheries & Food's guide 'Food Portion Sizes' (Crawley, 1992). Daily energy intakes for each subject were then analysed using the Compeat 4 analysis program by two coders, both blind to the cycle phase of the subjects. This program calculates total energy intake from foods, input in grams, and also calculates quantity of macronutrients, nutrients and vitamins contained within these foods. For this study total energy intake, and energy intake consumed from fat, protein, carbohydrate, sugar and starch was recorded.

Intakes were analysed for each day, and split into energy consumed from meals and from snacks. Where information was available on the exact type of food consumed, the macronutrient information was taken from the food packaging itself, so as to gain as accurate an estimation of energy and macronutrient intake as possible. Where foods were not included in the Compeat 4 program, nor brand name given, macronutrient information was taken from nutrient information sheets, supplied by Marks & Spencer. This nutrient information list was the only one available that contained a breakdown of energy from carbohydrate (i.e., sugar and starch content).

7.2.7   Accuracy of reporting in food intake diaries

It has recently been noted that energy intake is under-reported by young, non-obese adults (de Vries, Zock, Mensink & Katan, 1994). To establish accuracy of diary-keeping in this study, basal metabolic rates were noted for each individual using estimates provided by Robertson & Reid (1952). Energy intakes required to maintain stable body weight for each subject were then calculated by multiplying the basal metabolic rate per day of each individual by an activity factor of 1.5. The factor of 1.5 rather was used due to the moderate activity level of the subjects (Department of Health, 1991). Average energy intakes were found to be $0.015\% \pm 0.04$ greater than the average energy intakes needed to maintain body weight, suggesting good reporting of energy intake throughout the study period.

7.2.8   Assessment of cycle phase

Data were taken from each subject's daily food and symptom diaries for the 10 days preceding menstruation, all days of menstruation, and the ten days postmenstrually.

Data were then split into 5 phases: 1) Early premenstrual phase: the six to ten days premenstrually, 2) Late premenstrual phase: the five to one days premenstrually, 3) Menstruation: all days of bleeding, 4) Early postmentrual phase: the one to five days postmenstrually. 5) Late postmenstrual phase: the six to ten days postmenstrually.

In five cases, information was available for only nine postmenstrual days, and in a further 2 cases, information on only 8 postmenstrual days was provided. In these instances, an average of the final 4 and 3 days respectively was taken to obtain an estimate for the 6-10 days postmenstrually.

As much of the previous literature has compared the ten pre- with the ten post-menstrual phases, data were also divided into these phases to enable a direct comparison with previous research. Thus, the two premenstrual phases were averaged, and the two postmenstrual phases were averaged.

7.2.9   Statistical analysis

Two way analysis of variance (ANOVA) was used to compare differences in calorific intake across the five phases of the cycle, day of starting (2 levels) x cycle phase (5 levels), with the latter as a repeated measures factor. Repeated measures analysis of variance was used to compare differences in calorific intake and in macronutrient intake across the five phases of the cycle.

To assess the relationship between severity of premenstrual symptoms and energy intake, Pearson r correlations were calculated. Partial correlations were also calculated to control for the strong association observed between severity of premenstrual food craving and negative mood. In all tables, partial correlations are noted first, with zero order correlations given in brackets. All analyses were carried out using the Statview 4.02 statistical analysis program and SPSS, version 4.0.

7.3   Results

7.3.1   Cyclical change in energy intake

A marginally significant effect of cycle phase on energy intake was observed ($F_{4,23}= 2.33$, $p<.06$), with intake shown to be increased in the premenstrual, as compared with the postmenstrual phases of the cycle.   Energy intake increased from ten days premenstrually, with no difference apparent between the early and late premenstrual phases, (see Figure 7.2).   When the ten premenstrual and ten postmenstrual phases were contrasted to allow direct comparison with the literature, a decrease of 142 Kilocalories was observed from pre- to post-menstrual days.   22 of the subjects (73%) showed a change in this direction.

No differences were observable between those subjects who completed the study from day 1 to day 1 and those who started the study mid-cycle ($F_{1,23}=0.28$, $p=$n.s.) nor were any time by group interactions observable ($F_{4,23}=0.80$, $p=$n.s.).   Hence, change in intake between pre- and post-menses within cycles appears comparable with change in intake between cycles.
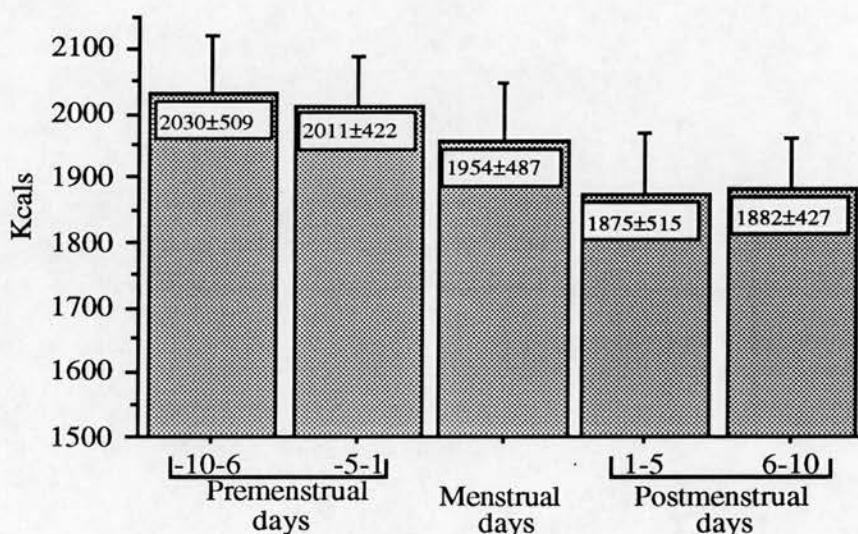

Figure 7.2 - Mean energy intake across each cycle phase.   Standard error bars are shown, with means± standard deviations shown in text inserts. (Mean energy intake per day across all phases = 1949 ± 416 Kcals).

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7.3.2   Cyclical change in macronutrient intake

Macronutrient intakes showed a similar pattern to that of total energy intake, with intakes of each macronutrient observed to be increased in the premenstrual phases of the cycle (see Figure 7.3).   As can be seen in Figure 7.3, energy intake from each macronutrient was observed to increase from the early premenstrual phase (i.e. days -10 to -6), with no difference between this phase and the late premenstrual phase (i.e. days -5 to -1).

There was a significant effect of cycle phase on carbohydrate intake ($F_{4,25}= 3.98$, p=0.005), and protein intake ($F_{4,25}= 2.55$, p=0.043), with intake decreasing from pre- to post-menstrual phases.   Starch and sugar intake showed a similar pattern to that of carbohydrate ($F_{4,25}= 2.66$, p=0.036, and $F_{4,25}= 3.41$, p=0.011, respectively), although sugar intake remained high during the menstrual phase of the cycle (see Figure 7.3E).   No significant effect for fat intake was observed, although a slight trend was apparent in the predicted direction, (see Figure 7.3B).

7.3.2.1   Proportion of macronutrients ingested as energy across cycle phase

Percentage of energy ingested as each macronutrient was calculated for each cycle phase[10].   Overall proportion of energy ingested did not differ across cycle phase for carbohydrate ($F_{2,27}= 0.42$, p<0.66), protein ($F_{2,27}= 0.30$, p<0.75) or fat ($F_{2,27}= 0.66$, p<0.53), with an average of 44% energy consumed as carbohydrate, 13% as protein and 39% as fat, throughout the study.   Increased intake in the premenstrual phases therefore appeared to reflect a general increase in all macronutrients, rather than a specific increase in carbohydrate intake.

7.3.3   Energy taken as meals and as snacks.

There was no effect of cycle phase on percentage of total energy ingested as meals ($F_{2,27}=0.09$, p=.91) or as snacks ($F_{2,27}= 0.607$, p=.55).   Approximately 74% of energy came from meals across all phases of the cycle, and 26% from snacks.   Nor was any relationship observed between severity of premenstrual craving and percentage of energy consumed as snacks in the five premenstrual days (r=0.07).

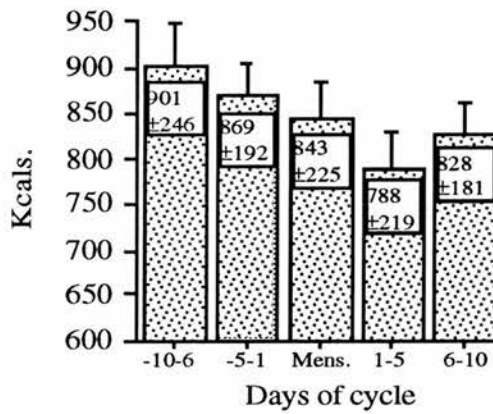[10]By dividing calories consumed as each macronutrient (protein, fat , and carbohydrate) by total Kcal intake.
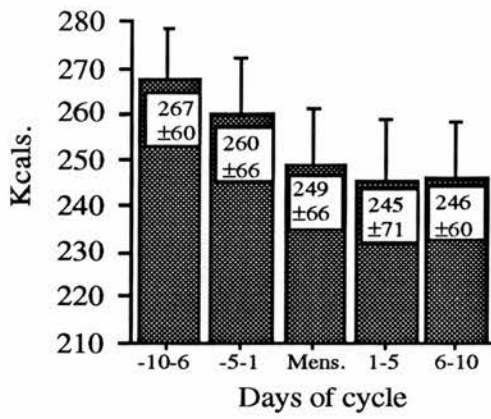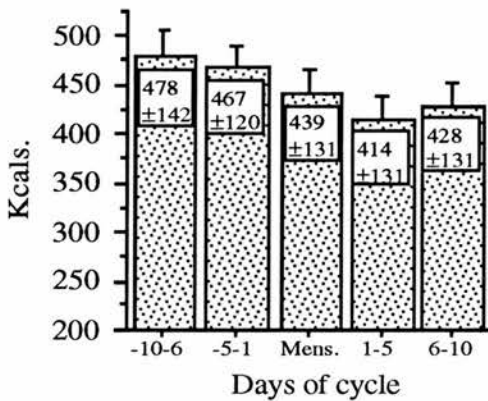
A. Protein intake
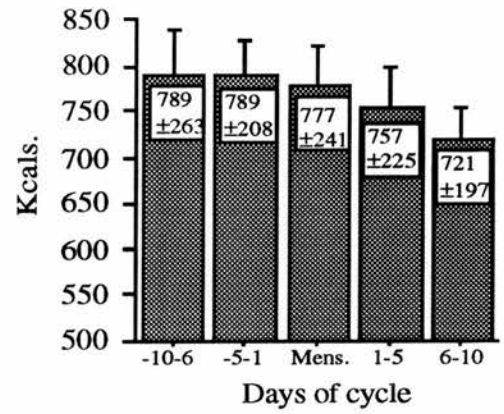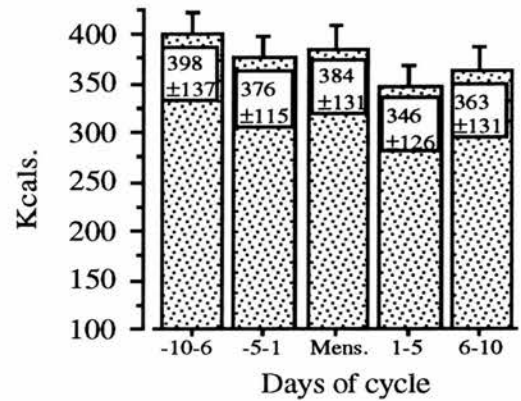
B. Fat intake

C. Carbohydrate intake

D. Starch intake

E. Sugar intake

Figure 7.3 - Mean energy intakes for each macronutrient across the five cycle phases. Standard error bars are shown, with means± standard deviations shown in text inserts.

7.3.4   Temporal relationship between energy intake and premenstrual symptoms.

7.3.4.1   Cyclical changes in severity of symptoms.

There was a significant effect of cycle phase on severity of food craving ($F_{4,25}$= 15.21, p<0.0001), negative mood ($F_{4,25}$= 8.16, p<0.003) and physical discomfort ($F_{4,25}$=20.90, p<0.0001). In contrast to the pattern observed for energy intake however, there were observable differences between the early and late premenstrual phases, with food craving and negative mood observed to be most severe between 1 and 5 days premenstrually (see Figure 7.4). Similarly, physical discomfort peaked in the five days premenstrually, although this remained high during the menstrual phase.

Change in energy intake did not therefore appear to relate directly to change in severity of symptoms. Whilst energy intake appeared to be increased from the ten days premenstrually, premenstrual symptoms did not peak until five days prior to menstruation.
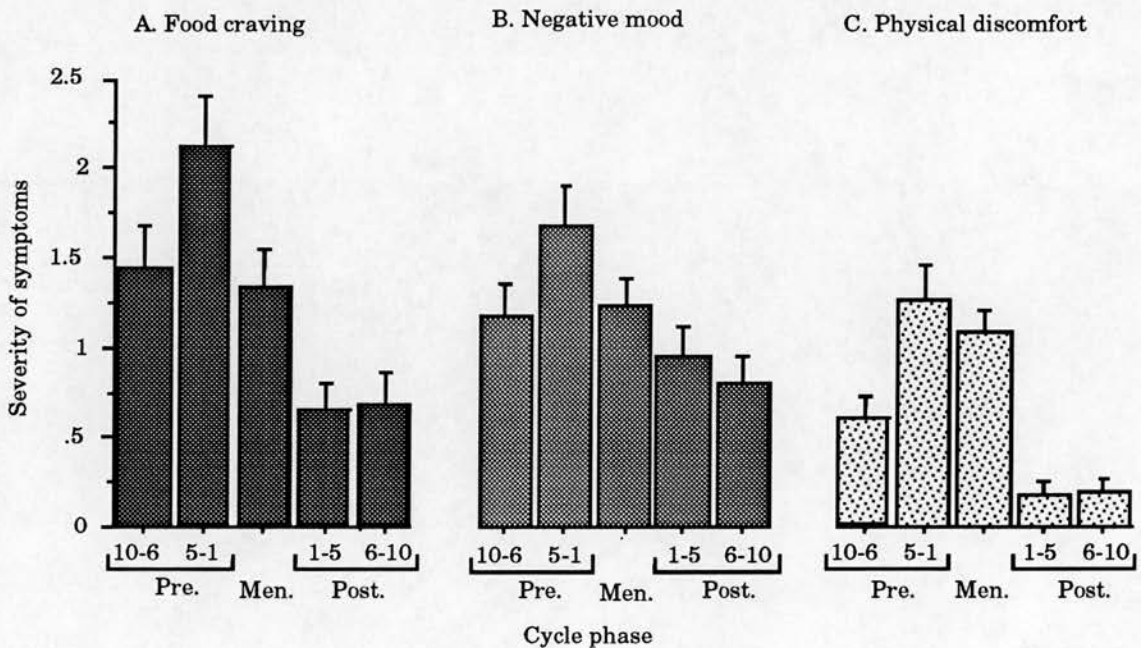

Figure 7.4 - Mean severity ratings for food craving, negative mood and physical discomfort across each cycle phase ± s.d.

7.3.5   Relationship between premenstrual food craving, negative mood and energy intake

In the remaining sections, focus has been placed on the five premenstrual days, as this is where symptoms of premenstrual food craving and negative were reported to be most severe. As physical discomfort was not a major variable of interest in this study, no further analysis was carried out using this variable.

The average of the five premenstrual days were calculated for food craving, negative mood and energy intake. In examining the associations between severity of food craving, negative mood and energy intake, partial correlations were used to control for the strong relationship observed between food craving and negative mood (r=0.693, p<0.001).

As shown in Table 7.2, a trend was observed between severity of premenstrual food craving, and energy intake, such that increased food cravings were associated with decreased energy intake in the late premenstrual phase of the cycle, (r=-.26, p<0.09). This is in direct contrast to the assumption that food craving would be related to increased intake. Further, a more general association between severity of premenstrual food craving and average energy intake (i.e. daily intake across all days of the cycle examined) was observed, such that severity of premenstrual craving was negatively associated with average energy intake throughout the study period, and with energy consumed from protein and fat. No association was observed between severity of premenstrual craving and average intake of carbohydrate.

In contrast to food craving, there was no observable relationship between severity of premenstrual negative mood and premenstrual energy intake, nor was any association apparent between premenstrual negative mood and average energy intake, (see Table 7.2).

Table 7.2 - Pearson r correlations between severity of symptom ratings in the five premenstrual days and energy intakes both for average daily intake, and intake in the five premenstrual days. Correlations with food craving have negative mood partialled out. Similarly, correlations with negative mood have food craving partialled out. Zero order correlations are shown in brackets. (*p<0.04; **p<0.03; ***p<0.01).

	Premenstrual Food craving		Premenstrual Negative mood	
Premenstrual Energy intake	-.26	(-.28)	.08	(-.14)
Average Energy intake	-.35*	(-.38)*	.11	(-.19)
Average Carbohydrate intake	-.25	(-.28)	.06	(-.15)
Average Protein intake	-.43***	(-.42)**	.19	(-.17)
Average Fat intake	-.37**	(-.38)**	.14	(-.17)

7.3.6 Exacerbation of symptoms - relationship to increase in energy intake

Giannini et al. (1985), reported a relationship between increase in symptoms and increase in intake from post- to pre-menstrual phases. To assess whether exacerbation of symptoms from the post- to pre-menstrual phase was associated with a greater increase in energy intake, the mean of the five premenstrual days was subtracted from the mean of the five post-menstrual days. This gave a measure of the magnitude of change in severity of symptoms and a measure for change in energy intake from the premenstrual to the postmenstrual phase of the cycle. Again, due to the strong association between premenstrual food craving and negative mood, the effects of each variable were controlled for using partial correlations.

As shown in Table 7.3, no association was found between change in severity of cravings and change in energy intake from the five pre- to the five days post-menstrually. Neither was there any association with carbohydrate, protein or fat intake. Similarly, no association was found between change in severity of negative mood and any of these variables.

Table 7.3 - Pearson r correlations between change in severity of symptom ratings from pre- to post-menses and change in energy intake. Correlations with food craving have negative mood partialled out. Similarly, correlations with negative mood have food craving partialled out. Zero order correlations are shown in brackets. (Δ = change).

	Δ in ratings of Food craving		Δ in ratings of Negative mood	
Δ in Total energy intake	-.04	(-.01)	.05	(.03)
Δ in Carbohydrate intake	-.01	(.07)	.10	(.12)
Δ in Protein intake	-.23	(-.24)	.07	(-.10)
Δ in Fat intake	-.07	(-.06)	.05	(-.01)

7.3.7   Relationship between premenstrual symptoms and macronutrient intake

To control for the negative association between severity of food craving and average energy intake, the percentage of energy ingested as each macronutrient was calculated.

As shown in Table 7.4, severity of food craving was found to be negatively associated with percentage of energy consumed as protein ($r=-.43$, $p<0.01$)[11], with no relationship observable between severity of craving and percentage of energy consumed as carbohydrate or fat.   In contrast, severity of negative mood change in the five days premenstrually bore no relationship to percentage of energy consumed as protein, carbohydrate or fat, (see Table 7.4).

Table 7.4 - Pearson r correlations between severity of symptom ratings in the five premenstrual days and percentage of energy consumed as carbohydrate, protein and fat in this phase. Correlations with food craving have effect of negative mood partialled out. Similarly, correlations with negative mood have effects of food craving partialled out. Zero order correlations are shown in brackets. (*p<0.04; ***p<0.01).

	Premens. Food craving		Premens. Negative mood	
% carbohydrate	.23	(.23)	-.11	(.08)
% protein	-.43***	(-.37$^{*)}$	.25	(-.09)
% fat	-.16	(-.09)	.14	(.04)

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[11] This was not a result of a tendency for those with more severe premenstrual cravings to eat proportionately less protein in general ($r=-.157$, $p=0.208$ between severity of premenstrual craving, and average percentage of protein consumed as energy across all cycle phases).

7.3.8 Characteristics of the food craving group

Severity of premenstrual food craving was strongly associated with decreased daily energy intake. Further, when the ratio of average intake across the cycle to energy intake required to maintain weight at constant levels was calculated, there was found to be a significant association between this measure and severity of food craving (r=-.34, p<0.04). Food craving was therefore associated with a propensity to consume fewer calories per day than would be required to maintain body weight at constant levels. Despite this, a positive association was observed between severity of food craving and body mass index (r=.32, p<0.05).

This suggested the possibility that those women reporting more severe premenstrual cravings might be restraining their intake throughout the period under examination. When restraint scores from the questionnaire study (Chapter 2) were examined, restraint was shown to be highly correlated with reported energy intake across the cycle, (r=-.50, p<0.005) and with severity of premenstrual food craving. However when negative mood was controlled using partial correlation, no correlation was apparent between severity of premenstrual food craving and eating restraint (see Table 7.5).

These findings suggest that eating restraint and severity of premenstrual food craving are independently associated with lower levels of energy intake across the cycle.

Table 7.5 - Pearson r correlations between premenstrual food craving, eating restraint, energy intake and BMI. Correlations with food craving have effect of negative mood partialled out. Zero order correlations are shown in brackets. (*p<0.05; **p<0.04; ***p<0.03; ****p<0.01; *****p<.005).

	Premens. food craving		Eating restraint
Eating restraint	.03	(.40)***	-
Average energy intake	-.35	(-.38)**	-.50*****
Average intake/ ideal	-.34**	(-.35)	-.46****
Body mass index	.32*	(.22)	-.04

7.4   Summary discussion

Observations regarding the timing of food cravings accord with the findings of Chapters 3 and 6 and with previously published reports which have noted cravings to be most severe in three to four days prior to menstruation (Bancroft, Cook & Williamson, 1988; Rozin, Levine & Stoess, 1991). Similarly, the strong association between food craving and negative mood in the five days prior to menstruation accords with the results of chapters 2 and 3 and with the findings of Tobin, Schmidt & Rubinow (1994).

In terms of change in energy intake across the cycle, the results of this study are similar to studies reporting an increase in energy intake in the premenstrual as compared with the post-menstrual phase of the cycle, outlined in the introduction. Increased energy intake was observable in around three-quarters of our sample population, suggesting it to be a relatively robust phenomenon. The findings of this study not only correspond with the change in energy intake previously observed but are comparable with the magnitude of the change previously observed. From the summary table of related literature given in the introduction, an increase in energy intake of approximately 10% during the premenstrual phase of the cycle is calculable. This compares with the 8% increase in energy intake observed in this study. It would therefore appear that increased energy intake in the premenstrual phase of the cycle is no more pronounced in women reporting premenstrual cravings than in other community sample populations. These findings question the assumption that women who report premenstrual cravings subsequently increase their calorific intake in this phase of the cycle any more so than do community sample populations of women (Giannini et al., 1985; Wurtman et al., 1989). Yet, this still does not preclude the possibility that food cravings account for the increase in energy intake observed, given the prevalence of food craving and the large percentage of subjects within community samples that report cravings to be related to their menstrual cycles (Cohen et al., 1987; Hill & Heaton-Brown, 1994; Rozin et al., 1991; Tomelleri & Grunewald, 1987; Weingarten & Elston, 1991)

From analysis of the temporal relationship between symptom reporting and energy intake however, there appeared to be no clear relationship between emergence of premenstrual symptoms and increase in energy intake, with energy intake increasing before symptoms peaked. This conflicts with the suggestion by Wurtman et al. (1989), that increased intake may result from cravings for certain foods, in that energy intake was already increased before symptoms peaked. Similarly, change in macronutrient intake showed no clear relationship to symptoms. Therefore, our main analysis found no evidence to suggest a relationship between energy intake and premenstrual symptoms.

Although the correlational analysis carried out is based on a small number of subjects and must therefore be regarded with caution, it allows development of several hypotheses for future research. As concerns the relationship between negative affect and energy intake in community samples, DeCastro et al (1986) reported high proportionate intake of carbohydrate to be negatively correlated with depression, as did Jansen, van den Hout & Griez (1989). Johnson, Carr-Nangle & Bergeron (1995) by contrast, observed a positive association between high proportionate intake of carbohydrate and negative mood. In this study, no relationship was found between severity of negative mood and either total energy intake or macronutrient intake. This finding accords with Rogers & Jas (1994), who recently reported on an unpublished study where no relationship between premenstrual negative mood and food choice was observed.

By contrast, several interesting correlations between food craving and energy intake were apparent. When energy intake across the entire period of study was examined, a negative relationship between average energy intake and premenstrual food craving was observed (see Figure 7.5 overleaf). There was also a negative relationship between severity of food craving, and 'relative'[12] energy intake. In other words, women with severe premenstrual food cravings were eating less than necessary to maintain body weight throughout the study period. These observations appeared to fit well with the proposal that dietary restriction leads to increased food cravings (Streigel-Moore, Silberstein & Rodin, 1986; Wardle, 1987). As low energy intake is associated with levels of eating restraint (Johnson et al., 1994; Klesges, Isbell & Klesges, 1992; van Strein, Frijters, Bergers & Defares, 1986; Wardle & Beales, 1987; Wardle et al., 1992) it was hypothesised that dietary restraint might lead to lowered intake, which in turn might lead to increased severity of food cravings.

Further analysis revealed eating restraint to be negatively associated with energy intake across the study period but not to be associated with food craving. It therefore appeared that the connection outlined above between dietary restraint, energy intake and food craving was untenable. This is perhaps unsurprising given both the results of Chapter 2 and previous research suggesting there to be no relationship between food craving and eating restraint (Hill, Weaver & Blundell, 1991; Rodin, Mancuso, Granger & Nelbach, 1991; Weingarten & Elston, 1991). Yet these findings do not preclude the potential relationship between actual dietary restriction (i.e. lowered calorific intake) and food craving, as has been suggested by studies failing to observe a relationship between these variables. Eating restraint measures not only behaviour (actual calorific intake), but also

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[12]Energy intake required to maintain body weight constant.

measures attitudes towards eating to the extent that it measures worry about intake. The association between eating restraint and actual energy intake may therefore be separate from the effect of lowered intake on food craving (see Figure 7.5). In individuals who are particularly vulnerable to the effects of dietary restriction at this stage of the cycle, food cravings may occur.
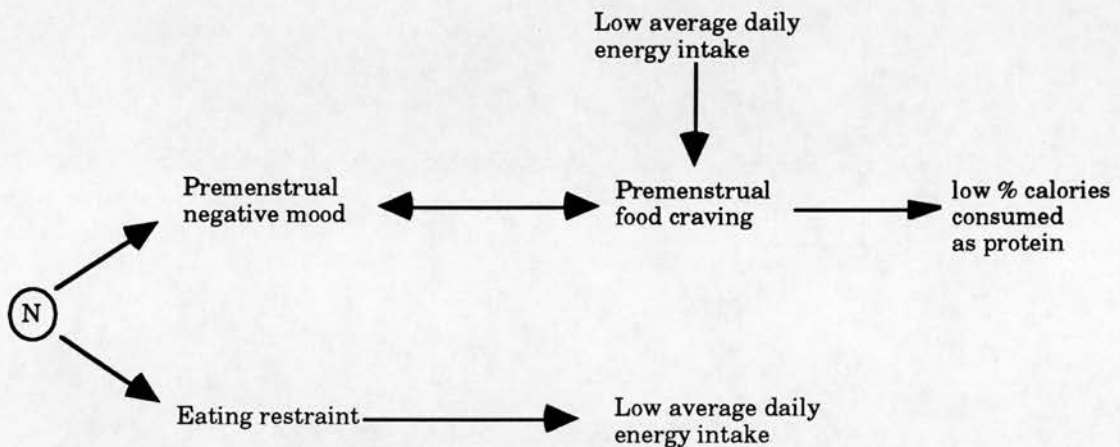

Figure 7.5 - Hypothesised relationship between key variables

When macronutrient intake was examined, women with severe premenstrual cravings were seen to be ingesting relatively less protein during this phase of the cycle. This suggested that women therefore indulged their cravings (presumably both in meals and as snacks), since cravings are commonly reported to be for relatively protein-poor foods (see Chapters 2 and 6). How then can decreased average intake and indulgence of cravings co-exist?

Several subjects in Chapter 6 found a problem with identifying cravings. From anecdotal reports it appeared that identification was easier when cravings were more severe. Percentage of time that cravings are satisfied also relates to severity (as noted in Chapter 4). Therefore subjects with severe cravings may have been more likely to satisfy them but because they were aware of the craving, then overcompensated by decreasing their intake of other foods. Dietary restriction in the early phase of the cycle could lead to cravings. Cravings are then likely to be satisfied, but women who are aware of this, may attempt to overcompensate for this 'extra' energy intake by cutting back on other foods. In turn, both 'giving in' to cravings and restricting other foods may lead to exacerbation of negative affect. This ties in with Chapter 4, where a proportion of women noted no negative affect when cravings were first noticed but noted guilt in relation to satisfaction of cravings.

This directional hypothesis is in contrast to Wurtman et al (1989), who suggest food craving to result in altered intake. It also argues against the hypothesis that food cravings result from negative affect, and suggests that there may be a two way process apparent.

In terms of other findings, the observed relationship between negative affect and eating restraint has been noted before (Bowen & Grunberg, 1990). This relationship could potentially result from their link to a common factor. Neuroticism is reported to correlate highly both with eating restraint (Davis, Durnin, Gurevich, Le Maire & Dionne, 1993; Davis, Shapiro, Elliott & Dionne, 1993) and reporting of premenstrual negative mood, but is only weakly associated with food craving (Bancroft, Williamson, Warner, Rennie & Smith, 1993).

Before concluding, it is worth emphasising again that the correlational analyses reported in this study were based on a relatively small sample size and therefore findings should be treated tentatively, although some of the relationships observed fit well with previous literature (i.e. the observed relationships between eating restraint and energy intake, food craving and body mass index, and eating restraint and negative affect).

In summary, these findings confirm the relationship between premenstrual food cravings and negative mood. They also suggest the possibility that food cravings may be exacerbated by dietary restriction and that in turn, increased severity of food cravings and intake in response to cravings, may exacerbate negative affect by producing feelings of guilt . However, due to the small sample size in which these observations were made, the conclusions reached act only as guiding hypotheses for future research.

Chapter 8 - Effect of cycle-related food craving on diabetic control

8.1 Introduction

This study assessed the potential effect of food craving on diabetic control in the perimenstrual phase of the cycle, in women with insulin-dependent diabetes mellitus (IDDM).

8.1.1 Cycle-related changes in diabetic control

Many women with insulin-dependent diabetes anecdotally report an increase in insulin requirement premenstrually, with an abrupt decrease in requirement on the first day of menses (Moberg, Kollind, Lins & Adamson, 1995). In line with this, several studies have noted an impairment in diabetic control around the time of menstruation. Cramer (1942) for example, noted that of a sample of diabetic women admitted to hospital with ketoacidosis[1], half were either menstruating on arrival or within two days of admission. Walsh & Malins (1977) similarly observed 58% of ketoacidotic episodes in women to occur during menses. These authors further noted that of a sample of 200 women interviewed, 76 (38%) reported changes in diabetic control around the time of menstruation. Of these, 53 (70%) found that control deteriorated and hyperglycaemia occurred, in particular in the one to three days prior to menstruation. The remaining 23 (30%) reported hypoglycaemia as a problem.

More recently, in a large questionnaire study examining the relationship between diabetic control and premenstrual syndrome, Cawood, Bancroft & Steel (1993) observed that of a sample of 150 women with IDDM, approximately three quarters noted cycle-related changes in diabetic control in both the premenstrual and menstrual phases of the cycle. Of these women, 75% noted hyperglycaemia in the premenstrual phase of the cycle and 60% noted this in the menstrual phase of the cycle. The remaining 25% and 40% of subjects noted hypoglycaemia as a problem. Several other early reports also noted increased insulin requirement premenstrually in women with IDDM (see Levy, Widom & Simonson, 1994). There are two possible reasons that might account for the high prevalence of hyperglycaemia in the premenstrual phase of the cycle: lowered insulin sensitivity and increased carbohydrate intake.

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[1] Associated with extremely high blood glucose levels. It occurs when carbohydrate is not metabolised and is broken down to ketones by the liver.

8.1.2 Change in insulin sensitivity across the menstrual cycle

Clinical studies into possible changes in insulin sensitivity in women with IDDM remain somewhat inconclusive. In one study, insulin sensitivity across the cycle was examined in 16 women with IDDM, seven of whom noted a history of premenstrual hyperglycaemia, using the hyperglycemic clamp technique[2]. Results showed patients with a history of premenstrual hyperglycaemia to experience a non-significant decrease in glucose uptake (i.e. a decrease in insulin sensitivity) from the follicular to the luteal phase of the cycle, whilst the remaining subjects (n=9) displayed significantly increased glucose uptake in the luteal phase of the cycle (Widom, Diamond & Simonson, 1992).

Two other studies using the glycemic clamp technique have however observed non-significant changes in insulin sensitivity across the menstrual cycle. Scott, McDonald, Bowman & Jeffcoat (1990) observed a slight but non-significant increase in insulin sensitivity in the luteal phase of the cycle in 9 women with IDDM, whilst Moberg et al. (1995) noted slight decreases in insulin sensitivity in this phase of the cycle. This latter study reported no differences in terms of glucose uptake in the premenstrual phase of the cycle between subjects who reported a history of premenstrual hyperglycaemia (n=5) and the remainder of the sample population (n=10). They subsequently concluded that although minor alterations in insulin sensitivity could not be discounted, changes in diabetic control reported by women across the menstrual cycle were likely to be attributable to factors other than change in insulin sensitivity.

8.1.3 Premenstrual food craving and impairment of diabetic control

The second potential explanation for impairment of diabetic control is that some women may increase their carbohydrate intake in the premenstrual phase of the cycle as a result of satisfying food cravings. In the large questionnaire study noted above, which examined the relationship between diabetic control and PMS, premenstrual glycosuria was observed to be significantly more likely to occur in IDDM patients who reported PMS than in non-reporters (Cawood et al., 1993). Women who reported PMS were also more likely to alter their daily insulin (p<0.0001). More importantly, the only single symptom that was significantly associated with impaired diabetic control was that of craving for sweet foods (p<0.004). This would initially suggest a potential link between increased carbohydrate intake and impaired diabetic control. However, no account of whether carbohydrate intake was altered was noted in this study.

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[2] Both oral glucose tolerance tests, and intravenous tolerance tests are known to have poor reproducibility (see Levy et al, 1994). The hyperglycemic clamp technique allows precise quantification of glucose metabolism in response to large, constant infusions of glucose and insulin. Glucose levels are maintained above normal physiological levels.

The aim of the study reported here was therefore to assess the impact of food craving on reported change in diabetic control across the menstrual cycle. It was hypothesised that diabetic subjects who reported cycle-related changes in blood glucose would also report both increased food cravings and increased carbohydrate intake in the perimenstrual phase of the cycle.

8.2 Method

8.2.1 Subjects

Recruitment of subjects for this population has already been discussed in the method section of Chapter 2. 190 subjects provided complete information for purposes of analysis.

8.2.2 Measures

8.2.2.1 Questionnaire design

The following questions were included in the larger questionnaire described in Chapter 2. Subjects were asked to respond to six questions relating to diabetic control. The initial three questions concerned general information about diabetic control. The first two questioned the frequency with which subjects checked their blood glucose on a six point scale (from several times a day to never) and the time of day at which blood glucose was checked. A third question asked how often subjects increased or decreased insulin dose when they wanted to eat more or less carbohydrate than their daily exchanges allowed. Again subjects responded on a three point scale (from 'never' to 'whenever I feel the need').

The final three questions related to diabetic control around the time of menstruation. The first asked whether subjects noticed changes in diabetic control that were related to their menstrual cycle. Those subjects answering yes were requested to state whether blood sugar levels were lower, higher or no different than usual in four cycle phases (in the week prior to menses, during menses, in the week following menses and for the remainder of the cycle). Subjects were then asked to state why these changes occurred (i.e. whether changes in blood glucose were a result of eating more carbohydrate or less carbohydrate than usual, or whether they occurred without any alteration in carbohydrate intake). Subjects were also asked whether they altered insulin intake as a result of this change in diabetic control. All questions are included in Appendix 2, Part III).

8.2.3   Statistical analysis

Examination of differences between subjects reporting cycle-related changes in blood glucose and those not were assessed using Chi square tests for nominal variables (i.e. frequency of checking, frequency of altering insulin). Differences in age, age of onset of diabetes and BMI were assessed using t-tests (unrelated). Two way analysis of variance was used to assess differences in severity of craving across the cycle in subjects noting change, or no change, in blood glucose, group (2 levels) x time (4 levels), with the latter as a repeated measure. Post hoc comparisons were carried out using unrelated t-tests. One way analysis of variance (group, 3 levels) was used to acompare severity of food craving amongst those subjects who noted increase, decrease or no change in diabetic control in the premenstrual and menstrual phases of the cycle. All of these analyses were carried out using the Statview 4.02 statistical analysis program for Apple Macintosh.

8.3   Results

8.3.1   Characteristics of subjects reporting cycle-related changes in diabetic control

Of the 190 women with diabetes who responded to this section of the questionnaire, 103 (54%) noted changes in blood glucose that were related to their menstrual cycle. Fewer subjects using oral contraceptives (38% of n=56) reported cycle-related changes in diabetic control than non-pill users (61% of n=134, X^2=7.82, df=2 p<0.006). By contrast, no differences were apparent in terms of age (t=1.15, p<0.26) or body mass index (t=1.17, p<0.25, see Table 8.3). Frequency of blood glucose checks similarly revealed no differences between those women who noted cycle-related changes in blood glucose and those who did not (X^2=4.85, df=10,p<.43, see Table 8.1).

Women who noted cycle-related changes in blood glucose were however likely to report altering their insulin dose more frequently when they wished to alter their daily carbohydrate intake (X^2=7.21, df=4 p<.03, see Table 8.2) and also had an earlier onset of diabetes[3] (t=3.52, p<0.0005).

Table 8.1 - Percentage of subjects reporting perimenstrual changes in blood glucose.

| | Change in blood glucose | |
	Yes (%)	No (%)
n	103	87
>2 day	22	13
>1 day	19	21
Daily	14	13
<1 day	19	22
<1 week	16	16
Never	10	16
Total	100	100

Table 8.2 - Subjects reporting a tendency to change insulin intake to suit carbohydrate intake.

| | Change in blood glucose | |
	Yes (%)	No (%)
n	103	87
Never	8	15
Special occasions	30	41
Whenever needed	62	44
Total	100	100

Table 8.3 - Characteristics of subjects

| | Change in blood glucose | |
	Yes (%)	No (%)
Age±s.e.	33.5±.61	32.4±.72
Age of onset	16.2±.97	20.6±.82
BMI	26.1±.42	25.4±.42

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[3]Data collected from patient records held at the Department of Diabetes, Royal Infirmary of Edinburgh.

In terms of differences between groups in severity of food craving across the cycle, a significant group by time interaction was noted ($F_{3,187}$= 5.64, p<0.0008). As shown in Figure 8.1, this was due to subjects who reported cycle-related changes in diabetic control also rating more severe cravings in the premenstrual, menstrual and postmenstrual phases of the cycle (p<.006 for all post hoc comparisons).
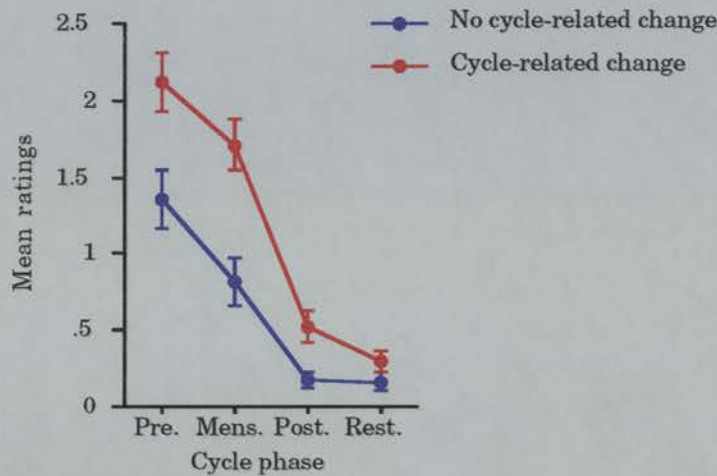

Figure 8.1 - Mean severity of food craving across each cycle phase in subjects reporting cycle-related change in blood glucose and those not

8.3.2   Perimenstrual changes in diabetic control

From the above results, it initially appeared that food cravings might induce impairment in diabetic control by causing an increase in carbohydrate intake. However, when the direction of change in diabetic control was examined, although 29% of subjects reported increased blood glucose in the premenstrual phase of the cycle, a further 15% reported a decrease in blood glucose (see Table 8.4). In the menstrual phase, subjects were equally as likely to report decreased levels of blood glucose as increased levels. Changes in blood glucose levels in either the postmenstrual phase or remainder of the cycle were minimal, as shown in Table 8.4.

Table 8.4 - % of subjects reporting changes in blood glucose levels across each cycle phase (n=190).

Blood glucose	Phase of cycle			
	Premenstrual	Menstrual	Postmenstrual	Rest of cycle
Increase	29	22	2	1
No change	56	59	89	97
Decrease	15	19	9	2

To determine whether subjects noting perimenstrual increases in blood glucose reported more severe food cravings than either subjects reporting no change in diabetic control or decreased blood glucose levels, analysis of variance was carried out. Both decreased and increased levels of blood glucose in the premenstrual and menstrual phases of the cycle were associated with significantly greater severity of food craving than subjects who reported no change in diabetic control ($F_{2,187}=10.18$, $p<.0001$ and $F_{2,187}=11.38$, $P<.0001$ for premenstrual and menstrual phases respectively, see Figure 8.2).
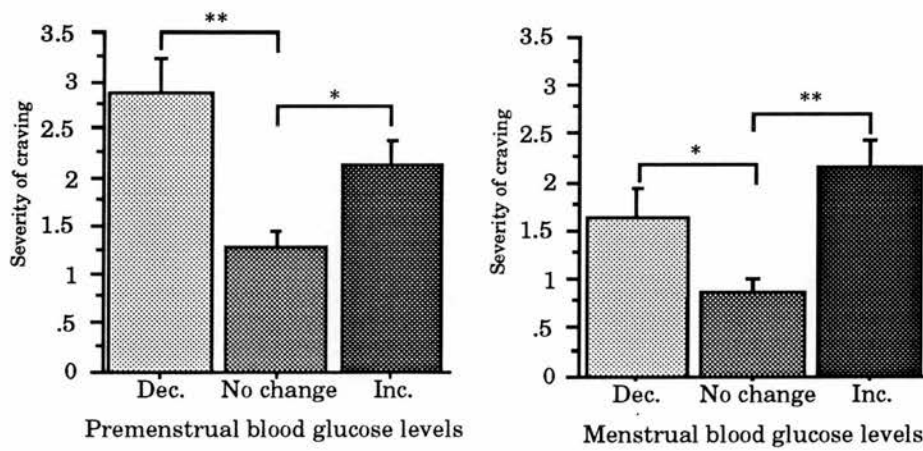

Figure 8.2 - Mean severity of food craving in subjects reporting change in blood glucose levels in the premenstrual and menstrual phases of the cycle. Dec. = decreased blood glucose, Inc. = increased blood glucose   (* p<0.05, **p<0.0004).

8.3.3   Change in diabetic control and relationship to food intake

In terms of the reasons given for change in diabetic control, approximately half (49% and 60%) of those subjects noting premenstrual or menstrual increases in blood glucose reported this to be a result of increased intake of carbohydrates (see Table 8.5). The remaining subjects reported increases to occur without any change in carbohydrate intake.

Subjects reporting decreased blood glucose levels were less likely to report altered carbohydrate intake to be the cause of altered diabetic control. Approximately 90% in each phase reported decreased blood glucose to occur without any change in carbohydrate intake. By contrast, only 2 subjects noted a decrease in intake premenstrually, with 4 subjects reporting this menstrually.

The majority of subjects in each cycle phase altered insulin intake in response changes in diabetic control (see Table 8.5). 71% of those noting a premenstrual increase in blood glucose increased insulin intake in response to these changes, and 52% of those reporting a decrease in blood glucose noted decreasing insulin intake.

Table 8.5 - Reasons reported by subjects for change in diabetic control (% of subjects), and % altering insulin in each cycle phase.

	Increase in blood glucose		Decrease in blood glucose	
	Premenstrual	Menstrual	Premenstrual	Menstrual
n	55	42	29	37
Eat more carbohydrate	49	60	3	0
No change in intake	51	40	90	89
Eat less carbohydrate	0	0	7	11
Alter insulin	71	64	52	68

8.4   Summary Discussion

Around half (54%) of the 190 subjects who responded to this section of the questionnaire reported cycle-related changes in diabetic control. This is somewhat lower than the 77% of subjects reported by Cawood et al. (1993), but higher than the 38% reported by Walsh & Malins (1977), a finding which may simply reflect differences in selection procedures. Walsh & Malins (1977) questioned 200 consecutive women attending a diabetic clinic. By contrast, the study by Cawood et al. (1993) involved subjects responding to a magazine article which focused on cycle-related changes in diabetic control. Women in this study may therefore have been more likely to respond if they noticed such changes. Our study, whilst asking a great many more questions about non-cycle related symptoms and change in diabetic control than Cawood et al's, may have encouraged women noting cycle-related symptoms to return the questionnaire, although the group as a whole is likely to reflect a more representative sample than that reported by Cawood et al (1993).

Approximately two thirds of the subjects who reported premenstrual changes in diabetic control noted hyperglycaemia as common, consistent with the findings of Walsh & Malins (1977) and Cawood et al. (1993), who reported 70% and 75% of their sample populations respectively to report this. In line with Cawood et al's (1993) proposal that increased blood glucose might reflect food cravings in the premenstrual phase of the cycle, these women reported more severe cravings than those reporting no change in blood glucose. Further to this, almost one half of these subjects reported increased carbohydrate intake in both the premenstrual and menstrual phases of the cycle, suggesting food craving and associated increases in carbohydrate intake to play an important role in perimenstrual hyperglycaemia. This is in contrast to the findings of Walsh & Malins (1977) who noted that despite questioning subjects about changes in dietary habits, there was no suggestion that this could be a factor in altered diabetic control.

Despite the 49% of subjects reporting increased carbohydrate intake to account for hyperglycaemia in the premenstrual phase (60% in the menstrual phase), there remained a substantial proportion of women who noted increased blood glucose with no change in carbohydrate intake. There could be several reasons for this. Firstly, it could be that certain women do exhibit decreased insulin sensitivity in the premenstrual phase of the cycle, as suggested by Widom et al. (1992). It might also result from a change in type of carbohydrate intake, as sugar produces more substantial increases in blood glucose than does starch (Lyons & Truswell, 1987). Indeed, several subjects noted that they often satisfied cravings by substituting chocolate for one of their daily carbohydrate exchanges. In addition to this, four subjects noted that they felt lethargic during the premenstrual

phase of the cycle, and suggested that decreased exercise might account for increased blood glucose levels.

Besides those subjects noting increased blood glucose perimenstrually, around one third of subjects reporting premenstrual changes in blood glucose, and around one half of those reporting menstrual changes, noted low blood sugar to be a problem. Again, this is in line with Walsh & Malins and Cawood et al's findings of 30% and 24% of subjects respectively, reporting this to be the case. This reflects the heterogeneous nature of the problem. Heterogenous patterns have also been reported in many of the studies examining change in insulin sensitivity (Moberg et al., 1995; Scott, McDonald, Bowman & Jeffcoate, 1990; Widom et al., 1992). The increased food cravings in this subsample are perhaps relatively unsurprising, given that hypoglycaemia is frequently associated with hunger (Deary, Hepburn, MacLeod & Frier, 1993) and carbohydrate-rich foods offer to rapid source of energy.

Aside from the interest in the association between food craving and change in diabetic control, the general differences between those reporting cycle-related changes in diabetic control and subjects reporting none appear important factors to consider. It is unlikely that awareness of changes simply reflects a higher frequency of glucose checks than women reporting no changes, since around fifty percent of each group reported at least daily checks on blood glucose levels. Subjects reporting cycle-related changes did however have an earlier onset of diabetes and were more readily willing to alter their insulin dosage when they wanted to alter their carbohydrate intake than were those subjects who reported no change in diabetic control across the cycle. These findings suggest several possibilities.

It seems improbable that subjects with earlier onset of diabetes were simply more likely to notice changes in diabetic control because they had a longer experience of diabetes, given that average duration of diabetes in each group was over ten years. However, age of onset may be associated with awareness of cycle-related changes in diabetic control for another reason. Women observing changes reported onset of diabetes during adolescence (mean age = 16.2 years, as compared with 20.6 years in the group observing no change). Growth hormone secretion during adolescence causes decreased insulin sensitivity, often making type I diabetes particularly difficult to control during this time (Dunger et al., 1991). Adolescent diabetes is also associated with a higher than normal incidence of menstrual irregularity (Adcock et al., 1995). A co-occurrence of menstrual irregularities and inconsistent diabetic control could therefore increase awareness of a pattern between the two.

Another possible link between awareness of cycle-related change in diabetic control and age of onset of diabetes relates to the longer time that women noticing changes in diabetic control have had the condition. Frequently in type 1 diabetes, there is a 'honeymoon period', whereby residual endogenous insulin action helps to maintain good diabetic control. This effect fades with duration of the illness. Hence, subjects who have been diabetic for longer may be more susceptible to small changes in carbohydrate intake.

The other factor of interest in relation to reporting of cycle-related changes in diabetic control, is that women observing cycle-related changes in control were also more likely to report greater willingness to alter their insulin when they wanted to change their daily carbohydrate intake. Women who are not happy about altering insulin may become more proficient at ignoring their cravings and thereby come to notice them less than those who 'give in' to cravings and alter insulin as required.

In summary, it would appear that perimenstrual food cravings play an important role in perimenstrual hyperglycaemia and may therefore be an important consideration in the management in type 1 diabetes. Although a less common problem, potential causes for perimenstrual hypoglycaemia remain to be elucidated, but their link with food cravings would be of interest to examine in more detail. Other factors, such as age of onset of diabetes and willingness to alter insulin when wanting to alter carbohydrate intake would be of importance to consider in future studies of this type. In view of the retrospective and self-reported nature of this study, a more comprehensive investigation including prospective objective data, such as actual consumption of food, blood glucose levels and insulin intake is warranted.

Chapter 9 - General Discussion

The aim of this thesis has been to elucidate the relationship between food craving and negative mood, to examine the nature and experience of food craving, and to determine possible reasons for mood change observed following satisfaction of food cravings. It also aimed to assess the practical impact of food cravings on diabetic control.

To concentrate initially on relationship between the food craving and negative affect, both information from retrospective reports (Chapter 2) and daily diary ratings (Chapter 3 and 7) suggested these symptoms to be most severe in the premenstrual phase of the cycle. The retrospective questionnaire suggested that approximately one third of the variance observed in premenstrual food craving scores was shared with negative affect. This was confirmed prospectively in Chapter 3, and in Chapter 7 almost one half (48%) of the variance observed was common to both symptoms. These findings support both the anecdotal reports of an association between food craving and negative affect outlined in the introduction, and previous empirical research noting a strong relationship between the two.

In Chapter 2, the structural model that best fitted the data posited negative affect to predict severity of food craving. This hypothesis was supported to some extent by the results of Chapter 4, where approximately half of all subjects noted negative affect to be present when cravings were first noticed. So too, it was supported by the observation that reporting of food craving was predicted by the propensity to eat when in a negative emotional state, shown by the association between emotional eating and food craving (Chapter 2).

This unidirectional hypothesis appeared however, to oversimplify the relationship, given both the findings from correlational analysis in Chapter 7 and the additional reports suggesting neutral mood to be apparent at craving onset in at least some instances where it was reported (Chapter 4). In Chapter 7, results suggested food craving to be induced, in part, through dietary restriction. In turn, increased severity of cravings appeared to result in more instances of 'giving in' to cravings, and it was postulated that this then increased feelings of low self-esteem and thereby exacerbated negative affect. Although the sample size in this study was small, the concepts included in this chapter accorded with reports of the experience of craving given in Chapter 4. In this study, there was a strong correlation between the strength and frequency of cravings and the amount of time these were satisfied. Moreover, a large proportion of subjects reported feeling low following satisfaction of cravings, usually due to feelings of guilt that emerged following

satisfaction of cravings. Where cravings were not satisfied, increased tension and irritability were reported to occur. Therefore, it would follow that severity of craving may at times exacerbate negative affect, via either the effect of satisfying cravings, or of restraining from giving in to them. These findings serve to highlight the complex, dynamics of the relationship between food craving and negative mood.

Principal components analysis of both retrospective (Chapter 2) and prospective data (Chapter 3) suggested all mood symptoms to load on the same factor and to be highly correlated with one another. It may be of greater use in future, not to examine each mood symptom in isolation but to look at negative affect as a single variable, in attempting to determine predictors of it.

Whether both premenstrual negative affect and food craving are products of a common neuroregulatory dysfunction was not discernible from the results of these studies and may be untenable, given their close relationship to one another. However, as negative mood and food craving are at least partly independent of one another, it is of interest to examine other factors that influence their reporting. Negative affect in the retrospective questionnaire study (Chapter 2) was strongly linked to a vulnerability factor, postulated to reflect negative affectivity, or neuroticism. In addition, this factor predicted current emotional state, history of depression and perceived stress. As pointed out in the discussion of Chapter 2, neuroticism has been linked not only to a propensity for depressive illness, but is also linked to length of depressive episode and prognosis for recovery. It is also known to be associated with bulimic symptomatology (Janzen, Sakolske & Kelly, 1993). These findings conflict with Watson & Pennebaker's (1989) suggestion that negative affectivity does not relate to long-term health status, but acts as a general nuisance factor in health research. At least in terms of mental health, neuroticism may well be an important contributory factor in predicting both chronic and cycle-related depression.

The concept that a potential genetic risk factor might account for shared variance between neuroticism and depression, suggested by Kendler, Neale, Kessler, Heath & Eaves (1993) is of interest in this respect. It is very likely that large personality traits such as neuroticism, which are heritable and remain relatively stable across time, are under polygenetic control. If this is the case, it would be more beneficial to concentrate on the cognitive characteristics of the personality trait, such as a preponderance towards negative thoughts, than attempt to elucidate chromosomal determinants of the trait. Whilst there is no doubt that antidepressants are effective in the treatment of premenstrual negative affect, as discussed in Chapter 1, cognitive processes associated

with premenstrual symptomatology deserve consideration. Certainly, more studies examining the relationship between neuroticism, premenstrual negative affect and the other variables examined in Chapter 2, such as stress and emotional state, are warranted, given that no actual measure of neuroticism was used in this study. By understanding the psychological influences and cognitive processes governing negative affectivity, we will undoubtedly be in a better situation to offer more effective means of treatment to women seeking help for cycle-related problems.

Few factors other than negative affect bore any relationship to severity of premenstrual food craving. As noted by previous researchers (Hill, Weaver & Blundell, 1991; Rodin, Mancuso, Granger & Nelbach, 1991) no relationship between food craving and body mass index was observed. Nor did any relationship exist between worry about intake (eating restraint) and food craving. Nor was it directly related the factor hypothesised to reflect neuroticism. Hence it seems to be a relatively independent phenomenon. In terms of timing, it appeared to be strongly related to the premenstrual phase of the cycle, and in particular its onset appeared to relate to the time at which oestrogen levels start to decrease rapidly (see Chapter 3). It could be that the change, or rate of change in oestrogen induces food craving, although the mechanisms of why this occur remain unclear. This concept is worth considering further however, given the observations of increased intake (which presumably reflects increased desire for food) in several other mammalian species. One potential possibility relates to requirement of fatty acids for the synthesis of steroids. When steroid levels begin to fall, a compensatory mechanism may act to increase material for their production and thereby sustain the steroid environment within the uterus that is necessary for supporting early pregnancy. Prospective assessment of the relationship between energy intake, food craving and oestrogen would serve to indicate whether this might be a viable hypothesis to examine further.

To concentrate now on the nature of food craving and the potential factors determining mood change following intake, several previous studies suggested craved foods to be for carbohydrate-rich foods, and results from Chapters 4 and 6 confirmed the high carbohydrate, high fat and low-protein content of these foods in both diabetic and non-diabetic subjects. This initial observation aligned with Wurtman's hypothesis that women overconsume carbohydrates in the premenstrual phase of the cycle. Several other findings however, conflicted with the suggestion that improvement in mood was in any way linked to changes in serotonergic activity. The initial problem with this hypothesis was the that the subjects described in Chapter 4 noted the beneficial effects of satisfying a craving to occur immediately, and therefore well before any biochemical effects emerged. This time scale was confirmed prospectively in Chapter 6. Subjects in Chapter 4 also stated that it

was the sensory aspects that they particularly liked, such as taste, and this was again confirmed in the high correlations observed between perceived pleasantness of taste and mood in Chapter 6. These observations did not however preclude the possibility that biochemical changes might produce more subtle effects on mood at later time points.

The studies contained within Chapter 5 and 6 did however suggest this to be unlikely. Despite the findings that carbohydrate-rich drinks increased the tryptophan to competing amino acid ratio, this increase was relatively small (around 23% increase from baseline) and did not occur until between 60 and 120 minutes following intake, well after mood changes were observable. Furthermore, findings from Chapter 6 suggested carbohydrate-rich, protein-poor drinks to have no differential effects on mood to protein-rich drinks, despite the likelihood that they were producing differential effects on the tryptophan to competing amino acid ratio. Our lack of observation of any differential change in mood following carbohydrate intake in either Chapter 5 or 6 aligns with much of the literature outlined in Chapter 5 which concluded little effect of carbohydrate intake on mood in either random or self-selected populations. Indeed, of those studies observing an effect on mood following test meals, all were the product of a single research group.

In addition to the lack of association between change in the tryptophan to competing amino acid ratio and the improvement in mood observed, the theoretical likelihood that this mechanism acts as a 'hard wired' control for stabilising mood, as suggested by Wurtman et al (1989), is questionable. The time scale of change in 5HT following intake of carbohydrate is relatively slow. Given that it takes at least sixty minutes to increase plasma levels of tryptophan to competing amino acid ratio, it presumably takes longer to result in increased central serotonergic functioning. It is also liable to change following subsequent energy intake. As such, it reflects a relatively unstable and delayed mechanism to act as a viable 'hard wired' system for the control of mood.

The observation that diabetics report craving for carbohydrate-rich foods is of interest in terms of Wurtman et al.'s (1989) hypothesis. The proposal that craving results from lowered serotonergic functioning remains untested. If true, it is also likely to be a 'hard-wired' mechanism in mammalian species, with some evolutionary purpose. It could therefore remain in insulin-dependent diabetics, irrespective of the acute pancreatic dysfunction that leads to type 1 diabetes. By contrast however, the suggestion that improvement in mood is due to increased serotonergic functioning is not viable in insulin-dependent diabetics, as the effects of carbohydrate intake on serotonergic functioning are insulin mediated. If change in serotonergic activity did indeed result in mood changes, it would be expected that diabetics would not observe positive mood change following intake.

Further, as there would be no positive reinforcement in insulin-dependent diabetics, we might expect their craving for carbohydrate-rich foods to be decreased. This was not however found to be the case.

There is a wealth of evidence both from retrospective reports and the double-blind study outlined in Chapter 6 to suggest that factors other than biochemical alterations produce improvement in mood following satisfaction of cravings, with no evidence found to suggest substrate driven changes in 5HT activity play any role in mood changes observed following satisfaction of a craving.

Despite this, cycle-related food craving remains of interest to examine for several reasons, not least because it may exacerbate premenstrual negative affect in some instances, as discussed above. As noted in Chapter 1, perimenstrual craving appears to be a pervasive phenomenon, that has detrimental effects on both mood, as observed in Chapter 4, and on diabetic control, as outlined in Chapter 8. Potential factors determining its severity, such as change in production of oestrogen would therefore be of interest to examine, using prospective methods of determination.

To summarise, this thesis set out to elucidate the nature of cycle-related food craving and negative mood. The conclusions that are drawn from the experiments described support a cognitive approach to the treatment of premenstrual negative affect, given its strong relationship to negative affectivity. The relationship between food craving and negative affect was found to be complex and dynamic with both symptoms postulated to influence one other in the premenstrual phase of the cycle. Experiments examining reasons for mood changes observed following satisfaction of cravings failed to substantiate any effect of substrate driven change in 5HT activity on mood, and confirmed mood changes following satisfaction of food cravings to be governed by psychological factors, such as the simple enjoyment derived from eating pleasant tasting foods.

Product	%prot	%cho	%fat
Biscuit boost	5.6	47.2	47.2
Coconut boost	6.5	39.0	54.5
Peanut boost	8.3	40.1	51.6
Caramel	4.6	48.9	46.4
Chocolate cream	2.9	67.6	29.5
Chomp	4.7	56.8	38.5
Crunchie	3.8	60.5	35.7
Curly wurly	4.5	60.4	35.1
Double decker	5.1	56.4	38.5
Five centres	3.1	66.7	30.2
Flake	6.3	44.7	49.0
Fudge	2.9	63.0	34.1
Orange cream	2.9	67.6	29.5
Peppermint cream	2.7	66.2	31.1
Picnic	8.5	41.7	49.8
Spira	5.6	43.8	50.6
Strollers	4.7	54.7	40.6
Tasters	6.0	44.8	49.3
Time out	5.4	41.9	52.7
Turkish delight	2.1	78.6	19.3
Twirl	6.5	42.7	50.8
Wispa	5.4	38.2	56.5
Bournville	3.2	47.5	49.3
Bournville fruit and nut	4.1	47.7	48.1
Buttons	5.9	43.9	50.2
White buttons	6.3	44.6	49.1
Dairy milk	5.7	44.0	50.3
Fruit & nut	6.7	44.6	48.7
Nut crisp	5.2	45.1	49.7
Wholenut	6.7	33.8	59.5
Applause	4.3	53.9	41.8
Bounty milk	3.8	46.5	49.7
Bounty dark	2.7	47.7	49.6
Galaxy chocolate	6.8	42.5	50.7
Minstrels	4.9	56.6	38.5
Ripple	6.8	42.5	50.7
M&M choc	4.3	57.3	38.4
M&M peanut	7.9	44.6	47.5
Maltesers	8.1	49.8	42.1
Mars	3.5	61.6	34.9
Milky way	3.9	65.0	31.1
Revels	6.1	52.9	41.0
Snickers	8.2	43.7	48.0
Topic	6.0	45.7	48.4
Tracker-choc	7.2	44.7	48.1
Tracker-nut	7.8	40.9	51.3
Twix	4.7	51.3	44.0
Average	**5.3**	**50.4**	**44.3**

QUESTIONNAIRE 1

GENERAL

1. Please give your DATE OF BIRTH   Day   Month   Year

2. What HEIGHT are you?   Feet   Inches   Cm   or

3. What WEIGHT are you?   Stones   Pounds   Kg   or

4. Are you?

Single	☐ 1
In a relationship	☐ 2
Married	☐ 3
Living with a partner	☐ 4
Separated	☐ 5
Divorced	☐ 6
Widowed	☐ 7

5. Do you have a JOB?

Yes full-time	☐ 1
Yes part-time	☐ 2
Doing voluntary work, part-time	☐ 3
Doing voluntary work, full-time	☐ 4
No	☐ 5

If <u>Yes</u>, what is your job?.. ☐☐

If <u>No,</u> are you?

Unemployed	☐ 6
Housewife	☐ 7
Student	☐ 8

If married/ living with a partner, what is your partner's job?............. ☐☐

6. Do you have any CHILDREN?   No ☐ 0   Yes ☐ 1

If <u>Yes,</u> how many children do you have?   .... ☐☐

What is the age of your YOUNGEST child?   .... ☐☐

7. Are you currently   Pregnant   ☐   1

                                              Breastfeeding   ☐   2

                                              Neither   ☐   3

8. The scales below describe a range of body weights.

A   B   C   D   E   F   G   H   I
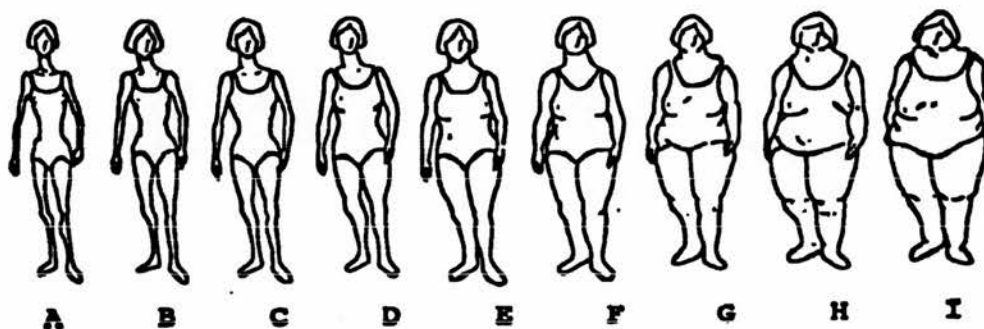
Please pick the letter of the drawing which MOST CLOSELY describes the usual appearance of:

     1..........Yourself now   ▨☐

     2..........Your ideal self (or how you would like to look)   ▨☐

9. Are you currently on a SPECIAL DIET ?   No   ☐   1

                                            Yes   - weight reducing   ☐   2

                                                        - vegetarian   ☐   3

                                                        - vegan   ☐   4

     Please specify condition.........................   - medical   ☐   5

     Please specify condition.........................   - other   ☐   6

10. Are you ALLERGIC to any foods?   No   ☐   0

                                                  Yes   ☐   1

     If **Yes**, please specify..   ▨☐

11. Do you SMOKE regularly?   No   ☐   0

                                                  Yes   ☐   1

     If <u>Yes</u>, In the last 6 months, HOW MANY cigarettes have you smoked

     per day, on average?.......................

11b. If you have EVER SMOKED, how long ago did you stop?.................. ☐☐

YOUR REPRODUCTIVE HEALTH

12. What is the NORMAL length of your menstrual cycle (ie. from the <u>first day</u> of one period to the <u>first day</u> of the next period, eg: 29 days)

Usually ☐☐ days

13. Would you say that your periods are usually

Extremely regular	☐	1
Fairly regular	☐	2
Fairly irregular	☐	3
Extremely irregular	☐	4

14. On this page is a list of physical, behavioural and emotional changes which you may or may not have experienced BEFORE, DURING and AFTER your LAST period. Please put a number in **each box** to indicate whether or not you experienced that symptom and if so how severe that symptom was. The number will indicate how severe the symptom is.

Any symptom should be scored 0-5

0. no symptom
1. very mild
2. mild
3. moderate
4. severe
5. very severe

EXAMPLE OF HOW TO ANSWER

If you felt moderately nauseated and sick in the week before your period, found the nausea severe in the weeks during and after your period but were free of it for the remainder of your period, you would answer as follows:

Week Before Period	During Period	Week After Period	Remainder of Cycle
3	4	4	0

	Week Before Period	During Period	Week After Period	Remainder of Cycle
Bloatedness	☐	☐	☐	☐
Breast tenderness	☐	☐	☐	☐
Period type pains	☐	☐	☐	☐
Depression	☐	☐	☐	☐
Irritableness	☐	☐	☐	☐
Clumsiness	☐	☐	☐	☐
Increase in appetite	☐	☐	☐	☐
Decrease in appetite	☐	☐	☐	☐
Strong urges / cravings for particular foods	☐	☐	☐	☐

(Please specify)...............................

15. Which method of CONTRACEPTION, if any, are you using at the moment?

      None ☐ 1

      Hysterectomy ☐ 2

      Contraceptive pill (Give name)....................... ☐ 3

      Other (Please specify).................................. ☐ 4

16. Do you believe that you suffer from PREMENSTRUAL SYNDROME (PMS)?

      No ☐ 1

      Maybe ☐ 2

      Don't know ☐ 3

      Yes ☐ 4

If <u>Yes</u>, for how long do you think you have suffered from PMS?...................... ☐☐

17. Are you currently taking any MEDICATION either prescribed by your doctor (excluding the Pill) or bought at a chemist / health food shop (eg: vitamins, iron tablets)? If yes, please give the names of these and/or the reasons you take them.

      ....

      ....

If you would be willing to fill in a further questionnaire on this subject we would be extremely grateful for your help, whether or not you experience any changes that you think may be related to your menstrual cycle. Please indicate whether we may send you a further questionnaire by completing the slip below.

☐ No, I do not wish to participate further

☐ Yes, I am willing to participate further

      NAME   ....

      ADDRESS   ....

                      ....

      TELEPHONE daytime:...

                     evening:...

All information will be treated as strictly confidential.

Thank you for taking the time to complete this questionnaire

QUESTIONNAIRE 2

PART 1 - Eating Habits
Please answer each question in this section by placing a tick in the box which corresponds most closely to how you generally behave/ feel. Do not spend too much time thinking about each question.

	Never	Seldom	Some-times	Often	Very Often	Not Applic
1. When preparing a meal are you inclined to eat something?	☐	☐	☐	☐	☐	☐
2. Do you have the desire to eat when you have nothing to do?	☐	☐	☐	☐	☐	☐
3. How often do you try not to eat between meals because you are watching your weight?	☐	☐	☐	☐	☐	☐
4. Do you have a desire to eat when you are depressed or discouraged?	☐	☐	☐	☐	☐	☐
5. If you walk past a snackbar or café, do you have the desire to buy something delicious?	☐	☐	☐	☐	☐	☐
6. If food tastes good to you, do you eat more than usual?	☐	☐	☐	☐	☐	☐
7. If you have put on weight, do you eat less than you usually do?	☐	☐	☐	☐	☐	☐
8. Do you have the desire to eat when you are bored or restless?	☐	☐	☐	☐	☐	☐
9. Do you try to eat less at mealtimes than you would like to eat?	☐	☐	☐	☐	☐	☐
10. Do you have the desire to eat when you are irritated?	☐	☐	☐	☐	☐	☐
11. If you have something delicious to eat, do you eat it straight away?	☐	☐	☐	☐	☐	☐
12. How often do you refuse food or drink offered because you are concerned about your weight?	☐	☐	☐	☐	☐	☐
13. If food smells and looks good to you, do you eat more than usual?	☐	☐	☐	☐	☐	☐
14. Do you watch exactly what you eat?	☐	☐	☐	☐	☐	☐
15. Do you have the desire to eat when you are cross?	☐	☐	☐	☐	☐	☐

	Never	Seldom	Some-times	Often	Very Often	Not Applic
16. Do you have the desire to eat when something unpleasant is about to happen?	☐	☐	☐	☐	☐	☐
17. Do you deliberately eat foods that are slimming?	☐	☐	☐	☐	☐	☐
18. If you walk past the baker, do you have the desire to eat something delicious?	☐	☐	☐	☐	☐	☐
19. Do you have the desire to eat when somebody lets you down?	☐	☐	☐	☐	☐	☐
20. When you have eaten too much, do you eat less than usual the following days?	☐	☐	☐	☐	☐	☐
21. Do you get the desire to eat when you are anxious, worried or tense?	☐	☐	☐	☐	☐	☐
22. If you see others eating, do you also have the desire to eat?	☐	☐	☐	☐	☐	☐
23. Do you deliberately eat less in order not to become heavier?	☐	☐	☐	☐	☐	☐
24. Do you have the desire to eat when things are going against you or when things have gone wrong?	☐	☐	☐	☐	☐	☐
25. Do you eat more than usual when you see others eating?	☐	☐	☐	☐	☐	☐
26. How often in the evening do you try not to eat because you are watching your weight?	☐	☐	☐	☐	☐	☐
27. Do you have the desire to eat when you are disappointed?	☐	☐	☐	☐	☐	☐
28. If you see or smell something delicious, do you have a desire to eat it?	☐	☐	☐	☐	☐	☐
29. Do you have the desire to eat when you are emotionally upset?	☐	☐	☐	☐	☐	☐
30. Do you take into account your weight with what you eat?	☐	☐	☐	☐	☐	☐
31. Do you have the desire to eat when you are feeling lonely?	☐	☐	☐	☐	☐	☐
32. Can you resist eating delicious foods?	☐	☐	☐	☐	☐	☐
33. Do you have the desire to eat when you are frightened?	☐	☐	☐	☐	☐	☐

PART II - *Reproductive Health*

1. Considering your periods in the last six months, how many
   days BLEEDING do you usually have?

   Usually [ ][ ] days

2. What is the NORMAL length of your menstrual cycle? (ie:
   from the <u>first day</u> of one period to the <u>first day</u> of the next)

   Usually [ ][ ] days

3.   Below is a list of physical, behavioural and emotional changes which you may or
may not have experienced BEFORE, DURING and AFTER your <u>LAST</u> period. Please put
a number in <u>each</u> box to indicate whether or not you experienced that symptom and if so
how severe that symptom was.

	Week before period	During period	Week after period	Rest of cycle		Week Before period	During period	Week after period	Rest of cycle
Mood swings	☐	☐	☐	☐	Lack self-control	☐	☐	☐	☐
Feel tired/ lack energy	☐	☐	☐	☐	Tend to smoke more	☐	☐	☐	☐
Tender breasts	☐	☐	☐	☐	General aches/ pains	☐	☐	☐	☐
Headaches	☐	☐	☐	☐	Weight gain	☐	☐	☐	☐
Nausea and/ or sickness	☐	☐	☐	☐	Hot flushes/ sweats	☐	☐	☐	☐
Feel bad about myself	☐	☐	☐	☐	Easily upset	☐	☐	☐	☐
Feel depressed	☐	☐	☐	☐	Feel tense	☐	☐	☐	☐
Get angry for no good reason	☐	☐	☐	☐	Drink more alcohol than usual	☐	☐	☐	☐
Strong urges/craving for particular foods	☐	☐	☐	☐	Change in sleeping patterns	☐	☐	☐	☐

(Please specify).................................   (Please specify)..................................

Are there any cycle related symptoms that are not mentioned on the previous page, but that
you experience? If so, please write below:

....   ☐ ☐ ☐ ☐   ....   ☐ ☐ ☐ ☐

Part III- Diabetes

1. HOW FREQUENTLY do you check your blood sugar level?

Several times a day	☐	1
At least twice a day	☐	2
Daily	☐	3
Less than once a day	☐	4
Less than once a week	☐	5

2. At what TIME(S) OF DAY do you usually check your blood glucose levels? (eg: morning, before dinner, before bed, etc.)

    ....

3. Do you increase or decrease your INSULIN dose if you want to eat more or less than your daily exchanges allow?

Never	☐	1
Only on special occassions	☐	2
Whenever I feel the need	☐	3

4. Do you notice any CHANGES in your blood sugar level that you think may be related to your menstrual cycle?

    No ☐

    Yes ☐ If yes, please tick the box that best describes these changes:

	Decrease in blood sugar	No change in blood sugar	Increase in blood sugar
In the week before your period	☐	☐	☐
During your period	☐	☐	☐
In the week after your period	☐	☐	☐
For the rest of the cycle	☐	☐	☐

5. Please state why you think that these changes in your blood sugar level occur (ie: is it due to you eating more or less carbohydrate than is usual for you, or does it occur without you changing the amount of carbohydrate that you eat?)

    ....

    ....

6. Are these changes in your blood sugar level often large enough to make you ALTER your insulin?

    No ☐

    Yes ☐

    If <u>Yes</u>, by how many UNITS would you alter your daily insulin requirement? (Please indicate the week(s) of your menstrual cycle in which this change in insulin is required, and whether you require more or less insulin than usual.)

    ....

PART IV- *Urges or cravings for particular foods*

This section asks about urges that you may have to eat particular food(s) that you think are related to your menstrual cycle. Most questions should be answered in your own words, though questions 2-6 should be answered as shown in the box below.

EXAMPLE OF HOW TO ANSWER

Each rating should be scored 0-5

If you had food cravings most of the time in the weeks before and after your period, only a little of the time during your period, and did not have them at all for the remainder of the cycle, you would answer as follows:

0. None of the time
1. A little of the time
2. Some of the time
3. A lot of the time
4. Most of the time
5. All of the time

Week before period	During period	Week after period	Remainder of cycle
4	1	4	0

Do you <u>ever</u> experience strong urges or cravings to eat a particular type of food?

No ☐   Please turn to PART V, on page 7

Yes ☐   If **Yes**, Taking a typical example of a food for which you might sometimes have urges:

1.   What food(s) is it most likely to be?   Food(s) X = ...

2.   How often do you experience urges to eat this food/ these foods?(Please fill in **each** box)

0. None of the time
1. A little of the time
2. Some of the time
3. A lot of the time
4. Most of the time
5. All of the time

Week Before Period	During Period	Week After Period	Remainder of Cycle
☐	☐	☐	☐

3.   How strong are these urges?

0. Not applicable
1. Not at all strong
2. Slightly strong
3. Moderately strong
4. Very strong
5. Extremenly strong

Week Before Period	During Period	Week After Period	Remainder of Cycle
☐	☐	☐	☐

4.   How difficult is it to ignore these urges?

0. Not applicable
1. Not at all difficult
2. Slightly difficult
3. Moderately difficult
4. Very difficult
5. Extremely difficult

Week Before Period	During Period	Week After Period	Remainder of Cycle
☐	☐	☐	☐

5. How much of the time do you tend to satisfy your urge?

| 0. None of the time
1. A little of the time
2. Some of the time
3. A lot of the time
4. Most of the time
5. All of the time | Week
Before
Period
☐ | During
Period
☐ | Week
After
Period
☐ | Remainder
of
Cycle
☐ |

6. Is there any time of the day when you notice your cravings to be particularly strong?

| 0. Not applicable
1. No particular time
2. Morning
3. Afternoon
4. Evening
5. All day | Week
Before
Period
☐ | During
Period
☐ | Week
After
Period
☐ | Remainder
of
Cycle
☐ |

7. Is there any particular place where you are most likely to have an urge for Food X?

....

8. What do you most like about eating Food X?..

....

9. Is there anything that you dislike about eating Food X?...

....

10. How much of Food X do you usually eat, at any one time? (Please give quantity, eg:

2 spoonfuls)..

11. The following questions are about how you feel before, during and after you get a craving to eat a particular food. Please answer in your own words, how you tend to feel:

i. when you first get a craving/ strong urge for a particular food (ie: happy, sad, no particular frame of mind, etc.)

....

ii. whilst you are eating the food craved

....

iii. shortly after you have eaten the food

....

iv. a couple of hours after having eaten the food craved

....

v. if you do not eat the food

....

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PART V - Health and Well-being

1. How often do you EXERCISE? (ie: for more than 20 minutes at any one activity, such as cycling, swimming, squash, aerobics, tennis, badminton, basketball, etc.)

Daily	☐	1
At least once a week	☐	2
At least once a fortnight	☐	3
At least once a month	☐	4
Never	☐	5

2. How much of the time, during the last month:
    a) Have you felt very nervous?

1	2	3	4	5	6
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

    b) Have you felt so down in the dumps that nothing could cheer you up?

1	2	3	4	5	6
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

    c) Have you felt calm and peaceful?

1	2	3	4	5	6
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

    d) Have you felt downhearted and low?

1	2	3	4	5	6
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

    e) Have you been happy?

1	2	3	4	5	6
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

3. Over the last 3 months, how much STRESS would you say you have been under?

A great deal of stress	☐	1
Some stress	☐	2
A little stress	☐	3
No stress	☐	4

4. How HAPPY is the relationship between you and your partner ?

Very happy	☐	1
Fairly happy	☐	2
Not very happy	☐	3
Not at all happy	☐	4

5. Did you suffer from any MOOD CHANGES after the birth of any of your children?
    (Please tick the appropriate box below). If you have no children, go to question 6.

    No depression at all ☐ 1

    No depression lasting a week or more ☐ 2

    Depressed for more than a week but not badly ☐ 3

    Very depressed for more than a week but did not seek help ☐ 4

    Very depressed for a week or more and saw a doctor ☐ 5

6. Have you ever received treatment from any doctor for any
    gynaecological disorder (eg: heavy periods, polycystic ovaries,
    endometriosis, etc)?

    No ☐
    Yes ☐

    If <u>Yes.</u> please give the name of the disorder..

7. a) Have you ever suffered from, or do you suffer from, DEPRESSION?
       (Excluding POST NATAL depression)

       No ☐ 1
       Yes, in the past ☐ 2
       Yes, at present ☐ 3

    b) If <u>Yes.</u> Are you being treated, or were you treated, with anti-depressants?

       No ☐ 1
       Yes ☐ 2

    c) For how long have you been, or were you, treated?...............................

8. a) Have you ever suffered, or do you suffer from either anorexia or bulimia nervosa?

	<u>Yes, in the past</u>	<u>Yes, at present</u>	<u>No</u>
Anorexia nervosa	☐	☐	☐
Bulimia nervosa	☐	☐	☐

    b) If you think that you have ever suffered, or still suffer from either of the above,
       for how long do you think that you (have) suffered?...............................

*The information that you have provided for us will be treated confidentially and
will be used for research purposes only. If you would be willing for us to contact
you again please tick the appropriate box below.*

☐   Yes I would be willing to be contacted
☐   No I do not wish to be contacted

Thank you for taking the time to complete this questionnaire

Table 2.5 - Principal components analysis of the Dutch Eating Behaviour Questionnaire. Bold type indicates significant loadings of ≥.35.on factors at p<0.01, using the Burt-Banks formula, (Childs, 1990).

Questions asked	Emotional eating			Eating restraint			External eating		
	Diab	Com.	Self.	Diab	Com.	Self.	Diab	Com.	Self.
<u>Do you have the desire to eat when:</u>									
2. You have nothing to do	**.43**	**.40**	.20						**.43**
4. You are depressed or discouraged	**.61**	**.68**	.29						.31
8. You are bored or restless	**.53**	**.44**	.28						**.44**
10. You are irritated	**.71**	**.65**	**.62**						
15. You are cross	**.75**	**.67**	**.68**						
16. Something unpleasant is about to happen	**.56**	**.69**	.70						
19. Somebody lets you down	**.54**	**.66**	**.61**						
21. You are anxious, worried or tense	**.70**	**.77**	**.62**						
24. Things are going against you	**.72**	**.76**	**.61**						
27. You are disappointed	**.75**	**.73**	**.63**						
29. You are emotionally upset	**.71**	**.77**	**.65**						
31. You are feeling lonely	**.56**	**.46**	.33						
33. You are frightened	**.47**	**.36**	**.61**						
3. How often do you try not to eat between meals because you are watching your weight?				**.63**	**.68**	**.63**			
7. If you have put on weight, do you eat less than you usually do?				**.51**	**.65**	**.71**			
9. Do you eat less at mealtimes than you would like to eat?				**.56**	**.71**	**.55**			
12. How often do you refuse food or drink because you are worried about your weight?				**.70**	**.80**	**.73**			
14. Do you watch exactly what you eat?				**.47**	**.63**	**.61**			
17. Do you deliberately eat foods that are slimming?				**.74**	**.67**	**.66**			
20. When you have eaten too much, do you eat less than usual the following day?				**.65**	**.74**	**.68**			
23. Do you deliberately eat less in order not to become heavier?				**.77**	**.86**	**.79**			
26. How often in the evening do you try not to eat because you are watching your weight?				**.55**	**.73**	**.66**			
30. Do you take into account your weight with what you eat?				**.73**	**.77**	**.81**			
1. When preparing a meal are you inclined to eat something?							**.44**	.33	**.36**
5. If you walk past a cafe, do you have the desire to eat something delicious?							**.55**	**.65**	**.62**
6. If food tastes good to you, do you eat more than usual?							**.58**	**.63**	**.62**
11. If you have something to eat, do you eat it straight away?							**.51**	**.42**	**.44**
13. If food smells and looks good to you do you eat more than usual?							**.61**	**.66**	**.60**
18. If you walk past the baker do you have the desire to eat something delicious?							**.58**	**.66**	**.62**
22. If you see others eating do you also have the desire to eat?							**.70**	**.49**	**.59**
25. Do you eat more than usual when you see others eating?							**.49**	**.47**	**.53**
28. If you see or smell something delicious do you have the desire to eat it?							**.71**	**.67**	**.73**
32. Can you resist eating delicious foods?							**.59**	**.50**	**.57**

DIARY BOOKLET

DAILY DIARY FOR SEVEN DAYS
MONDAY TO SUNDAY

SUBJECT NUMBER ☐☐☐☐

MONDAY'S DATE ☐☐/☐☐/☐☐

INSTRUCTIONS

1. Please start your diary-keeping on the day asked. If this does not happen to be a Monday just put a line through the earlier unused days (even if this means you only use the last day in the booklet).

2. Please enter Monday's date on the front cover.

3. Each night please rate how you have felt that day for all the items listed. If you happen to forget please complete the diary as soon as possible the next day, or if you can no longer remember, put a line through that day.

4. Please keep your diaries in a safe place until it is time for you to return them.

5. Where applicable, please give the names of foods craved.

THANK YOU

*

RATINGS:

Please rate your mood and physical state by ringing the appropriate number alongside each item

0 = Not at all

1 = Very mild

2 = Mild

3 = Moderate

4 = A lot

5 = Extremely

MONDAY

MOOD

	Not at all			Moderate		Very severe
Feeling tense	0	1	2	3	4	5
Mood up and down	0	1	2	3	4	5
Irritable	0	1	2	3	4	5
Cheerful, happy	0	1	2	3	4	5
Angry without reason	0	1	2	3	4	5
Miserable, depressed	0	1	2	3	4	5

PHYSICAL

	Not at all			Moderate		Very severe
Menstrual bleeding	0	1	2	3	4	5
Feeling bloated	0	1	2	3	4	5
Energetic, active	0	1	2	3	4	5
Tender breasts	0	1	2	3	4	5
Period-type pain	0	1	2	3	4	5
Fatigued, tired	0	1	2	3	4	5
Craving for foods	0	1	2	3	4	5
Specify................						

DRUGS/ MEDICATION
Please note any taken today:..

NOTES
If anything has happened today which has markedly affected the way you feel i.e. sad, happy, worried or angry, please note it in the space on the page opposite.

TUESDAY

MOOD

	Not at all			Moderate		Very severe
Feeling tense	0	1	2	3	4	5
Mood up and down	0	1	2	3	4	5
Irritable	0	1	2	3	4	5
Cheerful, happy	0	1	2	3	4	5
Angry without reason	0	1	2	3	4	5
Miserable, depressed	0	1	2	3	4	5

PHYSICAL

	Not at all			Moderate		Very severe
Menstrual bleeding	0	1	2	3	4	5
Feeling bloated	0	1	2	3	4	5
Energetic, active	0	1	2	3	4	5
Tender breasts	0	1	2	3	4	5
Period-type pain	0	1	2	3	4	5
Fatigued, tired	0	1	2	3	4	5
Craving for foods	0	1	2	3	4	5
Specify................						

DRUGS/ MEDICATION
Please note any taken today:..

NOTES
If anything has happened today which has markedly affected the way you feel i.e. sad, happy, worried or angry, please note it in the space on the page opposite.

PLEASE COMPLETE THIS PAGE WHILST YOU ARE EATING THE FOOD

Time of day: _____

Please give the name of the food that you are eating _____

Please place a vertical mark on each of the lines below, to describe how good the food/ drink tastes:

Extremely
pleasant ————————————————————
Extremely
unpleasant

Please place a vertical mark on each of the lines below, to describe how you are feeling now:

Happy ———————————————— Sad

Tense ———————————————— Relaxed

Alert ———————————————— Tired

Angry ———————————————— Calm

Proud ———————————————— Guilty

Hungry ———————————————— Full

Please give the total amount of food/ drink eaten (when you finish) _____

IF YOU HAVE TAKEN A DRINK, PLEASE ALSO GIVE THE NUMBER OF THE DRINK ON THE CONTAINER _____

PLEASE COMPLETE THIS PAGE WHEN YOU FIRST NOTICE THE CRAVING

Time of day: _____   Date: _____

For what food do you have a strong urge/ craving ? _____

How strong is the craving?

Not at all   Slightly   Moderately   Very   Extremely
Strong   Strong   Strong   Strong Strong

Please place a vertical mark on each of the lines below, to describe how you are feeling now:

Example: If you felt quite relaxed, you might place a mark as shown below

Tense ————————|———— Relaxed

Happy ———————————————— Sad

Tense ———————————————— Relaxed

Alert ———————————————— Tired

Angry ———————————————— Calm

Proud ———————————————— Guilty

Hungry ———————————————— Full

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PLEASE COMPLETE THIS PAGE EITHER:
A: ONE HOUR AFTER THE CRAVING STARTED
B: ONE HOUR AFTER EATING THE FOOD

Time of day: _____

Have you eaten any food since completing page 2? YES / NO

If YES, please write down what you have

eaten, and the time at which you ate.

_____
_____
_____

Please place a vertical mark on each of the lines below, to describe how you are feeling now:

Happy |_____| Sad

Tense |_____| Relaxed

Alert |_____| Tired

Angry |_____| Calm

Proud |_____| Guilty

Hungry |_____| Full

PLEASE COMPLETE THIS PAGE EITHER:
A: TWO HOURS AFTER THE CRAVING STARTED
B: TWO HOURS AFTER EATING THE FOOD

Time of day: _____

Have you eaten any food since completing page 3? YES / NO

If YES, please write down what you have

eaten, and the time at which you ate.

_____
_____
_____

Please place a vertical mark on each of the lines below, to describe how you are feeling now:

Happy |_____| Sad

Tense |_____| Relaxed

Alert |_____| Tired

Angry |_____| Calm

Proud |_____| Guilty

Hungry |_____| Full

FOOD AND DRINK RECORD

NAME ....

DATE OF BIRTH

Day	Month	Year
☐☐	☐☐	☐☐

CODE NO. ....

PLEASE

Write down *everything* you eat and drink each day. Include all meals, snacks, plus sweets and drinks etc.

Only write down what you *actually* eat, not what you start off with on your plate. DO NOT include leftovers on your food record.

Write down the foods and drinks immediately after you have eaten them, NOT from memory at the end of the day.

Remember, it is *very important* that you do not change what you normally eat while you are keeping this record

DESCRIBING FOOD AND DRINK - GUIDELINES

Please write down what you have to eat and drink giving as much detail as possible about each item

1. Cooking methods

Write down how your food has been cooked, eg:
- Are your eggs boiled, poached or scrambled?
- Are your potatoes boiled, mashed or chipped?
- Is your bacon grilled or fried?

2. Brand names

Write down the brand names of foods where you can, eg:
- Blue Band margarine
- Jacobs cream crackers

3. Names

Name the type of biscuit, cake, cereal you eat, eg: digestive biscuit, fruit cake, weetabix
Name the type of cheese, fish or meat you eat, eg: cheddar cheese, haddock, pork chop

4. Made up dishes

Please write down what the dish is called and give the ingredients if you can, eg: Stew (with beef, carrots, onions and gravy)

5. Sauces and dressings

Please do not forget to include sauces (eg: tomato ketchup, cheese sauce), salad dressings and gravy when completing your record

TO SHOW THE AMOUNT OF FOOD YOU EAT

In the 'amount eaten' column of your record, you should write down the quantity of each item that you have eaten or drunk. Use the following guidelines to help you:

1. Give the number of cups of tea/ coffee, rashers of bacon, eggs biscuits, sweets, slices of meat, slices of bread (remember to describe the type of bread and whether it is thick, medium or thin sliced)

2. The amount you eat of some foods can be described as:
   - Cupfuls, eg: cereal, soup, drinks
   - Tablespoonfuls, eg: vegetables, cereals, casseroles, minced meat, gravy sauces, baked beans, puddings
   - Teaspoonfuls, eg: sugar, jam, butter

3. Use comparisons for describing the amount you have eaten, eg:
   - Potato (size of hen's egg)
   - Cheese (size of ordinary matchbox)

4. Use the weights marked on tinned and packet foods, eg: half a 15oz can of baked beans

5. If you need to ,describe the amounts of food you eat as:
   - Small/ medium/ large
   or - Thin/ medium/ thick eg: small banana, thick slice cake

POINTS TO REMEMBER

If you wake up in the middle of the night and have something to eat or drink, write down what you have had on the record of the day you have just finished

If you wake up and have something to eat or drink after 5am in the morning, start a new page on your record and write the new day and date on each page that you use for that day

Use as many pages for each day's record as you need

Remember to write only one item on each line on your record, ie: if you have a cheese and tomato sandwich write each of the ingredients (the cheese, bread, butter, tomato) on separate lines not forgetting to write how much you ate of each in the 'amount eaten' column

Leave a line between each meal or snack that you have

Remember to write down in your record whenever you have ANYTHING to eat or drink

If you eat away from home, eg: restaurant, friends, take your record with you and write down what you have eaten as normal

It is IMPORTANT that you write down foods and drink immediately after you have eaten and NOT from memory at the end of the day

EXAMPLE

DESCRIPTION OF FOOD AND DRINK

Day.........Monday.................. Date......22nd February 1993...

One item per line

Leave a line after each snack or meal

Start a separate page for each day

TIME	AMOUNT EATEN	DETAILS OF FOOD AND DRINK	Leave Blank
6 am	1 cup	tea	
9 am	2 cups	tea	
	2 med. slices	white toasted bread	
	2 teaspoons	butter	
	2 teasp.	marmalade	
11 am	1 mug	coffee	
	3	custard creams	
11.45 am	2	peppermint polos	
12 noon	2 small	grilled lamb chop	
	3 tablespoons	thick gravy	
	3 scoops	mashed potato	
	1 tabs	peas (frozen)	
	thin slice	fruit cake	
3 pm	4 squares	Cadbury's milk chocolate (30p bar)	

TIME	AMOUNT EATEN	DETAILS OF FOOD AND DRINK	Leave blank
4 pm	1 cup tea		
6 pm	twice size of matchbox	Scottish cheddar cheese	
	1/2 inch	cucumber (not peeled)	
	2 medium thin slices	cold boiled ham (with fat)	
	2 thick slices	Mother's Pride white bread (no butter)	
	2 tablespoons	apple crumble (homemade)	
	3 tablespoons	custard	
7.30 pm	2 med. glasses	white wine	
10.30pm	1 mug	drinking chocolate (made with milk)	
	2	oatcakes (plain)	
3 am	small glass	milk	

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TIME	AMOUNT EATEN	DETAILS OF FOOD AND DRINK	Leave blank

DESCRIPTION OF FOOD AND DRINK

Day............

Date............

One item per line

Leave a line after each snack or meal

Start a separate page for each day

TIME	AMOUNT EATEN	DETAILS OF FOOD AND DRINK	Leave Blank

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