Feeding behaviour and appetite in young children with non-organic failure to thrive

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FEEDING BEHAVIOUR AND APPETITE IN YOUNG CHILDREN WITH NON-ORGANIC FAILURE TO THRIVE

BY

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ABSTRACT

The study reported in this thesis was aimed at investigating taste preferences and caloric compensation in one to two year old children with non-organic failure to thrive (FTT) as compared to normally developing children of the same age. The sample studied included 28 cases with non-organic FTT, and 28 controls with normal growth.

The study comprised two experiments. The first tested the child's relative preference for sucrose sweetened solutions versus water. The test session included six 60 second presentations of tastant at three levels of concentration i.e. water, 0.2 Mol sucrose solution, and 0.4 Mol sucrose solution, with at least 30 second intervals between presentations. The second experiment measured caloric compensation, by testing the child's intake from a standard meal on two occasions, after a pre-load of no-calorie or high-calorie drink. In addition meal-time behavioural observations were made, and information about the child's feeding history was obtained from parent reports.

All children regardless of whether they were failing to thrive or not preferred 0.2 Mol sucrose solution to 0.4 Mol sucrose and to water. The energy intake of children with FTT was lower than that of controls, and meal-time behaviours showed some differences between groups in both the child and parent behaviours. Unlike the controls the FTT children showed no caloric compensation, but showed a trend towards the opposite of compensation. Analysis of growth data showed that FTT in the sample studied was present from birth.

DEDICATION

To my daughter Dambisa

"Imiti ikula e'mpanga"

[Ancient African (Bemba) proverb. Literally meaning 'sprouting trees are the forest', it refers to children, who like the forest that sustains us, are to be valued and nurtured]

ACKNOWLEDGEMENTS

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The RVI Pharmacy staff, especially Mr. John Gillroy, and Mr. John Stapleton, played a major role in the research by preparing blind randomised pre-load drinks for the study, and for this I thank them. My thanks also go to the staff of RVI Catering and the Wellcome Laboratory for letting me use their space, and also to the staff of Newcastle Nutrition for their co-operation. My special thanks go to all the parents who allowed their children to participate in the research, for without them this project would not have been possible.

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CHAPTER ONE

Introduction

1.1 Overview of the thesis

The research reported in this thesis was aimed at investigating taste preferences and caloric compensation in one to two year old children categorised as failing to thrive without organic cause, as compared to normally growing children of the same age.

Chapter One of this thesis is an introduction to the subject studied, and it reviews the existing literature on the concepts relating to, and the issues surrounding growth, feeding and failure to thrive in infancy and early childhood. A number of hypotheses have been drawn on the basis of the existing literature, and are presented at the end of this chapter.

The methods and procedures used in the two main investigations of this research i.e. test of preference for sucrose sweetened solutions versus water, and caloric compensation are described in Chapter Two. Some growth data, demographic information and parent reports on the child's feeding history, are presented in Chapter Three.

The findings of the main investigations (described in Chapter Two) are presented in two chapters. Chapter Four contains the results of the test of preference for sucrose. The remaining results are in Chapter Five which is in three parts. The first part describes the results of the caloric compensation investigation. The second part describes the procedures and results of the test of reliability of the measures used in the behavioural observations. The third part of Chapter Five describes the results of the observation of meal-time behaviour during the standard test meal (i.e. the meal given as part of the caloric compensation investigation).

The findings of this study are discussed in the light of the literature reviewed in Chapter One. A general discussion of the findings of the research is presented in Chapter Six.

1.2 Changing perspectives of non-organic failure to thrive: conceptualisation and aetiology

Although the study of failure to thrive (FTT) goes back a century, there is still a lot of confusion and controversy about FTT. This lack of understanding is evident in the terms that have been used for FTT over the years, including: hospitalism, anaclitic depression, institutionalism, environmental retardation, maternal deprivation syndrome, psychosocial deprivation dwarfism, deprivational dwarfism, deprivation syndrome, failure to thrive, environmental failure to thrive, and failure to thrive syndrome (Woolston, 1991). In recent years the term 'failure to thrive' has come to be preferred. The terms used over the years reflect differing conceptions of the aetiology of failure to thrive, and some of these will be discussed later.

'Essentially, failure to thrive refers to children who fail to gain weight adequately and therefore do not achieve a normal or expected rate of growth' (Whitten, Pettit, and Fischhoff, 1969). The term FTT is sometimes used interchangeably with 'growth retardation' although the latter is usually used to refer to older children while FTT is reserved for infants (Skuse, 1985).

Woolston (1991), however, defined FTT to include not only marked deceleration of weight gain, but also slowing or disruption of acquisition of emotional and social developmental milestones. But whether the latter ought to be part and parcel of the definition of FTT is debatable since research on these aspects of FTT has not yielded consistent results (Powell et al., 1995). Deceleration of linear growth and head circumference growth are also associated with FTT but are not essential to its definition (Woolston, 1991).

Although all FTT is organic in manifestation, its aetiologies may be organic or non-organic, thus the distinction between organic failure to thrive and non-organic failure to thrive. Organic FTT results when the lack of weight gain is caused by organic factors within the child such as underlying disease. For example, failure to thrive is common among infants and young children with cerebral palsy. The communication difficulties, and severe degrees of oral-motor dysfunction associated with the organic disorder may lead to severe feeding difficulties which in turn contribute to insufficient nutritional intake and poor growth (Skuse, 1993; Reilly and Skuse 1992). The number of primary medical illnesses that can be associated with FTT is large, but physical illnesses contributing to FTT can be identified relatively easily through thorough paediatric history, physical examination, and minimal screening laboratory tests (Woolston, 1991). In a study aimed at distinguishing organic from non-organic FTT, the organic aetiologies diagnosed included chronic diarrhea, chronic urinary tract infection, intrauterine growth retardation, cystic fibrosis, congenital lung malformation, liver disease, and microcephaly or other CNS (central nervous system) defect (Rosenn, Loeb and Jura, 1980).

Non-organic FTT is diagnosed when there is no known underlying organic cause. According to Harris (1993) non-organic FTT is 'weight faltering down across centile lines to a point below the third centile on standardised weight charts. Weight faltering would have to last for a period longer than six months with onset typically at three to nine months of age. Such weight faltering would also have to occur in the absence of any organic disease which might explain such loss'. Essentially the assumption has been that if a child does not have an organic illness, then the FTT must have environmental or social aetiology (Rosenn et al., 1980). But it is possible that the cause is within the child, such as some aspect of their feeding control system, but not illness.

The distinction between organic and non-organic FTT may not always be easy to draw. Infants initially diagnosed as non-organic FTT are sometimes found to have associated organic disorder. Although such an organic disorder is not usually thought by itself to be serious enough to lead to growth faltering, it may in interaction with other factors contribute to feeding problems (Harris, 1993). There is for instance, a possibility that oral motor difficulties have a role to play in some cases of organic and non-organic FTT. In children with Turner's syndrome, a neurological disorder, oral motor difficulties is the major reason for under-nutrition (Skuse et al., 1995). However, oral motor difficulties have also been found in a primarily non-organic FTT sample of children from a deprived inner-city area recruited from a community population (Heptinstall et al., 1987). This group was observed to have significantly more oral incoordination than a group of pair-matched controls from the same area, which suggests that the oral motor problems in this case was most likely associated with non-organic FTT.

Furthermore, some organic factors may be caused by the malnutrition associated with FTT as well as aggravating its course. Woolston (1991) suggests that malnutrition may for instance, suppress immune functions so that children with FTT are at risk for chronic respiratory and gastro-intestinal infections. The illnesses that these infections produce may interfere with the infant's ability to ingest adequate food, which exacerbates the infant's state of malnutrition. Furthermore, infants with FTT are at risk for vitamin and mineral deficiencies, especially of calcium, iron, and zinc. These deficiencies result in blood abnormalities and metabolic disturbances that worsen the infant's clinical state.

Woolston (1991) summarises organic factors in the concept that illnesses that coexist with FTT belong in a continuum, from those that actually cause malnutrition at one end, to those that are caused by malnutrition at the other.

In this thesis, the term failure to thrive (FTT) is used to denote non-organic FTT unless otherwise specified.

"Traditionally, the child's growth failure has been attributed to inadequate parenting in the form of 'maternal deprivation syndrome'" (Boddy and Skuse, 1994). The maternal deprivation syndrome described either infants living in institutions or in their own homes who did not receive adequate mothering in the form of emotional warmth, social contact, and physical handling, and tended to be apathetic and withdrawn (Whitten et al. 1969). This notion was derived from research by Spitz and others (e.g. Spitz, 1945, 1946) which was concerned with the impact of separation from the mother early in life (Boddy and Skuse, 1994).

In 1945 Spitz recognised the role of nurture and coined the term 'anaclitic depression' to describe growth failure in infants separated from their mothers. Based on research on institutionalised infants, Spitz (1945, 1946) concluded that prolonged mother-child separation tended to result in psychogenic disorders, notably 'anaclitic depression' and 'hospitalism'. The symptoms of anaclitic depression included delayed physical growth and psychosocial development. It was further argued that mental contentment in infants and young children was created by a loving relationship with a mother figure. This psychic state produced an unnamed physical process that caused growth. While a minimal nutritional state was obviously required for life, mental contentment was held to be more crucial than energy intake for growth (Widdowson, 1951; Woolston, 1991).

Despite the widespread acceptance of the 'emotional deprivation' perspective the early studies conducted to support this theory were methodologically flawed, and have been heavily criticised and discredited (Woolston, 1991; Boddy and Skuse, 1994). Research into the 'maternal deprivation syndrome' was based on the premise that children who fail to thrive were receiving adequate nutrition, and so their poor growth was a direct consequence of emotional deprivation (Boddy and Skuse, 1994). Whitten et al. (1969) set out to test this hypothesis and conducted a study on a group of hospital referred children who were failing to thrive and were thought to have experienced inadequate parenting. The majority of these children gained weight when they had an adequate energy intake, even without stimulation from a caregiver. These results led to the conclusion that maternally deprived infants were underweight because of under-eating, which was secondary to not being offered adequate food or not accepting it, and not because of some psychologically induced defect in the absorption mechanism.

It has since been widely argued that whatever other factors may be at play, all failure to thrive is primarily caused by under-nutrition (Whitten et al., 1969; Skuse, 1985; Boddy and Skuse, 1994; McCann et al., 1994). However, it is still often assumed that the under-nourishment in itself has its origins 'in an antagonistic or chaotic emotional life of the parents and because of problems of interaction between mother and child' (Boddy and Skuse, 1994).

According to Woolston (1991) the persistence of the 'love versus food' debate has been due to the fact that FTT is a syndrome with two components, a physical component (i.e. weight gain and growth deceleration) and a behavioural/emotional component (i.e. developmental delays). Inadequate energy intake is the primary cause of growth deceleration while emotional and socio-economic deprivation is the primary cause of the developmental delays.

However, the case is not always as clear-cut as this, in that factors may often be intertwined. For instance, the depression-like symptoms associated with FTT may reduce the infant's interest in feeding, rendering the infant harder to feed, and similarly, the significant malnutrition associated with FTT can produce a state of apathetic withdrawal (Woolston, 1991).

The recognition of the fact that various factors in FTT may interact has led to a more multi-dimensional perspective in which a more balanced view of the parent-child relationship is favoured (Skuse, 1985; Harris, 1993; Boddy and Skuse, 1994). According to Skuse (1985) for example, the various factors, particularly those surrounding the mother-child interaction, may be inter-related: early in the causal chain of events, provoking maternal behaviours may be different from those that emerge subsequently, and the pace and direction of a mother's influence is to a large extent determined by the child. Demanding growth-retarded babies may make their mother tense and anxious, which leads her to handling them aggressively, while slow apathetic babies will tend to be ignored. Inadequate nutrition and feeding difficulties may interact; it is possible for example that insufficient food may be provided because of maternal disorganisation and/or lack of maternal awareness as to how much the baby consumes. Alternatively, a depressed or over anxious mother may cause her child to be tense and subsequently not feed well. The mother's emotional problems may render her intolerant of the behaviour of the child and she may habitually stop the feed prematurely, leaving the child angry and hungry. 'A vicious circle thus develops to which both infant and care-giver contribute' (Skuse, 1985). It is also argued that attention must focus away from the mother alone, since the ability of a parent to cope with her child depends upon a number of factors, including not only the characteristics of the child but other psycho-social stressors as well (Boddy and Skuse, 1994).

While recognising the multi-dimensional nature of non-organic FTT, Woolston (1991) suggested that the aetiologies of FTT may differ depending on the age of onset. Typically, infants who have the onset of FTT before the end of one year of life are more likely to have been deprived of food or to have primary physiological disorders that interfere with energy intake. When the initial onset of FTT occurs in older infants and toddlers, it is more likely that there are active interactional difficulties between the child and the primary caregiver that manifest as eating disorder. Therefore, the two phases of FTT though initially associated with different factors may overlap. For instance, a young infant who presents with FTT may respond rapidly to adequate feeding, but the same social/familial conditions that are associated with such acute malnutrition may also be associated with chronic emotional and physical deprivation and poor infant-caregiver relationships, and so the child may suffer from the second phase of FTT. Although this seems a plausible theory, there is hardly any research evidence to support it.

More recently research has focussed on the various factors that have been associated with non-organic FTT and these include: under-nutrition; socio-economic factors; parent-child interaction, including feeding and play; feeding skills of child and/or parent; parental attitudes and knowledge of healthy food; and factors relating to food acceptance, such as internal mechanisms and learning (Heptinstall et al., 1987; Wolke, Skuse, and Mathisen, 1990; Grantham-McGregor et al., 1991; Huchenson, Black, and Starr, 1993; Skuse, 1993; McCann et al., 1994; Powell et al., 1995). With perhaps the exception of under-nutrition, it is still not clear whether the relationship between any of these factors and FTT is a causal one or whether some of them merely facilitate, or simply co-exist with FTT. Research findings relating to the various factors are discussed in fuller detail later in this chapter.

1.3 Measuring growth and determining failure to thrive

Growth monitoring has been promoted world-wide as an effective means for detecting growth faltering and preventing under-nutrition in infants and young children (Piwoz et al., 1994). One of the most important indicators of well-being in the first year of life is weight gain (Giani, Filosa and Causa, 1996). Weight measures are used to monitor growth in young children. Other measures of growth include height, head circumference, limb circumference and skinfold thickness (Waterlow et al., 1977).

Of the above measures, weight and length are the most commonly used. Weight is a measure of the varying combination of bone, internal organs, fat and muscle, and as such a less simple measure than length. However, it is of practical value as it is sensitive to change in the child's nutritional status, and is also widely available. Weight is easy to measure and more accurate than length in infancy and early childhood, a period when length measurement requires special equipment and training and so is more time consuming and costly (Wright et al., 1994a). Skinfold thickness gives information about body composition additional to that given by weight, while mid-arm circumference and head circumference measurements are generally regarded as proxies for weight and height, and their usefulness in particular situations is largely determined by practical considerations (WHO Working Group, 1986).

The predictive superiority of weight over length measures was demonstrated by Piwoz et al. (1994). They investigated the power of weight and length measures in the first few months of life as predictors of growth of children at 12 months of age. Cut-offs for determining adequate growth were obtained from published reference data, and sensitivities and specificities of each indicator were calculated. Results showed that low weight gain in early infancy, especially from one to two months, is useful for predicting low weight at one year (sensitivity = 81%, specificity = 65%, at the 25th percentile cut-off). Monthly length gains were found to be weak predictors of low length for age at 12 months. As predictors of length for age at 12 months, length measures at the age of two to three months had the sensitivity of 65%, and specificity of 67% using the 25th percentile cut-off. Even so, length or height measures are still important since together height and weight measures, if they can both be obtained, provide a more informative index of growth and nutritional status (WHO Working Group, 1986).

Weight, and height and any other anthropometric measures can be combined to form indices of growth, such as weight for height, weight for age, or height for age (WHO Working Group, 1986). The use of weight for height and height for age have been particularly recommended in the assessment of nutritional status in children between the ages of one and ten years (Waterlow et al., 1977). Prior to these recommendations weight for age was the more commonly used index, but it has a disadvantage in that it does not distinguish between current and past malnutrition. The use of weight for height and height for age takes care of this problem: weight for height is taken as an indicator of the present state of nutrition while height for age indicates past nutrition.

Linear growth is a slower process than growth in body mass. Because it is expected that a child should treble its weight in the first year of life, but only double its height, a significant degree of stunting takes longer to be established, while wasting can develop very rapidly (WHO Working Group, 1986). These underlying differences strengthen the case for using weight measures below the age of 12 months. Weight for age is therefore considered the most useful below the age of 12 months, particularly when length measures cannot be performed accurately (Waterlow et al., 1977).

The distinction between weight for height as an index of current nutritional status and height for age as an index of past nutritional status prompted the use of special terms to distinguish between the two deficits, and the processes underlying each deficit (WHO Working Group, 1986). The term 'wasting' was coined to refer to 'thinness' or the deficit in weight for height, which is associated with acute or present malnutrition. Wasting indicates a deficit in tissue and fat mass compared with the amount expected in a child of the same height or length, and may result either from failure to gain weight or from actual weight loss. The term 'stunting' was coined to refer to 'shortness' or the deficit in height for age; it describes chronic or past malnutrition. Stunting signifies a deficit in linear growth. The growth rate may be reduced from birth, but a significant degree of stunting, representing the accumulated consequences of retarded growth, may not be evident for some years (WHO Working Group, 1986).

In order to determine whether the weight or height (or any derived index) of a particular child or a group of children is adequate or not, a standard of what is considered to be the normal or expected weight or height of children is used for comparison. Reference standards are derived from growth data compiled from large populations of children of the relevant age and sex groups. Growth standards are compiled by sex as well as age because boys and girls show different growth patterns. On the whole, boys tend to be bigger from birth through the early years of childhood, although girls do temporarily catch up at the age of 11 (Freeman et al., 1995).

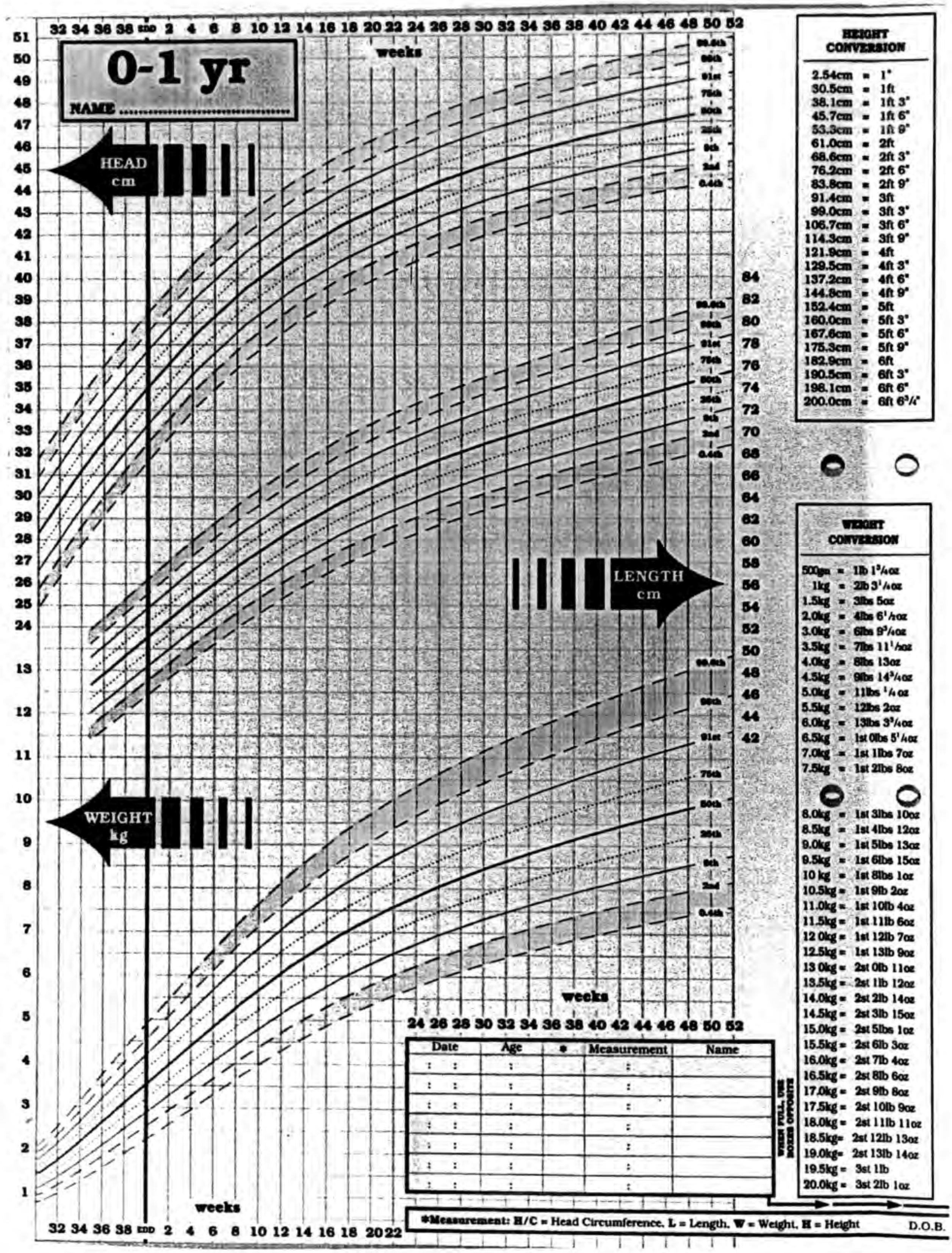
There are two ways of presenting and analysing these data, by using centiles or standard deviation (SD) scores. The use of centile charts is the most popular and perhaps the easiest and least time-consuming way to detect deviation from a normal pattern of growth (Giani, Filosa and Causa, 1996). The growth data for the particular age and sex groups are presented as centiles. An example is given in Figure 1.1. Separate graphs or charts are used for weight for height, height for age, and weight for age, and they each show centiles at selected intervals, including the third, fifth, ninety fifth and ninety seventh centiles. These centiles are used so that extremes are well characterised (Waterlow et al., 1977).

When a particular centile, say the third, is selected as a cut-off point for defining FTT, it means that 3% of the children in the population are by definition failing to thrive (Batchelor and Kerslake, 1990). The reported incidence of FTT has in the past been varied depending on whether the focus is on hospital cases or community populations. In studies from the US and Britain prevalences of between 1 - 10% have been reported in various settings (Batchelor and Kerslake, 1990).

While centile charts allow useful visual comparison to be made, the comparison is not numerically precise (Wright et al., 1994a). Centiles are also limited by the range of the reference population so that children falling outside this range cannot be accurately classified (Waterlow et al., 1977). The use of standard deviation (SD) scores has been suggested as a better alternative, especially where large numbers of children fall above the upper or below the lower centiles (Waterlow et al., 1977).

SD scores are transformations of weight and length measures. Like centiles, SD scores tell us the relative standing of an individual child in relation to a reference population. But unlike centiles, SD scores can be extended beyond the normal limits of a centile chart thus allowing for classification of children who might be outside the standard reference range (Waterlow et al., 1977). SD scores are also more easily manipulated numerically (Wright et al., 1994a).

Figure 1.1 Boys growth chart (birth to five years), including centiles for weight, height and head circumference. The chart was designed and published by 'Child Growth Foundation 1996/1, London W4 1PW. The chart exists in two versions, one for boys and one for girls. Both versions were used in the research reported in this thesis.


0-1 yr
NAME
weeks
HEAD cm
LENGTH cm
WEIGHT kg
99.6th
98th
91st
75th
50th
25th
9th
2nd
0.4th
HEIGHT CONVERSION
2.54cm = 1"
30.5cm = 1ft
38.1cm = 1ft 3"
45.7cm = 1ft 6"
53.3cm = 1ft 9"
61.0cm = 2ft
68.6cm = 2ft 3"
76.2cm = 2ft 6"
83.8cm = 2ft 9"
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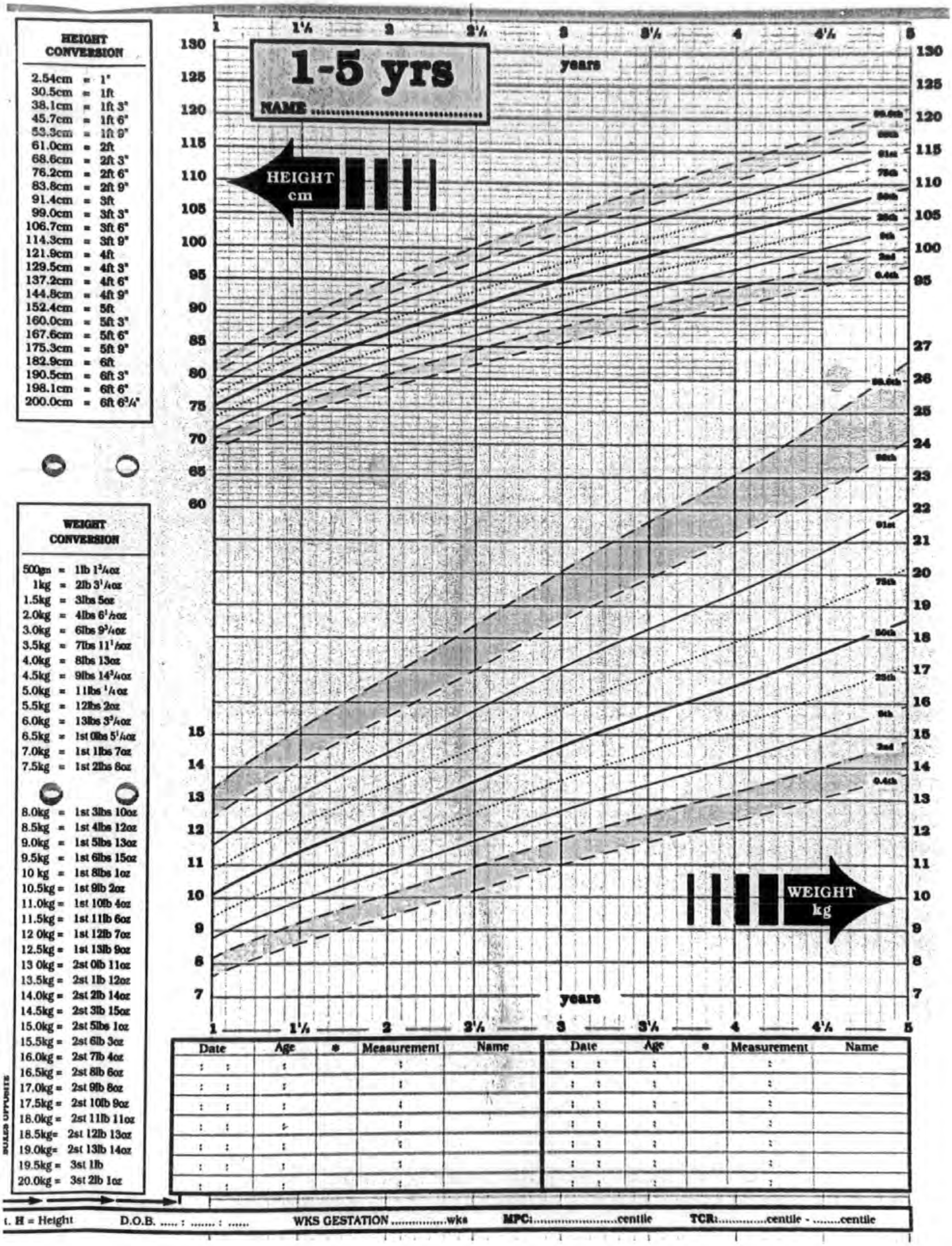
121.9cm = 4ft
129.5cm = 4ft 3"
137.2cm = 4ft 6"
144.8cm = 4ft 9"
152.4cm = 5ft
160.0cm = 5ft 3"
167.6cm = 5ft 6"
175.3cm = 5ft 9"
182.9cm = 6ft
190.5cm = 6ft 3"
198.1cm = 6ft 6"
200.0cm = 6ft 6³/₄"
WEIGHT CONVERSION
500gm = 1lb 1³/₄oz
1kg = 2lb 3¹/₄oz
1.5kg = 3lbs 5oz
2.0kg = 4lbs 6¹/₂oz
3.0kg = 6lbs 9³/₄oz
3.5kg = 7lbs 11¹/₂oz
4.0kg = 8lbs 13oz
4.5kg = 9lbs 14³/₄oz
5.0kg = 11lbs ¹/₄oz
5.5kg = 12lbs 2oz
6.0kg = 13lbs 3³/₄oz
6.5kg = 1st 0lbs 5¹/₄oz
7.0kg = 1st 1lbs 7oz
7.5kg = 1st 2lbs 8oz
8.0kg = 1st 3lbs 10oz
8.5kg = 1st 4lbs 12oz
9.0kg = 1st 5lbs 13oz
9.5kg = 1st 6lbs 15oz
10 kg = 1st 8lbs 1oz
10.5kg = 1st 9lb 2oz
11.0kg = 1st 10lb 4oz
11.5kg = 1st 11lb 6oz
12 0kg = 1st 12lb 7oz
12.5kg = 1st 13lb 9oz
13 0kg = 2st 0lb 11oz
13.5kg = 2st 1lb 12oz
14.0kg = 2st 2lb 14oz
14.5kg = 2st 3lb 15oz
15.0kg = 2st 5lbs 1oz
15.5kg = 2st 6lb 3oz
16.0kg = 2st 7lb 4oz
16.5kg = 2st 8lb 6oz
17.0kg = 2st 9lb 8oz
17.5kg = 2st 10lb 9oz
18.0kg = 2st 11lb 11oz
18.5kg = 2st 12lb 13oz
19.0kg = 2st 13lb 14oz
19.5kg = 3st 1lb
20.0kg = 3st 2lb 1oz
Date
Age
*
Measurement
Name
WHEN FULL, USE BOXES OPPOSITE
*Measurement: H/C = Head Circumference, L = Length, W = Weight, H = Height
D.O.B.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3.5kg = 7lbs 11½oz
4.0kg = 8lbs 13oz
4.5kg = 9lbs 14¾oz
5.0kg = 11lbs ¼oz
5.5kg = 12lbs 2oz
6.0kg = 13lbs 3¾oz
6.5kg = 1st 0lbs 5¼oz
7.0kg = 1st 1lbs 7oz
7.5kg = 1st 2lbs 8oz
8.0kg = 1st 3lbs 10oz
8.5kg = 1st 4lbs 12oz
9.0kg = 1st 5lbs 13oz
9.5kg = 1st 6lbs 15oz
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11.5kg = 1st 11lb 6oz
12 0kg = 1st 12lb 7oz
12.5kg = 1st 13lb 9oz
13 0kg = 2st 0lb 11oz
13.5kg = 2st 1lb 12oz
14.0kg = 2st 2lb 14oz
14.5kg = 2st 3lb 15oz
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16.0kg = 2st 7lb 4oz
16.5kg = 2st 8lb 6oz
17.0kg = 2st 9lb 8oz
17.5kg = 2st 10lb 9oz
18.0kg = 2st 11lb 11oz
18.5kg = 2st 12lb 13oz
19.0kg = 2st 13lb 14oz
19.5kg = 3st 1lb
20.0kg = 3st 2lb 1oz
1-5 yrs
NAME
HEIGHT cm
WEIGHT kg
years
Date
Age
Measurement
Name
H = Height
D.O.B.
WKS GESTATION ....wks
MPC: ....centile
TCR: ....centile - ....centile

Most growth charts are produced from nationally adopted standards, but charts derived from particular populations are also applied internationally to populations that are not necessarily similar to the reference population (e.g. Piwoz et al., 1994; Leung et al., 1996). The National Center for Health Statistics (NCHS) standards derived from a US population, and the Tanner and Whitehouse standards derived from a British population are examples (Wright, Waterston and Aynsley-Green, 1993). The issue of whether it is appropriate to apply such standards on different populations has been of concern (Soysa and Waterlow, 1981), but it has been argued that the standards can still be of great use in the classification of the nutritional status of other populations, as long as an adjustment is made in cut-off points (Waterlow et al, 1977).

In populations where many children lie outside the extreme centiles of the reference population, classification has usually been based on percentage deviation from the median of the reference population. In such classifications it has been usual to distinguish grades of deficit (mild, moderate, and severe) by establishing arbitrary cut-off points (Waterlow et al., 1977). The cut-off points are based on percentage deviations from the median and are chosen because they were assumed to correspond approximately to 1, 2, and 3 SDs of growth indices such as weight for height and height for age. This is however, only an approximate relationship in that although the same percentage cut-off may apply (e.g. 90%), there are fluctuations in SD as the value of one axis (e.g. height or age) changes. This means that the relative proportions of children diagnosed as under-nourished may differ as the age and size of the children changes, depending on whether centiles or SD cut-offs are used (Waterlow et al., 1977).

Soysa and Waterlow (1981) also pointed out that the 'percentage of the median' approach can be misleading. Using the Harvard median as a standard for comparing height for age in a Sri Lankan population, they demonstrated that the apparent nutritional deficit of children with a slow rate of growth tended to increase with age, even though their growth rate remained unchanged. This source of error is eliminated by the use of separate age-ranges for diagnosis.

In using standard references, it must also be noted that they can go out of date. Wright et al. (1993) found that a local Cambridge standard based on prospectively longitudinal data collected in 1984/5, were more closely matched to a whole city population of UK children, than either the Tanner and Whitehouse, or the NCHS standards. The authors argued that the poor match found with the latter two standards may have, in part, been due to the reference data having been collected over 30 years ago. As demonstrated by Whitehead, Paul and Cole (1982) the growth patterns of children in early infancy have since changed, possibly as a result of changes in feeding practices.

In reaction to these and other concerns raised about growth reference standards for the UK, up-to-date standards were established based on data from children across the country between 1978 and 1990 (Freeman et al., 1995). These are the UK 1990 standards. The data used came from a number of surveys and included over 25 000 infants, children and adults. Later, a correction on the standards for girls was made on the basis of evidence that the standards screened twice as many girls for FTT as they did boys, from about the age of three months. This error in screening was a result of an observed slower growth of girls in the first few weeks of life, which had been incorrectly smoothed out in the UK 1990 standards (Wright, Corbett and Drewett, 1996; Wales and Kennedy, 1996). The standards have now been revised (Preece, Freeman and Cole, 1996)

Although other anthropometric measures could be used, failure to thrive in this study was identified as poor weight gain in the first two years of life. Weight was used as the anthropometric measure because it is a more sensitive measure than length, and because it is weight that is routinely measured in well-baby clinics. Weight gain rather than weight was used because weight gain is a measure of post-natal growth, while weight per se depends on birth weight as well as post-natal growth.

Weight gain can be measured as the difference between two weights over a specified interval at a specified age, and reference data are available for gains in weight and length over one to three month intervals in the first two years (Guo et al., 1991). Guo et al. suggest that their reference data may aid early detection of failure to thrive, and identification of failure to thrive based on weight gain was used by Altemeier et al. (1985). Weight gain, however, is negatively correlated with birth weight (Fergusson, Horwood and Shannon, 1980), and in general infants tend to 'regress towards the mean' - i.e. those whose initial weights are either unusually low or unusually high tend to be closer to the average for the population at follow-up. Unconditional weight gain standards that do not take starting weight into account therefore tend to underestimate the number of initially light infants and overestimate the number of initially heavy infants whose subsequent weight gain is unusually low.

The use of standards conditional upon initial weight is more appropriate (Berkey, Reid and Valadian, 1983). The practical use of conditional standards therefore depends upon the use of reasonable approximations, and a practical procedure for screening for failure to thrive in infancy was first provided by Wright et al. (1994a). This utilised two weights, an early weight recorded at about six weeks and a later weight recorded between nine and 24 months. The conditional standards were derived from a regression of later weights on early weights for a one year birth cohort of children in Newcastle-upon-Tyne. At each later age over the nine to 24 month period, the average later weight attained was calculated for each earlier weight, and the later weight corresponding to the fifth centile for weight gain, i.e. the weight that cuts off the 5% of infants with the poorest weight gain. Infants among these slowest growing 5% constitute cases of failure to thrive.

1.4 Parental factors in non-organic failure to thrive

Most children are raised in a family and their intake of food depends upon the family's eating arrangements. Interaction with family members and in particular, the principle caregiver, who in most cases is the mother, are important to the child's food intake.

In failure to thrive, the feeding interaction appears to be unsuccessful as the child does not achieve adequate nutritional intake. It has been suggested that maladaptive feeding interactions are a result of dysfunctional relationship patterns which lead to such problems as inconsistency in feeding and conflict at mealtimes (Boddy and Skuse, 1994). The ability of the parent to provide adequate nutrition partially depends on the parent's ability to interpret the infant's behaviours which signal hunger (Wright, 1987). Parents' responses to their child's hunger signals can become apparent in observation of their interaction during the feeding situation as well as in interactions outside of feeding.

Beliefs and attitudes are also important because they are powerful determinants of behaviour; and they may not only influence the parent's own food intake, but also affect what and how they feed their infant. A study of parental beliefs and attitudes may therefore, facilitate our understanding of factors surrounding feeding problems, although these may not always reflect actual behaviour (Boddy and Skuse, 1994).

Research into factors surrounding non-organic FTT has been characterised by methodological problems. A lot of the earlier research has for instance, been criticised for using hospitalised infants rather than community based samples. Hospitalised samples are likely to bias findings due to the fact that many of the infants with non-organic FTT in the community do not get referred to hospital for specialised treatment (Dowdney et al, 1987; Wolke, Skuse and Mathisen, 1990). Furthermore, a hospital setting is limiting in terms of the range of behaviours observed; the infant is observed, for example, in a strange environment, interacting with strangers. A number of authors (e.g. Oates, Peacock and Forrest, 1985; Dowdney et al. 1987; Casey et al., 1994) have noted that many studies did not use control groups so that cases were not compared with a normally growing group of children. According to Wolke et al. (1990) observational studies tended to focus solely on maternal and environmental factors, and took little account of the infant's behaviour.

In recent years, research has been more focused on community samples (e.g. Wolke et al., 1990; Black et al., 1995); and investigators have turned their attention towards the interactional characteristics of non-organic FTT infants and their mothers particularly during feeding (Hutcheson, Black, and Starr, 1993). However, many studies still draw their samples from areas where socio-economic deprivation is predominant (e.g. Heptinstall et al., 1987; Grantham-McGregor et al., 1991; Hutcheson, Black and Starr, 1993; Black et al., 1995). Although failure to thrive may be over-represented in poor areas, it is by no means restricted to this sector of society (Batchelor and Kerslake, 1990; Wright, Waterston and Aynsley-Green, 1994b). Therefore, research on FTT ought to include samples from the cross-section of the community. It has been argued that case-control comparisons made on samples of children drawn from the same disadvantaged socio-economic background may be adversely affected, in that, when children are drawn from the same disadvantaged community the negative influence of poverty on children's health and development, may confound any effects of nutritional status (Hutcheson et al., 1993).

Heptinstall et al. (1987) proposed that both the physical and social environment had relevance to non-organic FTT; and that parental care was one of the intervening variables between social deprivation and growth retardation. In a case-control study of four year old children living in a socio-economically deprived area they found that neither food intake, as indicated by parental reports and meal-time observations, nor gross environmental variables distinguished the two groups. However, meal-time observations revealed that case families were considerably more disorganised and had more negative attitudes. Retrospective interview of the parents indicated that these factors had possibly been operative since early infancy.

Research with younger children has also revealed characteristics in the parent-child interactions at meal-times which relate to non-organic FTT. It has been shown for instance, that mothers of infants with FTT terminated the feeding session more arbitrarily than did comparison mothers (Drotor et al., 1990; Hutcheson, Black, and Starr, 1993). Wolke, Skuse, and Mathisen (1990) showed that non-organic FTT infants were more fussy, demanding and unsociable while their mothers expressed more negative emotions during play interaction. Two to three year old children with non-organic FTT expressed less positive affect and more negative affect in the feeding and non-feeding situations than normally growing control children (Polan et al., 1991).

Among the measures used in these studies were parent reports of the child. The tendency of young children, particularly at the age of two to three years, to be perceived by their parents as difficult in feeding situations, may not be a special characteristic of FTT. Hutcheson et al. (1993) found that mothers of toddlers regardless of whether their children were failing to thrive or normally growing controls, perceived their children as more difficult than mothers of infants. However, within the case group, mothers of toddlers tended to be more hostile, intrusive, and less flexible than mothers of infants; while maternal behaviour did not differ in the control group.

These findings suggest that it may be a general characteristic of toddlers to be 'difficult', but in the case of non-organic FTT, this is associated with negative parental characteristics which may be a contributing factor, or merely the consequence of the child's seemingly difficult behaviour. Feeding difficulties in infancy are a source of great concern in many mothers (Wright, 1993), and in the case of non-organic FTT parental anxiety and tension at meal-times may be a response to the children's difficult behaviour during feeding. As proposed by Skuse (1985), the characteristics of the child and the behaviours or responses of the parent may serve to provoke responses from the other which in turn worsen the relationship between parent and child thus increasing the likelihood of feeding problems.

Wright (1996) reported that compared to controls, 13 to 30 month old children with FTT were described significantly more often as variable eaters, as undemanding and as shy, but less often as hungry and demanding by their mothers. This seems to contradict findings by others (e.g. Polan et al., 1991; Hucheson et al., 1993) that young children with FTT tend to be demanding and unsociable in feeding situations. However, there was no systematically structured measures of temperament used in this study, unlike the other studies cited, and so different aspects of behaviour and temperament may have been focussed upon. Another point to be considered is that the sample in Wright (1996) came from a whole city population surveillance, whereas the other studies recruited children from the lower socio-economic sector. Parental and environmental factors relating to socio-economic disadvantage may have implications for the parent-child interaction and nutritional status (Nelson and Naismith, 1979). This means that a possibility exists that when samples are drawn from different socio-economic strata of the same community, different parent or child characteristics may emerge in relation to FTT.

Research on parental attitudes and beliefs suggests that these may have consequences for the feeding and failure to thrive of children. It has been shown for instance, that in spite of their children having a subnormal weight gain and consuming levels of food below the recommended calorie intake, some parents of children with non-organic FTT were concerned about their children becoming obese, or developing heart disease, or eating habits that they themselves considered 'unhealthy' (Pugliese et al., 1987). Similarly mothers of children with non-organic FTT not only had high levels of dietary restraint, as compared to control mothers, but were also restricting their child's intake of foods that they considered to be 'sweet', 'fattening', or 'unhealthy' (McCann et al., 1994).

It has been suggested that in some cases of failure to thrive parents have insufficient knowledge about what comprises an adequate diet for a child. These parents tend to generalise the cautions meant for adults at risk of heart disease to their infants' diet. Consequently parents may provide a diet which is insufficient for their infant's growth (Pugliese et al., 1987). In some cases, parents who have adopted a low-fat, 'sugar-free' diet as the healthy thing for themselves may also feed their child in the same way, thus causing failure to thrive in their children (Rogers, 1996).

1.5 Developmental consequences of non-organic failure to thrive

There has been concern that children with FTT may be at increased risk for later growth, developmental and behavioural problems (Dowdney et al., 1987; Casey et al., 1994; Hampton, 1995). The adverse effects of FTT on subsequent growth are well documented (Dowdney et al., 1987; Pugliese et al., 1986; Black et al., 1995; Wright, 1996), and are indisputable . However, its consequences on other aspects of child development, such as cognitive development, are less straight forward and debatable. Developmental consequences reported include delayed cognitive, motor and language development (e.g. Dowdney et al., 1987; Powell et al., 1995; Grantham-McGregor et al., 1991), while social and behavioural problems have included lack of social maturity, emotional disturbances, and difficult and demanding behaviour (e.g. Oates et al, 1985; Wolke et al., 1990; Polan et al., 1991). In discussing outcomes, developmental consequences are referred to, although other terms are used wherever appropriate.

In general, research into adverse developmental consequences of FTT has yielded inconsistent results (Oates et al., 1985; Dowdney et al., 1987; Powell et al., 1995). For example, the proportion of children who present with developmental delay varies between studies, with some associating delay with the majority of the children and others with only a minority (review by Dowdney et al., 1987). The methodological problems that have been associated with research on non-organic FTT are partly responsible for the inconsistent results. The use of hospitalised samples in early studies, for example, meant that the children studied were among the most severely affected (Dowdney et al, 1987; Wolke, Skuse and Mathisen, 1990). Alternatively, admission to hospital may reflect other factors such as social class, family size or parental resources, which themselves could be linked with child development (Dowdney et al, 1987). Another factor is the variation of measures used; as noted by Dowdney et al. (1987) in measuring the same construct some investigators have used standardised instruments, others have relied on parental reports, or have not conducted formal assessments.

The issue of developmental consequences of non-organic FTT has been characterised by uncertainty about whether the developmental problems are a cause or consequence of failure to thrive, or whether they simply co-exit with failure to thrive (Mitchell, Gorrell and Greenberg, 1980; Batchelor and Kerslake, 1990).

Mitchell et al. (1980) conducted a study to establish whether behavioural and developmental deficits in a group of children were attributable to failure to thrive, rather than to social conditions coinciding with failure to thrive. In a study of 19 cases and 19 controls, the McCarthy Scales of Children's abilities was used to measure child development. A regression analysis revealed that FTT did not predict children's scores on the General Cognitive Index (GCI), while the 'Life events' score was the best predictor of GCI scores. Based on these results, it was concluded that the developmental deficits were not a consequence of FTT, but rather that social stresses in the family were more likely to be the cause of the developmental deficits which were seen both in children with FTT and in those with normal growth. It was thus inferred that both FTT and developmental delay are caused by the same environmental factors rather than FTT causing developmental delay or developmental delay causing FTT.

Using the same standardised measure of children's cognitive development in a similar case-control study, Dowdney et al. (1987) found an opposite result. In a study of 23 cases and an equal number of matched controls, living in an inner city deprived area, variables known to affect cognitive development, such as birth-weight and gestational age were controlled for, while social class was comparable between groups. The results showed that case children were comparatively significantly delayed in all areas of their cognitive development; in fact, one third were seriously retarded and likely to require special education. However, organic causes of the FTT in this sub-group could not be ruled out, and since their rather poor cognitive scores obviously had a great impact on the significance of the case-control difference, it is unclear whether a significant result could have been obtained if this sub-group had been either omitted from analysis, or replaced with straight-forward cases of non-organic FTT.

It has been suggested that the consequences of FTT may depend on factors such as the child's age, and the duration and severity of failure to thrive (Skuse et al., 1994). In a whole population prospective survey of children born in 1986 in a London inner-city area, Skuse et al. (1994) concluded that at 15 months of age, 37% of the variance in cognitive and psycho-motor outcome was related to the timing, duration and severity of growth faltering. Another study showed that the impact of intervention on cognitive development depended on the child's age at recruitment, with younger children showing more benefit from home intervention (Black et al., 1995). The children in this study also showed improved weight for age, weight for height, and height for age, as a result of the services received from a multi-disciplinary growth and nutrition clinic, including nutritional supplementation. But the improvements in growth were not significantly different between younger and older children. These results suggest that the severity of cognitive consequences of non-organic FTT may in part depend on the age of the child, but only through the mediating influence of social and parental factors.

Intervention has been used increasingly by investigators in recent years to study the nutritional and social factors as well as the effects of FTT. The idea is that by using intervention to alleviate the FTT, any changes in the consequences can then be monitored by looking at the children's growth and development (e.g. Casey et al., 1994; Powell et al., 1995).

Some studies have used intervention in the form of nutritional supplementation and developmental or psycho-social stimulation (e.g. Grantham-McGregor et al., 1991; Casey et al., 1994; Powell et al., 1995; Black et al., 1995). The typical procedure is to give children with FTT either nutritional supplementation, stimulation, or both supplementation and stimulation. In some cases a group of normal growth controls is included for comparison. In this way the effects of nutrition and developmental stimulation on growth and any other aspect of development can be monitored.

Using the procedure described, associations have been found between improved rate of growth and some aspects of development. In growth retarded children, aged two years and below, living in deprived city areas in Kingston, Jamaica, two years of intervention was associated with improved hearing, speech, and developmental quotient (Powell et al., 1995; Grantham-McGregor et al., 1991). In one case, developmental quotient (DQ) for the case group was lower than the non-stunted comparison group at the onset, but during the course of the study DQ for the non-supplemented FTT group declined further, thus increasing their deficit while DQ in the supplemented group increased gradually (Grantham-McGregor et al., 1991). However, these results may not necessarily be generalisable to groups of children with FTT in industrialised countries as they may not have the same characteristics.

Other intervention studies suggest that developmental delay in FTT may be related to other factors such as behavioural factors in the child, or parenting style. In a group of three year olds followed up from birth Casey et al. (1994) found that the beneficial effects of intervention on IQ scores were related to the children's compliance scores. i.e. FTT children with greater compliance (to the Infant Health and Development Program, indicated by attendance) had higher IQ scores and better behaviour scores at three years than FTT children with low compliance. Black et al. (1995) on the other hand found that children aged below 25 months whether in the FTT group or control group showed better socio-cognitive development if their parents were more nurturant and less neglecting.

Another form of intervention which has been used in FTT is zinc supplemention. Some studies have reported that zinc deficiency is common in children with non-organic FTT (Walravens, Hambidge and Koepfer, 1989; Buzina et al., 1980) and that zinc supplementation is associated with an increase in the growth factor IGF-I in blood (Ninh et al., 1996). However, the adequacy of the methods used for the assessment of zinc status has been questioned (Patrick, Golden and Golden, 1980) and zinc deficiency cannot be diagnosed with certainty.

The research reviewed in this section indicates that developmental delay in children with non-organic FTT is related to other factors in the child's environment. This means that these so-called 'outcomes' may in fact be a reflection of adverse environmental factors, such as lack of a nurturant family environment or motivational or behavioural problems in the child.

1.6 Feeding and appetite problems in fail to thrive

Failure to thrive has been attributed to the lack of sufficient nutritional intake (Whitten et al. 1969), and groups of children categorised as failing to thrive non-organically have been shown to have lower levels of energy intake than expected (Pollitt and Eichler, 1976; Pugliese et al., 1987; McCann et al., 1994). Poor nutritional intake can be caused by feeding problems which may be associated with poor appetite (Pollitt and Eichler, 1976; Maggioni and Lifshitz, 1995), emotional and behavioural difficulties of the child, or factors relating to the parent-child relationship around meal-times (Polan et al., 1991; Hutcheson et al., 1993), or family social factors (Nelson and Naismith, 1979). Minor oral-motor co-ordination problems found in a number of children with non-organic FTT, may also contribute to feeding problems and failure to thrive (Mathisen et al., 1989).

Maggioni and Lifshitz (1995) attributed FTT to infantile anorexia nervosa which is an infant disposition characterised by food refusal or extreme food selectivity and under-eating despite the parents' efforts to increase the infant's food intake. Research shows that compared with normally growing controls, non-organic FTT children have higher levels of poor appetite and food refusal (Iwaniec and Herbert, 1982; Pollitt and Eichler, 1976; Wright, 1996). According to Iwaniec and Herbert (1982) mothers of cases reported feeding difficulties dating back to weaning. Observation of the children showed that all index children persistently refused to take solids, (regurgitation and diarrhoea were also observed) and they tended to store food in the mouth, and were unable to swallow and chew. Compared to the controls more feeding problems were reported in the index group. Although there were two normal comparison groups in this study, there was no statistical analysis to test the apparent group differences.

In a similar study Pollitt and Eichler (1976) investigated 12 to 60 month old pre-school children. Up to 11 home visits per child were made by the public health nurse, during which information on the child's behaviour was obtained using interview on the child's feeding history, the 24-hour recall measure of dietary intake, direct observations, and open-ended interviews on the child's eating habits, response to food etc. The eating behaviours analysed were presence or absence of feeding difficulties during the first year of life, current meal patterns, snacking, general response to food, and atypical behaviour. Difficulties in infant feeding included poor appetite, poor suck, crying during feeds, vomiting after each feed, and refusal to switch from liquids to solid food. Statistical analysis showed that FTT children had more feeding difficulties as infants, had skimpier, less regular meals, and had poorer response to food when rated on a five-point scale. Their daily caloric intake was also lower. Specifically, 10 out of 19 cases as compared to only two (out 19) controls had feeding difficulties ($p<0.02$); three cases as compared to 13 controls had good-sized meals eaten regularly, while 16 cases and only six controls often skipped meals which were often skimpy ($p<0.01$).

The atypical meal patterns observed in the FTT group could be a reflection of their poor appetite, and in response to the children's lack of interest in food their parents may adopt irregular meals as a feeding strategy. Research by Wright (1996) showed that mothers of 13 to 30 month old children with non-organic FTT described them more often as variable eaters, undemanding and shy than control mothers did their children. This shows that the parents' perceived their children as undemanding and inconsistent eaters, which does not necessarily mean that the children were in fact not hungry. Alternatively, irregular meal patterns in the FTT group may be the reason that the children have low nutritional intake and failure to thrive. Investigations in which home and clinic intervention for families of FTT children included nutritional counselling and supplementation showed an improvement in the children's growth rate (Black et al., 1995); this suggests that irregular meals may be a cause rather than a consequence of failure to thrive.

According to Mathisen et al. (1989) oral-motor difficulties of the child may contribute to feeding problems which subsequently lead to failure to thrive. Oral-motor abnormalities can lead to difficulties with sucking, chewing and swallowing, tongue thrusting, involuntary tonic biting of the spoon or nipple, excessive drooling and intolerance of the textures of developmentally appropriate food (Lewis, 1982; Mathisen et al., 1989). In the case of organic failure to thrive oral-motor difficulties associated with the organic condition (e.g. cerebral palsy) lead to feeding problems and consequently poor nutritional intake and failure to thrive. Mathisen et al. (1989) proposed that children with non-organic FTT who are otherwise normal and healthy may have minor, undetected, oral-motor dysfunction which make them more difficult to feed. This was based on an earlier finding of significantly higher levels of oral-motor dysfunction in a group of non-organic FTT children as compared to normally growing controls (Heptinstall et al., 1987). Mathisen et al. (1989) devised a feeding assessment schedule to rate oral-motor behaviour objectively while the infants were being fed at home. It involved presenting the infant with a variety of foods of different textures, graded from liquid, through purees and semi-solids, to firm solids. The results showed that case infants had immature and abnormal oral-motor development that made them less able to be fed successfully.

Feeding difficulties have also been attributed to difficulties in the mother-child relationship, particularly around meal-times. According to Maggioni and Lifshitz (1995) feeding difficulties stem from the infant's thrust for autonomy, which results in mother and infant becoming embroiled in conflicts over autonomy and control, which manifest primarily during the feeding situation. This conflict leads to a battle of wills over the infant's food intake. Research shows that the behaviour and interactions of children and their parents observed during feeding are different between failure to thrive families and normal families (e.g. Mathisen et al., 1989; Drotor et al., 1990; Polan et al., 1991; Hutcheson et al., 1993). Section 1.4 of this chapter discusses these findings in more detail.

Although research shows an association between behavioural and temperamental characteristics of the child and failing to thrive, it is not clear whether these difficulties are the cause or merely consequences of failure to thrive. While they may contribute to feeding problems and failure to thrive, they are not unique to failure to thrive. Controlled research must therefore, continue to try and establish the precise roles that behaviour, temperament and family social factors play in the children's nutritional intake. Further research into the internal control mechanisms of energy intake of children who fail to thrive non-organically is needed before adopting alternative explanations of their low energy intake.

1.7 Regulation of energy intake in young children: the role of sweet taste, caloric compensation, and sensory specific satiety

Because it is still unclear which factors, or combination of factors are necessary for non-organic FTT to occur, all possible factors must continue to be investigated, especially those that directly relate to the child's nutrition and energy intake. The role of behavioural and emotional factors in the child have so far been discussed. It is also possible that other factors within the child which relate to internal mechanisms that regulate appetite and energy intake may be involved.

Taste and flavour play an important role in energy intake. Humans show sensitivity to taste from early infancy. Although unable to communicate their taste preferences through speech, infants as young as just a few hours old show differential responses to different tastes; these responses as well as the differential amounts consumed are used as a guide to infants' taste preferences. Infants tend to show specific facial expressions and move specific parts of their face in response to the four basic tastes i.e. sweet, salt, sour, and bitter (Lipsitt, 1977). For instance, bitter stimuli usually evokes a wry facial reaction characterised by tightly shut eyes, convulsive throat contractions, a wide opening of the mouth and ejection of the stimuli along with mucous; a sweet stimulus on the other hand tends to evoke an opposite reaction with a tendency to suck. Desor, Maller and Andrews (1975) investigated amounts consumed by one to four day old infants who were tested with water, sweet, salt, sour and bitter stimuli. Infants drank water the least, while their intake of salty and sour solutions was enhanced by adding sugar to them; intake of the bitter solution was not enhanced by adding sugar to it.

The attention that infants' response to sweet taste has received may be in part explained by the enhancing properties that sweet stimuli appears to have on infant feeding; in particular on infant sucking responses. Studies with newborn infants show that a sucrose solution was associated with increased sucking rates, and the more concentrated the sucrose solution the greater the number of sucks (Crook, 1977). Furthermore, when intra-oral fluid was briefly introduced during non-nutritive sucking there were changes in the sucking rhythm; relative to distilled water, sucrose solutions tended to lead to longer sucking bursts, while salt solutions led to shorter bursts (Crook, 1978). In studies with older children ingestion of sucrose led to inhibition of appetite at meals immediately following the pre-load (Anderson, 1995).

The effects of sucrose in children are not restricted to feeding and appetite. Sucrose has been used as an analgesic to reduce the crying response to pain in infants. Blass and Hoffmeyer (1991) demonstrated that during a heel prick blood collection, 28 to 54 hour old infants given 12 % sucrose solution to drink cried 50 % less than the placebo-treated control group. Similar results were obtained with a group of male infants who underwent a circumcision operation. Ramenghi et al. (1996) found that the analgesic effects of sucrose could be extended to a non-sucrose 'sugar-free' product used as a vehicle for paracetamol in 'Calpol' a pain reliever for children.

Research on dietary exposure to sucrose suggests that taste preferences may be shaped by prior dietary experience. Beauchamp and Moran (1982, 1984) found that infants' preference for sucrose solutions at six months and at two years of age was related to whether or not they had been regularly fed sugar water by their parents. When sucrose was presented in a fruit-flavoured base, however, prior exposure to sugar water made no difference.

Most of the existing literature on children's response to sweet taste is on children with normal growth patterns. It is possible that children with poor growth may show different response patterns. Buzina et al. (1980) associated zinc deficiency in children with poor growth with depressed taste acuity. Vazquez, Pearson and Beauchamp (1982) found that a group of malnourished infants had a depressed response to sucrose as compared to their well nourished counterparts. Although these studies show an association between poor growth on one hand, and a depressed response to taste, particularly to the sweet taste, on the other, it is not clear whether the relationship is a causal one. In under-nourished children, it is possible that the nutritional deficiency is responsible for poor growth, while accompanying deficiencies in vitamins and minerals may have other adverse effects; in particular, zinc deficiency may lead to poor taste acuity and anorexia. Alternatively, a depressed taste acuity may adversely affect energy intake, thus leading to under-nutrition. In man sugars and starch are a major source of food energy (HMSO, 1985), and so a depressed response to sweet substances may reduce intake of energy-containing foods and may consequently lead to under-nutrition and FTT in children.

Another mechanism involved in the regulation of energy intake in humans is caloric compensation. This is the ability to adjust one's energy intake at a given meal in response to an earlier energy load, thus maintaining a relatively constant amount of intake of energy (Johnson and Birch, 1994). Caloric compensation has, in most cases been investigated simultaneously with another mechanism called sensory specific satiety; this is the apparent drop in motivation to eat a food that has been eaten before as compared to other foods not yet eaten (Birch and Deysher, 1986). Both mechanisms have been associated with the self-regulation of energy intake (e.g. Birch and Deysher, 1986; Drewnowski et al., 1994).

The pioneer of work on the self-regulation of energy intake in infants and young children is Clara Davies (1929) with her investigations into food selection and growth. Her research showed that given nutritious choices, children did select an adequate diet without adult supervision, and did in fact grow well and were healthy. Based on this work, Birch et al. (1991) investigated the ability of 15 children aged two to five years to self-select a diet, using a much more rigorous design. The sample children's food intake was observed over a 24-hour period for six days; there were six meals observed on each day including breakfast, lunch, supper and three snack meals. It was shown that although the children's intake at individual meals was highly variable, the total daily intake was relatively constant for each child. The conclusion was drawn that children adjusted their energy intake at successive meals, with a high energy intake at one meal usually followed by low intake at the next meal or vice versa.

The observations that children tend to self-select an adequate diet, given a variety of foods to choose from (Davies, 1929), and that they reduced or increased their intake at a subsequent meal depending on intake at an earlier meal (Birch et al., 1991), point towards some sort of energy accounting mechanism which prompts appropriate behavioural responses which in turn control the child's intake at a given meal. Caloric compensation illustrates such a mechanism.

Birch and Deysher (1986) investigated this in 21 children aged two and a half to five years and 26 adults aged 25 to 35 years. The subjects participated in two sessions in which they consumed a pudding, and 20 minutes later were given access to an *ad libitum* lunch-time meal. The two sessions differed only in the caloric content of the pre-load pudding. On one occasion they received a high calorie, and on the other a low calorie pudding. The lunch-time meal consisted of a variety of snacks and was the same for all subjects. The results of this experiment showed that although all subjects ate less after a high energy pre-load, children showed clearer evidence of caloric compensation. The amounts consumed by adults in kilocalories (kcal), regardless of the calorie load of the pre-load were only slightly different at the two meals, leading to a much higher overall intake (i.e. energy intake from pre-load and ad libitum meal) on the occasion when a high calorie pre-load was received. Children on the other hand consumed much less at the meal following the high-calorie pre-load, leading to the overall intake remaining more or less the same as that on the low-calorie pre-load occasion. This shows that given a standard meal to eat from, children adjusted their intake according to an earlier calorie load, while the energy intake of adults was comparatively less affected by the pre-load.

It has been suggested that the better compensation shown by children may be because children rely more upon relatively physiological cues of hunger and appetite whereas adults have learned to rely more on external cues such as the timing of meals, and how appetising the food looked (Birch and Deysher, 1986; Birch et al., 1991). A study by Johnson and Birch (1994) showed that children whose parents exerted more control in the feeding situation showed less caloric compensation. Thus reduced choice to go with one's own appetite, in this case by having a controlling parent, was associated with reduced ability to self-regulate energy intake.

In caloric compensation experiments the rationale is simply that the effect of the pre-load on subsequent energy intake from the *ad libitum* meal is a measure of the effect of that particular pre-load on appetite. However conclusions derived from this approach must be based on a careful evaluation of many aspects of the experimental design of the reported studies. Among the factors to consider are time interval between pre-load and *ad libitum* meal, and the characteristics of the subject population, including the age and sex, and the presence of obesity or eating disorders (Anderson, 1995).

The results of caloric compensation experiments have been shown to be different depending on the time interval between the pre-load and the *ad libitum* meal. High energy breakfast preloads had an inhibiting effect on energy intake at the subsequent lunch time meal, but not at supper time in adult subjects (Drewnowski et al., 1994). This fall in the tendency to compensate when the delay between pre-load and *ad libitum* meal is increased has also been found in children. For example, Anderson (1995) reported caloric compensation in children when the pre-load drink was consumed 30 minutes before the *ad libitum* meal, but not after a 90 minute time interval. The most likely reason for this drop over time in compensation is that the energy consumed with the pre-load has gradually been absorbed.

In studies in which sugar has been used in the preloads, it is not only the type, amount and concentration of sugar that must be considered, but also whether or not the sweetness component of sugar is isolated in the experiment from its energy component. This is necessary in order to determine whether the effect on energy intake is a result of the sweetness of the pre-load or its energy content (Anderson, 1995).

In a study to investigate whether the effect of the pre-load on appetite was due to the sweetness or the energy content of the pre-load, or both, 24 adult males and females served under four experimental condition (Drewnowski et al., 1994). The study used a within-subject design and each subject served under each of the four conditions on a separate day. The pre-load for all conditions was a creamy white cheese either plain or sweetened with sucrose or aspartame. Aspartame is an intense sweetener which unlike sucrose has a very low energy content. The pre-load for Condition 1 contained sucrose (700 kcal); in Condition 2, the pre-load contained aspartame and maltodextrin (700 kcal); in Condition 3, the pre-load contained aspartame only (300 kcal); and in Condition 4 subjects received a plain pre-load (300 kcal). Consumption of low-energy preloads as opposed to high-energy pre-loads, regardless of sweetness, led to elevated hunger ratings and increased energy intakes at lunch time but not at supper time, indicating a short term effect of the pre-load on energy intake.

In the caloric compensation literature, levels of compensation are referred to. Not all children show perfect caloric compensation, but rather there is a great variability in children's compensation (Johnson and Birch, 1994). Perfect 'calorie-for-calorie' or 100% compensation would be shown if, for example, a child ate 150 kcal more after a low-energy pre-load than after a high-energy pre-load, when the low-energy pre-load contained 150 kcal less than the high-energy pre-load. The compensation index (COMPX) is an index indicating the level of compensation (Johnson and Birch, 1994). COMPX is devised to rank children on a continuum from negative compensation (i.e. actually eating more after consuming a high-calorie pre-load) to overcompensation i.e. consuming less after the high-calorie pre-load by more than the energy content of the pre-load. COMPX is calculated for each subject using the following formula:

$$\frac{\text{ad lib. kcal (low energy pre-load)} - \text{ad lib. kcal (high energy pre-load)}}{\text{drink pre-load kcal (high)} - \text{drink pre-load kcal (low)}} \times 100\%$$

Here the numerator contains the child's *ad libitum* energy intake after the low energy and the high energy pre-loads, and the denominator the energy intake associated with the high energy and the low energy pre-loads. Essentially the formula is for the difference between *ad libitum* energy intakes as a proportion of the difference between the energy content of the pre-loads. More than one COMPX measure per child can be obtained on different occasions and the stability of compensation over time and situations assessed.

Existing literature suggests that the self-regulation of energy intake may differ between individuals depending on their body mass or weight; in particular, individuals with greater bodily fat stores do not self-regulate their energy intake as well as their slimmer counterparts (Johnson and Birch, 1994; Rolls et al., 1994). Recent research has explored the possibility that different nutrients, in particular, carbohydrate and fat may evoke different appetite and satiation effects in subjects and that this effect may differ depending on sex and body weight. In a study testing the effect of preloads on energy intake at a later meal, Blundell et al. (1993) found that in lean adult male subjects a carbohydrate augmented pre-load taken at breakfast suppressed appetite at a meal taken 90 minutes, but not 270 minutes later, while a fat augmented pre-load had no detectable effect on appetite at any point in time. In a similar study including normal weight restrained and unrestrained eaters, and obese subjects, Rolls et al. (1994) found that normal weight, un-restrained male subjects showed adequate caloric compensation, while normal weight, unrestrained female subjects, and obese subjects, and normal weight restrained eaters of both sexes did not. Research findings on eating behaviour and energy intake in adults however, is not necessarily generalisable to young children.

Johnson and Birch (1994) showed that although there was great variability in the ability to compensate in a group of 77 three to five year old children, children who compensated poorly were significantly fatter; furthermore, the best predictor for caloric compensation was the children's weight. A study by Garcia et al. (1990) investigated self-regulation of food intake in three-to-five year old children with poor growth in rural Mexico, as defined by weight, weight-for-height and height-for-age. The children were observed throughout a day during which they could eat at will from an available diet, and all food offered and consumed was weighed. It was found that the children did self-regulate their energy intake from the foods provided. Though the study is not about caloric compensation it shows a general ability to self-regulate energy intake; based on this it is reasonable to assume that the children may also have the ability to self-regulate specifically to prior calorie load i.e. caloric compensation. However, there was no normal growth control group for comparison in this study, and so it is uncertain how these results relate to the findings that body weight is negatively correlated to ability to self-regulate energy intake (Johnson and Birch, 1994)

1.8 Investigation into self-regulation of energy intake in children with non-organic failure to thrive

Studies of energy intake in children who fail to thrive have not consistently shown that it is low. While some studies suggest that intake in children with non-organic FTT is somewhat lower than it ought to be (e.g. Pugliese et al., 1987; McCann et al., 1994), others show much to the contrary that their intake is not particularly low (e.g. Whitten et al., 1969; Heptinstall et al., 1987). The inconsistency of findings may, however, be due to the great difficulty of measuring energy intake precisely in young children (Davies et al., 1994). Whitten et al. (1969) showed that the weight gain of hospitalised children with FTT improved with adequate energy intake, and if children with FTT did have normal intake, it would have to follow that either their energy absorption was defective or their energy expenditure was abnormally high, since energy cannot simply disappear. Neither of these has ever been demonstrated.

If a child's energy intake is low, one possible explanation is a poor appetite. This might be the whole or part of the explanation of failure to thrive (for example, a poor appetite combined with certain patterns of child care might be the explanation). The research reported in this thesis was designed to investigate the possibility that children who fail to thrive may have poorly regulated appetites.

The first possibility to be investigated was unusual taste preferences. Human infants have been shown to prefer sweet taste over plain or other basic tastes (Desor et al, 1975); exposure to sweetened solutions, or the lack of it shapes preference for sweet solutions in older infants (Beauchamp and Moran, 1982, 1984). Preference for sweet in newly born infants may be seen as an inborn predisposition, which helps adapt the infant to getting nourished in its post-natal environment. As the infant grows this predisposition gives way to exposure and dietary experience to re-shape taste preferences; thus the child can be adequately nourished from within set family and cultural practices and food choices.

In the case of FTT, there are two possibilities, either the predisposition towards preference for sweet might be absent right from birth, or their post-natal exposure to a certain diet could have led to a depressed response to sweet. Another hypothesis is that poor taste acuity and anorexia, like poor growth are consequences rather than the cause of under-nutrition (Buzina et al., 1980). Whatever the case may be, it must first be established whether children with FTT are different from well nourished children with this regard. In this thesis a study is reported designed to investigated the possibility that children with non-organic FTT have a poorer response to sucrose sweetened solutions than well nourished controls. Preference for sucrose solutions at two levels of sweetness over water was determined on the basis of amounts drank. The protocol followed was an adaptation of one which has been reported to show differential responses to sucrose by young children (Vazquez and Pearson, 1982).

The second possibility investigated was food refusal, or more generally, unusual meal-time feeding patterns. It has been shown that parent-child interactions during meal-times differ between children with non-organic FTT and normal controls, there are differences in parental organisation and ability to cope at meal-times, and in the children's behaviour and affect (Wolke et al., 1990; Polan et al., 1991). However, the mediating variables between these emotional and social factors and energy intake need to be specified. These mediating variables relate to the specific behaviours during feeding which describe the intake of food or its refusal or rejection. Differences are investigated between children who fail to thrive and normal controls in observed meal-time behaviours; using a computerised behaviour inventory all specified feeding related acts were recorded for each child.

Observation of specific behaviours tells us whether or not food is being offered and eaten at meal-times. However, other information about the parental factors and the family environment may relate to tendencies at meal-times which either facilitate or inhibit the intake of food, and so may help explain non-organic FTT. These include family socio-economic status and parental knowledge and beliefs about healthy eating in childhood. Questionnaire information about family factors was obtained along with parental reports of their children's appetite and diet.

The third possibility investigated was unusual caloric compensation. Normally growing children have been shown to have the ability to compensate, i.e. to adjust their energy intake at a given meal in response to an earlier calorie load (Birch and Deysher, 1986), but no study has so far investigated caloric compensation in children with FTT. There is a possibility that inability to compensate may be a factor in the low energy intake of children with non-organic FTT. As in the case of response to sweet taste, children with FTT may lack the inborn predisposition which enables normal children to respond more to internal signals of hunger rather than external stimuli in a feeding situation. Alternatively, certain feeding practices may alter these tendencies so that children who fail to thrive may lack the ability to respond appropriately to hunger signals. To investigate this possibility, children with non-organic FTT were compared with normally growing controls on their intake of a meal following a high- or low-calorie drink. Caloric compensation was measured by looking at the amount by which intake of the meal was reduced on the occasion when a high-calorie pre-load was given. This investigation also allowed comparison of failure to thrive children and controls on overall energy intake during the meal.

CHAPTER TWO

Methods

2.1 The Parkin Service

The Parkin Service was set up in 1991, in Newcastle-upon-Tyne to monitor the growth of children with failure to thrive and to care for them. The project has on its staff a multi-disciplinary team including paediatricians, dieticians, a research nurse, health visitors and social workers. Apart from child growth monitoring and intervention, the Parkin Service is also involved in research on failure to thrive. The research reported in this thesis was initiated and carried out through collaboration with the Parkin Service. In particular, all children with FTT in the study were recruited through the Parkin Service FTT screening programme; children in the control group were also recruited with their help.

Although the Parkin Service was only officially set up in 1991, data on the growth of children in the Newcastle-upon-Tyne area was collected for about five years prior to this (First Report of the Parkin Project, 1992). A weight surveillance programme was set up based on the knowledge that most children living in the area were regularly weighed in the first year of life. Health Visitors were instructed to forward all weights to the central child health computer on specially designed weight forms. Other initial work included a FTT prevalence study, involving a one year birth cohort of 3,653 children living in Newcastle in 1989, aged 18 to 30 months (Wright et al., 1994a). The children were identified using the child health computer system; their health records were reviewed to collect birth weights, and up to six subsequent weights between birth and 18 months, together with some medical information. The results of the prevalence study prompted more work to try and improve the efficiency of screening methods (First Report of the Parkin Project, 1992).

The information from the prevalence study and the weight surveillance programme together with growth data from the Cambridge growth study (Wright et al., 1993) were used to develop new computer generated weight centile charts. The new 'Parkin Service Weight Monitoring Charts' are up-dated charts based on the 1990 UK National Standards (Freeman et al., 1995), with information on growth over time from children living in Newcastle-upon-Tyne between 1990 to 1994. These new charts have been adapted to make it easier for parents and health professionals to detect any fall a child makes from centile position; they also give some brief guidelines to identification of FTT and signs of recovery.

2.2 Criteria for screening failure to thrive

A child can have a low single weight (say below the third centile) either because they had a low birth weight or because they had a poor postnatal weight gain. So we need to identify FTT using a measure of postnatal weight gain; the Thrive Index (described below) is such a measure.

A single weight from an individual child does not tell us how much that child's growth deviates from the expected postnatal growth pattern (Wright et al., 1994a). This requires longitudinal data, and a longitudinal reference standard. A measure was therefore used which is based on establishing a 'baseline', which is the mean of up to three weight standard deviation (SD) scores, taken around six weeks of age (Wright, 1996). The baseline is used to predict the weight of the child at a subsequent age. The six weeks weight SD score is then multiplied by a constant calculated from the population data, using regression analysis. The constant is essentially the correlation between the two weights. In the case of the Newcastle children, the regression constant was found to be 0.65. The predicted weight SD score is derived as follows:

Predicted weight SD score = Baseline weight SD score x 0.65 (constant).

This allows for the regression to the mean of weight SD score. Regression to the mean refers to the tendency of very large and very small babies to move inwards towards the mean as they grow, rather than tracking along the same centile line (Wright, 1996).

Where a six weeks weight is not available, the predicted weight SD score is calculated from birth weight. The 'predicted weight SD score' is not necessarily the same as the child's later 'attained weight SD score' as the child may have gained weight at a greater or lesser rate than that predicted from the six weeks baseline. This discrepancy between the 'predicted weight SD score' and the 'attained weight SD score' is known as the 'Thrive Index' (Wright et al., 1994a), i.e.:

Thrive Index = Attained weight SD score – Predicted weight SD score.

The Thrive Index indicates whether a child's attained weight at any point in time is as predicted; it also shows the degree to which the attained weight is less than the predicted weight. A child was defined as having FTT if their Thrive Index was less than about -1.26 SD (standard deviations); this is the average threshold below which 5% of children fell in the original prevalence study of FTT in the Newcastle children. The threshold was arrived at by a cross sectional analysis of rate of weight gain achieved by each three month period in the first year and each six month period in the second year (i.e. 3, 6, 9, 12, 18 months etc.). The Newcastle-upon-Tyne population data were later re-analysed using the 1990 UK national standards, which showed that the slowest growing 5% of the children would have to make a fall of -1.30 SD (Wright, 1996). Table 2.1 shows these new thrive index thresholds for the slowest growing 5% of the children in different age groups (Wright et al., 1994a). This shift from -1.26 to -1.30 SD as the screening threshold meant that some of the most mildly affected children, when compared with the new standards, would not make a sufficient fall to put them below the new 5% threshold. In order to include all cases earlier classified by the Parkin Service as falling below threshold, the threshold was set at -1.25 SD (Wright, 1996).

Table 2.1 Screening threshold for children in different age groups.

AGE	THRESHOLD (Thrive Index)
3 months	-0.85
6 months	-1.21
9 months	-1.42
12 months	-1.40
18 months	-1.51
9 - 24 months (Latest weight taken at this age in whole group)	-1.48

All the children falling below threshold are formally referred to the Parkin Service for full assessment and intervention. A full growth assessment involves retrieving all of the child's recorded weights from the child health computer; the Health Visitor is also instructed to submit subsequent weights at three monthly intervals. Children's length is also measured where possible, and their parents' heights are obtained and the mid-parental height calculated and converted into SD scores (Wright, 1996); this provides a reference from which constitutionally small children could be identified. Medical assessment is conducted by a paediatrician and at this stage organic causes of FTT, if present, are identified.

Initial intervention involves simple dietary and behavioural advice to parents, and family support. If no improvement occurs, specialist management is the next step, including dietary assessment and medical examination (Wright and Talbot, 1996). Children are only discharged from follow up when they have demonstrated consistent recovery above the screening threshold, ideally with two weights above the screening threshold three months apart (Wright, 1996).

The children included in the FTT group of this study were those that had either just screened in with non-organic FTT, or existing cases that were not showing recovery. Cases making early recovery were excluded from the study. Based on the Parkin Service studies, FTT in the children seen in the project lasts a long time. Half the cases met screening criteria by the age of six months, although referrals were not made until after the age of 12 months, so the children may have had poor weight gain for six to 18 months before the Parkin Service became involved (Wright and Talbot, 1996).

2.3 General aim of the research

This research was aimed at investigating satiation patterns and taste preferences of non-organic FTT infants as compared to normally developing infants. Two investigations were carried out on the same children. Investigation 1 tested children on preference for sucrose sweetened solutions over water. Investigation 2 tested children for satiation and involved two lunch time meal observations. In addition a questionnaire was administered to the parent to provide dietary information about the child.

2.4 Subjects

The Case group comprised 28 children aged 12 to 24 months at the time of recruitment. The child must have screened into the Parkin Project for non-organic FTT. The age of children in this group was 12 to 25 months at the time of actual participation in the research. This age range was chosen because in most cases, failure to thrive becomes apparent in the first year of life, and in the population from which the sample was drawn screening for FTT is usually not until after the age of 12 months (Wright and Talbot, 1996). For a study of feeding behaviour in children aged one year and above, an age-range of one year is just about right, as wider ranges may introduce greater variability in feeding. Parents of all children in the above defined category were approached and asked to participate in the research. (Two families were not approached based on clinical considerations.) All the families that were approached agreed to participate.

The criteria used for inclusion in the FTT group are outlined in section 2.2 above. Verbal consent was obtained from the parents, subject to signed consent at the time of actual involvement in the research.

The Control group comprised 28 children with normal growth. They were chosen to be comparable with cases on the following characteristics in this order:

1. General Practice: The Control children had to be registered at the same Medical Practice or Health Centre as the Cases. To be certain of their

geographical proximity with each other, their postal area code was noted. Both Medical Practice and postal code were used as a guide to the socio-economic status of the families.

2. Sex: For each boy or girl in the Case group a same sex Control was recruited.

3. Age: The children in the FTT group were aged 12 to 24 months. For every Case a Control was recruited, comparable in age to the Case. The Control child had to be not more than three months younger and not more than one month older than the Case. Because recruitment of controls took weeks sometimes, it was better to include the younger children in the recruitment criteria so that by the time they were investigated they were not too old compared to the Case. At the lower extreme of the age range, therefore, a comparable Control for a Case aged 12 months, would be between nine and 13 months old at recruitment. While at the upper extreme a comparable Control for a Case aged 24 months would be between 21 and 25 months old. Therefore, the age range of the Control group at recruitment was nine to 25 months (as compared to 12 to 24 months for the Cases). However, no child was actually tested until they were 12 months old, or just before; and so the age of children at the time they were tested was 12 to 24 months for the Cases and 12 to 25 months for the Controls.

4. Geographical proximity: For each Case recruited at least five children fitting the above three criteria were identified as possible Controls, and the one nearest to the Case child in geographical location as determined by residential address, was selected, subject to parental consent. A letter written and signed by a dietician was sent to the five families explaining that the research was aimed at investigating 'Appetite in children aged one to two', and asking them to participate in the research. An addressed stamped envelope was enclosed

with a reply slip which said 'I DO/DO NOT wish to be involved in the "research on appetite in children"' (Appendix one shows the letter in full). If no reply was received from any of the families, the researcher called round at the families' homes to ask them in person. In most cases a family was recruited when the researcher called at their homes.

5. Ethnicity: The above procedure (1 to 4) of choosing Controls could not be applied to non-Caucasian subjects due to the scarcity of children of similar ethnicity in the area in which the research was conducted. For these children, the area Health Visitor was approached for a list of children of the particular ethnic group and parents of any available children were approached. Non-Caucasian children were recruited as a child of the same national origin, in an attempt to limit cultural bias. Of all the 56 subjects seen only two Cases and two Controls were non-Caucasian. One of the cases was Pakistani by descent and was paired with a Control that was also Pakistani by descent. However, for the other non-Caucasian Case who was Indian by descent a suitable Indian Control could not be found; a Pakistani child was recruited as the closest alternative.

2.5. Investigation 1

Investigation 1 was aimed at comparing the Case and Control groups on their preference for sucrose sweetened solutions versus water. The design closely followed that of Vazquez, Pearson, and Beauchamp (1982).

2.5.1 Materials

A parent's information sheet was handed to parents on the day of the test, which described the nature of the tests to be done. A consent form for parents to sign and a recording sheet for recording volumes and weights of solutions before and after intake, were also used. Digital baby scales were used to weigh the children (SECA, model 724). A digital timer was used to time the child's drinking.

The tastant was presented in six drinking bottles or beakers, each containing 50 ml of the solution; two of these contained water, two contained a sucrose solution (0.2 Mol), and the other two contained a higher concentration sucrose solution (0.4 Mol). These levels of concentration were based on an earlier study (Vazquez et al., 1982) which showed that a difference of 0.2 Mol in sucrose concentration does evoke differential responses in children of this age. The 0.2 Mol sucrose solution was made by dissolving 6.8 g of sucrose in 100 ml of sterile water. The 0.4 Mol sucrose solution was made by dissolving 13.7 g of sucrose in 100 ml of sterile water.

The tastant was prepared not more than 48 hours before the experiment. This was based on the dietician's advice on the handling and storage of sucrose solutions. When they were ready, the solutions and water were transferred into feeding bottles or drinking beakers (i.e. a cup with a lid on and a 'spout' to drink from, used during the transition from using a feeding bottle to a cup by infants and toddlers), weighed and stored in the refrigerator ready for the experiment.

2.5.2 Procedure

The sucrose preference test was done on the Experimenter's first visit to the household (unless she had been there earlier for control recruitment). Whichever the case was rapport with the child had to be established. To start with the Experimenter talked to the parent for some five to ten minutes in the presence of the child. The Experimenter reviewed the information given earlier about the research, outlined the specific investigations and procedures involved, and described the procedure for the day. The Experimenter then weighed the child (accurate to one tenth of a gram) with the help of the parent. Children were weighed without clothes on, except for a dry nappy. This order of procedures allowed the child to be familiar with the Experimenter; but even so a number of children were still quite timid and needed a lot of prompting from the parent when it came to the tasting session.

An effort was made to keep the testing environment as close to the child's usual feeding environment as possible. And so the tasting was done in the child's home, and where possible, in the child's usual feeding position. In most cases this was either sitting up in a high-chair or parent's lap, and unless they were in a high-chair the children often wandered about the room while being tested. Those children who normally drank from a bottle were given the tastant in bottles, and those that normally drank from a cup or a beaker used a beaker. Prior to the visit the parent had been instructed not to allow the child any food or drink for at least 30 minutes before the experiment.

Before the testing began the Experimenter explained the procedure to the parent as follows:

"I would like your child (X) to taste some drinks. I have got with me six such drinks in small quantities, and I would like to see how much (X) likes them. I will be handing you a bottle/beaker at a time and you are to give it to (X) for about a minute; I will tell you when to start and when to stop, and then I will give you another bottle/ beaker. I will be weighing your child when he/she has finished drinking."

The Experimenter then answered any questions from the parent and explained the procedure as required.

The order and duration of the presentation of drinks is summarised below:

1. Bottle 1	Rest	**2.** Bottle 2	Rest	**3.** Bottle 3
(water)		(0.2 Mol sucrose)		(0.4 Mol sucrose)
60 s	30 s	60 s	30 s	60 s

Rest (5 minutes) and continue as follows:-

4. Bottle 4	Rest	**5.** Bottle 5	Rest	**6.** Bottle 6
(0.4 Mol sucrose)		(0.2 Mol sucrose)		(water)
60 s	30 s	60 s	30 s	60 s

The whole procedure was scheduled to take approximately 12 - 15 minutes, but it took longer in a few cases due to the lack of compliance by the children.

2.6 Investigation 2

2.7 Investigation 2 was aimed at examining the children's intake at a meal following a pre-load drink of either zero or 96 kcal (kilo calories). Each child was tested at a lunch meal on two separate days, and each meal was video-recorded.

2.6.1 Pre-load drinks and the standard test meal

Pre-load drinks of 150 ml in volume were prepared by the Hospital Pharmacy at the Royal Victoria Infirmary (RVI), Newcastle-upon-Tyne. The pre-load drink contained either no energy (0 kcal) or contained energy (96 kcal) In prior studies of children aged from two-and-a-half to five years (e.g. Birch and Deysher, 1986; Johnson and Birch, 1994; Anderson, 1995) differences in the caloric content of pre-loads ranged between 100 to 147 kcal, with the low calorie pre-load containing as little as three to 32 kcal. Because the children in this study were a lot younger (i.e. one to two years old) it was decided, after a number of trials and tasting sessions with a paediatric dietician, that the pre-loads contain no more than 100 kcal. Calories are used as the unit of measure of nutritional energy (although they are not an SI unit), because the NHS nutritional and dietetic services, and commercial producers (e.g. Maxijul) work in calories which makes it easier to use. The joule (J) is the SI base unit for energy, and is usually quoted as the kilojoule (kJ); the nutritional calorie is 1 kcal or 4.184 kJ (Drewett, 1993).

The pre-load drinks were either in orange or black currant flavour. The pre-load drinks were specially made so that there was very little difference in taste between the no-calorie and the high-calorie pre-loads of the same flavour. This was achieved by using calorie-free squash in both pre-loads, and adding the same flavour calorie-dense drink in the high-calorie pre-load. The resulting no-calorie and high-calorie drinks were very similar in taste.

The high calorie pre-load was prepared by adding 50 ml of Maxijul to 30 ml of calorie-free squash. Both the Maxijul and the squash used was in either the orange or black currant flavour, so that the orange flavoured Maxijul was mixed with the orange flavoured squash and likewise for the black currant. The mixture was then diluted in 70 ml of water. Liquid Maxijul is a calorie-dense drink (available in black currant, lemon and lime, orange and natural flavours) distributed by Scientific Hospital Supplies Limited, Liverpool, England. It contains approximately 1.92 kcal per 1 ml. Maxijul is produced by a controlled hydrolysis of food starch, to give a pure carbohydrate energy source. Its composition is 50 % carbohydrate, 0.004 % potassium, and 0.0023 % sodium, and it is gluten-, lactose-, and fructose-free (British Medical Association and the Royal Pharmaceutical Society, 1997). The calorie-free squash used contained approximately 1 to 1.4 kcal per 100 ml undiluted, which is a negligible amount.

The no-calorie pre-load contained no Maxijul and thus no calories. It was made up of 30 ml of calorie-free squash diluted in 120 ml of water to give 150 ml pre-load.

Based on practical considerations (i.e. ease of preparation, packaging and serving, and palatability to one and two year old children), a variety of snacks served at room temperature was used as the standard test meal for all the children. The snacks were from a major food store (TESCO). All the snacks as well as the ingredients for sandwich preparation, except for carrot and cucumber, came in packs from the shop complete with caloric information. Table 2.2 shows the food list. The sandwiches were prepared by first cutting the sides off the slices. The slices were then weighed separately and the low-fat spread put on. The slices were weighed again before putting of the tuna, cheese or marmite spread. Finally, the whole sandwich was weighed cut, put in a sandwich bag and weighed again with the bag.

2.6.2 Materials

A video camera (Camcorder) and tripod were used to record the meals. A portable computer was also used for keeping the meal time behaviour inventories. Digital scales (OHAUS GT4800) were used for weighing food before and after intake. A recording sheet was used to record all weights of food and drink before and after intake.

2.6.3 Procedure

As in Investigation 1, children were tested in their own homes, and all the children had already done the sucrose preference test (Investigation 1). This investigation was carried out at lunch-time; the specific time depended upon the time at which each individual child normally ate their lunch. The starting time for all children ranged between 11:00 to 14:00 hours.

Table 2.2 List of snacks, drinks and ingredients used in the standard test meal.

Food/drink	Ingredients	Calories per 100 g
Potato chips		521 kcal
Potato rings		519 kcal
Tesco cheese singles		295/310 kcal*
Tuna (and mayonnaise) sandwich	White, medium sliced bread	240/248 kcal*
	Low-fat spread	224/370 kcal*
	Tuna and mayonnaise paste	238 kcal
Cheese sandwich	White, medium sliced bread	240/248 kcal*
	Low-fat spread	224/370 kcal*
	Cheese paste	257 kcal
Marmite sandwich	White, medium sliced bread	240/248 kcal*
	Low-fat spread	224/370 kcal*
	Marmite	175 kcal
Carrot (sticks)		23 kcal
Cucumber (slices)		10 kcal
Fromage frais		125/140 kcal*
Jelly		75 kcal
Orange drink		34 kcal
Black current drink		50 kcal

*Calories per 100 g varied between supplies but remained within the range of the two figures given.

The test session began with the experimenter describing the procedure to the parent:

> "Today I brought some lunch for your child (X).
> But to begin with, I would like (X) to have some of this squash instead of his/her usual. I will allow him/her no more than 25 minutes to drink the squash before the lunch-time meal. I would like you to encourage him/her to drink up. I would like you to either feed or help (X) with feeding the way you normally do.
> I will be taking away any leftover food and drink in order to measure how much (X) has actually eaten."

The experimenter then answered any of the parent's questions and clarified the procedure where necessary.

The child was first given the pre-load drink and given up to 25 minutes to drink it up. Both the parent and the Experimenter were blind to the energy content of the pre-load. While the child was drinking the Experimenter set up the video recording equipment. After the pre-load was drunk, the child was given the meal, and allowed to eat with or without the help of the parent as they normally would. The entire meal was video-recorded (except for the drinking of the pre-load), and effort was made to keep the child and all feeding related activities in view. The parent did not need to be in full view, but any part they played in the feeding had to be visible. In cases where the child was not secured in a high-chair, the child tended to move around the room which meant that they did not always remain in view. Feeding continued until the child showed overt signs of being satiated by not accepting any more food, keeping the mouth shout, spitting food out, waving arms about or any other behaviours indicating reluctance to continue eating. The parent made the decision to discontinue the feed.

Leftover food and drink were collected and later weighed. An effort was made to collect all the leftovers including the bits of food that had in some cases been thrown about the floor etc. Any drink spilt was estimated, by the Experimenter with the help of the parent, and replaced before weighing the leftover drink. In some cases potato chips and rings which had been popped in and out of the mouth weighed more because they had become soaked in the child's saliva; these were counted and replaced with dry ones during post-weighing. The amounts consumed from both the pre-load and the *ad libitum* meal were calculated from the weights of the food and drink before and after intake, and known caloric content of individual food and drink. Amounts consumed were recorded both in grams and kilo calories (kcal).

2.6.4 Randomisation procedure

The procedure described above was repeated on a second day for all subjects. The only alteration to the investigation was the caloric content of the pre-load drink. Half the subjects received the no-calorie pre-load drink on the first day and the high-calorie drink on the second day, while the other half received the high-calorie drink first. For the purpose of randomising the assignment to each of these two groups, the Case and Control groups were sub-divided into two groups and further divided into blocks of four in which two were assigned to one group and the other two to the other. The assignment to groups within the blocks was randomised. Appendix Two shows details of the randomisation order. The randomisation and the making up of the pre-load drinks were carried out in the RVI Hospital Pharmacy to ensure that the study was done blind.

Both the parent and the Experimenter were blind to the subject's condition i.e. which day they received the no-calorie and the high-calorie drinks. The parents were unaware of the difference in calorie load of the pre-load throughout the investigation. The Experimenter also remained blind to the order of pre-loads throughout the investigation until the behaviour coding had been done for all the meals, and weighed intakes from all subjects had been collected and converted to kcal. These measures were taken to ensure that neither the parent nor the Experimenter could at any point during the investigation bias the results.

2.7 Ethical approval

The study design was approved by the Joint Ethics Committee, Newcastle Health Authority, University of Newcastle upon Tyne.

CHAPTER THREE

Growth data, and parent reports on child appetite and feeding history

3.1 Weight gain and failure to thrive in the study children

Growth data for the children studied were collected in the form of weight measured in grams, from birth up to about 24 months of age. For the Cases the growth data came from the growth database held on cases managed by the Parkin Service. The weight data for the Controls was retrieved from the Newcastle-upon-Tyne Local Health Authority central child health computer. Additional data for both the Cases and Controls came from the weights obtained during the Researcher's visit. Up to 17 weights per child in the case group were obtained, but on the whole few weights were available per child for the control group.

Differences between Cases and Controls in weight are apparent from birth. The mean birth-weight for the Cases is 3163g, which is lower than the 3415g for the Controls (Table 3.1.1). This difference between groups is observable in girls as well as boys (Table 3.1.2), but is not statistically significant. The difference in means is about twice as much as that in medians for the same measures, suggesting the presence of extreme scores. The percentiles in Table 3.1.1 show that the heaviest children in the two groups as indicated by the 'maximum' values, are not that different in weight (i.e. 4340g and 4245g for Cases and Controls, respectively), with the Cases being heavier by 95g. The box plots in Figure 3.1.1 show that the upper 75% of the weight scores for the Cases fall within the same range as the Control group, which means that the greater mean and median weights for the Control group are a result of a few very low scores in the FTT group.

Table 3.1.1 Percentiles, and descriptive statistics for birth-weight and six weeks weight for Cases and Controls.

WEIGHT (g)		MINI-MUM	25TH	MEDIAN	75TH	MAXI-MUM	MEAN	SD
BIRTH-WEIGHT								
	Cases	1470	2757	3215	3645	4340	3163	689
	Controls	2740	3005	3370	3780	4245	3415	431
SIX WEEKS WEIGHT								
	Cases	3290	4107	4395	4750	6380	4478	668
	Controls	3700	4600	5040	5470	8800	5178	1077

Table 3.1.2 Mean weights at birth and around six weeks of age according to group, and sex.

	Cases		Controls	
WEIGHT (g)	Girls	Boys	Girls	Boys
BIRTH-WEIGHT	3065	3276	3258	3584
Case-control differences:	t = -1.62	p>0.1	NS	
SIX WEEKS WEIGHT	4090	4706	5291	5933
Case-control differences:	t = -2.84	p<0.01		

The weight data for the children at around six weeks of age show similar group and sex differences as those in birth-weight (Tables 3.1.1 and 3.1.2). However, the differences in mean weight between the Cases and Controls are not only greater at six weeks (i.e. 4478g and 5178g for Cases and Controls, respectively), but also statistically significant ($p < 0.01$). This difference is evident in the box plots in Figure 3.1.2 which show that the range and median for the Cases are well below those of the Controls, unlike the trend in birth-weights discussed earlier (Figure 3.1.1). A two-way analysis of variance (ANOVA) showed that these group differences at six weeks of age are sustained when sex is included in the analysis ($p < 0.009$).

Even though the children with FTT are only diagnosed as failing to thrive when they are around six months old (Wright and Talbot, 1996), these results show that the fall in their weight gain begins very early in life, and within six to eight weeks a clear difference in weights between the Cases and the normally growing Controls is apparent.

SD scores are useful in illustrating the degree of weight faltering. Any fall or gain in weight is easily translated into a corresponding fall or gain in SD score, and this can be presented visually in graphs around a mean of zero. In this study the UK 1990 growth standards (Freeman et al., 1995) were used as the basis for comparison. Each child's weight was transformed into an SD score based on the population mean and SD for the particular sex and age group. Due to insufficient weight data in the Control group, comparison of the two groups was not possible, and so the Cases' growth was compared to that of the UK 1990 population.

Figure 3.1.1 Birth-weight of Cases and Controls

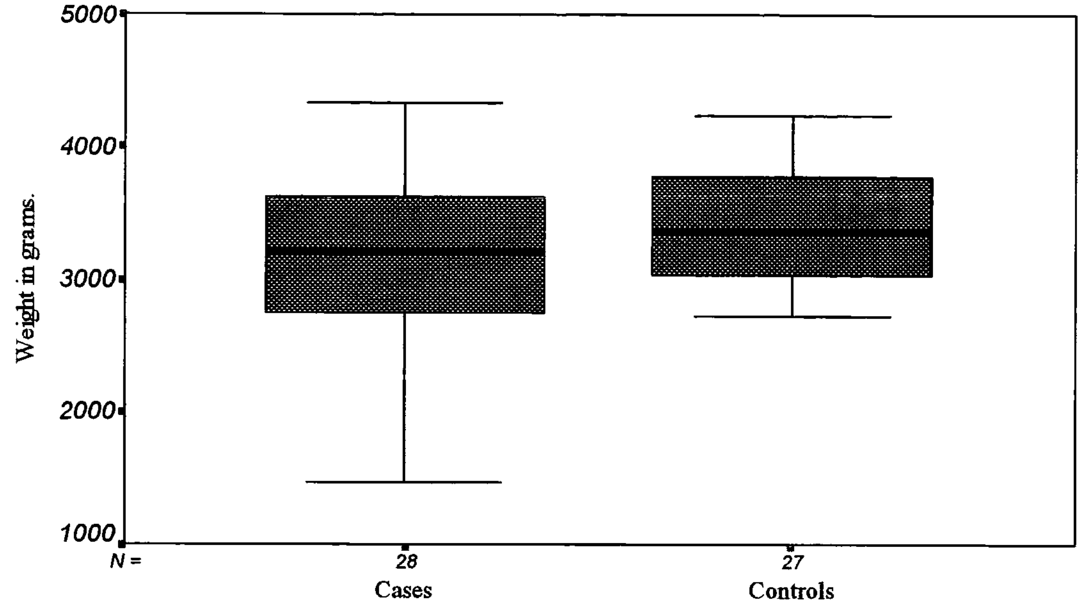


Figure 3.1.2 Weight of Cases and Controls at around six weeks of age.

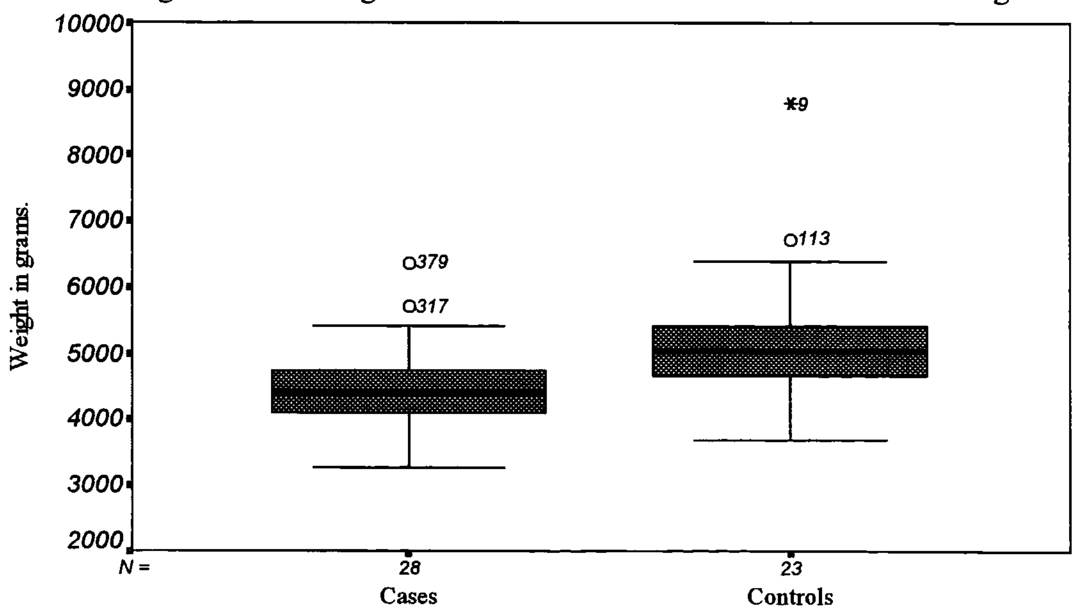


Figure 3.1.3 shows weight SD scores for the Cases over a 30 month period. With an SD of 0 as the population mean, the graph shows the children initially distributed between +2 and -2 SD at birth (0 months), except for one very low birth-weight child at about -4 SD. A sign-test of the median was done to test whether the birth-weight SD scores for the group were significantly different from the population median (0). The group median was -0.33, with 17 cases below and 11 cases above the population median; the test showed no significant difference between the case birth-weights and the population median.

From birth onwards the weight SD scores show a general downward trend. Figure 3.1.4 shows that for all the children except for one child who started off with a very low birth-weight, whose drop occurs later, there is a downward trend in weight SD scores over time. This drop in weight SD scores per se is not at all surprising as it characterises FTT. However, it is interesting that this fall generally begins right after birth. Figures 3.1.5 to 3.1.10 show this downward trend in weight SD scores for six case children picked at random using a table of random numbers. All six show a fall from the second score, which is the six weeks weight. Except for two (case No. 24 and case No. 28) the SD scores are falling right from birth.

Figure 3.1.3 Weight in SD scores over time; Cases only.

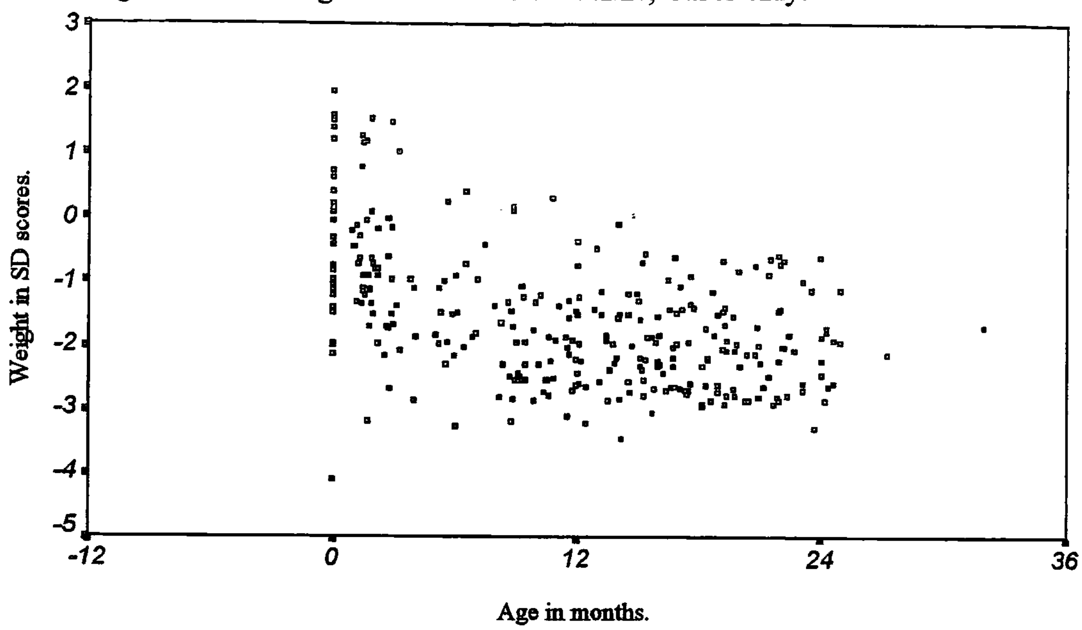


Figure 3.1.4 Weight in SD scores over time; Cases only.

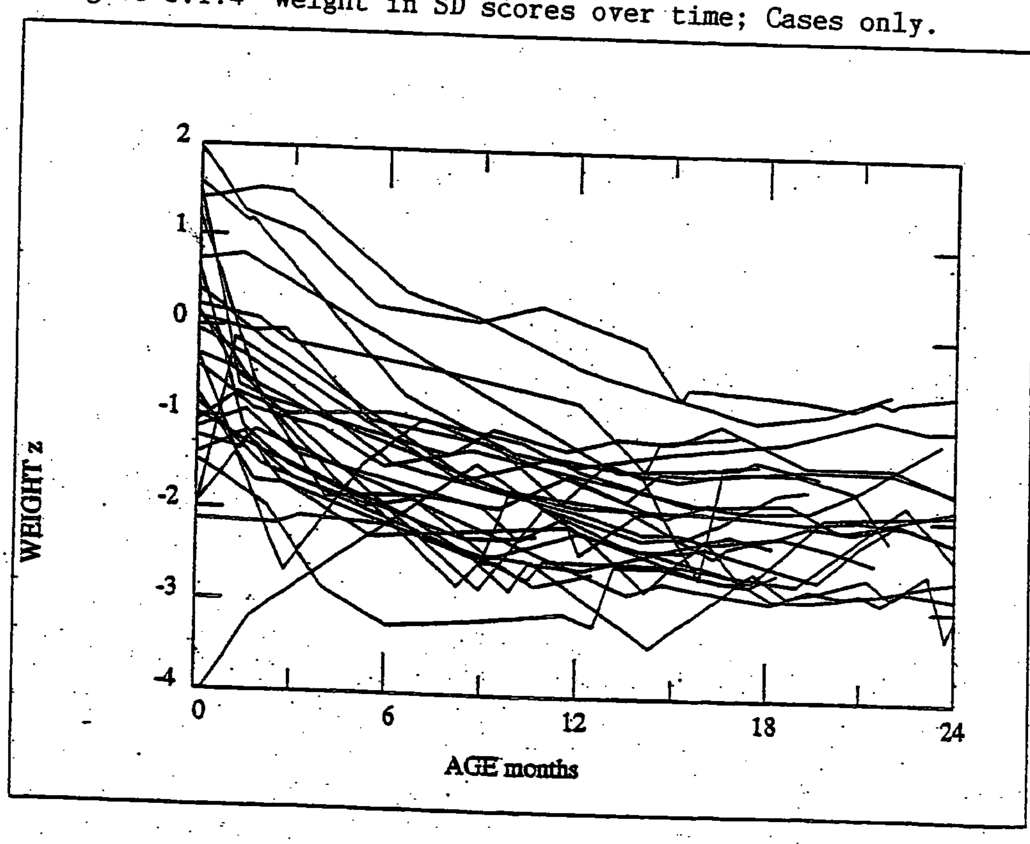


Figure 3.1.5 Weight in SD scores against age for case No. 1 (female).

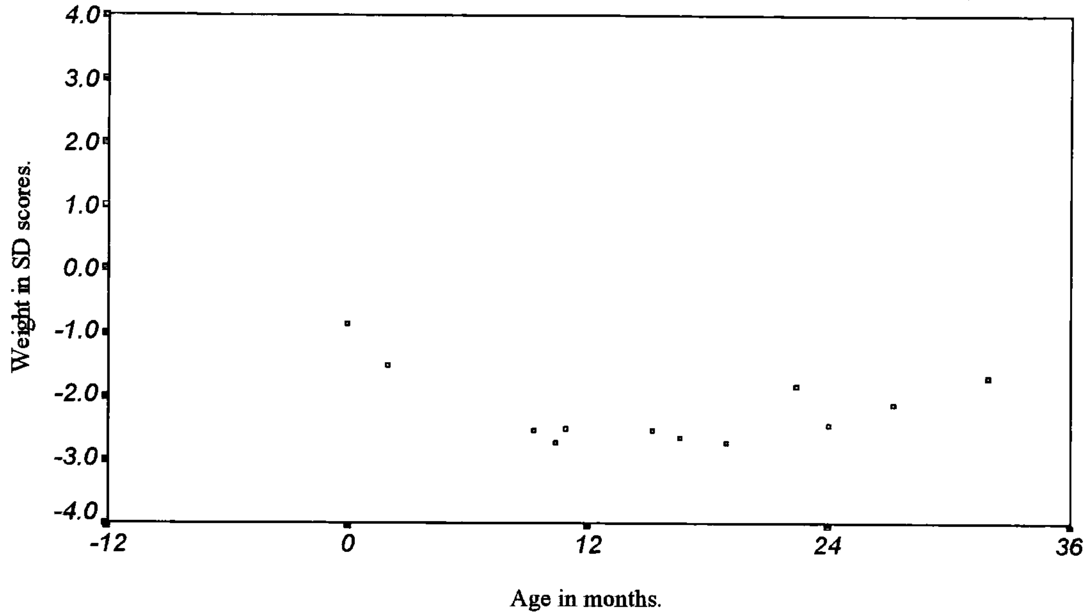


Figure 3.1.6 Weight in SD scores against age for case No. 2 (female).

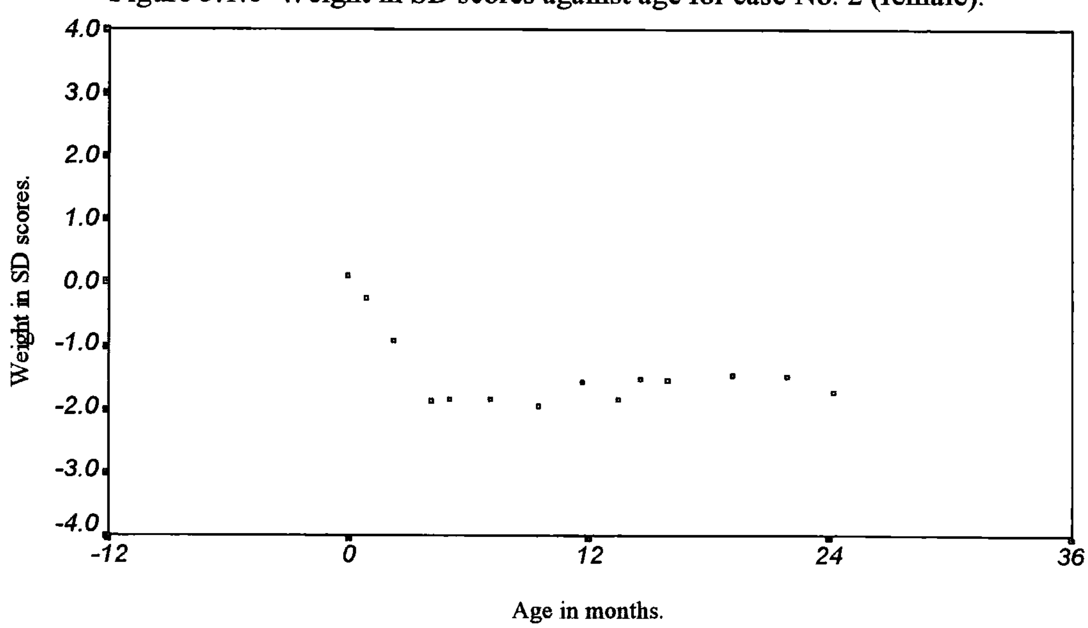


Figure 3.1.7 Weight in SD scores against age for case No. 9 (female).

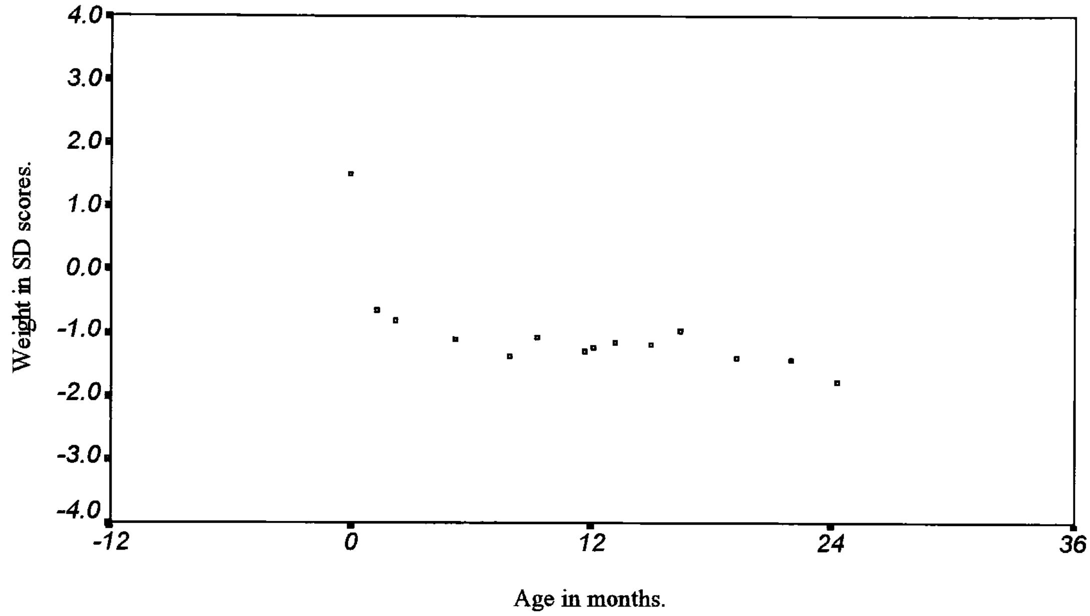


Figure 3.1.8 Weight in SD scores against age for case No. 24 (male).

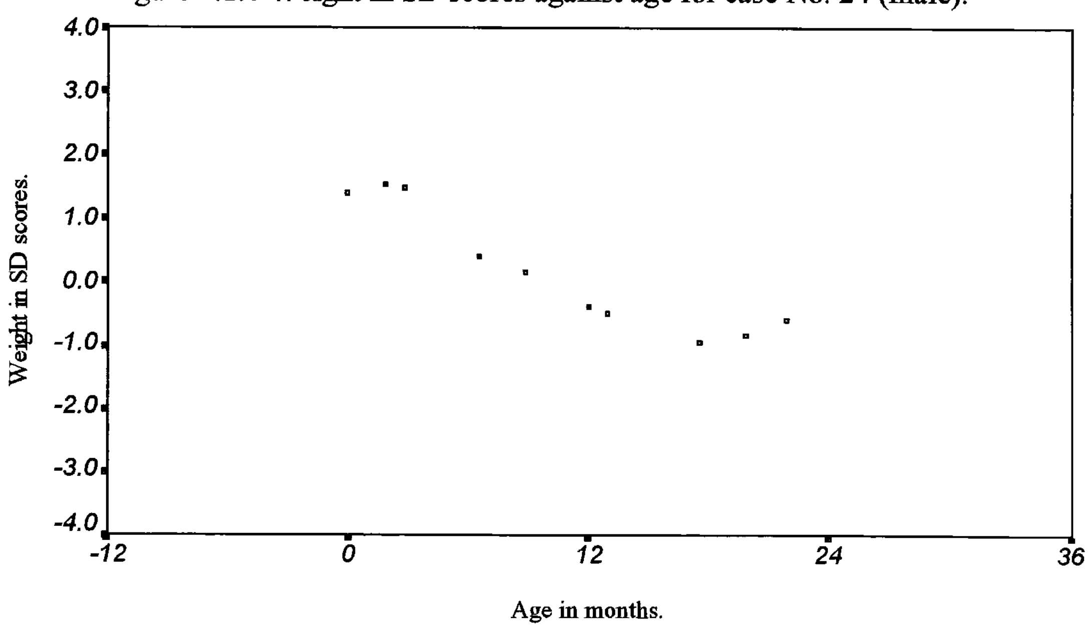


Figure 3.1.9 Weight in SD scores against age for case No. 25 (male).

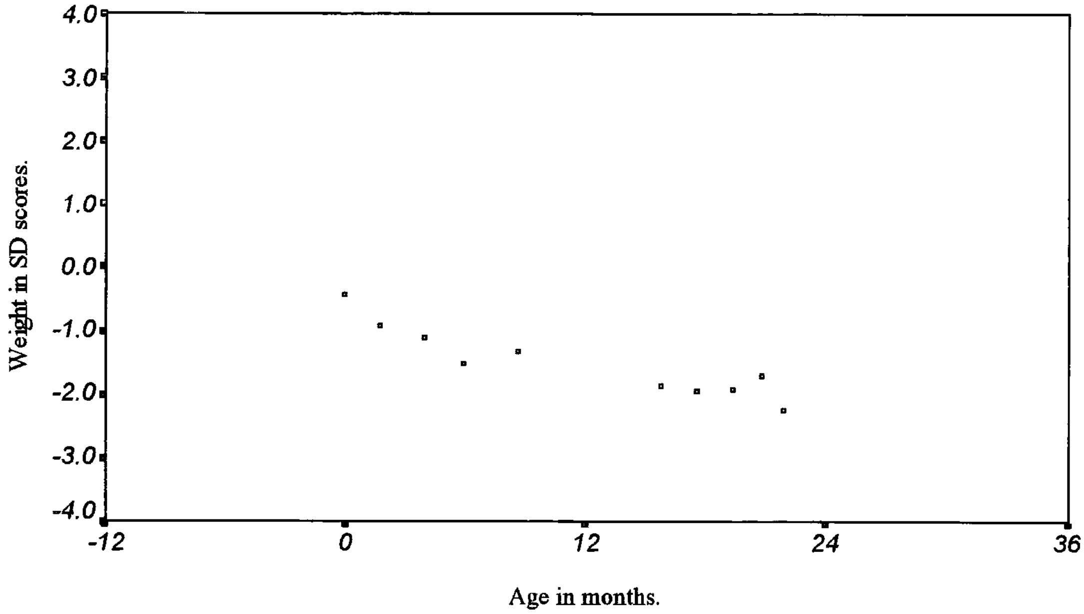
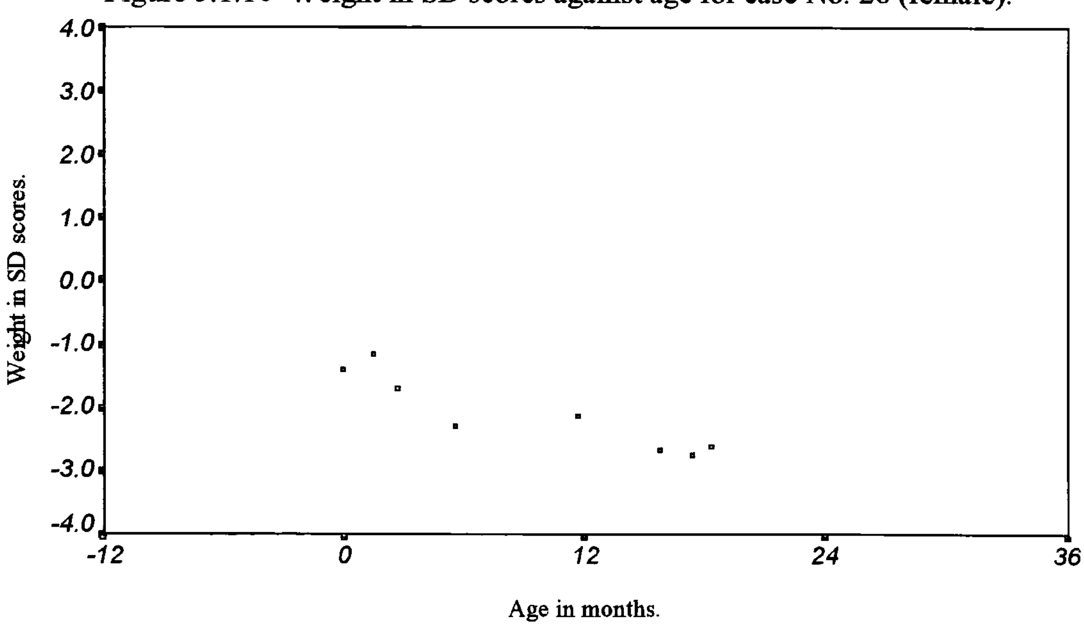


Figure 3.1.10 Weight in SD scores against age for case No. 28 (female).



3.2 Parent reports on child appetite and feeding history

Dietetic assessment is carried out for all children screening into the Parkin Service for non-organic FTT. The relevance of the work of the Parkin Service is discussed in more detail in the Methods section. For the purposes of the research reported in this thesis, the dietetic assessment was carried out on the control group as well. The assessment includes a questionnaire administered to parents, which was designed to gather information on the child's appetite, diet and feeding history as reported by them. For the children in this study a Parkin Service dietician carried out the dietetic assessment after they were recruited.

The Parkin Service assessment was used instead of specially designing a questionnaire for this investigation. It was decided as a matter of policy that questions from the Parkin Service questionnaire which were found to be relevant to the research be incorporated to avoid burdening the families with having to answer the same questions on different occasions.

3.2.1 Variables

Certain items in the questionnaire are important for the intervention work with the FTT group, but are not of relevance to this thesis. Only those items that relate to the child's appetite and food intake and some limited information on parental and family demographic factors are included in this chapter. Table 3.2.1 shows the categories and variables included; these relate to 'age', 'parental and family factors', 'feeding problems', 'meal-times', and 'parental involvement in meal preparation'. The category labelled 'age variables' contains data which relates to either parental factors or feeding history, but are grouped together for the sake of statistical analysis.

Answers to questions under the 'age variables' category and the variables 'NOSIBS' and 'RANK' took a numerical value, while answers to questions under the 'parental involvement in meal preparation' category were in the form of ratings on a scale from one to four. With the exception of 'FEESEL' for all other 'meal-time variables' parents had to answer either 'rarely' or 'mostly'. For example, the child was described as 'rarely' hungry, or 'mostly' hungry at meal-times. Parents answered either 'yes' or 'no' to questions relating to the remaining variables. A sample of the complete questionnaire appears in Appendix Three under the title 'The Parkin Service Assessment'.

3.2.2 Analysis of data

The data for the 'age variables' (Tables 3.2.2 and 3.2.8) were not only numerical, but also close to normally distributed. The t-test for two independent samples was used for differences between groups.

The data under the 'parental/family factors' category, with the exception of the variables 'NOSIBS' and 'RANK', were categorical, i.e. subjects fall in mutually exclusive categories. For example, parents either responded 'Yes' or 'No'. This was the case for the data in the 'feeding problems' and the 'meal-time' variable categories as well. The data under the 'meal preparation' category was originally in the form of ranked responses from one to four, for example,

1) cooks a lot
2) a little
3) not at all
4) can't cook

Table 3.2.1 List of variables

VARIABLES	VARIABLE DESCRIPTION
Age variables	
MOAGE	Mother's age
FAGE	Father's age
AGESOL	Age of the child when he/she was introduced to solid food
AGEFING	Age of the child when he/she was introduced to finger foods
Parental and family variables	
PAREMPL	Is either parent employed (Yes, No)
OWNHOME	Home ownership (Yes, No)
OWNCAR	Car ownership (Yes, No)
NOSIBS	Number of siblings in the family
RANK	Rank of the child in the family
Variables relating to feeding problems	
PSUCK	Reported problems with sucking (Yes, No)
PSWAL	Reported problems with swallowing (Yes, No)
PCHEW	Reported problems with chewing (Yes, No)
Variables relating to meal-times	
FEESEL	Ability of child to feed him/her self (Yes, No)
REATALL	Child rarely/mostly eats up all food on the plate
RHUNGRY	Child is rarely/mostly hungry at meal-times
RMENJOY	Mother (Parent) rarely/mostly enjoys meal-times
RCHENJOY	Child rarely/mostly enjoys meal-times
Parental involvement in meal preparation	
WCOOK	Whether parent cooks or not: (original responses were: a lot, a little, not at all, or can't cook. In analysis categories were reduced to two, 'does cook' or 'does not cook')
LCOOK	Parent likes/does not like to cook (original responses were: likes a lot, a little, not at all, or can't cook. In analysis categories were reduced to two, 'likes' or 'dislikes'; can't cook was left out)

As there were relatively few respondents, in the analysis the categories were reduced to two. In the above example, 1) and 2) became 'does cook', while 3) and 4) became 'does not cook'. And so the data were treated as binary.

The Pearson chi-square test was used to test group differences for the variables with categorical data. Although expected frequencies were not large, the Yates continuity correction was not used for reasons given in Howell (1992).

The data for the variable RANK is ordinal. The values in both NOSIBS and RANK are quite small (i.e. between zero and four), and the frequency distributions are not normal (see Tables 3.2.4 and 3.2.5). A non-parametric test has been used.

3.2.3 Case-control differences

The mothers of the Cases were aged 18 to 40 years (mean 28), which is not significantly different from the mothers of Controls (mean 30), whose age range was 19 to 42 years. Case fathers age range was 21 to 51 years (mean 32), which is not significantly different from the age of Control fathers whose age range was 22 to 49 years (mean 31). Percentiles, descriptive statistics, and t-test results for these variables (i.e. mother's age abbreviated as 'MOAGE' and father's age abbreviated as 'FAGE') are presented in Table 3.2.2.

The variables 'parental employment' (PAREMPL), 'home ownership' (OWNHOME), and 'car ownership' (OWNCAR) provide a guide to the families' socio-economic status. Table 3.2.3 shows that significant differences were obtained between Case and Control families on parental employment (PAREMPL, $p < 0.02$), and home ownership (OWNHOME, $p < 0.01$), but not on car ownership. The table shows that 24 out of the 28 (85.7%) of the Control parents were employed compared with only 11 out of the 27 (59.3%) of the Case parents. Furthermore, 20 of the 28 (71.4%) Control parents owned their home as compared to only 10 out of the 27 (37.0%) Case parents. Similarly, a greater proportion of the Control parents (75%) owned a car as compare to Case parents (59.3%), although this difference was not statistically significant.

The data on family size (i.e. NOSIBS) are presented in Table 3.2.4. These data show a significant difference between Cases and Controls, with the Case families tending to be larger. Control children did not have any more than two siblings, and the majority (89.3%) had either one sibling or no other sibling at all. Cases on the other hand had up to four siblings with the majority (85.7%) having up to two siblings.

Table 3.2.2 Parental age in Case and Control families.

	MINI-MUM	25TH	MEDIAN	75TH	MAXI-MUM	MEAN	SD	N
MOAGE (in years)								
Cases	18.0	25.0	28.0	31.0	40.0	28.1	5.4	28
Controls	19.0	24.5	30.0	33.5	42.0	29.7	5.9	28
$t = 1.24$	$df = 54$		$p > 0.2$					
FAGE (in years)								
Cases	21.0	26.2	30.0	36.7	51.0	32.0	7.7	28
Controls	22.0	26.0	30.0	34.2	49.0	30.9	6.3	28
$t = 0.60$	$df = 54$		$p > 0.3$					

Table 3.2.3 Socio-economic indicators in Case and Control families: Parental employment (PAEMPL), ownership of home (OWNHOME), and ownership of car (OWNCAR).

	NO. OF RESPONSES		PERCENTAGE	
	CASES	CONTROLS	CASES	CONTROLS
PAREMPL				
No	11	4	40.7	14.3
Yes	16	24	59.3	85.7
Column total	27	28	100.0	100.0
Pearson's test:	Chi-square = 4.85	df = 1	p < 0.02	
OWNHOME				
No	17	8	63.0	28.6
Yes	10	20	37.0	71.4
Column total	27	28	100.0	100.0
Pearson's test:	Chi-square = 6.56	df = 1	p < 0.01	
OWNCAR				
No	11	7	40.7	25.0
Yes	16	21	59.3	75.0
Column total	27	28	100.0	100.0
Pearson's test:	Chi-square = 1.55	df = 1	p > 0.2	

The data for the variable RANK are presented in Table 3.2.5. A significant difference between groups was obtained for RANK ($p < 0.01$). For the control group all the children were ranked first, second, or third, while the Cases were ranked first to fourth. Twenty five of the 28 Controls (89.5%) fell under the first and second ranks, while about the same proportion (i.e. 24 of the 28 or 85.7%) of the Cases fell under the first three ranks. The difference was mainly due to the Controls being much more concentrated in the first two ranks, while the Cases were more spread out over four ranks.

3.2.4 Number of siblings (NOSIBS) in Case and Control families: Group frequencies and Mann-Whitney U-test results.

NUMBER OF SIBLINGS	FREQUENCY		PERCENTAGE		CUMULATIVE %	
	Cases	Controls	Cases	Controls	Cases	Controls
None	7	12	25.0	42.9	25.0	42.9
One	8	13	28.0	46.4	53.6	89.3
Two	9	3	32.1	10.7	85.7	100.0
Three	3	0	10.7	0.0	96.4	100.0
Four	1	0	3.6	0.0	100.0	100.0
TOTAL	28	28	100.0	100.0	100.0	100.0

Mann-Whitney U-test:
Mean rank (Cases) = 33.80
(Controls) = 23.20 U = 243.5 $p < 0.01$

Table 3.2.6 shows the data relating to 'feeding problems'. Most parents in both groups reported their children as having had no problems with either sucking (PSUCK) or swallowing (PSWAL), and so there was no significant difference between the two groups according to these variables. However, while none of the Control parents reported problems with chewing (PCHEW), six out of the 28 (78.6%) Case parents did report their children as having had problems with chewing, leading to a statistically significant difference between groups.

Table 3.2.5 RANK (birth-order of the child) for Cases and Controls: Frequencies and Mann-Whitney U-test results.

RANK	FREQUENCY		PERCENTAGE		CUMULATIVE %	
	Cases	Controls	Cases	Controls	Cases	Controls
One	8	13	28.6	46.4	28.6	46.4
Two	8	12	28.6	42.9	57.1	89.3
Three	8	3	28.6	10.7	85.7	100.0
Four	4	0	14.3	0.0	100.0	100.0
TOTAL	28	28	100.0	100.0	100.0	100.0

Mann-Whitney U-test:

Mean rank (Cases) = 33.36
(Controls) = 23.64 U = 256.0 $p < 0.01$

Table 3.2.7 shows results for the variables relating to meal-times. There was no significant difference between Cases and Controls on parents reports on whether they were able to feed themselves without the parent's help or not (FEESEL). Significantly more Control parents reported that their children mostly (rather than rarely) ate up their food at meal-times (REATALL, $p < 0.03$), and that their children were mostly hungry at meal-times (RHUNGRY, $p < 0.002$). As shown by the small 'p' value, this difference is highly significant.

Table 3.2.6 Feeding problems in Cases and Controls: Chi-square for problems with sucking (PSUCK), problems with swallowing (PSWAL), and problems with chewing (PCHEW).

		NO. OF RESPONSES (N)		PERCENTAGE	
		Cases	Controls	Cases	Controls
PSUCK					
	No	27	27	96.4	96.4
	Yes	1	1	3.6	3.6
	Column total	28	28	100.0	100.0
Pearson's test:					
	Chi-square = 0.00	df = 1	p = 1		
PSWAL					
	No	27	28	96.4	100.0
	Yes	1	0	3.6	0.0
	Column total	28	28	100.0	100.0
Pearson's test:					
	Chi-square = 1.02	df = 1	p = 1		
PCHEW					
	No	22	28	78.6	100.0
	Yes	6	0	21.4	0.0
	Column total	28	28	100.0	100.0
Pearson's test:					
	Chi-square = 6.72	df = 1	p < 0.009		

Table 3.2.7 shows that 20 out of 28 (i.e. 71.4%) Control parents, as compared to 12 out of 28 (i.e. 42.9%) Case parents reported that the parents mostly (rather than rarely) enjoyed meal-times with their child, the variable is RMENJOY. Although a higher percentage of Control parents reported their children to 'mostly enjoy' meal-times (RCHENJOY), this difference was not statistically significant.

Table 3.2.7 Meal-time variables in Cases and Controls: Chi-square for self-feeding (FEESEL), eating up the meal (REATALL), hunger at meal-time (RHUNGRY), whether parent enjoys meal-times (RMENJOY), and whether child enjoyment of meal-times (RCHENJOY).

		NO. OF RESPONSES		PERCENTAGE	
		Cases	Controls	Cases	Controls
FEESEL					
	No	2	0	7.1	0.0
	Yes	26	28	92.9	100.0
	Column total	28	28	100.0	100.0
Pearson's test:					
	Chi-square = 2.07		df = 1	p > 1	
REATALL					
	Mostly	10	18	35.7	64.3
	Rarely	18	10	64.3	35.7
	Column total	28	28	100.0	100.0
Pearson's test:					
	Chi-square = 4.57		df = 1	p < 0.03	
RHUNGRY					
	Mostly	13	24	48.1	85.7
	Rarely	14	4	51.9	14.3
	Column total	27	28	100.0	100.0
Pearson's test:					
	Chi-square = 8.81		df = 1	p < 0.002	
RMENJOY					
	Mostly	12	20	42.9	71.4
	Rarely	16	8	57.1	28.6
	Column total	28	28	100.0	100.0
Pearson's test:					
	Chi-square = 4.67		df = 1	p < 0.03	
RCHENJOY					
	Mostly	19	25	70.4	89.3
	Rarely	8	3	29.6	10.7
	Column total	27	28	100.0	100.0
Pearson's test:					
	Chi-square = 3.07		df = 1	p > 0.07	

The chi-square results for 'meal-times' and 'feeding problems' in general show that parents of Cases tended to report their children as having more problems and less hunger and eagerness at meal-times, while the parents of Controls tended to report the opposite. Furthermore, more Control parents expressed a tendency to enjoy meal-times with their child than Case parents.

The mean age at which solid foods were introduced is younger for Controls (3.4 months) than for Cases (3.7 months), but the difference was not statistically significant (Table 3.2.8). The t-test results in the same table, show a significant difference between Cases and Controls on the age at which finger foods were introduced (AGEFING), with finger foods having been introduced to the Controls on average at an earlier age (mean 6.3 months) than the Cases (mean 6.9 months).

Table 3.2.8 Age of introduction to solids (AGESOL) and finger foods (AGEFING) in Cases and Controls.

	MINI-MUM	25TH	MEDIAN	75TH	MAXI-MUM	MEAN	SD	N
AGESOL (in months)								
Cases	1.5	3.0	3.5	4.0	9.0	3.7	1.4	28
Controls	1.5	2.8	3.4	4.0	5.5	3.4	1.0	28
$t = 0.94$	$df = 54$	$p > 0.3$						
AGEFING (in months)								
Cases	5.0	6.0	7.0	7.0	9.5	6.9	1.2	27
Controls	5.0	6.0	6.0	6.5	8.0	6.3	0.7	25
$t = 2.18$	$df = 50$		$p < 0.03$					

There was no significant difference found between Cases and Controls in how often parents cooked if at all (WCOOK) or if they liked to cook (LCOOK) (see Table 3.2.9). For WCOOK none of the parents in either group rated themselves on point four, which said 'can't cook', meaning that all the parents were able to do some cooking.

Table 3.2.9 Parental involvement in meal preparation in Case and Control families: Chi-square for whether parent cooks at all (WCOOK), and whether they like to cook (LCOOK).

		NO. OF RESPONSES (N)		PERCENTAGE	
		Cases	Controls	Cases	Controls
LCOOK					
	One	12	13	48.0	48.1
	Two	13	14	52.0	51.9
	Column total	25	27	100.0	100.0
Pearson's test:					
	Chi-square = 0.0001	df = 1	p > 0.9		
WCOOK					
	One	19	23	76.0	85.2
	Two	6	4	24.0	14.8
	Column total	25	27	100.0	100.0
Pearson's test:					
	Chi-square = 0.70507	df = 1	p > 0.4		

3.2.4 Discussion

In discussing the results of the dietetic assessment, it must be noted that the instrument used to assess children was not a precise measure of the attributes studied. Apart from being based on parent reports whose reliability has been questioned (Dowdney et al., 1987), it was designed for clinical purposes and as such was meant to be a general guide to the feeding history of children with FTT. However, the data presented in this section provides factual information that cannot easily be obtained in any other way (e.g. socio-economic information, or age of introduction to solid foods), and also information on the parent's perception of the child's meals.

Significant differences were found between Cases and Controls on parental employment and ownership of the home, but not on car ownership, though a similar trend was apparent. These results indicate that the Control families tended to be of higher socio-economic status than the Case families, even though the recruitment procedure was designed to make the two groups on average comparable, by stratifying on general practice membership, geographical location and postal code. Even though possible controls were identified from the Local Health Authority GPs register, families that finally participated in the research had to agree to do so. Control parents who volunteered to participate were in the event of a somewhat higher socio-economic status than the Case parents.

The difference in socio-economic status found between the groups can thus be attributed to two possible reasons: Firstly, that there is a difference between Cases and Controls in social class, which stratifying on variables used in this study does not make comparable. Prior research suggests that FTT is more commonly found in low socio-economic groups (Oates et al., 1985). However, this may simply mean that referral processes favour deprived areas because poor growth is expected to be common in these areas. Wright et al. (1994b) conducted a whole city prospective study of an annual cohort of 3418 children aged 18 to 30 months, and found that children from deprived families were twice as likely to have failure to thrive than children from (socio-economically) intermediate families. However, children from affluent areas also showed increases rates, which according to the authors could be due to higher rates of breast-feeding in affluent families. A further complication according to Wright et al. (1994b) is the fact that children from deprived areas are more likely to have low birth-weight, which means that differences in the incidence of FTT may not necessarily be attributable to poor rates of post-natal growth in deprived areas, but may well be due to intra-uterine factors. The second possibility is simply that higher socio-economic status controls, but not cases are more likely to volunteer to participate in research of this nature. Further discussion on how the recruitment procedure may have contributed to such an outcome is in Chapter Six of this thesis.

There was a significant difference between groups on number of siblings in the family. According to Nelson and Naismith (1979) family size may be inter-related with socio-economic status in that the more the number of siblings in a family, the more stretched out the resources may be. Alternatively, large families may be associated with poor parental education, which is in turn associated with socio-economic status. However, a number of studies failed to find an association between failure to thrive and factors relating to family size (Pollitt and Eichler, 1976; Kotelchuck and Newberger, 1983; Wilensky et al., 1996). These findings are discussed further in Chapter Six of this thesis.

Rank was also significantly different between Cases and Controls. This may be merely by virtue of its connection to 'number of siblings' i.e. in the Case group there are more ranks to be assigned because the family size is larger. The results show that Control children are mostly concentrated in the first and second ranks. Theoretically, the first and second ranks are more likely to be associated with better parental attention than the later ranks, because parenthood is still a novelty at this stage. Furthermore, as the family gets larger parental attention and energy is shared out among more children and so each individual child gets less (Nelson and Naismith, 1979). Parental disorganisation at meal-times (Heptinstall et al., 1987) and neglectful parental dispositions (Black et al., 1994) have been found to be more closely associated with FTT families than with control families.

There was a significant difference between groups on hunger ratings, with more Cases reported as rarely hungry at meal-times than Controls. Similarly, more Cases were reported to 'rarely' eat their meal up. These results are consistent with FTT in that the children in this group are somehow not consuming sufficient calories for growth, and poor appetite may be a reason. Wilensky et al. (1996) also reported poor appetite in FTT children according to their mothers' reports. Another significant aspect of meal-times was shown to be parental enjoyment of meal-times, with more Case parents reporting that they rarely enjoyed meal-times with their child. It has been suggested that parental anxiety and tension at meal-times may be in response to the child's difficult temperament or behaviour at meal-times, and that such child and parent characteristics may in interaction lead to failure to thrive (Skuse, 1985).

There was also a significant difference found between Cases and Controls in the age of introduction to finger foods. There was only a median difference of one month, with the Controls on the whole being introduced earlier, but in the first year of life even small age differences can make a difference to nutritional status (Waterlow et al., 1977).

Delayed introduction to textured and finger foods may be associated to difficulties observed in feeding and meal-times, in the FTT group. It has been suggested that there is a 'sensitive period' in infant feeding during which introduction to textured foods can be readily accepted, while any delay may lead to feeding problems (Skuse, 1993). Parental reports of feeding related problems showed that Cases had more problems with chewing. However, whether these feeding problems have been caused by the later introduction of textured food in the group with FTT is an issue for further research. Although earlier research has shown that a greater proportion of children in the non-organic FTT group had oral-motor problems as compared to the normally growing control group (Heptinstall et al., 1987), it is yet to be ascertained whether any oral-motor problems in groups of children with non-organic FTT have been prompted by ineffectual exposure to textured foods, or a result or some minor, underlying, yet undetected organic condition (Harris, 1993).

CHAPTER FOUR

Results: Preference for sucrose sweetened solutions versus water

4.1 Introduction

The results from the test of preference for sucrose solution vs water are reported in this chapter. The test was aimed at investigating the preference of children for sucrose sweetened solutions, and to see whether preferences would be different between the Cases and Controls. The data are in the form of children's intake of water, and of sucrose solutions at 0.2 Mol and 0.4 Mol levels of concentration, in grams. Two intake scores per child were obtained for each sucrose solution and water, and these were added together to give an overall score for each tastant.

Preference is expressed as the difference between intake of water and intake of sucrose solution. There are two preference scores per child, preference for the 0.2 Mol sucrose solution, and preference for the 0.4 Mol sucrose solution i.e.

$$\Delta\ (0.2\ \text{M}) = 0.2\ \text{Mol sucrose solution intake} - \text{water intake}$$

$$\Delta\ (0.4\ \text{M}) = 0.4\ \text{Mol sucrose solution intake} - \text{water intake}$$

Therefore, a positive Δ (difference) score means that more of the sucrose solution was consumed than water, while a negative Δ score means that more water was consumed.

Intake and preference scores are presented as percentiles and descriptive statistics in Table 4.1. Intake of water is the standard against which preference for the sucrose solutions is ascertained, and is presented first. Then intake scores for the sucrose solutions are presented, and then preference scores follow.

Table 4.1 shows that the data for all the intake variables are skewed upwards towards the maximum, since in all the cases, the value of the median is smaller than that of the mean. The box plots in Figures 4.1 to 4.5, also show the upward skew with the dark line indicating the median, quite low towards the bottom of the distribution. The box plots also show a good number of outliers for all the variables.

With a repeated measures design and data on a ratio scale, the best way to analyse the effects of the factors and any interaction effects was through the use of a multivariate analysis of variance (MANOVA), which is a parametric technique. In order to apply parametric statistics to the data, the scores were converted into logarithms (to base 10), a transformation which has its greatest effect on the highest scores, thus making the distribution closer to normal. As seen in Figures 4.6 to 4.10, the distributions of the scores as logarithms, for all variables do not appear as skewed as they do in Figures 4.1 to 4.5 before the transformation.

Table 4.1 Percentiles, and descriptive statistics for intake of water, 0.2 Mol sucrose and 0.4 Mol sucrose solutions in grams, and Δ (difference) scores.

(Grams)		MINIMUM	25TH	MEDIAN	75TH	MAXIMUM	MEAN	SD
WATER INTAKE								
	Cases	0.40	2.30	4.40	7.50	29.30	7.36	7.85
	Controls	0.30	2.57	4.70	11.00	25.40	7.46	6.73
SUCROSE INTAKE (0.2 Mol)								
	Cases	0.10	2.40	5.80	20.60	62.40	14.16	16.75
	Controls	0.40	4.90	10.80	24.47	71.10	18.05	20.03
SUCROSE INTAKE (0.4 Mol)								
	Cases	0.20	1.60	3.90	12.90	93.30	13.10	21.23
	Controls	0.20	3.15	5.90	13.22	74.80	12.91	18.74
Δ (0.2 Mol)								
	Cases	-18.40	-1.60	1.30	14.00	58.90	6.79	15.23
	Controls	-14.20	-1.20	4.50	12.55	65.40	10.59	19.92
Δ (0.4 Mol)								
	Cases	-28.00	-1.80	1.10	7.00	76.20	5.74	18.73
	Controls	-19.30	-3.02	-0.15	8.87	72.20	5.46	19.53

4.2 Preference for sweet

The two sets of Δ scores shown in Table 4.1, show that for both Cases and Controls, percentiles range from negative at the minimum end to positive scores at the maximum end. This means that in both groups some children drank more water than the sucrose solutions indicated by the negative scores, and some children drank more sucrose solution than water as shown by the positive scores.

The median Δ scores for 0.2 Mol is 1.3 for the Cases and 4.50 for the Controls. The medians in both cases are in the direction of sucrose solution preference with the Controls' score being greater. For Δ (0.4 Mol) the median score for the Cases is 1.10 for the Cases and -0.15 for the Controls. The difference between the median scores for the Cases and Controls is only 1.25, but with the Controls median on the negative side, indicating possible preference for water over the 0.4 Mol sucrose solution.

The question asked at this stage is whether these differences are statistically significant or not. To answer this question a test of statistical significance must be administered which not only compares the Cases and Controls but tests the difference across the three levels of intake in both groups.

Figure 4.1 Amount of water drank by Cases and Controls.

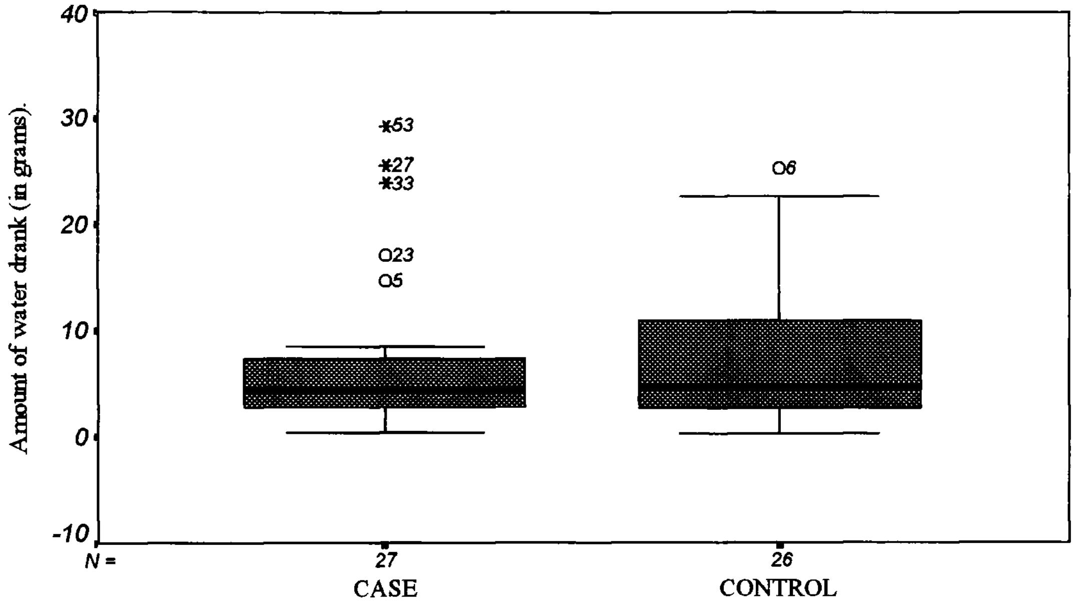


Figure 4.2 Amount of sucrose solution (0.2 Mol) drank.

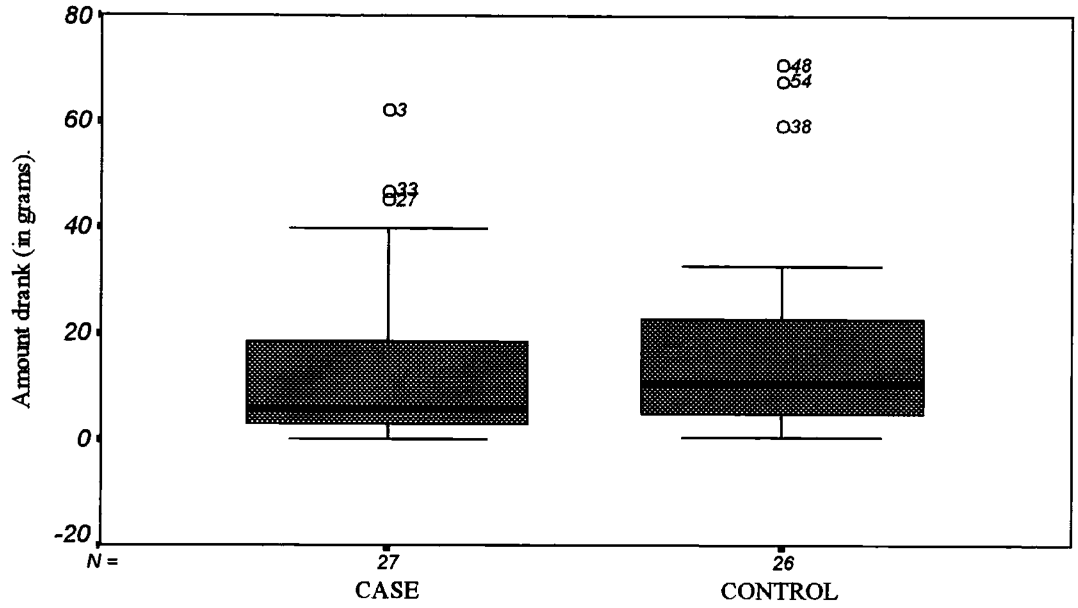


Figure 4.3 Amount of sucrose solution (0.4 Mol) drank.

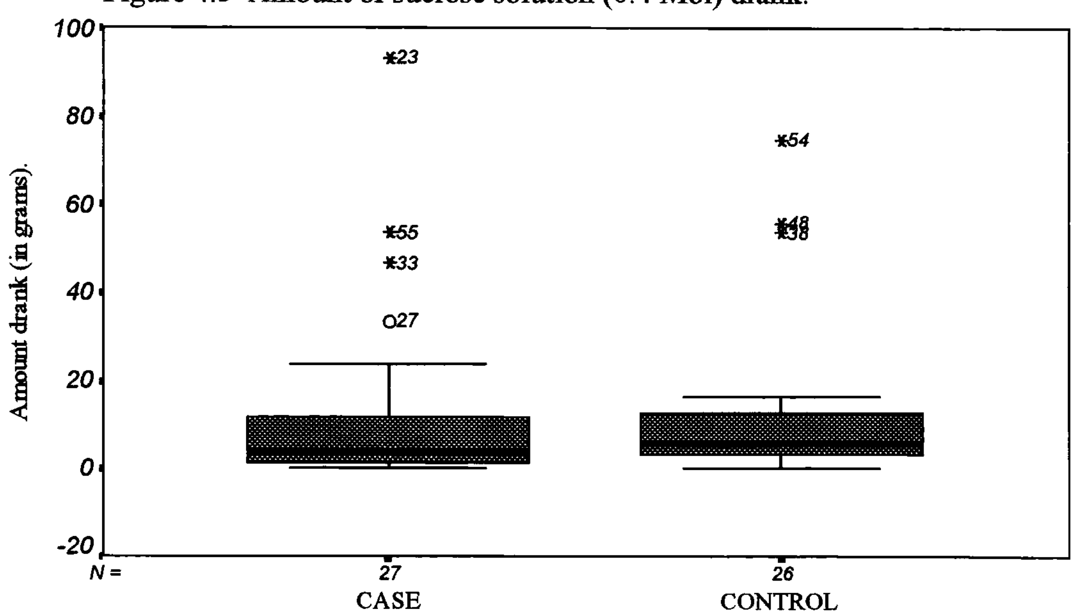


Figure 4.4 Difference in intake of sucrose solution (0.2 Mol).

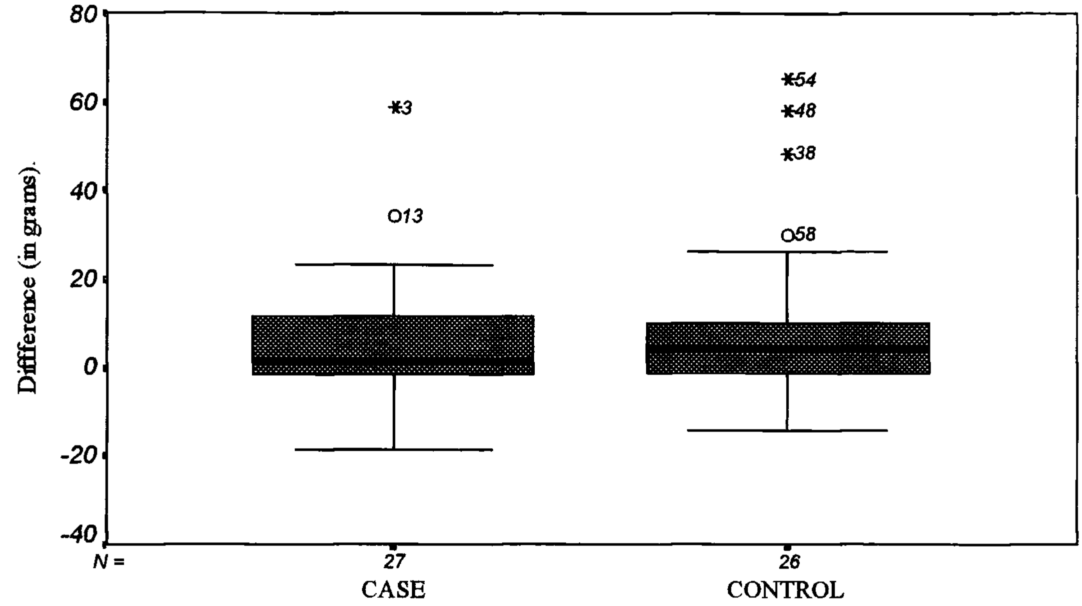


Figure 4.5 Difference in intake of sucrose solution (0.4 Mol).

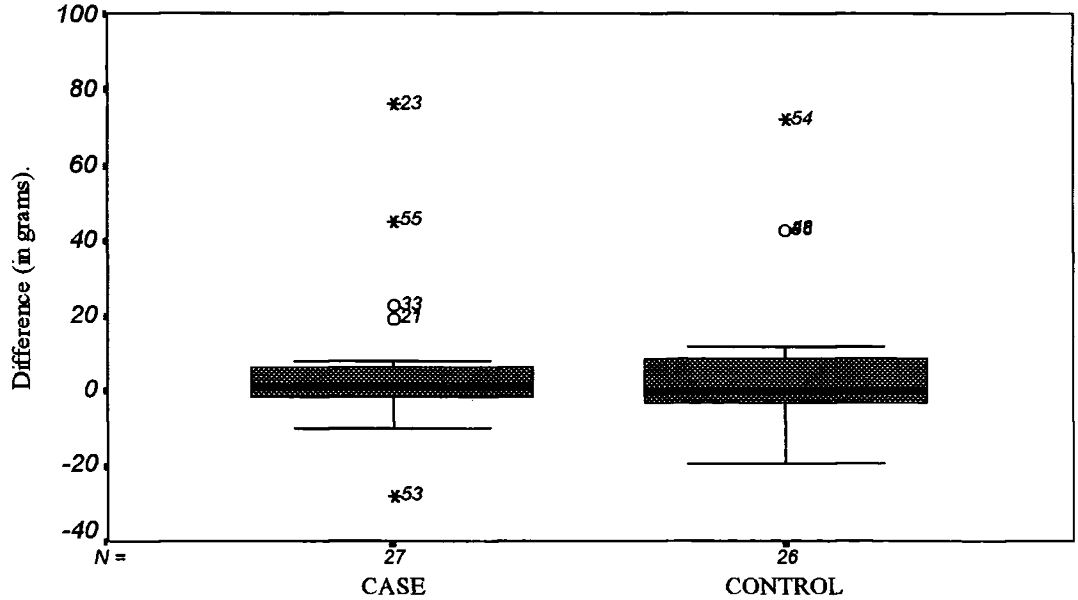


Figure 4.6 Amount of water drank (log).

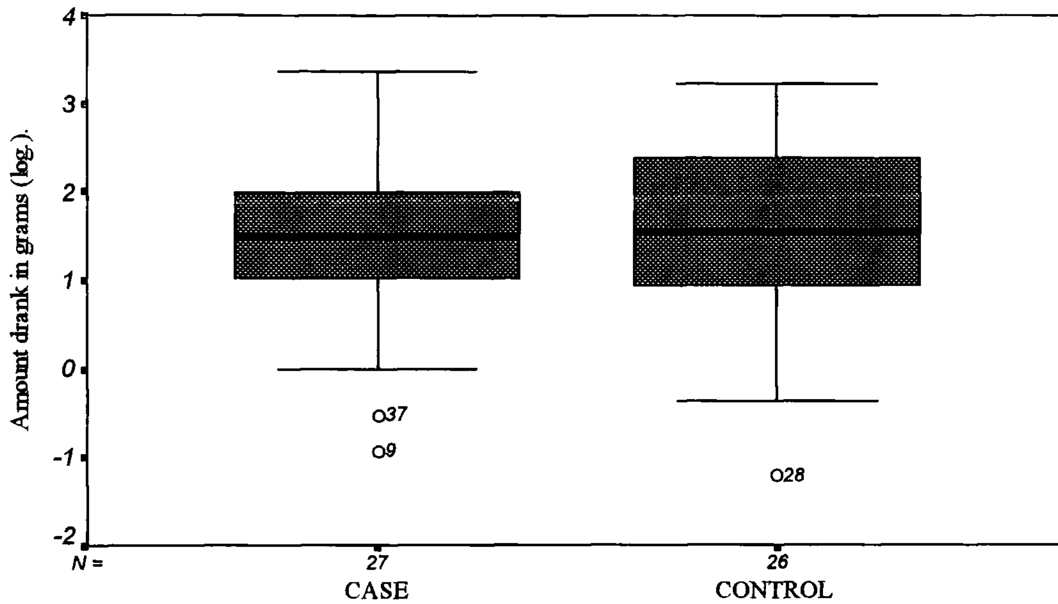


Figure 4.7 Amount of sucrose solution (0.2 Mol) drank (log).

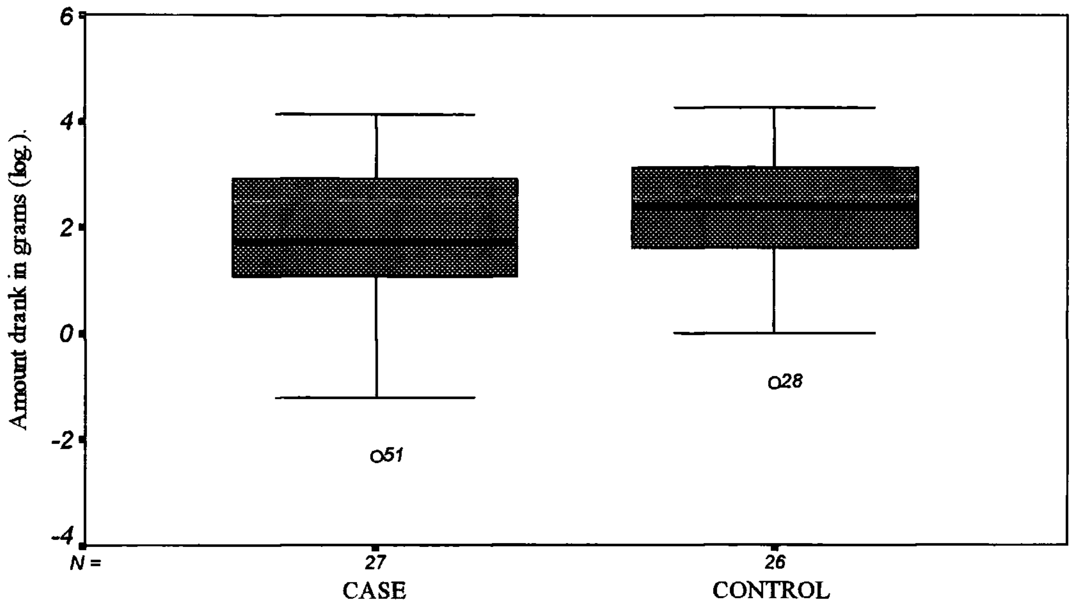


Figure 4.8 Amount of sucrose solution (0.4 Mol) drank (log).

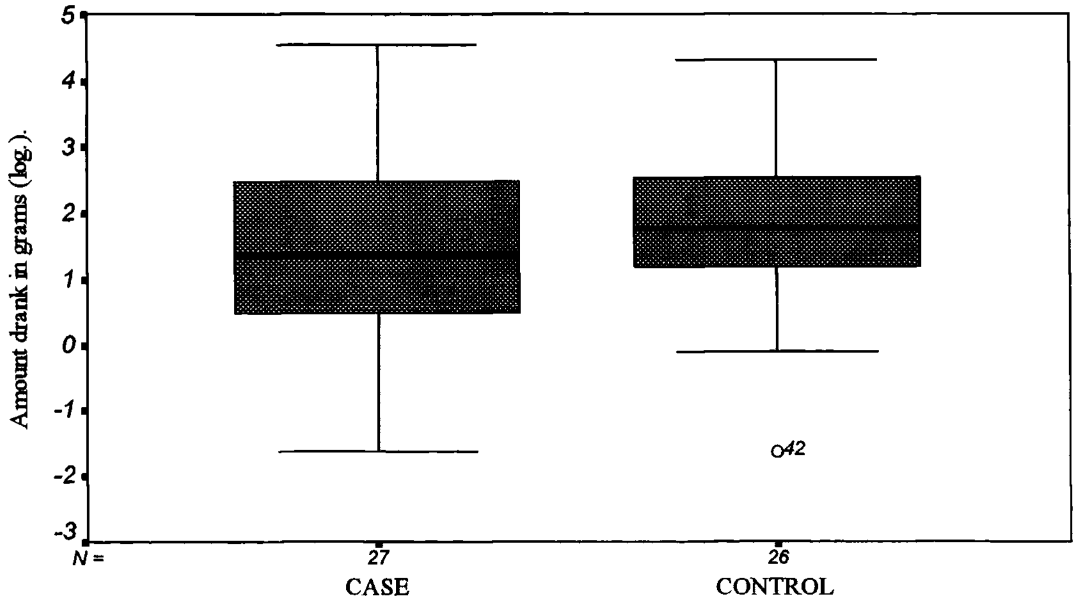


Figure 4.9 Difference (0.2 Mol sucrose - water logs).

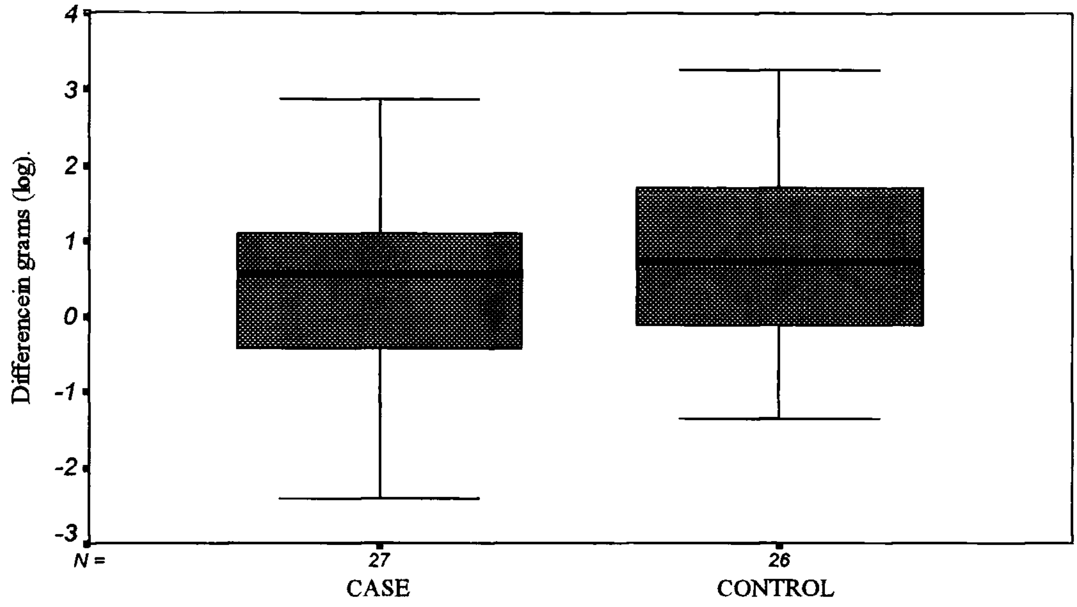
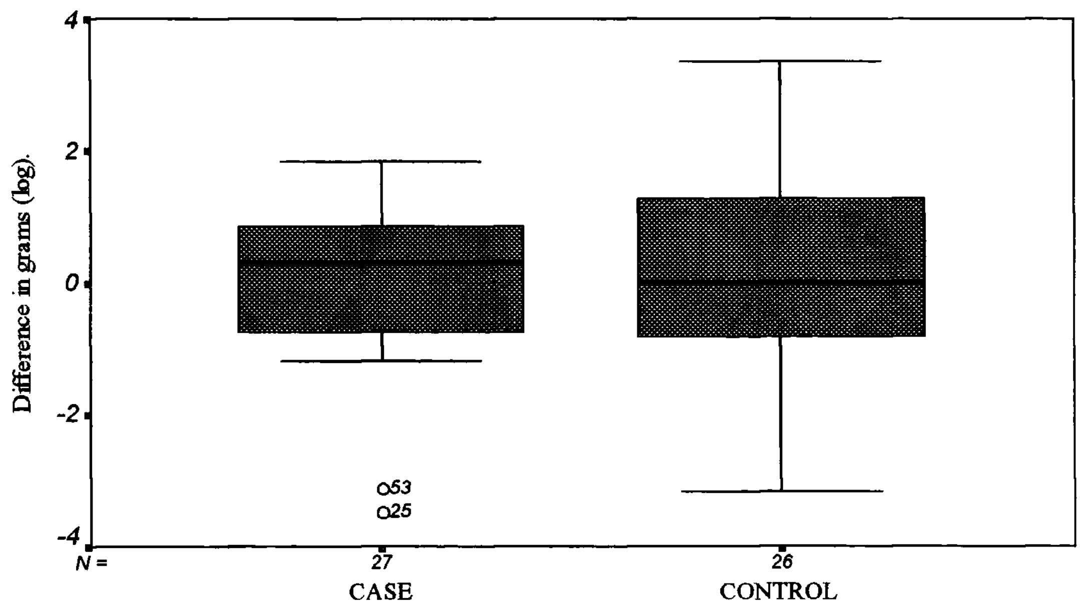


Figure 4.10 Difference (0.4 Mol sucrose - water logs).



4.3 Testing for group differences at three levels of intake

As mentioned earlier, the comparison in intakes at three levels, is made between Cases and Controls. In this analysis Group is one factor, with two levels i.e. Case and Control. Dose is intake at three levels i.e. water, 0.2 Mol sucrose solution, and 0.4 Mol sucrose solution.

The analysis of variance (ANOVA) for repeated measures was used to examine the relationships in this design. The ANOVA for repeated measures involves multivariate hypothesis testing, and is therefore, treated in SPSS as a multivariate analysis of variance (MANOVA). This simply means that the analysis involves the testing of two or more dependent variables. The assumption is made in either case that the population from which the sample is drawn has a normal distribution. In a repeated measures design the statistical procedure tests the differences or contrasts between the measures involved. These contrasts form new variables, which may involve any combination of the original variables, and the analysis is done on the new variables (Norusis, 1985).

Table 4.2 shows the results of the MANOVA. At the top of the table are the results of the 'Test of between subjects effect'; this is the test of the overall mean across all the levels of the factor (Group). As shown by the small F-value and the large significance (p) value, the difference in means across Group is not statistically significance. The multivariate tests involved the effect of 'Group by Dose' and that of 'Dose' by itself. These analyses show no significant effect of the interaction variable (i.e. 'Group by Dose'), while the effect of 'Dose' alone was highly significant ($p<0.002$). The results of univariate analyses, shown under the sub-title 'Tests involving Dose within-subject effect', also show no effect of 'Group by Dose', and again show a significant effect of 'Dose' ($p<0.009$).

The results of the MANOVA show that although there is no 'Group' effect i.e. there is no difference in intake of any or all two test solutions and water, there is a significant effect of 'Dose'. From the summary statistics in Table 4.1, the effect of 'Dose' is coming from the higher intake of the 0.2 Mol sucrose solution than both water and 0.4 Mol sucrose solution by both groups. Furthermore, the MANOVA results in Table 4.2 suggest that although 'Group' by itself has no significant effect, the effect of 'Dose' is stronger when analysed alongside the 'Group' variable, which suggests that the latter is contributing to the higher significance of 'Dose' in the multivariate analysis.

Table 4.2 Mutivariate analysis of variance (MANOVA); testing the effects of 'Dose' and 'Group'.

TEST OF BETWEEN-SUBJECTS EFFECTS

Tests of significance for T1 using UNIQUE Sums of Squares.

Source of variation	SS	DF	MS	F	Significance of F
Within + Residual	186.11	51	3.65		
Group	2.78	1	2.78	0.76	0.387

EFFECT OF GROUP BY DOSE

Multivariate test of significance (S=1, M=0, N=24).

Test name	Value	Exact F hypoth.	DF	Error DF	Significance of F
Pillais	0.0242	0.6211	2.00	50.00	0.541

EFFECT OF DOSE

Multivariate test of significance (S=1, M=0, N=24).

Test name	Value	Exact F hypoth.	DF	Error DF	Significance of F
Pillais	0.215	6.859	2.00	50.00	0.002

TEST INVOLVING DOSE WITHIN-SUBJECTS EFFECT

	SS	DF	MS	F	Significance of F
Within + Residual	79.72	102	0.78		
Dose	7.70	2	3.85	4.93	0.009
Group by Dose	0.79	2	0.39	0.51	0.605

In terms of the hypothesis under test, the key result is the lack of a significant interaction term, either in the multivariate or univariate analyses. This shows that the effect of adding sucrose to water is no different in children who fail to thrive and in controls.

CHAPTER FIVE

Results: Caloric compensation, reliability study, and behavioural observation

5.1 Caloric compensation

The aim of this investigation was to measure caloric compensation in the sample children. All children in the study were given a standard test meal on two occasions. One meal followed a no-calorie pre-load and the other a high-calorie pre-load. Data analysed in this section take the form of energy intakes in kcal, and meal durations.

Energy intakes from the no-calorie pre-load are always 0 kcal. Energy intakes from the high calorie pre-load take a value which depends on the child's intake of the pre-load, to a maximum of 96 kcal (the energy content of the 150 ml offered). The intake of the pre-load varies among children because they cannot be forced to take the whole amount offered.

Intakes at meals are the total energy intakes (from everything eaten or drank) at the meal. There are two intake measures - intake at the meal following a no-calorie pre-load and intake at the meal following a high-calorie pre-load. Correspondingly, there are two meal durations.

The intake and duration measures taken at the meal following the no calorie pre-load are used as reference or control meal measures and are given first in Table 5.1.1(a). The energy intake of the high-calorie pre-load is given next. Then follow the energy intake at the meal following the high-calorie pre-load and the duration of the meal, but these are expressed as differences from their values at the reference or control meal, i.e.

Δ intake = intake following high-calorie pre-load – intake following no-calorie pre-load.

Δ duration = duration following high-calorie pre-load – duration following no-calorie pre-load.

Expressed in this way, negative scores imply a reduction, so for example, Δ intake = -96 means that the child ate 96 kcal less following the high-calorie pre-load than following the low-calorie pre-load. If the child drank 96 kcal in the pre-load, this would imply perfect caloric compensation. A positive Δ intake denotes an increased intake following the high-calorie pre-load.

5.1.1 Case-control differences

Table 5.1.1(a) gives a summary of the data in the form of percentiles, descriptive statistics and t-test results, and Table 5.1.1(b) gives the summary of the principal differences between the Cases and Controls. The data were normally distributed except for a slight skew in the Pre-load data for Controls (Figure 5.1.1). For this a non-parametric test of significance (Mann-Whitney U-test) was calculated along with the t-test, but the results did not differ in any important way. Further statistical analysis of caloric compensation was required, and instead of using COMPX (discussed in Chapter One) regression analysis was used. Both procedures result in the quantification of caloric compensation, however, regression analysis also allows us to build in other variables for statistical control. In regression analysis a coefficient of 1 for the regression of Δ intake on pre-load indicates perfect compensation; < 1 indicates less than perfect compensation; > 1 indicates over-compensation.

Although all the children were offered 150 ml of pre-load containing 96 kcal on the high-calorie pre-load day and were encouraged to drink up, few of the children in either groups actually drunk it all up. Table 5.1.1(a) shows that the control children consumed significantly more pre-load than the Cases ($p < 0.007$). The box plots (Figure 5.1.1) however, show that the range of scores for the two groups were almost the same. In both groups some children consumed little or no pre-load, and some children consumed most of the pre-load. Energy intake at meals on the no-calorie day was significantly different for the Cases and the Controls ($p < 0.001$), with the Controls consuming more than the Cases (Table 5.1.1(b)), and this difference is clearly shown in the box plots in Figure 5.1.2. Although there were 28 Cases and 28 Controls in this investigations, not all the children had complete data on all the variables investigated.

Table 5.1.1(a) Percentiles, descriptive statistics, and t-test results for 'intake' and 'duration' variables.

	MINI-MUM	25TH	MEDIAN	75TH	MAXI-MUM	MEAN	SD	t-test
INTAKE (kcal) on no-calorie occasion								
Cases	25.44	111.17	156.19	214.81	385.26	164.25	81.46	t= -3.58
Controls	23.42	181.42	250.83	322.95	449.05	257.27	106.30	p<0.001
DURATION (minutes) on no-calorie occasion								
Cases	12.08	20.07	26.12	31.72	41.82	26.68	7.62	t= -1.93
Controls	14.29	20.08	32.80	37.14	47.49	31.08	10.16	p>0.6
PRE-LOAD (kcal) on high-calorie occasion								
Cases	0.00	12.75	33.00	56.25	85.00	36.42	25.69	t= -2.80
Controls	1.00	38.25	59.00	85.50	95.00	59.21	27.82	p<0.007
Δ INTAKE (kcal)								
Cases	-225.30	-44.78	28.90	86.90	148.05	14.24	86.06	t=3.26
Controls	-236.83	-121.05	-49.86	-20.22	108.23	-66.11	86.10	p<0.002
Δ DURATION (minutes)								
Cases	-25.68	-7.23	1.34	5.84	9.51	-1.31	9.26	t= 0.32
Controls	-21.56	-9.12	-1.40	3.89	20.53	-2.31	9.94	p>0.7

The difference between the Cases and Controls is also significant for change in intake (Δ intake) ($p < 0.002$; Table 5.1.1(b)). The mean Δ intake for the Controls was -66.11 and shows caloric compensation as it is negative. For the Cases, the mean was 14.24, which does not show compensation.

Table 5.1.1(b) Summary of principal differences between Cases and Controls on 'intake' and 'duration' variables.

	MEANS		t-test	p-value
	Cases	Controls		
INTAKE (kcal)	164.25	257.27	-3.58	$p<0.001$
DURATION (minutes)	26.68	31.08	-1.93	$p>0.6$
PRE-LOAD (kcal)	36.42	59.21	-2.80	$p<0.007$
Δ INTAKE (kcal)	14.24	-66.11	3.26	$p<0.002$
Δ DURATION (minutes)	-1.31	-2.31	0.32	$p>0.7$

Both the percentiles (in Table 5.1.1(a)) and the box plots (in Figure 5.1.3) show that in both groups, some children had negative scores (showing some caloric compensation), and some children had positive scores (showing the opposite of compensation). However, the majority of the Control children showed some compensation, with a median of -49.86, and more than 75% of the scores being below zero, whereas for the Cases, the median was 28.17 and less than 50% of the scores were below zero.

As shown in Table 5.1.1(b) there was no significant difference found between the two groups in either the duration of the reference meal, or the change in duration (Δ duration).

Figure 5.1.1 Amount of pre-load drank on the high-calorie pre-load day.

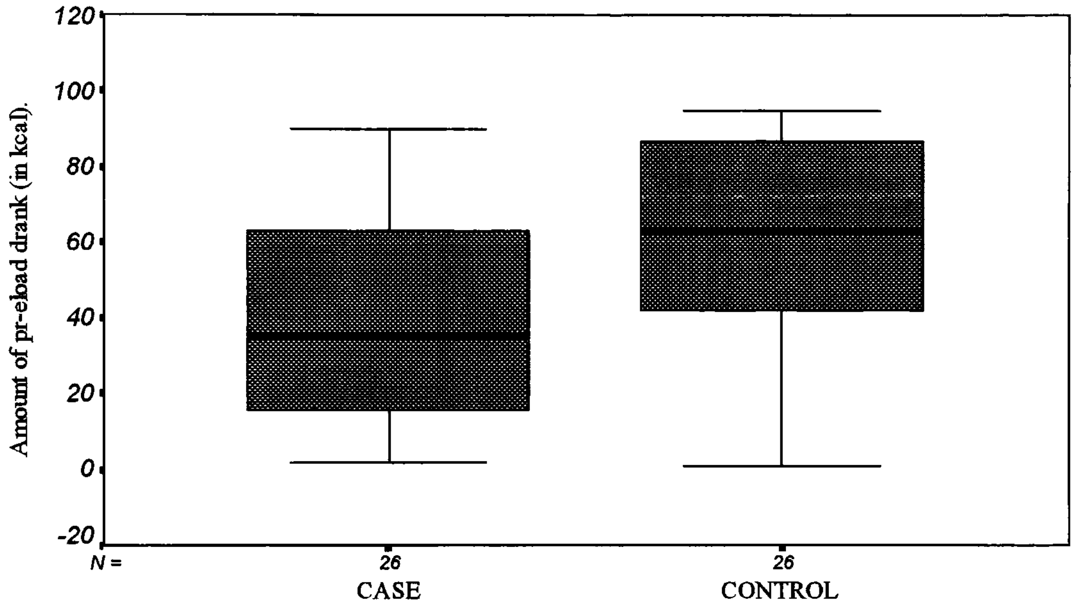


Figure 5.1.2 Energy intake from meal on the no-calorie pre-load day.

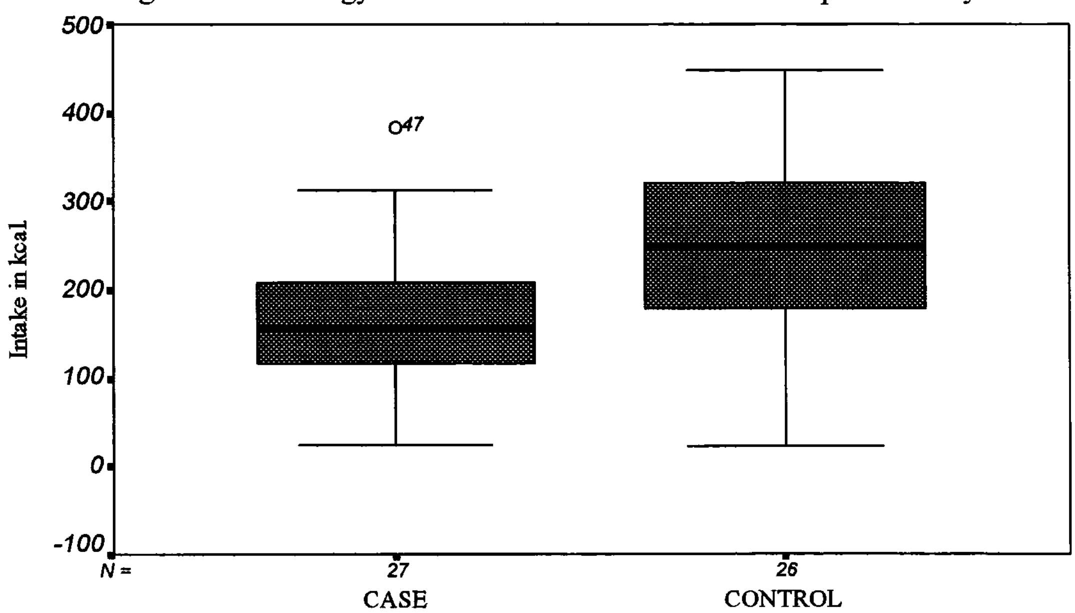
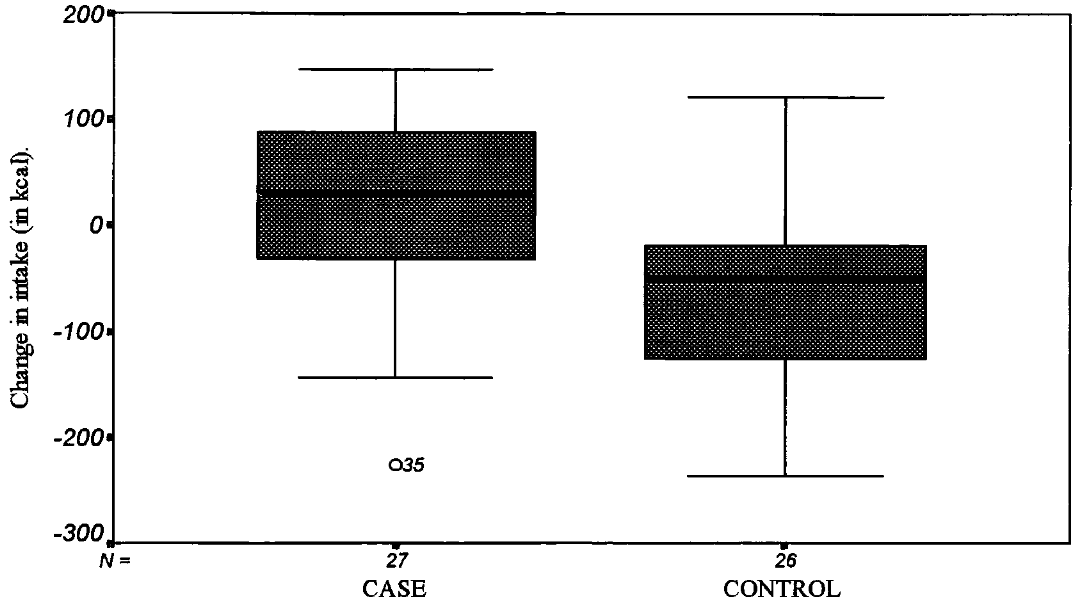


Figure 5.1.3 Change in intake.



5.1.2 Relationships between variables

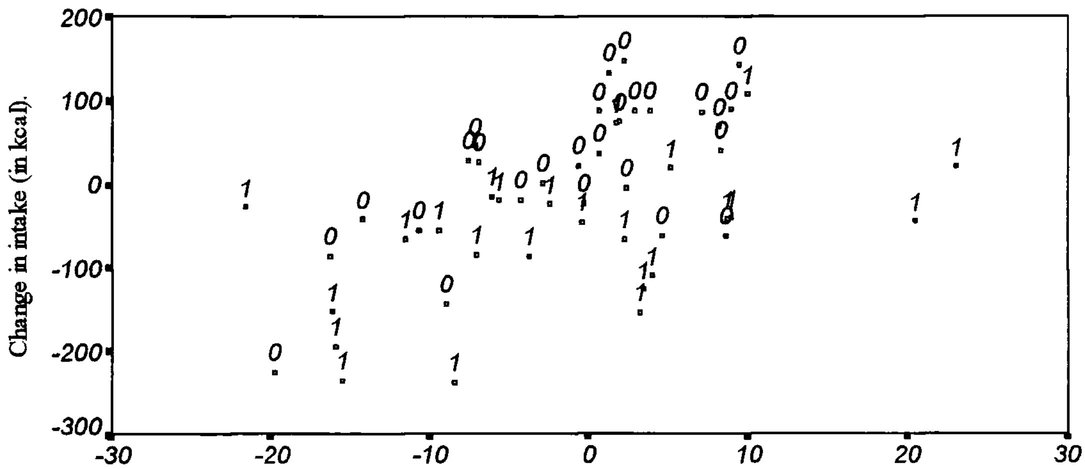
The t-test results for Δ duration do not show the same differences between groups observed for Δ intake. However, when Δ intake is plotted against Δ duration for both groups combined (Figure 5.1.4), a positive though only moderate relationship is revealed ($r = 0.51$). This indicates that compensation in intake is positively associated with a reduced feeding time. Those children therefore, who ate less in response to a high-calorie pre-load also reduced their feeding time, while those children that did not eat less, did not reduce their feeding time. This may mean that children reduced their intake, at least partly, by reducing their feeding time.

The relationship between Δ intake and Δ duration was also plotted as scatter plots for the Cases and the Controls separately. The linear relationship between the variables was stronger for the Cases (Figure 5.1.5) ($r = 0.67$), than for the

Controls (Figure 5.1.6) (r = 0.48). This difference in correlation seems to be attributable to the fact that for both groups the children who showed compensation in intake also showed compensation in duration (i.e. they cut down their intake as well as the time taken to eat on the high-calorie pre-load day). However, for the Cases, those children who had higher (non-compensating) scores on Δ intake also had high scores on Δ duration, thus the linear relationship between the two variables for this group; while for the Control group, very few children had high (non-compensating) scores on both Δ intake and Δ duration, but rather continued to have negative 'compensating' scores on Δ intake but with higher non-compensating scores on Δ duration, leading to a less linear relationship.

When Δ intake was plotted against amount of pre-load, a pattern emerged showing a concentration of the Control children's scores in the bottom right hand side of the plot (Figure 5.1.7). This plot indicates that for the majority of Control children who consumed more than half the calories from the pre-load (i.e. more than 48 kcal), the corresponding Δ intake score fell below zero, thus showing some caloric compensation. However, for all the Case children who consumed a similar amount of pre-load, Δ intake scores remained high above zero, showing no caloric compensation and even over-compensation. This trend towards compensation shown by the Controls becomes less distinctive when Δ intake is replaced with Δ duration (Figure 5.1.8). The relationship between Δ intake, group, and amount of pre-load consumed was defined quantitatively using regression analysis.

Figure 5.1.4 Change in intake against change in duration.



0 Cases

1 Controls

Figure 5.1.5 Change in intake against change in duration for Cases.

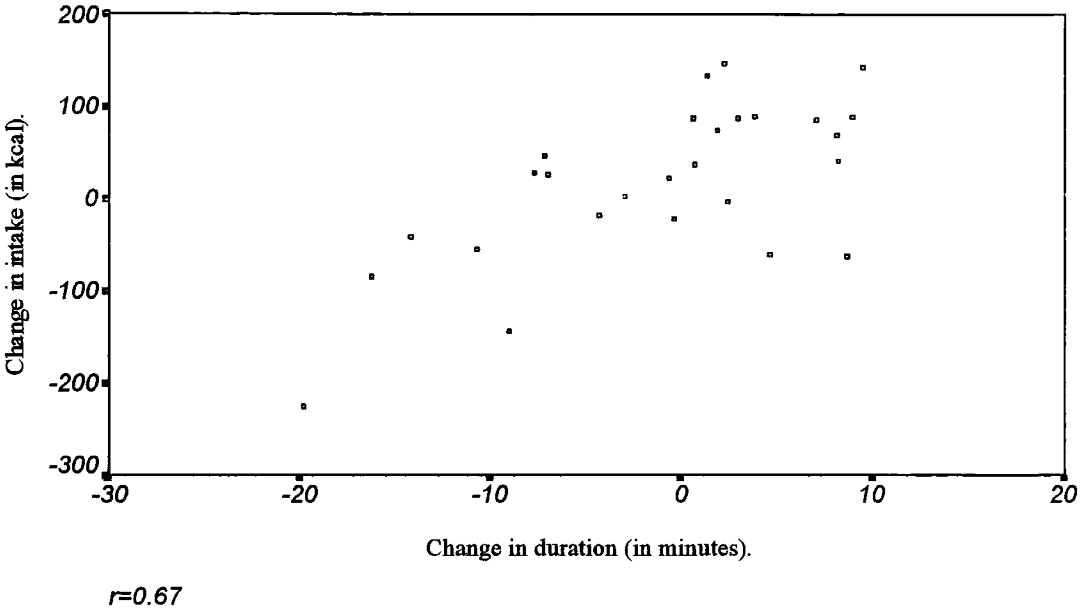


Figure 5.1.6 Change in intake against change in duration for Controls.

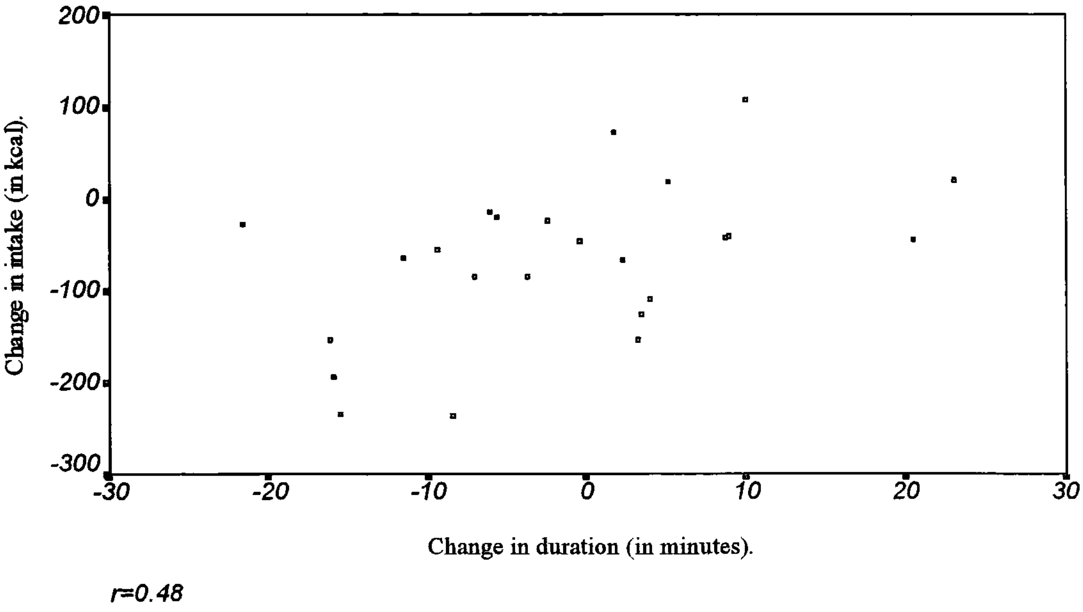
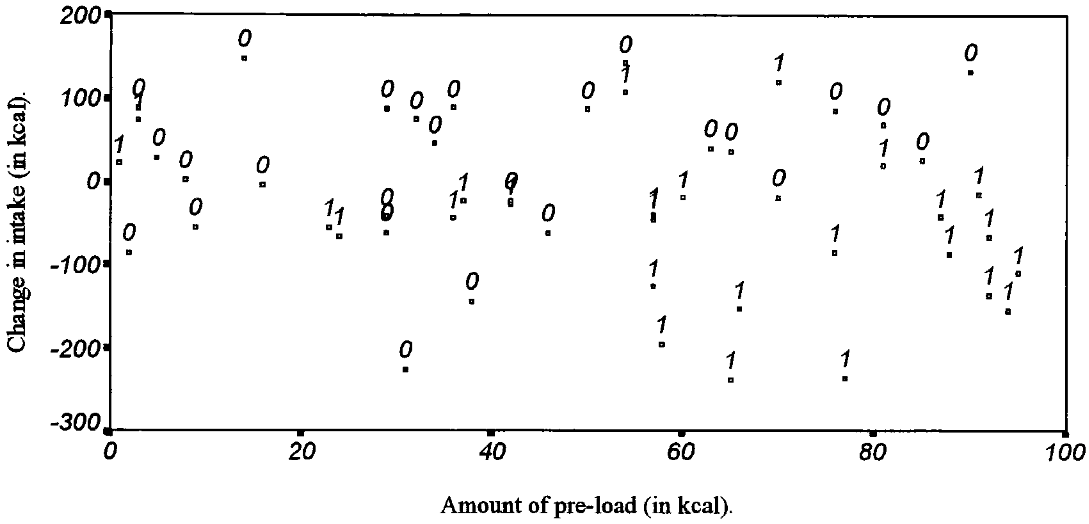


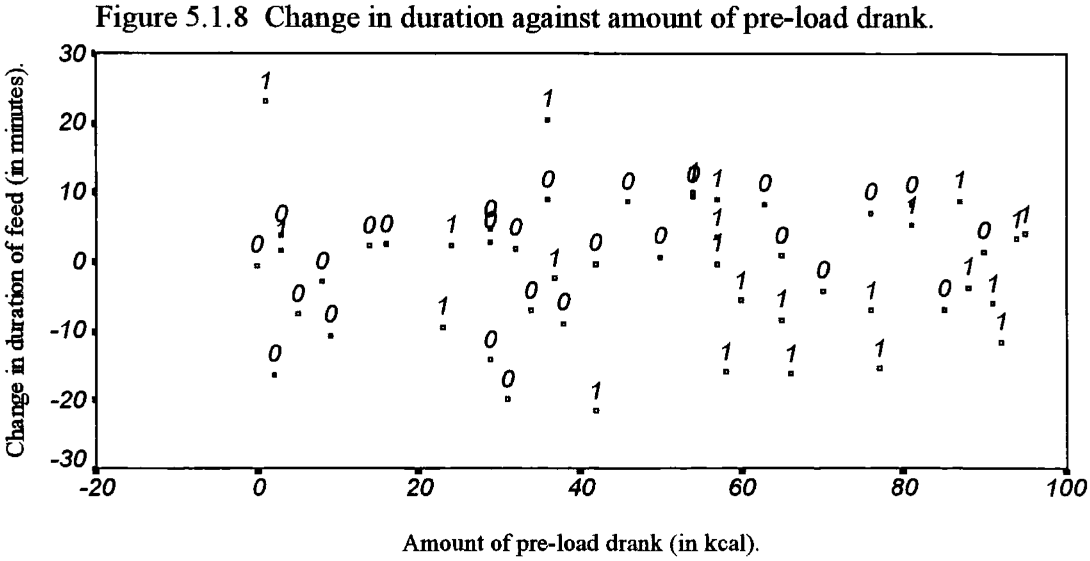
Figure 5.1.7 Change in intake against amount of pre-load drank.



0 Cases

1 Controls

Figure 5.1.8 Change in duration against amount of pre-load drank.



0 Cases

1 Controls

The regression analysis in Table 5.1.2 shows the regression of Δ intake on 'Pre-load'. In both cases the unit is kcal, so the regression of Δ intake on 'Pre-load' shows the relationship between intake of the pre-load and subsequent reduction in intake, both in kcal.

$$\Delta \text{ intake} = \alpha + \beta \text{ Pre-load}$$

Assuming that the estimate for α is 0, then the coefficient for β shows the average amount by which Δ intake changes in kcal for each kcal taken in as pre-load. Perfect caloric compensation implies a coefficient of -1. Here there are two groups, cases and control, and we are interested in whether this relationship differs between the groups. The group is identified by an indicator variable ('Group') which takes the value of 0 for Controls and 1 for Cases. An interaction term, 'Group x Pre-load', takes the value implied by its name, i.e. the product of 'Group' and 'Pre-load'. The multiple regression equation is now

$$\Delta \text{ intake} = \alpha + \alpha' \text{ Group} + \beta \text{ Pre-load} + \beta' \text{ (Group x Pre-load)}$$

Consider the two groups separately. In the Controls, Group is 0, so (Group x Pre-load) is also 0. So for this group

$$\Delta \text{ intake} = \alpha + \beta \text{ Pre-load}$$

In the Cases, Group is 1, so (Group x Pre-load) = Pre-load. In the Cases, therefore

$$\Delta \text{ intake} = \alpha + \alpha' + \beta \text{ Pre-load} + \beta' \text{ Pre-load}$$

This can be rearranged as

$$\Delta \text{ intake} = (\alpha + \alpha') + (\beta + \beta') \text{ Pre-load}$$

We are therefore estimating separate constants and slopes in the two groups, and can test the statistical significance of the differences between groups by considering the estimates of α' and β', their respective standard errors, and associated t tests. The estimates can be seen in Table 5.1.2.

For Controls

$$\Delta \text{ intake} = \alpha + \beta \text{ Pre-load}$$

$$\Delta \text{ intake} = 10.30 + (-1.18 \text{ x Pre-load})$$

For Cases

$$\Delta \text{ intake} = (\alpha + \alpha') + (\beta + \beta') \text{ Pre-load}$$

$$\Delta \text{ intake} = (10.30 - 22.57)$$

$$+ (-1.179703 + 1.985036) \text{ Pre-load}$$

$$\Delta \text{ intake} = -12.263475 + (0.805333) \text{ Pre-load}$$

When pre-load = 96 kcal, the total amount of calories given in the pre-load,

for Controls

$$\Delta \text{ intake} = 10.304753 + (-1.179703 \text{ x } 96)$$

$$\Delta \text{ intake} = -102.94674$$

for Cases

$$\Delta \text{ intake} = -12.263475 + (0.805333 \times 96)$$

$$\Delta \text{ intake} = 65.048493$$

Table 5.1.2 Regression analysis of variation in Δ intake in relation to Group, Pre-load and the interaction Group x Pre-load.

Multiple R	0.501
R squared	0.251
Adjusted R square	0.205
Standard error	86.882

ANALYSIS OF VARIANCE

	DF	Sum of squares	Mean square
Regression	3	123994.115	41331.372
Residual	49	369872.357	7548.415

F = 5.475 Signif F = 0.0025

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	t	ρ
(constant)	10.30	42.06	0.245	0.807
Group	-22.57	51.25	-0.440	0.662
Pre-load	-1.18	0.63	-1.868	0.068
Pre-load x Group	1.98	0.89	-2.232	0.030

This means that given 96 kcal of pre-load the Controls intake of the meal following the high-calorie pre-load was reduced by approximately 103 kcal, showing very accurate compensation, while intake for the Cases on the same meal was actually increased by 65 kcal, showing the opposite of compensation.

The tests of significance of differences in the analysis (Table 5.1.2) show a significant F-value ($p < 0.0025$) indicating that there is a highly significant relationship somewhere in the variables analysed. The regression analysis shows no significant effect of Group and Pre-load, separately, but the interaction of Group by Pre-load is significant ($p < 0.03$). The effect of pre-load only just failed to reach significance at 0.05.

These results confirm the trend in the scatter plots (Figure 5.1.7) discussed earlier. It also shows that compensation is very accurate in the Controls, with 1 kcal of pre-load on average reducing subsequent intake by 1.18 kcal, but completely absent in the Cases.

5.1.3 Controlling for the socio-economic factor

The results obtained from questionnaire data, reported in Chapter Three of this thesis, indicate a significant difference between the Cases and Controls on two out of the three indicators of family socio-economic status used. As these indicators were associated with Group, it is possible, though not likely, that this confounding means that the difference between the groups reported in the preceding section are attributable to social class rather than FTT per se. One of the two indicators, 'Ownhome', which relates to whether the family owned their own home or not, was introduced into the regression analysis to examine its relationship with caloric compensation. Regression analysis allows us to simultaneously control statistically for a confounding variable of this kind. Any one of the three variables could have been used for this purpose since they were correlated with each other. The correlation coefficients (phi-coefficient) are, $r = 0.67$ (for Ownhome and Employment), $r = 0.45$ (for Ownhome and Owncar), and $r = 0.53$ (for Owncar and Employment).

The results of the regression analysis (Table 5.1.3) show an interesting relationship between the socio-economic indicator and other variables. Although Ownhome either on its own, or in interaction with Pre-load (i.e. 'Pre-load x Ownhome') is not statistically significant as a predictor of caloric compensation (Δ intake), controlling for this variable makes the effects of Group and Pre-load even clearer. The Pre-load effect which is not independently statistically significant in prior regression analysis (Table 5.1.2) becomes significant when Ownhome is included in the analysis (Table 5.1.3). Similarly, the effect of the interaction variable Pre-load x Group though statistically significant in both analyses, becomes stronger when Ownhome is introduced, with a p-value of 0.01 as compared to an initial 0.03. There is no independent effect of the housing variable Ownhome; p is > 0.2 for the main and the interaction effect.

These conclusions would remain unchanged if either Owncar or Employment had been used in the regression analysis in place of Ownhome. Comparable analyses with Owncar and Employment gave similar results. When Owncar was used F change for Group and Pre-load x group entered together after the other variables was 7.10, when Employment was used F change was 6.71, and was in both cases significant at $p < 0.01$. Whichever one of the three socio-economic indicator was used, the regression of Δ intake on Group x Pre-load remained highly significant ($p < 0.02$), showing that the difference between groups was due to the Group effect rather than socio-economic differences.

Table 5.1.3 Regression analysis of variation in Δintake in relation to Group, Pre-load, Ownhouse, and interaction variables.

Multiple R	0.528
R Square	0.279
Adjusted R Square	0.201
Standard Error	87.551

ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean of Squares
Regression	5	136641.422	27328.284
Residual	46	352599.549	7665.208

F = 3.56524 Signif F = 0.0083

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	t	p
(Constant)	-4.44	32.82	-0.135	0.893
Ownhome	-40.45	52.43	-0.772	0.444
Pre-load x Ownhome	1.25	0.97	1.297	0.201
Group	41.30	54.12	0.763	0.449
Pre-load	-2.12	0.92	-2.292	0.026
Pre-load x Group	2.59	0.99	2.613	0.012

F change for Group and Pre-load x Group entered together after the other variables is 7.49 with 2, 46 df, $p < 0.01$

5.2 Analysis of feeding behaviour: Reliability study

The reliability of the measures of feeding behaviour used in the research reported in this thesis had to be established. The measures used were based on a behaviour inventory developed to study feeding-related behaviour in young children. A computerised program for behaviour coding called 'Minkey.exe' (Marsh, 1988) was used for coding behaviour.

The 'Minkey' program enables the user to enter individual subjects' identification information, and then enter behavioural codes for each subject. This information is then written out on a separate disk as the program is designed to hold only the information of the working file. The program also has an in-built timer which times the onset of each coded act.

5.2.1 Behavioural measures of feeding

Feeding behaviour in children under the age of two years involves parental input in varying degrees depending partly on age of the child and also on parenting style (Negayama, 1993). The child may feed themselves, or they may be fed by the parent or other care giver, and so codes are needed to describe what the carer does as well as the child. Furthermore, a child fed by a carer may refuse food, and so codes are needed to describe responses to offers of food. Feeding whether by the parent or the child themselves may be done with or without a spoon. At the onset of weaning infants are normally fed semi-solids such as baby rice using a spoon, and finger-feeding comes later with the introduction of proper solids such as toasted bread (Negayama, 1993). Similarly feeder-cups or drinking beakers are used as an intermediate between drinking from a bottle and using a cup as infants get older. It is therefore, important to code method of feeding.

The substance fed also needs to be coded. Separate categories were required for drinks, semi-solid, and solid food, because the ease with which food is manipulated orally in children aged up to two years partly depends on its texture (Gisel, 1991). Savoury food must also be distinguished from sweets, because children's acceptance of a particular food may depend on their preference for a particular taste. This additional information also helps put observed behaviour into context as it shows what the child was being fed when the behaviour in question was observed.

Agras et al. (1988) observed eating behaviour in parents and their 18 month old children. Both parents and their children ate a lunch-time meal from a standard buffet on separate days. The child ate with the help of the mother who herself ate nothing on this occasion; parents were observed on a different occasion. The buffet was made up of a main course, salads, desserts, and drinks, all of which composed a variety to choose from. The behavioural measures used were bites of food (number and frequency), durations of chewing and active feeding, and drinking (number of drinks and time). In a similar study, Harris, Thomas and Booth (1990) observed younger infants (16 to 25 weeks old) being fed cereal by their parents. They analysed feeding behaviour and mode of acceptance of food using a category system devised for spoon-fed infants aged from 3 to 12 months. The system included categories that described facial expressions, gaze, and head and body movements (e.g. positive or negative expression), and also categories that defined food acceptance behaviours (e.g. the infant opens its mouth before the spoon is proffered; or the infant accepts food when the spoon is proffered). Both studies established high rates of inter-rater reliability on the behaviour coding categories used (i.e. between 0.80 and 0.97).

The coding systems discussed above (Agras et al., 1988; Harris et al., 1990) were used as the basis to develop a provisional coding scheme which was then revised and adapted. Because it was initially developed for use in a study of younger children (aged not more than one year), the inventory had to be revised and adapted further for use with older children. Apart from the addition of one extra code, the alterations made at this stage were relatively minor. The final inventory was composed of behavioural codes which fell under substance, and method, and also parent (behaviours), and child (behaviours). The category 'substance' described anything that the child ate or drank (i.e. water or juice, semi-solid, savoury, sweet), and method described the method of feeding (i.e. bottle, cup or feeder, spoon, finger). The parent (behaviours) category defined the parent's behaviours which were directly related to the child's feeding such as giving or handing the child some food. While the child (behaviours) category defined the child's behaviours which were directly related to eating food or turning it down. An extra code was included for coding mistakes, which meant that coding sessions could go on in spite of errors and corrections could be made later.

Table 5.2.1 shows the codes used to designate substances fed, methods used, and the various behaviours looked at in the study. The single upper-case alphabetical letter is the code used to stand for the behavioural term in brackets. Beside these is a brief description of the behaviour that fall into the category. After a trial run of this revised version of the inventory, further notes were added to clarify situations which were found to be ambiguous (see 'Further notes on Behavioural Inventory' in Appendix Four).

5.2.2 Derived variables

Those behavioural terms in the coding scheme which involved actual feeding behaviours, for example, 'Give', 'Feedself', 'Release' are described as 'original variables' in the analysis of data (Table 5.2.1). These variables were also used to derive new variables. For example, the variable 'Feedacts' is an overall count of 'Feedself', 'Give' and 'Hand'. Table 5.2.2 shows the list of derived variables.

Table 5.2.1 The behaviour coding inventory.

Substance:		W (water/juice), R (semi-solid), T (solid), X (savoury), C (sweet).
Method:		U (bottle), I (cup/feeder), O (spoon), P (finger).
PARENT		
	A (Give)*	Brings spoon/food to infant's mouth and places food/spoon in mouth.
	S (Hand)*	Places food in child's hand (not placing food in front of child).
	D (Retract)*	Withdraws spoon/cup after failure to gain child's attention
	Y (Take off)*	Takes off cup/bottle directly from child's mouth.
CHILD		
	F (Feedself)*	Baby grasps spoon/food etc. and brings it towards mouth without assistance (assumed infant is successful in getting some food into mouth).
	H (Refuse)*	Baby refuses to open mouth or closes mouth as spoon etc. approaches and before spoon is fully in mouth and / or turns head away, arches back, pushes spoon away, covers mouth. Or refuses to take food in hand.
	J (Reject)*	Expel nipple/spoon from mouth and/or spit out drink/food or hands back food to parent or throws food. (Excludes putting food down).
	K (Release)*	Baby releases nipple, or use to code stop drinking when baby removes cup from mouth.
	L (Accept)*	Takes food from spoon or parent's hand directly into child's mouth.
	M	Feeding invisible.
	N	Feeding visible (again).
	B (Mistake)	When wrong code has been entered, press mistake code then enter correct code. When later editing files, delete mistake and enter correct code at appropriate time.

* Included in the list of original variables for data analysis.

Derived variables were used to summarise combinations of certain original variables. This way basic behavioural acts were grouped together to form broader descriptive categories of feeding behaviour, which helped describe more general tendencies, such as autonomy of the child in feeding or food refusal. In particular, it was necessary to look at 'Feedacts' or all feeding acts ('Feedself', 'Hand' and 'Give') summed; and 'Turndown' or negative responses to food (Refuse and Reject) summed. Ratios of self feeding to amount of offers (P.fdself), and ratios of 'Turndown' to food offers (P.tdown) were also examined. 'P.fdself' must be a value not exceeding one, as it is the ratio of 'Feedself' to the sum of 'Feedself', 'Hand' and 'Give', and the value of the numerator cannot exceed the value of the denominator. However, in the case of 'P.tdown', scores could have values greater than one. This was due to the fact that in the formula for 'P.tdown', i.e. Turndown / (Hand + Give), some of the 'Rejects' were not a direct response to either 'Hand' or 'Give', meaning that the value of 'Turndown' was in some cases greater than the value of the denominator, leading to a result that was greater than one in some cases.

Feed duration (Duration) and total number of acts (N.acts) were included under 'other variables' (Table 5.2.3), and are neither derived from, nor included in the behavioural coding scheme, but were used in the analysis of data.

Table 5.2.2 Derived variables.

	VARIABLE DESCRIPTION	VARIABLE CALCULATED AS
DERIVED VARIABLES		
Feedacts	Number of feeding acts	Count of Feedself + Hand + Give
Turndown	Number of negative responses to food	Count of Refuse + Reject
P.fdself	Feedself as proportion	Feedself / Feedacts
P.tdown	Turndown as proportion	Turndown / [Hand + Give]

Table 5.2.3 Other variables.

	VARIABLE DESCRIPTION
OTHER VARIABLES	
Duration	Duration of feed in minutes
N.acts	Total number of acts (codes) entered

5.2.3 Behavioural coding by two independent observers

Using the behavioural coding scheme described above, two researchers coded the behaviour from video recorded feeding sessions of 30 children. Both researchers were female and were experienced in research on infant feeding. The thirty children used were from the caloric compensation study (described in Chapter Two). The first 30 cases and controls recruited in the study were used. Each child was observed at a standard test meal given to all children. Although two standard meals were given per child only one meal was used in the reliability exercise. This means that rather than using 30 feeds, two each from 15 children, one feed per child from 30 children were used. Recorded meals were included in the reliability exercise soon after the caloric compensation study. Given the limited amount of time in which the reliability exercise had to be done, it was best to include the first feeds obtained from each child. Second feeds had the disadvantage of occurring up to two weeks later than the first, and were not guaranteed to take place since families could opt out of the research at any point.

A behavioural coding session gave an output file with the date and subject's identification number, along with a sequential list of behaviour codes entered for that particular subject. Each behavioural code appeared with the time of onset of the act, to the nearest one hundredth of a second, next to it. Appendix Five is an example of an output file for a single subject.

5.2.4 Data analysis

Coded behaviour for each session was written out as an output file '*.obs', containing a list of coded behaviour with the time that each behaviour code was entered (as hour, minute, and second). The * stands for the name of an individual file, while .obs is common for all coding outputs. This nomenclature applies to '*.rl' and '*.out' files discussed later, too. The statistical procedures were carried out using SPSS (Statistical Package for the Social Sciences). But before this could be done the *.obs outputs had to be converted into a form that could be read into SPSS, which required revision of the time formats. So each of the 30 *.obs files was converted to this format using a UNIX macro and written out to a new file *.rl.

SPSS was used to run a series of computations on each *.rl file. A program 'Prog.csh' was created to carry out the analysis in SPSS sequentially on all *.rl files. The computations done included counts of all behaviours entered under each defined category. In the case of derived variables specified formulae describing relationships between variables from which they were derived were also used in the computation. The time at which particular acts occurred were converted from the 'hour, minute, second' format to seconds only. Appendix Six shows the SPSS command file.

The output from the SPSS computational procedures were written out to a file named *.out. The output contained sums of individual acts observed in the feeding session, including durations in seconds. The latter was later used to compute the precise duration of the complete session. Summary information was then saved in a data file for all the children, for subsequent statistical analyses.

For each subject a count of behaviours observed under each category was taken as the score on that particular variable. For the analysis of data, behavioural categories (as seen in Tables 5.2.1 to 5.2.3) were used as variables. The original variables list included a set of categories from the behavioural observation inventory, which described behaviours directly relating to feeding. The variables are rearranged and presented as sub-groups (Table 5.2.4). 'Feedself', 'Hand' and 'Give' appear at the top of the list; they describe the actual feeding of the child or offers of food by the carer. 'Accept', 'Refuse' and 'Reject' are next on the list;

these are all responses to food being offered or presented for ingestion. 'Retract', 'Release' and 'Takeoff' relate to food or drink being withdrawn from the child.

Table 5.2.4 Percentiles, descriptive statistics and correlation coefficients (Spearman rho) for first (M) and second (B) observers' coding of variables from the original behavioural coding scheme.

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	rho
FEEDSELF								
M	7.00	31.25	47.00	66.75	129.00	49.93	29.64	
B	5.00	29.50	46.00	69.25	100.00	49.00	27.94	0.90
HAND								
M	0.00	2.00	4.00	6.50	29.00	5.67	6.26	
B	0.00	2.75	7.00	9.00	48.00	8.00	9.19	0.76
GIVE								
M	0.00	8.50	31.50	57.00	79.00	32.57	25.08	
B	0.00	6.50	26.50	47.00	75.00	28.47	22.80	0.80
ACCEPT								
M	0.00	7.75	23.50	35.00	57.00	21.73	16.49	
B	0.00	5.00	20.50	31.00	56.00	19.67	16.05	0.74
REFUSE								
M	0.00	2.00	6.00	20.25	36.00	10.20	10.00	
B	0.00	4.00	6.50	18.50	32.00	10.47	9.39	0.80
REJECT								
M	0.00	0.75	2.00	4.25	19.00	3.00	3.87	
B	0.00	3.00	4.00	6.00	34.00	6.20	6.89	0.61
RETRACT								
M	0.00	0.00	0.00	1.00	4.00	0.57	1.01	
B	0.00	1.00	4.00	10.00	17.00	5.83	5.56	0.60
RELEASE								
M	0.00	1.00	3.50	6.00	14.00	4.33	3.96	
B	0.00	1.00	3.00	6.25	13.00	4.43	4.16	0.95
TAKEOFF								
M	0.00	0.00	0.00	0.00	2.00	0.17	0.46	
B	0.00	0.00	0.00	0.00	3.00	0.23	0.63	0.64

Table 5.2.4 shows the mean, standard deviation (SD), percentiles and correlation coefficients for the behavioural data from the two independent observers (M and B) on original variables. In general, these data have skewed distributions, with medians closer to the minimum than the maximum. These characteristics of the distributions in the original variables are also present in the derived variables (Table 5.2.5); and so non-parametric correlations have been calculated. The Spearman rank-order correlation revealed high and positive correlation between the two observers for most variables (Tables 5.2.4 and 5.2.5). Both Spearman rank-order and Pearson product-moment correlation coefficients were calculated for the variables 'Feedself', 'Give', 'Feedacts', 'P.fdself' and 'P.tdown' whose data were normally distributed. However, the resulting correlation coefficients were closely similar, so only the Spearman correlation coefficients are presented.

5.2.5 Discussion

The results show that a high and positive correlation (i.e. rho > 0.70) between raters was achieved for most variables, and a moderate correlation (rho > 0.50; rho < 0.70) for variables 'Reject', 'Retract', 'Takeoff', and 'P.tdown' (see Table 5.2.4).

A review of the behavioural categories revealed that the more specific and less ambiguous the categories the greater the chances of agreement between raters. The variable 'Reject' was found to be ambiguous in relation to the actual behaviour during observation. The 'Reject' category has been defined in the inventory as including 'expelling nipple/spoon from mouth and/or spitting drink/food or handing back food to parent or throwing food' (Table 5.2.1). It was found in a lot of cases that food/drink might be expelled from the mouth seemingly unintentionally, but perhaps due to the child having too much in the mouth, and as 'Reject' was meant to include negative responses to food rather than passive occurrences, it was not clear from the coding guidelines whether to code such behaviour as 'Reject' or not to code it at all, as it was not described in any other category. The effects of this ambiguity would obviously be carried over to the variable 'P.tdown' which was derived from the variables 'Reject' and 'Refuse'.

Table 5.2.5 Percentiles, descriptive statistics and correlation coefficients for first (M) and second (B) observers coding of derived and other variables.

DERIVED VARIABLES

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	Spearman rho
FEEDACTS								
M	28.00	69.75	85.00	103.25	146.00	88.17	28.19	
B	25.00	72.25	80.50	99.00	157.00	85.47	25.67	0.93
TURNDOWN								
M	0.00	4.75	8.50	23.00	43.00	13.20	11.74	
B	0.00	6.50	12.00	27.00	65.00	16.67	14.23	0.81
P.FDSELF								
M	0.11	0.37	0.55	0.80	1.00	0.57	0.27	
B	0.08	0.35	0.59	0.88	1.00	0.58	0.28	0.79
P.TDOWN								
M	0.00	0.19	0.33	0.42	0.83	0.35	0.20	
B	0.00	0.30	0.38	0.62	2.00	0.50	0.38	0.58

OTHER VARIABLES

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	Spearman rho
DURATION								
M	12.88	24.02	32.30	38.76	56.36	31.65	9.72	
B	12.86	24.74	31.37	38.71	58.05	31.64	9.42	0.92
N.ACTS								
M	44.00	124.50	143.48	176.00	245.00	148.40	48.80	
B	56.00	138.50	170.00	195.00	320.00	172.03	51.78	0.84

The reliability coefficient for 'Retract' was only moderate (rho = 0.60). The coding of 'Retract' by the two observers may have been affected by the fact that in reality the reference point for a 'Retract' was not specific in that it was somewhere in the space between the parent and the child. Since the parent held the food up and unless the child accepted immediately by opening the mouth and/or leaning forward, the parent normally continued holding up the food with slight and sometimes sudden movements back, forth and sideways. It is possible for two individual raters to use slightly different movements of the spoon as criteria for retract and thus arrive at different counts of the behaviour.

'Takeoff' was observed quite rarely, and in fact did not occur at all in some meals. This is reflected in the relatively small values in the entire distribution as seen in Table 5.2.4. Because the scores had small values, any slight difference in coding would bring about a greater change in correlation.

The correlation coefficient for 'Duration' was high (rho = 0.92), but not as high as expected. Since a computerised inventory timed the individual acts as well as the entire feeding session, it was expected that any one session coded by different observers should only differ by a few seconds, if at all, and the correlation should be close to the value of one. However, a closer look at the raw data revealed that although for most of the feeding sessions the difference in 'Duration' between the two observers was only a matter of seconds, there were a few cases in which the difference was unusually large, i.e. as much as ten minutes in one case. A careful study of the four feeding sessions in question revealed that towards the end of the sessions, periods in which feeding rarely occurred were common, and in some cases the child went out of view away from the food. These situations brought to question the clarity of the criteria for the end of a feed, as the two observers did in these cases stop coding at different points of the feeding session. In order to improve the reliability for 'Duration' in future, the criteria for the end of feed must be clarified; in particular, the duration of time of no feeding activity, to be considered as the end of feed, must be specified. Such a criterion must be based on a careful study of a wide range of feeding sessions.

The behavioural observation scheme used in this study has been under on-going revision and improvement. The findings of this reliability study will help improve on those categories found to be unclear and difficult to code and perhaps the inclusion of new ones.

5.3 Meal-time behavioural observation

The behavioural observation data for the Cases and Controls falls under two categories - 'original' and 'derived' variables. Original variables include some of the acts described in the behaviour inventory, and these are Feedself, Hand, Give, Accept, Refuse, Reject, Retract, Release, and Takeoff. Derived variables have been derived from the original variables and include Feedacts, Turndown, percentage of feedself (P.fdself) and percentage of turndown (P.tdown). The duration of the feed is also included. Detailed information about the derivation of these variables is found in section 5.2.2 of this chapter.

Descriptive statistics and percentiles have been compiled for each variable to provide information on the distribution of scores. Correlation coefficients have also been calculated to determine the day to day correlations of scores for each variable, within the groups. Tests of statistical significance were carried out to determine the significance of the difference in scores, between the Cases and Controls.

5.3.1 Day to day correlations in feeding behaviour

Both Pearson product-moment and Spearman rank-order correlation coefficients were obtained for all variables measured on the two meals within groups. They describe slightly different things, in the first case a linear association between absolute values, and in the second between their rank orders (McCall, 1986). The two correlation coefficients gave very similar results, but the rank-order coefficients are cited as the counts were generally skewed, in most cases positively (i.e. straggling up).

Table 5.3.1 shows these correlation coefficients and percentiles and descriptive statistics for 'Feedself', 'Hand' and 'Give'. For the Cases there was some correlation across the two test days for 'Feedself' and 'Hand' (rho = 0.42 and rho = 0.40 respectively), but the correlations for the Controls were smaller (rho = 0.30 and rho = 0.26 respectively) and not statistically significant. For the Spearman rank-order correlation coefficient, the critical value for 24 cases is 0.343, for 26 it is 0.329, and for 28 it is 0.313 (Siegel, 1956). However, there was a high positive correlation for 'Give' in both the Cases and Controls (rho = 0.84 and 0.73, respectively).

The correlation for 'Feedself' (the number of times the child brought food up to the mouth without assistance from the parent), would not be expected to be high across test days, as subjects received a calorie load prior to the meal on one day and not the other. Correlation coefficients on 'Give', or the parent feeding the child, are however, high and positive for both groups, showing that the parents' efforts to feed the child remained consistent over the two days. This is an interesting finding which shows that parents, unaware of the difference in calorie load of the pre-load drink fed their children in a consistent manner. This is supported by the results of a Wilcoxon matched-pairs signed-ranks test, which showed no significant differences between 'Give' on the two meals for either the Case or the Control parents. 'Hand' or the parent handing the child food, occurred infrequently in most cases, and did not occur at all in some (see Table 5.3.1). The small values in the distribution probably contributed to the poor correlation across days.

Table 5.3.1 Percentiles, descriptive statistics, and correlation coefficients for original variables 'Feedself', 'Give' and 'Hand'.

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	Spearman rho
FEEDSELF								
CASES (27)								
No-calorie pre-load	7.00	22.00	40.00	65.00	95.00	44.52	26.66	
High-calorie pre-load	14.00	30.00	47.00	72.00	121.00	52.78	27.70	0.42
CONTROLS (25)								
No-calorie pre-load	13.00	34.50	59.00	84.00	109.00	59.32	26.84	
High-calorie pre-load	13.00	34.00	49.00	55.00	129.00	48.52	22.49	0.30
HAND								
CASES (27)								
No-calorie pre-load	0.00	1.00	3.00	6.00	12.00	3.67	3.25	
High-calorie pre-load	0.00	2.00	3.00	5.00	12.00	4.26	2.99	0.40
CONTROLS (25)								
No-calorie pre-load	0.00	0.00	1.00	3.00	29.00	3.16	5.92	
High-calorie pre-load	0.00	0.00	1.00	4.00	19.00	3.40	5.31	0.26
GIVE								
CASES (27)								
No-calorie pre-load	0.00	12.00	25.00	39.00	79.00	26.78	21.26	
High-calorie pre-load	0.00	11.0 0	17.00	31.00	69.00	22.70	19.72	0.84
CONTROLS (25)								
No-calorie pre-load	0.00	4.00	13.00	32.50	74.00	20.80	22.04	
High-calorie pre-load	1.00	5.50	15.00	32.00	72.00	22.20	20.72	0.73

Data for 'Accept', 'Refuse' and 'Reject' are given in Table 5.3.2. In both the Case and Control groups, the correlation coefficients for 'Accept' (i.e. accepting food from parent directly into the mouth) and 'Refuse' were statistically significant and reasonably positive. This seems in contradiction to the poor correlation in both groups for 'Feedself', in that both variables refer to the amount being eaten. However, 'Accept' and 'Refuse' are responses to the parent's effort to feed the child while 'Feedself' refers to the child's own efforts to eat. The correlation coefficient for 'Reject' was 0.59 for the Control group, and 0.56 for the Cases (Table 5.3.2). 'Reject' or declining to eat the food occurred in most cases towards the end of the meal. If the rejection of food was therefore, a response indicating satiation, it would be expected to remain consistent across meals. And if a parent knew from experience that these behaviours occurred when the child was not keen on eating any more, then the parent would allow it to go on only for so long before stopping the feed.

Table 5.3.2 Percentiles, descriptive statistics, and correlation coefficients for original variables 'Accept', 'Refuse' and 'Reject'.

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	Spearman rho
ACCEPT								
CASES (27)								
No-calorie pre-load	0.00	3.00	13.00	29.00	57.00	17.70	16.28	
High-calorie pre-load	0.00	4.00	12.00	18.00	43.00	14.18	11.70	0.78
CONTROLS (25)								
No-calorie pre-load	0.00	1.50	9.00	23.00	50.00	13.40	13.22	0.67
High-calorie pre-load	0.00	3.00	9.00	25.50	39.00	13.92	11.89	
REFUSE								
CASES (27)								
No-calorie pre-load	0.00	2.00	7.00	13.00	23.00	8.44	7.31	
High-calorie pre-load	0.00	1.00	5.00	9.00	44.00	8.00	10.29	0.65
CONTROLS (25)								
No-calorie pre-load	0.00	1.00	3.00	8.50	36.00	6.68	9.11	0.79
High-calorie pre-load	0.00	1.00	3.00	11.50	36.00	7.72	9.98	
REJECT								
CASES (27/26)*								
No-calorie pre-load	0.00	0.00	1.00	5.00	9.00	2.56	3.05	
High-calorie pre-load	0.00	0.00	1.50	3.25	14.00	2.50	3.40	0.56
CONTROLS (25)								
No-calorie pre-load	0.00	0.00	0.00	3.00	5.00	1.48	1.80	
High-calorie pre-load	0.00	0.00	1.00	3.00	19.00	2.16	3.75	0.59

*First figure represents N on the no-calorie pre-load occasion, and the second is N on the other occasion

There was no statistically significant correlation across test days for either group for 'Retract', 'Release' or 'Takeoff' (Table 5.3.3). 'Retract' or the parent withdrawing food after failure to gain the child's attention, was very rarely observed, thus the poor correlation. This was also the case with 'Takeoff' (i.e. the parent releasing the nipple/drink after the child has been drinking). 'Release' or the child releasing the nipple/drink themselves could have been affected by the small scores in the distribution, but might also have been affected by the energy pre-load factor just as in 'Feedself', since 'Release' and 'Takeoff' were essentially a count of how often, during the meal, the child drank.

Table 5.3.3 Percentiles, descriptive statistics, and correlation coefficients for original variables 'Retract', 'Release' and 'Takeoff'.

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	Spearman rho
RETRACT								
CASES (27)								
No-calorie pre-load	0.00	0.00	0.00	1.00	4.00	0.67	1.24	
High-calorie pre-load	0.00	0.00	0.00	0.00	2.00	0.26	0.53	0.23
CONTROLS (24/25)*								
No-calorie pre-load	0.00	0.00	0.00	1.00	4.00	0.60	1.12	
High-calorie pre-load	0.00	0.00	0.00	1.00	2.00	0.42	0.58	0.12
RELEASE								
CASES (27)								
No-calorie pre-load	0.00	0.00	1.00	5.00	11.00	2.63	3.40	
High-calorie pre-load	0.00	0.00	2.00	4.00	14.00	2.85	3.56	0.10
CONTROLS (25)								
No-calorie pre-load	0.00	1.00	5.00	10.00	19.00	5.80	5.07	
High-calorie pre-load	0.00	0.00	2.00	7.00	13.00	3.68	4.18	0.22
TAKEOFF								
CASES (27)								
No-calorie pre-load	0.00	0.00	0.00	0.00	5.00	0.30	1.03	
High-calorie pre-load	0.00	0.00	0.00	0.00	2.00	0.18	0.56	-0.12
CONTROLS (25)								
No-calorie pre-load	0.00	0.00	0.00	0.00	1.00	0.08	0.28	
High-calorie pre-load	0.00	0.00	0.00	0.00	2.00	0.16	0.47	-0.11

*First figure represents N on the no-calorie pre-load occasion, and the second is N on the other occasion

The correlation coefficients for derived variables are obviously directly related to the coefficients of the variables from which they were derived. 'Feedacts' is a sum of all three feeding acts (i.e. 'Feedself', 'Hand' and 'Give'). 'Turndown' is the sum of 'Refuse' and 'Reject'. The correlation for 'Feedacts' for the Cases was low, and it was only moderate for the Controls (see Table 5.3.4) resulting from the moderate correlations for 'Feedself' and 'Hand' and the high correlation for 'Give'. And just like the correlation coefficients for 'Refuse' and 'Reject' (discussed above), the correlation coefficients for 'Turndown' across test days for both groups were reasonably high (i.e. rho = 0.61 and rho = 0.71 for Cases and Controls respectively).

'P.fdself' is a proportion, the ratio of 'Feedself' to the sum of 'Feedself', 'Hand' and 'Give'. Table 5.3.4 shows that it is highly correlated across the two days for the Cases and Controls (rho = 0.78 and rho = 0.83 respectively). This shows that those children in both groups who mostly fed themselves on one day, mostly did so on the other day as well, and those that were mostly fed on one day remained mostly fed on the other day. 'P.tdown' or the ratio of 'Turndown' to 'Hand' and 'Give' showed poor correlation across test days for either the Cases or Controls (Table 5.3.4). The correlation of 'P.tdown' is likely to have been affected by the poor correlation in the variable 'Hand' in both groups.

The correlation coefficients on 'Duration' across days were not that different for the Cases and Controls. Table 5.3.5 shows that for both groups there was moderate correlation across days (rho = 0.43 and rho = 0.58 for Cases and Controls, respectively).

Table 5.3.4 Percentiles, descriptive statistics, and correlation coefficients for derived variables.

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	Spearman rho
FEEDACTS								
CASES (27)								
No-calorie pre-load	25.00	60.00	73.00	90.00	134.00	74.96	26.44	
High-calorie pre-load	18.00	63.00	85.00	96.00	125.00	79.74	26.24	0.38
CONTROLS (25)								
No-calorie pre-load	23.00	67.00	85.00	96.50	146.00	83.28	28.94	
High-calorie pre-load	28.00	52.00	66.00	100.00	143.00	74.88	32.97	0.47
TURNDOWN								
CASES (27)								
No-calorie pre-load	2.00	4.00	10.00	16.00	30.00	11.00	7.79	
High-calorie pre-load	0.00	4.00	6.00	14.00	44.00	10.44	10.92	0.61
CONTROLS (25)								
No-calorie pre-load	0.00	1.00	5.00	8.00	41.00	7.88	10.11	0.71
High-calorie pre-load	0.00	2.00	5.00	13.00	43.00	9.88	12.29	
P.FDSELF								
CASES (27)								
No-calorie pre-load	0.11	0.40	0.62	0.80	0.99	0.58	0.26	
High-calorie pre-load	0.19	0.48	0.74	0.85	0.97	0.67	0.23	0.78
CONTROLS (25)								
No-calorie pre-load	0.16	0.63	0.78	0.92	1.00	0.73	0.24	
High-calorie pre-load	0.30	0.49	0.78	0.85	0.98	0.68	0.22	0.83
P.TDOWN								
CASES (27)								
No-calorie pre-load	0.07	0.28	0.38	0.50	9.00	0.72	1.67	
High-calorie pre-load	0.00	0.19	0.35	0.57	0.91	0.37	0.27	0.25
CONTROLS (24/25)*								
No-calorie pre-load	0.00	0.15	0.33	0.50	0.80	0.33	0.22	
High-calorie pre-load	0.00	0.12	0.43	0.65	2.00	0.44	0.42	0.36

*First figure represents N on the no-calorie pre-load occasion, and the second is N on the other occasion

Table 5.3.5 Percentiles, descriptive statistics, and correlation coefficients for feed duration.

	MINI-MUM	25th	MEDIAN	75th	MAXI-MUM	MEAN	SD	Spearman rho
DURATION								
CASES (27)								
No-calorie pre-load	12.08	20.71	26.33	32.61	43.86	27.43	7.85	
High-calorie pre-load	9.22	21.45	27.64	31.74	40.18	26.40	7.68	0.43
CONTROLS (25)								
No-calorie pre-load	8.83	19.42	33.09	38.25	47.49	30.62	11.17	
High-calorie pre-load	12.88	21.77	26.72	38.92	56.36	29.38	10.75	0.58

5.3.3 Case-control differences in behavioural responses to pre-loads

The Mann-Whitney U-test for two independent samples was carried out to test the significance of any difference in behaviour counts between Case and Control groups for all variables. A non-parametric measure was used because data are skewed, in most cases towards the higher scores.

Tables 5.3.1 up to 5.3.5 above show that for most of the variables, the median value is smaller than the mean. The only exceptions are the scores for 'P.fdself', the Control scores for 'Feedself' on the high-calorie pre-load meal, and the Case scores for 'Feedacts' on the high-calorie pre-load meal.

Table 5.3.6 Case-control differences for original variables (Mann-Whitney U-test).

	MEAN RANK Cases (27)	Controls (25)	Mann-Whitney U-value	2-tailed significance
FEEDSELF				
No-calorie pre-load	22.43	30.90	227.50	p<0.04
High-calorie pre-load	27.26	25.68	317.00	p>0.7
HAND				
No-calorie pre-load	29.63	23.12	253.00	p>0.1
High-calorie pre-load	31.80	20.78	194.50	p<0.008
GIVE				
No-calorie pre-load	29.11	23.68	267.00	p>0.1
High-calorie pre-load	27.19	25.76	319.00	p>0.7
ACCEPT				
No-calorie pre-load	28.43	24.42	285.50	p>0.3
High-calorie pre-load	27.11	25.84	321.00	p>0.7
REFUSE				
No-calorie pre-load	29.52	23.24	256.00	p>0.1
High-calorie pre-load	27.46	25.46	311.50	p>0.6
REJECT				
No-calorie pre-load	28.65	24.18	279.50	p>0.2
High-calorie pre-load	26.77*	25.20	305.00	p>0.6
RETRACT				
No-calorie pre-load	26.72	26.26	331.50	p>0.8
High-calorie pre-load	24.22	28.00*	276.00	p>0.2
RELEASE				
No-calorie pre-load	21.20	32.22	194.50	p<0.007
High-calorie pre-load	25.43	27.66	308.50	p>0.5
TAKEOFF				
No-calorie pre-load	26.96	26.00	325.00	p>0.6
High-calorie pre-load	26.44	26.56	336.00	p>0.9

* N is one subject less.

Table 5.3.6, shows the U-test results for original variables. The test shows that for 'Feedself', the Control group scored significantly higher than the Cases on the no-calorie pre-load day ($p < 0.04$) but not on the high-calorie pre-load day. The median scores (Table 5.3.4) show more 'Feedself' acts for the Controls on the no-calorie than on the high-calorie pre-load day. In a classic compensation study, children are expected to consume less food following a high calorie pre-load; the scores of the Control group for 'Feedself' are consistent with this expectation. More 'Feedself' acts during the no-calorie pre-load meal may indicate an effort by Control children to consume more food. The Cases on the other hand, have a lower median on the no-calorie pre-load day than on the high-calorie pre-load day (Table 5.3.4).

For the variable 'Hand', there was a significant difference between the Cases and Controls on the high-calorie pre-load day ($p < 0.008$), but not on the no-calorie pre-load day. Table 5.3.1 shows that for the meal at which the significant difference was obtained, the median score for the Cases is greater than that of the Controls, indicating that the parents of the Cases handed their children more food during the meal following a high-calorie pre-load than did the control parents. This trend is evident on the no-calorie pre-load day as well, although this difference between the groups is not statistically significant.

There was also a significant difference between the Cases and Controls for the number of 'Release' acts on the no-calorie pre-load day ($p < 0.007$), with the Control group having a greater score (Table 5.3.3). The number of 'Release' acts or the number of times the child releases the cup/bottle from the mouth after he/she has been drinking, indicates how often the child drank during the meal. The scores for the two groups on the two meals for 'Release' appear to be consistent with the trend in scores for 'Feedself', i.e. there is no significant difference in scores on the high-calorie pre-load day, and the Controls have higher scores on the no-calorie pre-load day. The median score for the Cases on the two days is the same.

There was no significant difference observed between the Cases and Controls for the variables 'Give', 'Accept', 'Refuse' and 'Retract', showing that the meal-time behaviours defined by these variables did not differ significantly between the groups.

Table 5.3.7, shows the U-test results for derived variables and for the duration of the meals. No significant differences were observed between the two groups for the variables 'Feedacts' and 'P.tdown'. However, significant differences were observed for the other three variables on the no-calorie pre-load day. For 'Turndown', the Cases scored significantly greater than the Control group ($p < 0.02$). The medians are 10.00 and 5.00 (Table 5.3.4). As earlier pointed out, there was no significant differences between the groups for the variables 'Refuse' and 'Reject' - these are the original variables of which 'Turndown' is comprised. However, for both 'Refuse' and 'Reject', the median score for the Cases is greater than the score for the Controls at both meals; although these differences were not statistically significant in the two variables separately, the pooled difference in 'Turndown' was significant on the no-calorie pre-load day.

For 'P.fdself', the Controls scored significantly greater than the Cases on the no-calorie pre-load day, i.e. on the no-calorie pre-load day, the Controls fed themselves (as opposed to being fed by the parent) significantly more than the Cases. On the high-calorie pre-load day, the median scores for the Case and Control groups were 0.74 and 0.78 respectively (Table 5.3.4) and not significantly different; however, on the no-calorie pre-load day, the Case median was 0.62 while the Control group median was 0.78. This trend is evident in both 'Feedself' and 'Release' discussed above.

The U-test result for 'Duration', or the duration of the entire feeding session in minutes, shows no significant difference between the Cases and Controls on either days. The median durations are given in Table 5.3.5.

The results summarised above show significant differences between the Cases and Controls for the variables 'Feedself', 'Release', 'Turndown', and 'P.fdself'. These differences show that the Control children altered their feeding behaviour, as measured by these variables, in the direction which suggests greater intake on the no-calorie pre-load day. The Case children on the other hand do not show this compensating trend; if anything they show an opposite trend.

Table 5.3.7 Mann-Whitney U-test results for derived variables and feed duration.

	MEAN RANK		Mann-Whitney	2-tailed
	Cases (27)	Controls (25)	U-value	significance
FEEDACTS				
No-calorie pre-load	23.93	29.28	268.00	p>0.2
High-calorie pre-load	28.48	24.36	284.00	p>0.3
TURNDOWN				
No-calorie pre-load	31.04	21.60	215.00	p<0.02
High-calorie pre-load	27.91	24.98	299.50	p>0.4
P.FDSELF				
No-calorie pre-load	22.02	31.34	216.50	p<0.02
High-calorie pre-load	26.19	26.84	329.00	p>0.8
P.TDOWN				
No-calorie pre-load	28.72	22.94*	250.50	p>0.1
High-calorie pre-load	25.89	27.16	321.00	p>0.7
DURATION (in minutes)				
No-calorie pre-load	24.11	29.08	273.00	p>0.2
High-calorie pre-load	25.04	28.08	298.00	p>0.4

* N is one subject less.

The parents' behaviour measured by 'Hand' is significantly greater for the Cases on the high-calorie pre-load day, and although the differences were not statistically significant this was also the trend on the no-calorie pre-load day, as well as on both days for 'Give'. It is evident from this that parents in the Case group actually made more effort to feed their children than the parents of the Controls, and this is consistent with the result for 'P.fdself' which shows that children in the Control group fed themselves more as opposed to being fed by the parent.

5.3.4 Behaviour coding by independent observers

Although the Researcher was blind to the order of presentation of high- and no-calorie pre-loads over the two occasions, she could not be blind to the child's group since she participated in the recruitment of the cases and controls. It was therefore valuable for behavioural ratings also to be made by independent coders, who were blind to both the order of pre-load, and the group membership of the child. Two independent observers participated in the coding of the video-recorded meals; one coded all of the first feeds, and the other the second feeds. Since the children in the study were already randomised according to order of pre-load, randomisation between the two coders was not necessary.

The results of the independent coding are presented in Tables 5.3.8 and 5.3.9. Apart from a few minor differences, the results from the independent coding are essentially the same as those obtained by the Researcher (see Tables 5.3.6 and 5.3.7). For every variable, differences that were statistically significant in the Researcher's result remained statistically significant. Except for 'Hand' on the no-calorie pre-load occasion, those variables that were not significant remained non-significant.

Table 5.3.8 Mann-Whitney U-test from independent coders (original variables).

	MEAN RANK Cases (27)	MEAN RANK Controls (26)	Mann-Whitney U-value	2-tailed significance
FEEDSELF				
No-calorie pre-load	22.78	31.38	237.00	p<0.04
High-calorie pre-load	27.44	26.54	339.00	p>0.8
HAND				
No-calorie pre-load	31.43	22.40	231.50	p<0.03
High-calorie pre-load	33.02	20.75	188.50	p<0.003
GIVE				
No-calorie pre-load	30.06	23.83	268.50	p>0.1
High-calorie pre-load	28.07	25.88	322.00	p>0.6
ACCEPT				
No-calorie pre-load	29.44	24.46	285.00	p>0.2
High-calorie pre-load	28.07	25.88	322.00	p>0.6
REFUSE				
No-calorie pre-load	31.04	22.81	242.00	p<0.05
High-calorie pre-load	28.20	25.75	318.50	p>0.6
REJECT				
No-calorie pre-load	29.72	24.17	277.50	p>0.2
High-calorie pre-load	27.59	26.38	335.00	p>0.7
RETRACT				
No-calorie pre-load	27.09	26.90	348.50	p>0.9
High-calorie pre-load	26.22	27.81	330.00	p>0.7
RELEASE				
No-calorie pre-load	22.22	31.96	222.00	p<0.02
High-calorie pre-load	24.94	29.13	295.50	p>0.3
TAKEOFF				
No-calorie pre-load	26.96	27.04	350.00	p>0.9
High-calorie pre-load	26.98	27.02	350.50	p>0.9

Table 5.3.9 Mann-Whitney U-test results from independent coders (derived variables and feed duration).

	MEAN RANK Cases (27)	Controls (26)	Mann-Whitney U-value	2-tailed significance
FEEDACTS				
No-calorie pre-load	24.09	30.02	272.50	p>0.2
High-calorie pre-load	28.35	25.60	314.50	p>0.5
TURNDOWN				
No-calorie pre-load	31.39	22.44	232.50	p<0.03
High-calorie pre-load	27.94	26.02	325.50	p>0.6
P.FDSELF				
No-calorie pre-load	22.37	31.81	226.00	p<0.02
High-calorie pre-load	25.93	28.12	322.00	p>0.8
P.TDOWN				
No-calorie pre-load	26.11	25.88*	321.00	p>0.9
High-calorie pre-load	25.59	27.48*	313.00	p>0.6
DURATION (in minutes)				
No-calorie pre-load	26.11	25.88*	321.00	p>0.06
High-calorie pre-load	25.59	27.48*	313.00	p>0.6

* N=24 on the no-calorie pre-load occasion, and N=25 on the high-calorie pre-load occasion.

5.3.5 Energy intake and behaviour at meal-times

In this chapter the findings of the investigation into the energy intake and caloric compensation of the sample children have been looked at. The findings of the behavioural observation at meal-times, as well as the reliability of the measures used in the behaviour rating are also presented in this chapter. The main findings of these investigations are discussed in fuller detail in Chapter Six of this thesis.

CHAPTER SIX

Discussion

6.1 Introduction

The review of literature in Chapter One revealed that there is interest in the meal-time behaviour of families of children with failure to thrive (e.g. Heptinstall et al., 1987; Black et al., 1994, 1995), and hunger and satiation patterns of normally growing children have been investigated (e.g. Birch and Deysher, 1986; Anderson, 1995), but there has been little focus on the regulation of appetite in children with FTT, and no comparison has been made with normal growth children. The study reported in this thesis investigated the possibility that children with non-organic FTT may have poorly regulated appetites. A number of hypotheses were tested.

The first was that children with non-organic FTT have unusual taste preferences compared with normally growing children. Prior research suggests that malnourished children have a depressed response to sweet and other tastes (Vazquez et al., 1982).

The second was that FTT families would be characterised by unusual meal-time feeding patterns. In particular, cases and controls were expected to be different in terms of observed feeding-related behaviours, and also in feeding history as reported by their parents.

The third hypothesis tested was that unlike normally growing children who compensate for calories at a given meal in response to an earlier calorie load (Birch and Deysher, 1986), children with non-organic FTT would show unusual caloric compensation. A lack of ability to self-regulate energy intake through caloric compensation may be a reason that children with FTT have insufficient energy intake.

6.2 Reliability of measures used in behavioural observation

The reliability of the coding schedule which was to be used as the basis for behavioural observations had to be established first. 'Minkey', a computerised program for behaviour observation was used, with a meal-time behaviour inventory particularly developed to observe feeding in children in the first year of life. The schedule used was adapted for the purposes of observing feeding behaviour in children aged between one and two years. The procedure for testing the reliability of the inventory is presented in Chapter Three. Two researchers participated in the coding of 30 separate feeds one each from the first 30 children recruited.

The results showed a high and positive correlation (i.e. rho > 0.70) between raters for most variables, and a moderate correlation (0.50 < rho < 0.70) for the variables 'Reject', 'Retract', 'Takeoff', and 'P.tdown'. The factors leading to the lower inter-rater coefficients for these variables arose either from some ambiguity in definition of the behavioural categories, or from the fact that the behaviour in question rarely occurred in the observed sessions, as discussed in Chapter Three.

Similar behavioural observation studies of children, in some cases observed with their parents, during play or meal-times have shown inter-rater reliability coefficients ranging from about 0.70 to 0.90 and over (Wolke et al., 1990; Reilly et al., 1995; Black et al., 1994). Polan et al. (1991) reported inter-rater reliability coefficients ranging from 0.42 to 0.89 on a number of measures of child affect in feeding and non-feeding situations. In a review of 'measures of non-verbal behaviour', Rosenfeld (1982) noted that many researchers neither assessed nor reported reliability coefficients of the measures used, and those that did so showed coefficients as high as 0.90 and above. Rosenfeld argued that these high coefficients may have, in part, been due to selective reporting of only those studies that reached acceptable standards of reliability.

Revision and re-definition of the behavioural categories to make them less ambiguous is one way of improving reliability. This is achieved through test-coding sessions during which problem items are noted and improved upon. Inter-coder discrepancies can be used as the basis for improving the coding system by scrutinising video-tapes for objective bases of disagreement (Rosenfeld, 1982).

The major problem with behavioural coding is that many different behaviours have to be condensed into one group or category. The number of codes that it is practical to use for describing a live session is limited, and so categories rather than individual behavioural acts are treated as codes. This inevitably leaves room for ambiguity, but within these limits behavioural categories must be re-defined and made as precise and concise as possible to reduce ambiguity. Studies reviewed by Rosenfeld (1982) showed that there is a relationship between the characteristics and complexities of the varied human activities and the observer's ability to identify boundaries between behavioural units. This means that basing descriptions of codable acts on known perceptual categories may provide a key to better reliability coefficients.

Another way in which the inter-rater reliability could be improved is by reducing the 'observational load' placed on the observer. Rosenfeld and Sullwold (1969) demonstrated the effect of observational load on the reliability of scoring by two experienced observers. They showed that inter-rater reliability fell from between 0.92 and 0.99 when observers were instructed to observe two variables, to between 0.44 to 0.79 when instructed to observe five variables. In studies which involve observation of recorded parent-child interaction, the observational load placed on the coder may be reduced by coding the behaviours of parent and child on separate occasions.

Black et al. (1994) in an investigation of parent-child interaction during feeding, reported inter-rater reliability coefficients of 0.90 and above in their study in which each of the two observers saw each video-recording twice, once to code the parent's behaviour and once to code the child's. Similarly, a procedure could be used in which only one or two behavioural categories or 'acts' are coded per coding session. As in Black et al. (1994) it means that each recorded session must be seen more than once for all the behavioural categories to be coded. The advantage of this procedure is that it minimises the probability of missing out the coding of some acts, especially when they occur too quickly. The problem with this however, is that it is time consuming, and would be costly and difficult to achieve with large samples.

The Spearman reliability coefficient for feed duration was 0.92, and although this is very high, it was surprising that the correlation was not perfect. Part of the problem was that while the criteria for start of feed was clear (i.e. the first feeding-related act which occurred), that of ending of feed (i.e. the last feeding-related act which occurred) was not as clear in practice, especially in the coding of feeds which had been video-recorded under difficult conditions. Although the criteria for start and end of feeds were signalled by the same 'acts', the end of feeds tended to be more difficult to tell due to long pauses in some cases, and other uncategorised behaviours which normally go with the end of a meal, such as the parent clearing up. This means that it is wrong to assume that the criteria for end of feed can be based upon the same acts as start of feed though true in reverse, and new definitions must be explored.

In two studies that included comparisons of meal durations between children who failed to thrive and controls, Heptinstall et al. (1987) reported that meal duration was the same in the two groups (mean 24 with SD 12 in the cases, and mean 17 with SD 8 in the controls), while Mathisen et al. (1989) reported a large and statistically significant difference (mean 8.5 with SD 6.0 in cases, and mean 21.1

with SD 4.4 in controls). Neither study reports a reliability figure for meal duration, or gives criteria for the start and end of the meal.

The reliability of the behavioural inventory when used to code video recorded sessions to some extent depends on the quality of the video recording. According to Rosenfeld (1982) situational characteristics such as lighting, distance of observers from subject, and angle of observation are likely to affect reliability. Since the sessions in this case occurred in the child's own home conditions were not always ideal for video recording. In such cases some behavioural acts were not always clearly visible. Other than getting the children to be tested in a specially prepared laboratory, which is limiting in that it is not a natural environment for the child, very little can be done about this problem except to learn by experience.

The inter-rater reliability coefficients obtained using the behaviour inventory for feeding behaviours in the study reported in this thesis are within the ranges described as acceptable to very good in other similar studies (Wolke et al., 1990; Reilly et al., 1995; Black et al., 1994; Polan et al., 1991). In view of the practical problems of using a computer to code video recorded behavioural sessions it can be concluded that the reliability coefficients achieved, even though they were only moderate in some cases, are satisfactory. Certainly when the whole coding was carried out independently by other blind observers, the differences between the groups found were essentially the same as those found in the initial coding by the author, as reported in section 5.3.4.

6.3 Appetite and feeding history as reported by parents

The results obtained from parental reports on their children's appetite and diet are presented in Chapter Three. These reports give, firstly a limited amount of demographic information namely parental age and socio-economic indicators, and secondly, the parent reports of their child's feeding and diet. Demographic information is considered first.

Average differences between FTT and Control children were found in two of the three socio-economic indicators used. There was less employment and less home ownership in the Case families than in the Controls, showing that the Control families in the study were of relatively higher socio-economic status according to these indicators.

For the Cases 16 out of the 27 parents (59.3%) and for the Controls 24 out of 28 parents (85.7%) reported that either they or their partner were employed, and Pearson's chi-square showed a significant group difference. Similarly, 10 out of the 27 of the Case parents (37%) and 20 out of 28 Control parents (71.4%) owned a home, and this difference was also statistically significant. This means that there is an overlap between Case and Control families according to these socio-economic indicators, but a larger proportion of the Case families were of lower socio-economic status than of the Control families.

In the recruitment of subjects, steps were followed to ensure that cases and controls were similar in terms of age, sex, membership of General Practice, and geographical location. The Cases were identified through a whole city surveillance of growth and failure to thrive in young children, and came from a cross-section of the society. But the procedure used for recruitment of controls resulted in groups which, though overlapping, were significantly different on socio-economic indicators.

These differences may have arisen because the Control families volunteered to participate in the study. The Case families were not volunteers in quite the same sense that controls were though they were free not to take part. Even though the parents were asked for their consent before participating in the research, their children were already involved in the Parkin Service and were being seen by the Service professionals. The Control families however, were recruited straight from the community, and were in most cases unaware of the Parkin Service, and so higher rates of refusal to participate came from them.

Per case child recruited letters were sent to five possible controls, and in the few cases where none of the five families were recruited, another five letters were sent out. Twenty eight cases were altogether recruited which means that not less than 140 possible controls were approached. Of these, 11 wrote back to say they 'did not' wish to participate in the research, and many more refused to participate when the researcher followed them up to their homes two weeks after the letters had been sent. At least one family refused to participate as controls for each case recruited. All the case parents approached agreed to participate in the study.

The recruitment procedure was aimed at producing case and control groups that were generally comparable in socio-economic status. The results show that the control families recruited were better off according to the socio-economic indicators used, and so it is likely that the lower socio-economic status families did not volunteer to participate to the same extent that parents of a higher socio-economic status did. A similar recruitment procedure was used in Newcastle-upon-Tyne at the same time in another study of failure to thrive; the resulting case and control groups were comparable in socio-economic status (Drewett et al., 1997). The difference seems to be that in the present study a much more extensive period of data collection was involved, in the child's home (three days in all). More exact information on the socio-economic level of the families than is provided by their GP practice and geographical proximity can only be obtained after the families have agreed to take part. However, the study design did not involve pair-wise matching, so there is no special difficulty in controlling statistically for average differences in socio-economic level, as long as there is reasonable overlap between the groups, as there was.

Further differences between Case and Control families were found in family size and birth-order (or rank) of the child. The Cases were on average from larger families, and were also more spread out in rank than the Controls who were more concentrated in the first two ranks. The difference in ranks was likely to be a result of the Control families being small. Prior studies found no differences between families of failure to thrive children and controls in the number of family members (Kotelchuck and Newberger, 1983), maternal parity (Wilensky et al., 1996), or number of siblings (Pollitt and Eichler, 1976), all related to family size. The association between FTT and family size may therefore, be an adventitious one.

Family size has however, been used along-side employment status, housing, and presence of a father, to identify children at risk for poor growth (Nelson and Naismith, 1979). Nelson and Naismith proposed that family size in relation to socio-economic factors may predict how much of the family income is spent on food, so that children from larger families and of a lower socio-economic background may be at increased risk of under-nutrition. Townsend, Phillimore, and Beatie (1986) used family-size in relation to the size of house occupied by the family to determine 'over-crowding' which was then used as a risk indicator of health. Although family-size has been used as a risk indicator for poor growth, research needs to show its exact relationship to these factors.

The use of parent reports as a means of studying feeding in children has been criticised as not valid. Parents may falsify information to give a good image of themselves or their child, or they may simply not remember the details well enough (Dowdney et al., 1987; Davies et al., 1994). It is primarily for this reason that direct observation and measurement were the main method used in this thesis. However, because parental reports provide information in cases where no other documentation exists they are still of some use.

In the research reported in this thesis, parental reports of child appetite and feeding were obtained to provide information additional to the direct measures of energy intake regulation and feeding behaviour which are the main focus of the research. The results obtained from parent reports show some consistency with the results obtained using the other measures.

The Cases were reported as less hungry than the Controls by their parents on the two hunger scales. Fourteen out of the 27 Cases (51.9%) were reported as 'rarely' hungry at meal-times, as compared to four of the 28 Controls (14.3%). Similarly, 64.0% of the Cases were reported to 'rarely' eat up their food at meal-times, as compared to 35.7% of the Controls. This shows an overlap between the two groups on both the scales, but the proportions of Cases and Controls that fell into the 'rarely' and 'mostly' categories were significantly different.

The t-test results from the caloric compensation measures presented in Chapter Five show that the children in the FTT group did indeed consume less energy from the standard test than the Control group. At the reference meal (i.e. the meal following the no-calorie pre-load), the mean intake for the Cases was 164 kcal while the mean intake for the Controls was 257 kcal, and the difference was statistically significant at the 0.001 level.

Prior research on the appetite and energy intake in groups of children with failure to thrive has yielded conflicting results. While some studies show that the intakes of children with FTT are lower than they should be (e.g. Nelson and Naismith, 1979; Pugliese et al., 1987), others show that their intakes are not particularly low (e.g. Whitten et al., 1969; Heptinstall et al., 1987). Part of the reason for the inconsistency in findings may be the different measures of intake used, as well as differences in study design.

Nelson and Naismith (1979) noted that surveys based on seven-day weighed food intakes provided the most accurate measure of food consumption. But unable to use this measure due to the poor co-operation rates attributable to difficulty in keeping weighed records in the community they were researching, they explored the use of a simpler method, based on household measures of intake. A seven-day validation of this method alongside the weighed intake method was carried out with 15 co-operative mothers, and there was very high agreement between the two methods in estimated energy intake, though there was less agreement on estimation of nutrients such as vitamin C and D.

The nutritional intake of one to 12 year old children from poor inner-city areas was measured for three days using the household measures method. The intakes of the children below the tenth centile for height (n=9) was significantly lower than that of the rest of the group, and so were the intakes of their siblings (n=22). However, one to 12 is too wide an age range for a study of nutrition in children because in the first year of life alone, changes in nutrition can result in a noticeable slowing down of the rate of weight gain (WHO Working Group, 1986).

Pugliese et al. (1987) investigated the intake of a small group of seven to 22 month old children hospitalised for failure to thrive. They used seven-day food records for four patients, in-hospital calorie counts for two patients, and an unstructured interview for one patient. Standard references were used to calculate the energy values of the food consumed. The intake of the children in the study was 63% to 94% of the recommended levels for their age and sex, but this rose to 94% to 147% after intervention in the form of intensive nutritional counselling. This study is subject to criticism because of the lack of a standard procedure for measuring the intake of the sample, the small number of children used and the fact that they were hospitalised for FTT, and no normal controls were used for comparison. Such methodological problems in the study of failure to thrive are discussed in fuller detail in Chapter One.

Whitten et al. (1969) studied three to 24 month old children, 13 of whom were hospitalised for failure to thrive, and three still at home following diagnosis. The exact measures of intake used are not clearly described, although a nurse did measure the food before and after the meal, and intake was quoted in calories. All the three community children and 10 of the 13 hospitalised children were reported to have accelerated weight gain attributable to increased nutritional intake. Two of the three that did not gain weight were reported to have had 'grossly inadequate voluntary caloric intake', while the third child gained weight at a slow rate.

Heptinstall et al. (1987) adopted the household measures technique described by Nettleton, Day, and Nelson (1980), which involves the use of tablespoons and standard portions to assess amounts provided and actually eaten. The subjects were 23 four year old children, from an inner-city London area, with FTT, and 23 normal growth controls from the same area. Three-day food diaries kept by the parents, and verified by measures taken by the researcher during the meal-time behaviour observation, showed that the intake of the FTT group was not significantly different from that of the controls.

The measures used in the above studies are either weighed intakes, household measures of intake or interview. In Whitten et al. (1969), and Pugliese et al. (1987), it is not clear what units of measurement were used though the resulting intake was quoted in calories. There is also a difference in standards against which the intake of failure to thrive children is measured - Nelson and Naismith (1979) and Heptinstall et al. (1987) used normal growth controls, while Pugliese et al. (1987) used the percentage of the median approach, and Whitten et al. (1969) did not use any standard for comparison at all. The age of children studied also differs among studies, and because there is not a lot of research in this area, studies which report the intake of different age groups are used for reference. All of these factors contribute to the inconsistency of intakes reported in children with failure to thrive.

The results from parent reports are also consistent with some of the findings from the behavioural observation. The behavioural observations showed a significant difference between the groups in 'Hand', showing that the parents in the Case group handed their children food more during the meal. This could simply mean that the parents in the Case group normally tend to assist their children more during feeding. Or it could also mean that the Case parents having accurately read the poor motivation to eat in their children, shown in the parent reports, made an effort to try and get them to eat more by offering more food. Even so they still failed to get their children to consume as much as the control children.

This in itself suggests inherent problems surrounding meal-times in families with FTT, and it is no wonder that the parents in this group reported that they enjoyed meal-times with their child less than did Control parents. In another study, meal-time observations of families with FTT children and normal growth controls showed that parents of FTT children showed significantly more negative affect than control parents (Heptinstall et al., 1987). Polan et al. (1991) also showed that the FTT children showed more negative affect during feeding than normally growing children.

In children living in industrialised communities where extreme cases of food scarcity are unlikely to occur in normal families, feeding problems are considered a possibility in FTT. It has been suggested that some children in the first few years of life have problems associated with acceptance and oral manipulation of food, and these stop them from having a sufficient intake of food energy (Skuse, 1993; Harris, 1993). These problems range from food refusal to inefficient oral-motor function. Although significant oral-motor disorders are ruled out in the diagnosis of non-organic FTT (Harris, 1993), children with non-organic FTT have been shown to have significantly higher proportions of oral-motor co-ordination problems than normally growing groups of children (Heptinstall et al., 1987; Skuse et al., 1995)

The results from parental reports presented in Chapter Three show that there were some case-control differences in feeding problems. In particular, the Cases were reported to have had more problems with chewing than the Controls. There were no significant differences in problems with sucking or swallowing. Because such problems in children with non-organic FTT either exist in mild forms (Harris, 1993), or only exist in a small proportion of the children (Skuse et al., 1995) it is unlikely that a strong statistical relationship with non-organic FTT will be shown consistently, even with measures of better sensitivity than parent reports.

The parent reports also showed that Cases were introduced to solids and finger foods later than the Control group, and the difference was significant for age of introduction to finger foods. The average difference in age was less than one month. An earlier study showed a significant difference of over one month, in the age of introduction to solids between the FTT group and normal growth controls (Heptinstall et al., 1987) .

Early weaning as compared to late weaning has been associated with earlier achievement of developmental milestones such as walking, and also accelerated weight gain at certain stages in the first year of life (Heinig et al., 1993). It has been proposed that late weaning may lead to feeding problems, particularly oral-motor co-ordination problems, and consequently predispose infants to FTT

(Skuse, 1993). The parent reports do show that later introduction of finger foods and oral-motor problems are reported more often in the FTT group than the control group. With these results it would be reasonable to suggest that the relationship between the FTT group being on average weaned later on one hand, and their having more chewing problems on the other, may be a causal one as suggested by Skuse.

However, the growth data shows that the fall in the weight gain of the Cases is observable from the very early weeks of life. In fact the growth faltering is apparent before weaning which normally starts at around three to four months (Harris, 1988), which means that feeding problems brought on by delayed weaning cannot be primarily responsible for the on-set of FTT. Studies of growth in the first weeks of life in relation to age of weaning suggest that neonates with lower birth-weights, and lower length for age measures tend to be weaned later (Harris, 1988; Harrison, Brush, and Zumrawi, 1992), which means that smaller infants are introduced to supplementary foods later (perhaps due to their having lower energy needs). Thus the causal direction may be that FTT leads to later weaning and to associated feeding problems, rather than vice versa.

6.4 Response to sucrose sweetened solutions

The review of literature in Chapter One shows that human preference for sweet tastes is present at birth (Desor et al., 1975; Lipsitt, 1977). It has been speculated that human sensitivity to sweet food is an inborn mechanism which directs them to carbohydrate energy sources (Anderson, 1995). This argument has been based on observations that animals experiencing certain deficiencies tend to have heightened responses to nutrients which relieve the particular deficiency.

Little work has been done to show the relationship between nutritional status and response to sweet taste in children. The findings of the sweetness preference test reported in Chapter Four of this thesis are discussed with reference to a similar study done in Mexico. Vazquez et al. (1982) conducted a study to show differences in response to four basic tastes in 113 malnourished children and a normally growing group of 87 children for comparison. The procedure used for testing the children involved brief presentations of the tastant, and this was repeated twice at each of the three levels of the tastant i.e. water, 0.2 Mol, and 0.4 Mol solutions. The children were tested with sweet (sucrose), salty (NaCl), sour (citric acid), and bitter (urea) tastes, but not all the children were tested with each tastant. The malnourished children were recruited from a special day care centre for treatment of children with malnutrition. It was observed that children in the index group were less responsive to sucrose soon after being admitted to the centre than after being under treatment for longer. This tendency was tested in the statistical analysis by dividing the index group into two, those that were tested for sweet preference less than six days after admission, and those that were tested six or more days after admission. The control group was group three. The results of the sweet preference test in the study by Vazquez et al. (1982) showed that in all three groups the intake of water was lowest followed by sucrose solution at 0.2 Mol, and intake was highest for sucrose solution at 0.4 Mol, and this effect was statistically significant. Intake at the three levels was highest for the control group, followed by group two (i.e. index children tested six or more days after admission) and as expected intake was lowest for group one, and the group difference was statistically significant. Groups two and three showed similar differential responses to sucrose at the two levels of concentration, i.e. the increase in intake from 0.2 Mol to 0.4 Mol sucrose was similar. The intake of group one however, was comparatively depressed at the two levels of sucrose. The group by tastant effect was nearly significant at the 0.05 level.

Using the same test procedure as above the results obtained in the research reported in this thesis showed a significant effect of dose, i.e. intake for all the children was dependent upon the level of the tastant. However, unlike the results from the Mexican study which showed maximum responsiveness to sucrose solution at 0.4 Mol, intake was highest for the 0.2 Mol sucrose solution for both groups. In fact, intake of the 0.4 Mol sucrose solution was comparable to intake of water. Although both studies show that children, malnourished or not, tend to show preference for a sweetened solution (i.e. 0.2 Mol) over water, when the concentration of sucrose is increased up to 0.4 Mol, preference increases for the Mexican children while it drops for the English children.

One possible explanation for this apparent difference in response to sweet taste between Mexican and English children may be differences in exposure to sugar in their diets. Beauchamp and Moran (1982, 1984) found that preference for sucrose sweetened solutions in two year old American children who had also been tested at birth and at six months of age, depended on whether or not they had regularly been fed sugar water in the interim. The effect of exposure on preference was also found to be specific to the medium in which sucrose was dissolved i.e. when a fruit-flavoured drink was used children with prior exposure to this particular drink drank more of it sweetened with sucrose than plain, while children without any exposure to it drank little of it whether sweetened or not (Beauchamp and Moran, 1984).

In industrialised communities, there is a great variety of commercialised infant food and drinks available on the market, and it is reasonable to expect that a good proportion of children will have been exposed to some commercial drink, and water as a beverage may be a less appealing option than the sweeter, flavoured drinks. In fact, in a group of pre-school and infant school children in Southampton (UK) 72.5% of the pre-school group and 50.0% of the infant school group never drank water according to the 48 hour diaries kept by their parents

(Petter, Hourinhane and Rolles, 1995). It is likely that being more accustomed to drinking flavoured drinks than water the English children's response to sucrose would be different if tested with a fruit drink as the medium.

Another possibility is that parental attitudes to sugar and sweet food in industrialised communities mean that they tend to cut down on the amount of sweet foods in their child's diet (McCann et al., 1994). This may consequently shape the children's responses to sweet. There are many other differences in diet according to cultural differences and geographical location, and any of them may contribute to the differences in response to sweet taste. More research is needed into the reasons why preference for sucrose differs in different groups of children.

Using the same statistical tool as Vazquez et al. (1982) i.e. the analysis of variance, the 'group by dose' effect was not statistically significant at the 0.05 level. Vazquez et al. show that within the malnourished group, there may be sub-groups according to how long they have been under treatment. The responses of the group who have been under intervention for a longer period of time to sucrose was much closer to that of the well nourished group. This suggests that the degree of malnutrition is related to the children's responses to sucrose, and a more systematic categorisation of children according to nutritional status may lead to clearer results. The exact relationship between under-nutrition and depressed responses to sweet taste could be demonstrated in a research procedure involving children categorised for degree of under-nutrition and a well-nourished control group.

6.5 Caloric compensation, meal-time behaviour and energy intake

Caloric compensation is a behavioural mechanism involved in the regulation of energy intake (Birch and Deysher, 1986). Behavioural implies some voluntary act on the part of the organism involved, and eating is such an act. The concept of caloric compensation thus reconciles the voluntary behaviour involved in food energy intake and the physiological mechanisms of hunger and satiation which lead the organism to eat, so that the two systems in interaction control energy intake.

In young children this mechanism operates quite efficiently, but adults show less precise caloric compensation (Birch and Deysher, 1986). Birch and Deysher (1986) argued that this difference may arise from the adults being more externally rather than internally responsive to food. Because adults have had repeated experience with food, they may have certain cognitions and expectancies regarding the caloric density and satiety value of familiar food which override their basic responses to caloric density. Children on the other hand have much less experience with food and eating, and are only beginning to form such expectancies, which allows them to be more responsive to internal physiological cues.

Studies of formula fed infants suggest that at a few weeks of age they do control energy intake precisely. Fomon et al. (1969) compared the intake of male infants fed two formulas which were similar except for the water content. One provided 0.67 kcal/ml, and the other provided 1.33 kcal/ml. The infants fed the more concentrated formula took in less milk, which shows that the energy intake of the infants was controlled. Fomon et al. (1976) also compared the intake of two formulas, one in which 29% of the calories were presented as fat and 62% as carbohydrates, and another with 57% of the calories presented as fat and 34% as carbohydrates. The energy intake of infants fed on the two formulas was the same. These results suggest that it is energy, rather than a precise macro-nutrient, that infants are regulating (Drewett, 1993). The infants studied by Fomon et al. only showed partial caloric compensation in the early weeks of life, but compensated fully by six weeks of age. Drewett (1993) proposed that this change is likely to be a result of the infant developing a system for monitoring its energy intake, and that this system is relatively independent of gastric emptying mechanisms.

According to Birch (1987) children's exposure to and experience with food is partly determined by social and cultural constraints on food and eating. This means that as children grow into adults and begin to adopt the socialised norms related to food and eating, they begin to rely more and more on external signals rather than the internal cues, and so what is the appropriate time and type of food to eat becomes more important than how hungry or satiated one actually is. As adults begin to control their behavioural responses to hunger their internal mechanisms are also somehow altered. These alterations in self-regulation mechanisms of intake seem to occur to a greater extent in adult females with greater body mass, than in lean males for instance (Blundell et al, 1993).

Adult cognitive restraint of their own eating has been associated with control over their children's intake (McCann et al., 1994), and increased parental control is associated with reduced ability of the child to self-regulate intake. Johnson and Birch (1994) demonstrated that the more control the parents exerted on their children's eating, the less the children's ability to compensate for calories.

The research reviewed on caloric compensation in young children shows that the children studied so far have been aged two years and above (Birch and Deysher, 1986; Birch et al., 1991; Birch et al., 1993; Johnson and Birch, 1994; Anderson, 1995). Furthermore, these studies have been conducted in a pre-school, laboratory context away from the child's home (Birch and Deysher, 1986; Birch et al., 1991; Birch et al., 1993; Johnson and Birch, 1994). The study reported in this thesis is the first study of caloric compensation in children aged one to two years old, and is probably the first in which caloric compensation has been shown in the home rather than a laboratory based study. The result of the study would therefore, be important even in the absence of the FTT group, as it shows that caloric compensation is quite precise even when the child is partly fed by the mother.

Although no studies have so far been done to compare caloric compensation in normally growing children and children with FTT, it has been suggested that weight status in children is correlated with their ability to compensate for calories (Johnson and Birch, 1994). According to the study by Johnson and Birch, those children that showed poorer caloric compensation were significantly fatter than the other children in the group, i.e. the greater the body mass and fat deposits the poorer the ability to compensate for calories.

The study reported in this thesis showed that the Control group showed better ability to compensate for calories than the Cases, although in both groups some children did and some did not show precise caloric compensation. The Cases as a group showed a trend in the direction opposite to compensation. These results from the test for caloric compensation are supported by the trends of the behaviour observed during the feeding sessions. The feeding related behaviours indicated that the Control group in general had more feeding activity on the occasion during which no calories were given in the pre-load. In particular, the control group fed themselves (i.e. 'Feedself' or raising food/drink up into their mouth) more on the no-calorie than on the high-calorie pre-load occasion, while the reverse was true for the FTT group, leading to a significant group difference on the no-calorie pre-load occasion. This was the case for 'P.fdself' (proportion of feedself, as opposed to being fed by the parent) as well. The difference in the difference i.e. the difference between groups in the difference across meals within each child, were statistically significant for 'Feedself' ($p<0.01$) and 'P.fdself' ($p=0.02$). The observed amount of 'Turndown' (i.e. number of times food was refused or rejected) for the Control group was lower on the no-calorie than on the high-calorie pre-load occasion, while for the FTT group the reverse was the case. The difference in 'Turndown' between groups was statistically significant on the no-calorie pre-load day, but the difference in the difference was not statistically significant.

In general the observations showed a tendency for the Controls to eat more and turndown food less on the no-calorie than on the high-calorie pre-load occasion, which is consistent with caloric compensation. The Cases on the other hand, tended to eat more at the meal following the high-calorie pre-load. This negative trend is also evident from the energy intake data and is quite contrary to caloric compensation.

Parental behaviour during feeding is consistent with the children's behaviour for both groups. The 'Hand' behaviour, which stands for the parent placing some food in the child's hand occurred in most cases when the child seemed to slow down in their own effort to eat, and so is related to their efforts in encouraging the child to eat. The Mann-Whitney U-test showed that on both occasions the Cases had a higher mean rank for 'Hand' than the Controls. The mean rank for the Cases was 29.63 on the no-calorie pre-load occasion and 31.80 on the high-calorie pre-load occasion, while for the Controls it was 23.12 on the former and 20.78 on the latter occasion. The group difference was statistically significant for the no-calorie occasion. The mean ranks for the Cases are greater on the high-calorie pre-load occasion than the no-calorie pre-load occasion and the reverse is true for the Controls. Although these within group differences are not statistically significant they follow a similar trend as does 'Feedself', 'Turndown', and 'P.tdown' discussed above, which is consistent with compensation in the Controls but not the Cases. Specifically, more 'Hand' acts are associated with the meal at which a high-calorie load was given in Cases, which suggests that the parents in this group made more effort to feed their children on this occasion.

If it were the case that from birth the parent adopted this feeding strategy of trying to get the child to eat more when they were not particularly hungry, the child may get accustomed to the parent controlling their intake. Therefore, a pattern may emerge in their meal-time interactions in which the parent gained more and more control over the child's intake, and consequently the child's own self-regulating mechanisms would suffer. Hutcheson et al. (1993) found that the mothers of toddlers with FTT were more hostile, intrusive and less flexible than mothers of infants with FTT, but there were no significant differences with control mothers of toddlers. And so they proposed that mothers of children with non-organic FTT may find it difficult to handle the increasing demands for autonomy during feeding in toddlers. Such controlling feeding strategies may also lead to the child developing negative dispositions associated to meal-times. FTT children have been found to have higher proportions of negative affect in feeding situations than normally growing children (Polan et al., 1991).

There is, however, also the possibility that children with non-organic FTT have from very early in life got a poor appetite and their parents are merely responding to this rather than bringing it about. The analysis of the growth data revealed that although at birth the Cases and Controls were not significantly different in weight, differences were clearly observed by the age of about six weeks. This fall in weight gain in the Cases continued until they were diagnosed for FTT which in most cases was at about six months of age. The steady fall in weight gain observed from about six weeks of age, and in some cases right from birth, may reflect poor appetite and perhaps some anomalies in the specific mechanisms of energy intake control. Indeed the apparent fall in weight gain observable from birth may imply some inborn pre-disposing factors.

Properly controlled research in energy intake in children with non-organic FTT is still in very early stages, and as such there is a lot of room for research into the control of hunger and satiation in this group of children. Further research is needed to show consistency in findings relating to the intake of children with FTT as compared to normally growing controls. It must also be shown consistently that self-regulatory mechanisms of intake such as caloric compensation, do not operate in the same way in children with non-organic FTT as they do in normally growing children as is provisionally shown in this thesis; further research is also needed into the reasons why. Controlled behavioural observation of meal-times in families with failure to thrive children and normal growth controls will help illuminate the behaviours of both parents and children that are specifically related to failure to thrive. Although a number of such studies have already been done, much more work is needed to show conclusively that any particular behavioural disposition is characteristic of failure to thrive.

6.6 Conclusions

The investigations conducted to ascertain whether children with non-organic FTT are any different from a similar group of normally growing children have yielded some important findings though they must be regarded as provisional until they are replicated. The main conclusions drawn from this research are as follows:

1. Children in the age group of one to two years prefer 0.2 Mol sucrose to water, but not 0.4 Mol to 0.2 Mol sucrose or water.

2. FTT children are no different from Controls in this.

3. Feeding behaviour can be described with reasonable reliability in children in this age group. There are two types of feeding at the same time - self feeding and feeding by parent. Both of these have been observed reliably.

4. Measured at the meals, there are differences in energy intake between FTT children and Controls. FTT children have significantly lower intake than the Controls.

5. There are also differences in behaviour at meal-times. Given a meal at which no prior energy-load is received, FTT children show less self feeding behaviour, and turn down food more than the Control group. They also show a lower proportion of feeding themselves to being fed by their parents. There is a difference in parent feeding of FTT children and Controls. FTT parents have a higher count of handing their children food than Control parents.

6. FTT children are different from Controls in the way they compensate for calories at meals. For each 1 kcal of pre-load the Controls' intake of a subsequent meal is reduced by 1.18 kcal. The intake of FTT children is increased by 0.81 kcal, showing the opposite of caloric compensation.

7. Analysis of growth data shows that using Thrive Index failure to thrive in the sample studied in this research is apparent from birth.

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APPENDIX ONE

Letter sent to parents of children identified for possible inclusion in the control group

Address for Correspondence
The Parkin Service
Shieldfield Health Centre
Stoddart Street
Newcastle upon Tyne
NE2 1AN ☎0191 2610789

Date as postmark

Dear parent

RE: RESEARCH ON APPETITE IN CHILDREN AGED 1-2

I am a dietician working on feeding and feeding problems in young children. Currently I am involved in research on normal families working in partnership with Mambwe Kasese-Hara. We would like to come and talk to you about this research and see if you would like to take part. If it is convenient could you please return the slip below in the envelope provided stating whether you wish to take part. If we have not heard from you in the next few days we may call on you to discuss this in person.

Yours sincerely,

J Loughridge (Mrs.)	M Kasese-Hara (Mrs.)	Charlotte Wright (Dr)
Dietician	Health Researcher	Project supervisor
Parkin Service	University of Durham	Dept. of Community Child Health
		University of Newcastle

✂ ____

I * DO/DO NOT wish to be involved in the research on "Appetite in children"

* delete as required

Name ____

Signature ______________________________ Date: __________________

Address ____

Post Code ______________________________ ☎ __________________

Please give an indication of which days and at what time it is most convenient for us to call

APPENDIX TWO

Randomisation order of high-calorie and no-calorie pre-loads for all children

STUDY TITLE: EFFECT OF A CALORIE LOAD IN CHILDREN

Study Code: RVI/CT/0794/724

Patient Number (Control)	Trial Number	Patient Number (Cases)	Trial Number
1	1	1	2
2	2	2	2
3	1	3	1
4	2	4	1
5	2	5	1
6	1	6	1
7	2	7	2
8	1	8	2
9	1	9	1
10	1	10	2
11	2	11	2
12	2	12	1
13	2	13	1
14	2	14	2
15	1	15	1
16	1	16	2
17	2	17	2
18	2	18	2
19	1	19	1
20	1	20	1
21	2	21	1
22	1	22	2
23	1	23	1
24	2	24	2
25	1	25	1
26	2	26	2
27	1	27	1
28	2	28	2

NOTES:

Treatment randomisation for the Patient group (Cases)

Trial number 1 = Drink containing 96 kcal in 150 ml taken first.
Trial number 2 = Drink containing 0 kcal in 150 ml taken first.

Treatment randomisation for the Control group

Trial number 1 = Drink containing 0 kcal in 150 ml taken first.
Trial number 2 = Drink containing 96 kcal in 150 ml taken first.

NB - If 'zero calorie' drink is taken first then drink containing 96 kcal in 150 ml is taken second and vice versa.

APPENDIX THREE

The Parkin Service Assessment: Parents' questionnaire to assess child diet and feeding history

THE PARKIN SERVICE ASSESSMENT

DOB:________________ IDENTITY NO:________________

ADDRESS:____

____________________________ ☎ __________________

HV:________________ BASE:________________ ☎ __________

GP:____

MOTHER'S NAME:__________________________ AGE:________

FATHER'S NAME:__________________________ AGE:________

SIBS
NAME:______________________ DOB:________________

NAME:______________________ DOB:________________

NAME:______________________ DOB:________________

ETHNIC ORIGIN?

FIRST LANGUAGE OF PRINCIPLE CARER?

DATE OF ASSESSMENT:______________

WHERE ASSESSED: HOME ☐ CLINIC ☐ OTHER ☐ PLEASE TICK ✓

PLEASE GIVE THE LATEST WEIGHT OF CHILD - OBTAINED WITHIN LAST MONTH

DATE:______________ WEIGHT:______________ KG

Have the family got any concerns about their child? Describe any particular events in his/her health from pregnancy onwards. (Continue on a separate sheet if necessary).

FEEDING

Was the child ever breastfed? Yes ☐ No ☐ Till what age?________

At what age were they given: solids___________ Finger foods_________

As a baby did he/she have any trouble with any of the following:

sucking	Yes ☐	No ☐
swallowing	Yes ☐	No ☐
chewing	Yes ☐	No ☐

Where does he/she mainly eat?

High chair ☐ Small table ☐ Dining table ☐

Sofa ☐ Floor ☐ Walking around ☐ PLEASE TICK ✓

Does he/she eat anywhere else?_________________________________

How does he/she usually feed him/herself? Spoon ☐ Finger ☐

	Every Day	Most Days	Some Days	Never
Does Mum enjoy child's meal times?	☐	☐	☐	☐
Does child enjoy meal times?	☐	☐	☐	☐
Is child enjoy hungry/ready for meals?	☐	☐	☐	☐
Does child eat everything on plate?	☐	☐	☐	☐

PLEAS TICK MOST APPLICABLE ANSWER FOR EACH QUESTION

Are you happy with the sort of foods your child eats? Yes ☐ No ☐

What sort of extra foods would you like your child to be eating?

<u>Describe a typical day:</u>

Do you have a regular routine? Yes ☐ Mostly ☐ Rarely ☐ Never ☐

What time does the child normally wake up?

When is **<u>breakfast</u>**?

Eaten with whom? Alone ☐ + Sibs ☐ +Mum ☐ +Dad ☐ Other ☐

What sort of food is eaten?

<u>Lunch</u> When does he/she eat this meal?

Eaten with whom? Alone ☐ + Sibs ☐ +Mum ☐ +Dad ☐ Other ☐

What sort of food is eaten?

<u>Tea</u> When does he/she eat this meal?

Eaten with whom? Alone ☐ + Sibs ☐ +Mum ☐ +Dad ☐ Other ☐

What sort of food is eaten?

<u>Snacks</u> What else does he/she eat in the day?

<u>Time</u> <u>What eaten</u>

Regular times? Yes ☐ No ☐ Fixed number Yes ☐ No ☐

<u>Drinks</u> What drinks does he/she normally drink in the day, **When and how much?**

What does he/she drink from in the day? Bottle☐ Feeding beaker☐ Cup/glass☐

SLEEP

What time does he/she go to bed?

Does he/she sleep at any time in the day? Yes ☐ No ☐

How much does he/she drink overnight?

What does he/she drink from at night? Bottle☐ Feeding beaker☐ Cup/glass☐

BEHAVIOUR AND DEVELOPMENT

Any behaviour problems related to food and eating?

Any other?

Does he/she appear to be developing normally?

I now need to ask a few questions to fill in the background details about your child.

MEDICAL HISTORY

Was he/she born normally?

Is he/she a healthy child?

Are there any medical worries about him/her?

Are there any illnesses in any other family members?

Do parents or HV feel a paediatric chek-up would be helpful?

Yes ☐ No ☐ Maybe ☐

FAMILY HISTORY

Is either parent in work? Yes ☐ No ☐

Do parents own their own home? Yes ☐ No ☐

Do parents have their own car? Yes ☐ No ☐

Are there any major social or financial problems in the family?

Do you want the Dietician to become involved? Yes ☐ No ☐ PLEASE TICK✓

If YES

- please complete the section below
- ask the family to complete the three day food diary
- return the assessment document and food diary to the Parkin Service
- the dietician will then contact you as soon as possible

FAMILY

Who acts as the main carer for this child?

Who offers and plans his/her meals?

Are there any other regular carers?

What support does the family have in general?

COOKING

Does main carer like cooking? very much ☐ a little ☐ dislikes ☐ can't cook ☐

How often does main carer cook? a lot ☐ a little ☐not at all ☐ can't cook ☐

What sort of food is cooked?

SHOPPING

Where, when and how does the family shop for food?

Cornershop:	Supermarket:
daily/twice weekly/fortnightly	daily/twice weekly/fortnightly
on foot/car/bus/taxi	on foot/car/taxi

DIETARY ASSESSMENT
to be completed by family before contact with Dietician

NAME OF CHILD________________________________DATE________

Please record everything that is eaten and drunk for the next 3 days

Try to:

- describe the food in detail and how it was cooked i.e. fried, grilled, boiled
- record the quantities offered **and how much was actually eaten**
- include any snacks eaten between meals i.e. sweets, crisps, biscuits etc.
- record the amount of milk, juice etc. drunk during the day
- record the amount of sugar added to cereals, puddings, drinks etc.
- record the amount of margarine, butter, low fat spread etc. used.

Day 1	Food and Drink	Amount
Breakfast: Time?		
In-betweens: Time?		
Lunch: Time?		
In-betweens: Time?		
Tea: Time?		
Bedtime Snacks?		

Day 2	Food and Drink	Amount
Breakfast: Time?		
In-betweens: Time?		
Lunch: Time?		
In-betweens: Time?		
Tea: Time?		
Bedtime Snacks?		

Day 3	Food and Drink	Amount
Breakfast: Time?		
In-betweens: Time?		
Lunch: Time?		
In-betweens: Time?		
Tea: Time?		
Bedtime Snacks?		

Food item eaten at least: When marked with * please tick appropriate answer	Daily	Week ly	less	likes but never given	Never tried
Baby food: jars, tins, packets					
Breakfast cereals *sweetened? Yes/No*					
Bread, chapatis, roti *white.wholemeal*					
'Butter' *butter/margarine/low fat spread/other*					
Jam and other sweet spreads, peanut butter					
Sausages, beefburgers, pies, pasties, sausage rolls					
Roast, fried, or grilled meat; cold meats					
Stewed mince, casseroled or braised meat, meat curries					
Tinned fish (e.g. tuna), steamed or boiled fish					
Fried fish, fish fingers					
Cheese					
Eggs					
Soup *tinned/home made*					
Chips/roast potatoes/fried potatoes/waffles/alphabets etc					
Other potatoes					
Pizza					
Boiled pasta or rice					
Tinned spagetti and other pasta shapes, pot noodles					
Baked beans, pulses, lentils, dahl					
Root and green vegetables, vegetable curries					
Salad vegetables					
Puddings					
Yoghurt, fromage frais					
Puddings: rice pudding, sponge pudding, crumble					
Ice-cream					
Fresh fruit					
Biscuits *chocolate/cream/plain/savoury*					
Cakes					
Crisps and other savoury snacks					
Chocolate and sweets					
Milk *whole/semi-skimmed/skimmed/formula					
Pop/squash sugar-free? Yes/No*					
Fresh fruit juice					
Tea/coffee					
Hot chocolate / chocolate milk					
Other foods or drink not mentioned above					

APPENDIX FOUR

Further notes on behavioural coding

Further notes on behavioural coding

Drinking:
Use appropriate method code for beginning drinking ('cup/feeder' or 'bottle')
REMEMBER TO USE 'FEEDSELF', 'GIVE' etc. WHEN CODING DRINKING.

'Release':
Use this code when child has finished drinking from cup/bottle when they have removed cup from mouth unassisted by parent. Use 'take off' if the mother removes the cup/bottle.

'Refusals':
Sometimes ambiguous (e.g. when infant keeps mouth shut on being offered food but does not turn head away etc.). Code as 'refuse' unless infant has clearly not notices the spoon. If infant has not noticed the spoon before it is withdrawn code as 'retract'.

Problem in coding when parent is feeding child and child is also feeding self at the same time especially because different types of substances and methods may be involved. In this case continue coding main activity, unless there clearly is a change.

'Accept' must always be preceded by 'give' and never by 'hand'.

Avoid rewinding video tape when coding to avoid making the timing on the computer inaccurate.

Remember to enter 'sweet' code when parent switches from savoury to sweet. (NB difficult for a few infants who are given sweet and savoury simultaneously).

APPENDIX FIVE

Example of a behavioural coding output file

Behavioural coding output for subject number four (4) (File name: Spos2.obs)

```
= = = 14: 8:52:50 23:11:1995
4 * p 14: 9:18:65 23:11:1995
4 * x 14: 9:19:64 23:11:1995
4 * f 14: 9:21:34 23:11:1995
4 * f 14: 9:28:76 23:11:1995
4 * f 14:10:26: 5 23:11:1995
4 * f 14:11:15:98 23:11:1995
4 * f 14:11:33:89 23:11:1995
4 * f 14:12:22:62 23:11:1995
4 * f 14:12:50:47 23:11:1995
4 * f 14:12:55:79 23:11:1995
4 * f 14:14:28:63 23:11:1995
4 * f 14:14:56:92 23:11:1995
4 * j 14:15:15:98 23:11:1995
4 * f 14:16:18:22 23:11:1995
4 * f 14:16:49:31 23:11:1995
4 * a 14:18:49:88 23:11:1995
4 * h 14:18:52:14 23:11:1995
4 * f 14:21:54:56 23:11:1995
4 * g 14:21:54:84 23:11:1995
4 * f 14:22: 3: 2 23:11:1995
4 * f 14:22: 8: 2 23:11:1995
4 * f 14:22:15:82 23:11:1995
4 * f 14:22:36:15 23:11:1995
4 * f 14:22:51:47 23:11:1995
4 * f 14:23:52:45 23:11:1995
4 * f 14:25: 1:77 23:11:1995
4 * f 14:25:17:92 23:11:1995
4 * i 14:26: 0:71 23:11:1995
4 * w 14:26: 1:43 23:11:1995
4 * f 14:26: 2:36 23:11:1995
4 * k 14:26: 4:72 23:11:1995
4 * f 14:26: 8:51 23:11:1995
4 * k 14:26:16:86 23:11:1995
4 * p 14:27:29:26 23:11:1995
4 * x 14:27:30:25 23:11:1995
4 * f 14:27:31:62 23:11:1995
4 * j 14:27:45:47 23:11:1995
4 * f 14:28: 3:48 23:11:1995
4 * a 14:28:26:83 23:11:1995
4 * h 14:28:29:63 23:11:1995
4 * a 14:29:46:37 23:11:1995
4 * h 14:29:48:18 23:11:1995
4 * i 14:30: 2:80 23:11:1995
4 * w 14:30: 3:51 23:11:1995
4 * f 14:30: 5: 5 23:11:1995
4 * k 14:30: 8:29 23:11:1995
4 * f 14:30:12:96 23:11:1995
4 * k 14:30:18:56 23:11:1995
4 * p 14:30:24:60 23:11:1995
4 * x 14:30:25:32 23:11:1995
4 * f 14:30:26:86 23:11:1995
```

4 * f 14:32: 9:91 23:11:1995
4 * f 14:32:55:72 23:11:1995
4 * j 14:33: 0:72 23:11:1995
4 * i 14:33:22:97 23:11:1995
4 * w 14:33:23:96 23:11:1995
4 * f 14:33:24:73 23:11:1995
4 * k 14:33:26:37 23:11:1995
4 * p 14:35:22:11 23:11:1995
4 * x 14:35:22:77 23:11:1995
4 * a 14:35:25:46 23:11:1995
4 * h 14:35:26:73 23:11:1995
4 * f 14:35:57: 0 23:11:1995
4 * f 14:36: 9:58 23:11:1995
4 * g 14:36: 9:96 23:11:1995
4 * f 14:37:22:91 23:11:1995
4 * s 14:37:49:72 23:11:1995
4 * f 14:38:21:19 23:11:1995
4 * f 14:38:26:68 23:11:1995
4 * f 14:38:34:43 23:11:1995
4 * f 14:38:55:74 23:11:1995
4 * f 14:39: 6:35 23:11:1995
4 * i 14:39:48:20 23:11:1995
4 * w 14:39:49:36 23:11:1995
4 * f 14:39:50:18 23:11:1995
4 * k 14:39:54:41 23:11:1995
4 * f 14:40: 7:48 23:11:1995
4 * k 14:40:14:84 23:11:1995
4 * o 14:42:11: 3 23:11:1995
4 * c 14:42:12: 1 23:11:1995
4 * a 14:42:21:79 23:11:1995
4 * l 14:42:23:11 23:11:1995
4 * a 14:42:25: 3 23:11:1995
4 * l 14:42:27: 1 23:11:1995
4 * a 14:42:30:91 23:11:1995
4 * l 14:42:31:73 23:11:1995
4 * a 14:42:35:25 23:11:1995
4 * h 14:42:36:62 23:11:1995
4 * a 14:42:44:26 23:11:1995
4 * h 14:42:44:75 23:11:1995
4 * a 14:42:49:59 23:11:1995
4 * l 14:42:50:80 23:11:1995
4 * a 14:42:55:57 23:11:1995
4 * l 14:42:57:22 23:11:1995
4 * a 14:43: 0:90 23:11:1995
4 * h 14:43: 2:77 23:11:1995
4 * a 14:43:16:28 23:11:1995
4 * l 14:43:16:94 23:11:1995
4 * a 14:43:25:62 23:11:1995
4 * l 14:43:26:72 23:11:1995
4 * a 14:43:30:90 23:11:1995
4 * l 14:43:33:97 23:11:1995
4 * a 14:43:38:81 23:11:1995
4 * l 14:43:40:12 23:11:1995
4 * a 14:43:45:45 23:11:1995
4 * l 14:43:47:49 23:11:1995
4 * a 14:43:50:95 23:11:1995
4 * l 14:43:52:54 23:11:1995
4 * a 14:44: 0:61 23:11:1995

4 * h 14:44: 5: 6 23:11:1995
4 * a 14:44:10:89 23:11:1995
4 * l 14:44:11:55 23:11:1995
4 * a 14:44:15:23 23:11:1995
4 * l 14:44:15:88 23:11:1995
4 * a 14:44:33:19 23:11:1995
4 * l 14:44:36:43 23:11:1995
4 * a 14:44:46:65 23:11:1995
4 * h 14:44:47:47 23:11:1995
4 * a 14:44:50:27 23:11:1995
4 * l 14:44:51:21 23:11:1995
4 * a 14:44:57:19 23:11:1995
4 * l 14:44:58:57 23:11:1995
4 * a 14:45: 1:97 23:11:1995
4 * h 14:45: 8:23 23:11:1995
4 * a 14:45:15:16 23:11:1995
4 * l 14:45:15:98 23:11:1995
4 * a 14:45:19:44 23:11:1995
4 * l 14:45:21:47 23:11:1995
4 * a 14:45:25:37 23:11:1995
4 * l 14:45:29:88 23:11:1995
4 * a 14:45:43:72 23:11:1995
4 * l 14:45:46:85 23:11:1995
4 * a 14:45:53:44 23:11:1995
4 * l 14:45:56: 8 23:11:1995
4 * j 14:46: 1:35 23:11:1995
4 * a 14:46: 8:82 23:11:1995
4 * h 14:46: 9:48 23:11:1995
4 * a 14:46:15:53 23:11:1995
4 * h 14:46:17:72 23:11:1995
4 * a 14:46:25:96 23:11:1995
4 * l 14:46:26:95 23:11:1995
4 * a 14:46:38: 5 23:11:1995
4 * l 14:46:39:70 23:11:1995
4 * a 14:47: 2:88 23:11:1995
4 * h 14:47: 7:44 23:11:1995
4 * a 14:47:23:92 23:11:1995
4 * h 14:47:24:58 23:11:1995
4 * a 14:47:39:46 23:11:1995
4 * h 14:47:41:22 23:11:1995
4 * a 14:47:50: 1 23:11:1995
4 * h 14:47:51:11 23:11:1995
4 * a 14:47:56: 5 23:11:1995
4 * h 14:47:56:93 23:11:1995
4 * a 14:48:12:48 23:11:1995
4 * h 14:48:14:34 23:11:1995
4 * a 14:48:24:45 23:11:1995
4 * h 14:48:25:38 23:11:1995
4 * a 14:48:57:85 23:11:1995
4 * h 14:48:58:95 23:11:1995
4 * a 14:49:18:78 23:11:1995
4 * l 14:49:21: 9 23:11:1995
4 * a 14:49:34:87 23:11:1995
4 * h 14:49:35:86 23:11:1995
4 * p 14:49:56:74 23:11:1995
4 * x 14:49:58: 0 23:11:1995
4 * f 14:49:58:93 23:11:1995
4 * f 14:50:15: 8 23:11:1995

4 * f 14:50:30:41 23:11:1995
4 * f 14:50:56:45 23:11:1995
4 * f 14:51:14:90 23:11:1995
4 * f 14:51:32:26 23:11:1995
4 * f 14:51:42:26 23:11:1995
4 * f 14:52:13:95 23:11:1995
4 * f 14:52:22: 3 23:11:1995
4 * f 14:52:28:95 23:11:1995
4 * f 14:52:39:61 23:11:1995
4 * f 14:52:53:34 23:11:1995
. . . 14:53:20:97 23:11:1995

APPENDIX SIX

SPSS command file

SPSS COMMAND FILE: 'Marie3.com'

```
TITLE ANALYSIS OF                                          /*this file
                                                           /*marie3.com
SET WIDTH=80
FILE HANDLE r1 / Name 'temp.rl'                            /*
DATA LIST FILE=r1 RECORDS=1
 /1 id 1-2 act 7 (a)  time 10-20 (time) date 23-32 (date)
FORMAT TIME (F11.2)
VARIABLE LABELS  TIME 'TIME OF ACT'
COMPUTE TIMESECS=34023.44                                  /*
COMPUTE TIME        =TIME-TIMESECS

/* print outfile          =r2
/*  /id act time date

COMPUTE PREV  =LAG(TIME,1)
COMPUTE PINT   =TIME-PREV
COMPUTE ACT0  =0
COMPUTE ACT1  =0
COMPUTE ACT2  =0
COMPUTE ACT3  =0
COMPUTE ACT4  =0
COMPUTE ACT5  =0
COMPUTE ACT6  =0
COMPUTE ACT7  =0
COMPUTE ACT8  =0
COMPUTE ACT9  =0
COMPUTE ACT10=0
COMPUTE ACT11=0
COMPUTE ACT12=0
COMPUTE ACT13=0
COMPUTE ACT14=0
COMPUTE ACT15=0
COMPUTE ACT16=0
COMPUTE ACT17=0
COMPUTE ACT18=0
COMPUTE ACT19=0
COMPUTE ACT20=0

RECODE ACT  ('a'=1)  (else=0)  into act0
RECODE ACT  ('s'=1)  (else=0)  into act1
RECODE ACT  ('d'=1)  (else=0)  into act2
RECODE ACT  ('y'=1)  (else=0)  into act3
RECODE ACT  ('f'=1)  (else=0)  into act4
RECODE ACT  ('g'=1)  (else=0)  into act5
RECODE ACT  ('h'=1)  (else=0)  into act6
RECODE ACT  ('j'=1)   (else=0)  into act7
RECODE ACT  ('k'=1)  (else=0)  into act8
RECODE ACT  ('l'=1)   (else=0)  into act9
RECODE ACT  ('n'=1)  (else=0)  into act10
RECODE ACT  ('m'=1)  (else=0)  into act11
RECODE ACT  ('w'=1)  (else=0)  into act12
RECODE ACT  ('r'=1)  (else=0)  into act13
RECODE ACT  ('t'=1)  (else=0) into act14
```

```
RECODE ACT ('x'=1) (else=0) into act15
RECODE ACT ('c'=1) (else=0) into act16
RECODE ACT ('u'=1) (else=0) into act17
RECODE ACT ('i'=1) (else=0) into act18
RECODE ACT ('o'=1) (else=0) into act19
RECODE ACT ('p'=1) (else=0) into act20

VARIABLE LABELS
   ACT0 'GIVE'
   ACT1 'HAND'
   ACT2 'RETRACT'
   ACT3 'TAKE OFF'
   ACT4 'FEEDSELF'
   ACT5 'MISSES'
   ACT6 'REFUSE'
   ACT7 'REJECT'
   ACT8 'RELEASE'
   ACT9 'ACCEPT'
   ACT10 'VISIBLE'
   ACT11 'INVISIBLE'
   ACT12 'JUICE'
   ACT13 'SEMISOLID'
   ACT14 'SOLID'
   ACT15 'SAVOURY'
   ACT16 'SWEET'
   ACT17 'BOTTLE'
   ACT18 'CUP'
   ACT19 'SPOON'
   ACT20 'FINGER'

COMPUTE FEEDACTS=SUM(ACT4,ACT1,ACT0)
COMPUTE TURNDOWN=SUM(ACT6,ACT7)
DESCRIPTIVES VARS=ACT4 ACT1 ACT0 ACT9 ACT6 ACT7 ACT2 ACT3 ACT5 ACT8
  /STATISTICS=SUM
DESCRIPTIVES FEEDACTS TURNDOWN
  /STATISTICS=SUM
DESCRIPTIVES VARS=TIME
  /STATISTICS=MAX MIN
list vars = id act time pint date
execute
finish
```