Cambridge University Press & Assessment
978-0-521-82787-4 — The Nutritional Psychology of Childhood
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Excerpt
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1 Introduction

1.1 Introduction

My aim in this book is to summarise recent research dealing with psychological aspects of nutrition in childhood. Broadly speaking, these psychological aspects involve two kinds of problem – those concerned with the development of behaviour that is related to food intake, and those concerned with the later consequences of malnutrition, or more generally with the later consequences of different types of nutrition. The overall organisation of the book is developmental. I deal in turn with problems that arise before or around the time of birth, with problems associated with infancy and the weaning period, and with problems which are more characteristically associated with later childhood and adolescence. These are the major transitions. Birth is a major transition because although malnutrition can arise before or after birth (and malnutrition in both periods can have effects on the child's development), its causes before and after birth are obviously different: only malnutrition after birth can result from problems with the child's own feeding behaviour, for example. Weaning is a major transition between two quite different kinds of feeding behaviour. Adolescence and the period preceding it involve transitions of a different kind, characterised by changes in the meaning and significance of food and body weight rather than in the nature of eating behaviour and the foods that are eaten. But although the overall organisation of the book is developmental, some departure from this order is necessary, and there cannot, of course, be any strict demarcations between the different stages of life. Important questions about infancy, for example, concern the later effects of early nutritional experiences, and important questions about adolescence concern the early precursors of the eating disorders that characteristically develop over the teenage years. So when we deal with problems in infancy we shall often also be looking forward, and when we deal with later problems we shall often also be looking backwards.

Here is a handful of questions that arise in this area. Does it matter if young infants gain weight very slowly, and if so why? Are infants who gain weight quickly more likely to be too fat as children, or even as adults? Does it matter whether infants are breast-fed or bottle-fed, and if so, in what ways? Does it matter if an infant is born very small? How should an infant born before term be fed? Does the way they are fed affect their subsequent development, and if so, how? How common is iron deficiency in infants? Does it have adverse effects on the child's intellectual development? Do other forms of malnutrition have adverse effects? What should we do about children who are picky eaters? Does it matter that their choice of foods is narrow, and if so why? How can we encourage healthy eating, especially the eating of fruit and vegetables by children? Are some children born to be fat? Are children who are fat more likely to suffer from low self-esteem, or in other ways? Is there an epidemic of obesity in children, and if so why has it arisen and how should we deal with it? Can schools help? How common is dieting in children and adolescents? Which children diet and why? Does dieting put a child at risk of the development of eating disorders? What other characteristics put children at risk of an eating disorder? In what kinds of family are we likely to find a child with an eating disorder, and how can we bring up our children so that they can steer the right course between the Scylla of obesity and the Charybdis of the eating disorders?

Some of these problems are wholly psychological in nature, and some are partly psychological. Health psychology is not very good at keeping within its academic boundaries, and nor, in my view, should it be – the human world was not organised to conform to the academic structures of British universities. They are all practical rather than theoretical problems, and my aim in this book is practical too: it is to offer a somewhat sceptical appraisal of recent research on psychological issues that arise in connection with nutrition in childhood. For reasons which will, I hope, become clear, I have concentrated on areas in which we can call upon a reasonably substantial body of research of reasonably good quality. It is difficult enough to arrive at clear conclusions even in these areas.

Before we embark on our developmental journey, there are some necessary preliminaries to deal with, and they take up the remainder of this chapter (Chapter 1). Chapters 2 and 3 deal with feeding behaviour in infancy, and then with the development of eating in older children. Chapter 4 deals with the growth of infants before birth, and with the nutritional problems of infants born too small, which may reflect malnutrition before birth, or born too soon, which can be associated with nutritional problems after birth. In Chapter 5 we turn to specific nutritional deficiencies, especially iron deficiency and protein-energy malnutrition. Much of the best research on these topics comes out of an interest in the health and welfare of children in less developed countries; perhaps surprisingly, though, both kinds of malnutrition are also quite common in infants and young children in more affluent countries. Chapter 6 deals with physical illnesses or disabilities. This is a big topic, and I have tried to do no more than sample one or two examples that have important nutritional aspects. In Chapter 7 I deal with infants who for no obvious medical reasons gain weight very slowly. Traditionally these are described as infants who 'fail to thrive'. This chapter might seem out of sequence, and it is, but dealing with this calls for some prior knowledge of the issues dealt with in Chapters 5 and 6. Chapter 8 deals with the opposite problem – children whose excessive weight gain puts them on the path to obesity. Finally, in Chapter 9, we consider the development of the major eating disorders of later childhood and adolescence, especially anorexia nervosa and bulimia nervosa. There's nothing much in Chapter 10.

1.2 Growth and development

A particular reason for considering the issues involved in childhood nutrition separately from those involved in adult nutrition is that childhood is the period of growth. When we talk in an everyday sense of a child's growth, we are generally referring to skeletal or *linear* growth, as it is reflected in their height. But every organ system in a child is growing, including their reproductive system and their central nervous system. The growth of all these is dependent on adequate nutrition, so nutrition and malnutrition in infancy and childhood can affect a child's development in ways that it does not in adults.

A useful overall framework for considering linear growth in childhood is provided by the infancy-childhood-puberty (ICP) model (Karlberg, 1987; 1989). This considers a child's growth as made up of three components. The infancy component is continuous with fetal growth (growth before birth), and lasts through the first year. This is a period of very rapid growth. Then follows a period of steady but slower growth, the childhood component, which lasts through to the beginning of puberty. In the pubertal component there is a growth spurt, together with a rapid maturation of secondary sexual characteristics, and skeletal growth then stops with the attainment of adult height. We meet different kinds of psychological problems over these different periods. The special feeding problems associated with nursing and weaning are characteristic of the infancy period. A key milestone in the development of obesity is the 'adiposity rebound' which develops from about 3 years of age, in the childhood period, when many eating habits are also formed. Eating disorders such as anorexia nervosa commonly develop over the pubertal

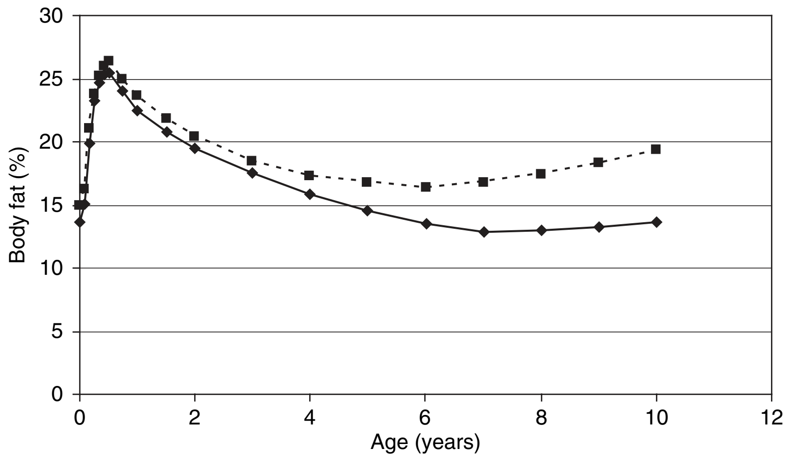

Figure 1.1 Body fat of the 'reference child' at different ages. The data represent the proportion of body fat in an average child at each age, and were derived from a variety of sources by Fomon *et al.* (1982). Males: ♦ Females: ■.

period, and important questions arise concerning their relationship to sexual development and the other somatic changes that occur over puberty.

Unlike the skeletal system, which develops particularly rapidly early in life, much reproductive development is rather late, though critical aspects of reproductive development also occur before birth. Males and females differ initially only in their chromosomes. The female has two large X chromosomes, and the male one large X and a one small Y chromosome. The presence of the Y chromosome leads by about eight weeks after fertilisation to the development of a testis, which begins a few weeks later to secrete the male sex hormone, testosterone. Testosterone leads to sexual differentiation of the body into that characteristic of a male; in its absence a female body develops. One obvious consequence of this process of sexual differentiation is the development of different external and internal genitalia in males and females, but there are other more subtle consequences. Girls mature faster than boys, for example (Tanner, 1989). They reach half their adult height by 1.75 years, compared with 2 years in boys, and they go into puberty earlier. It is principally because puberty is earlier in girls that they tend to be shorter than boys, who continue to grow for longer. As well as skeletal growth, there are important growth-related changes in fat deposition over infancy, childhood and puberty. The general pattern of fat deposition over the first ten years is reported by Fomon *et al.* (1982) and by Fomon and Nelson (2002) and is shown in Figure 1.1. At birth a typical boy's body is about 14% fat but this rapidly increases to about 25% at 6 months. This period of early infancy over which so much fat is stored corresponds to the period of exclusive or largely exclusive milk feeding, during which the mother's lactation provides a store of energy that the infant can call upon as they learn to feed independently. After 6 months body fat slowly declines again to a minimum of about 13% at about 7 years of age, from which point it starts to rise again (this is the 'adiposity rebound'). A generally similar pattern is seen in girls, though there is an important sex difference here too. Girls have stored noticeably more fat by the time they go into puberty.

The growth of the brain takes place principally before birth and in the early childhood period. The weight of the whole body of a child at birth is about 5% of the weight of a young adult's, and at 10 years it is about 50%; but the weight of a child's brain at birth is about 25% of the weight of a young adult's, and at 10 years it is about 95% (Tanner, 1989). Of course different components of the nervous system develop at different times. Neurones in the cerebral cortex, for example, are initially generated between day 42 and about day 138 of embryonic life (Kolb, 1999). They migrate towards their final positions up to about seven months of gestation. The production of axons, dendrites and synapses begins then, but continues after birth. Synaptogenesis mostly takes place after birth (Huttenlocher, 1999). Its exact timing is different in different areas of the brain: in the visual cortex, for example, it takes place largely over the first four months, and in the prefrontal cortex over the first year (Huttenlocher, 1999). In speech-related areas it occurs first in the primary auditory cortex, then in Wernicke's area, which is concerned with receptive language, and then in Broca's area, which is concerned with speech production (Huttenlocher, 1999). One general ground for concern about effects of nutrition early in life on subsequent psychological development lies in the fact that vulnerability to malnutrition may be particularly acute then (both before and after birth) as a result of the very rapid development of the brain.

Although there has been some direct anatomical and physiological work on the effects of malnutrition on the human brain, and extensive work on its effects on the brains of animals of other species, structural and physiological information concerning the effects of malnutrition on the brain can only be interpreted in a way that is of importance in practice if it can be related to functional effects of malnutrition. These functional effects are mostly psychological, and can be examined in a number of different ways. One possibility is to examine effects of malnutrition on particular psychological functions – for example, its effects on perceptual capacities, on different types of memory functions or on anxiety or other emotions. Another is to examine its effects on aspects of the child's development known to be of importance in their future lives. Learning to read, for example, is the foundation of educational success, and it would be important to know whether malnutrition delayed reading development – which it might do through an effect on a variety of basic perceptual or cognitive skills, or, for example, if it leads to absence from school.

In practice, though, much of the available research in this area has involved standardised developmental or intelligence tests. Whether an infant is showing a normal rate of developmental progress can be assessed informally by parents, by monitoring the attainment of different 'milestones' – taking the first step, speaking the first word and so on. In research and other contexts that call for more formal measures a number of tools are available to assess development in infancy in the same general way (Wyly, 1997). The most widely used have been the Bayley Scales of Infant Development, which were initially developed by Nancy Bayley in the 1930s. They were published in a standardised form in 1969 (Bayley, 1969) and in a revised and restandardised form in 1993 (Bayley, 1993). The original version covered the period from 2 to 30 months, and the revised version the period from 1 to 42 months. They assess infant development using a 'mental' scale, which is summarised as a mental development index (MDI), and a 'motor' scale, which is summarised as a psychomotor development index (PDI). Scores on these indices provide a measure of overall developmental progress, tested using a range of tasks that test skills of different kinds at different ages.

Studies that have investigated older children have generally used intelligence (IQ) tests. IQ tests can be used from 4 or 5 years of age, and involve a sample of tasks that reflect intellectual abilities, especially abilities of a kind that are important in an educational context. IQ tests use well-standardised procedures and have high reliability, and when IQ tests (or the standard developmental tests such as the Bayley Scales) have been used in research, it has been relatively easy to compare and combine the results of different studies, which is important in trying to arrive at firm generalisations. In unselected populations IQ tests show reasonably stable correlations with adult IQ from about 8 years of age, and they predict later educational and occupational success, even after other characteristics of the child's family have been taken into account (Fergusson, Horwood & Ridder, 2005; McCall, 1977). There are, however, difficult problems with the use of IQ tests in cultures other than those for which they were first developed (Baddeley, Gardner & Grantham-McGregor, 1995). Apart from language problems, the sample of intellectual skills that are appropriate in a Western educational context may not be appropriate elsewhere. Even in Western cultures, the *validity* of IQ tests is difficult to determine. A striking example of this problem is the remarkable rise in IQ over the last century, documented by Flynn (1987). There is no doubt that there has been a large rise in measured IQ in every country in which we have data, but there is considerable uncertainty about its meaning. We know children have got better at doing IQ tests, but it is much less certain what other intellectual tasks they have got better at.

Early developmental tests such as the Bayley Scales were developed as practical tools for the detection and assessment of delayed development, and some children whose development is delayed also have a relatively low intelligence when they are older, as is typically found in Down syndrome and other forms of learning disability. It does not follow that there is a general correlation between scores on a developmental scale such as the Bayley Scales and later intelligence. Bornstein *et al.* (1997) point out that many of the items on the Mental Scales tested in the first year involve perceptual-motor skills, for example ‘eyes follow rod’, ‘uses eye–hand coordination in reaching’ and ‘picks up cube’ at 4 months, and ‘turns pages of a book’, ‘fingers holes in pegboard’ and ‘builds tower of three cubes’ at 12 months. There is no reason to think that success at these tasks would reflect the sort of intellectual abilities required for success in intelligence tests at later ages, and the extent to which these and similar scales used in infancy actually do predict subsequent intellectual abilities in typically developing children is very limited (Kopp & McCall, 1982). Combining different studies, the median correlation Kopp and McCall found with IQ at 8 to 18 years if the infants were tested between 1 and 6 months was .06; tested from 7 to 12 months it was .25; tested from 13 to 18 months it was .32; and tested from 19 to 30 months it was .49.

Attempts to develop more specific measures of cognitive performance in infancy of a kind that might relate better to later intelligence have had some success. McCall and Carriger (1993), for example, review the relationship between performance on habituation and recognition memory tasks in infancy and later intelligence. Habituation tasks can be carried out from birth, and even before birth. They can use a variety of sensory stimuli; after birth visual stimuli have generally been used. If the same visual stimulus is presented repeatedly the time spent looking at it by the infant decreases over time. Controls involving the presentation of a changed stimulus show that this decrease is not due to tiredness or simple sensory adaptation. It involves, rather, the encoding of the stimulus into memory so that it becomes familiar and no longer attracts attention. A closely related task involves visual recognition memory, in which a pair of standard visual stimuli are presented together over a series of trials, and one of the two is then replaced with a novel stimulus. The higher proportion of time spent looking at the novel stimulus provides a measure of the extent to which the earlier standard stimuli have become familiar, something which again depends on the encoding of the stimulus into memory. McCall and Garriger (1993) summarised the results of a large number of studies of the relationship between habituation or recognition memory in the first year and later intelligence as measured with IQ tests. They found overall correlations of .39 for habituation and .35 for recognition memory studies. These are higher than the correlation found between traditional infant developmental scale scores in the first year and later intelligence. There is, however, also a worryingly high correlation (−.56) reported in this paper between the size of the correlation found in each study and the size of the sample in the study. The reason this is worrying is that a correlation of this kind is typically found when there is a publication bias in favour of larger effect sizes, which are more likely to be statistically significant (Sutton *et al.*, 2000). A publication bias of this kind would mean that the correlations of .39 and .35 could not be taken at face value.

In any case, any correlation between a test given in infancy and a test given later that is less than perfect ($r < 1$) implies that some children are changing their relative position over time – improving or getting worse – and no currently available test carried out in infancy shows a correlation with later intelligence of more than about .4. Children might recover from effects of malnutrition measured early in life, just as they recover from effects of other kinds of early adversity (Clarke & Clarke, 2000). So whether there are tests available in infancy that assess the same cognitive skills as intelligence tests in older children or not, it will always be necessary to examine both short-term and longer-term effects of malnutrition if its implications for the development of children are to be properly understood. There is no substitute for the long-term follow-up of the children involved. It would even be possible in theory for some kinds of adverse effects of early malnutrition only to become apparent for the first time late in life. Malnutrition may reduce structural and functional brain reserves in a way that comes to matter only in old age; and indeed, a number of recent studies do suggest that the time at which the cognitive impairments in the elderly first develop is related to their nutrition early in life (Abbott *et al.*, 1998; Graves *et al.*, 1996). Essentially, then, we need to examine effects over the whole lifespan if we are to know how abilities in later life are affected by malnutrition early in life. We are a long way from being able to do so. The best that is available in most of the areas we shall deal with is follow up into the middle school years.

1.3 Energy balance

All the activities of a child depend upon energy. So too does their growth, in which energy is stored in the tissues of the body. Many of the nutritional problems of children that we shall deal with involve energy balance. The problem of slow weight gain in infancy ('failure to thrive') is principally a problem of insufficient energy intake. Anorexia nervosa is principally an elective energy deficit that leads to weight loss in adults, and to poor growth and failure to gain weight adequately in children. Obesity is principally a problem of energy intake that is not being balanced by a comparable energy expenditure, leading to a storage of fat.

Energy is not an altogether straightforward concept. In its standard physical sense, it is the capacity to do work. But the term 'energy' is also used in a more figurative sense, in which it refers to the temporary or more lasting motivational characteristics of individuals, and it is important not to confuse the physical and motivation senses of the term. The decimal system of units currently used internationally in scientific work is the SI system, and in the SI system the unit of energy is the joule (J). So in nutritional research measurements of energy are now usually expressed as kilojoules (kJ) or megajoules (MJ). A megajoule is about as much energy as a croissant provides. A child 4 years old consumes and expends in the region of 5 MJ in a day (Davies *et al.*, 1994). In everyday nutritional contexts, however, the *calorie* is still widely used as the unit of energy. People on diets, for example, generally talk about 'counting calories'. A nutritional calorie is 4.184 kJ (slight differences in this value reflect the fact that the calorie can take five slightly different values). The use of calories in this area is hallowed by a long tradition, which predated our understanding of the interchangeability of heat and mechanical energy. But the use of a single decimal unit of energy must be simpler once we have got used to it, so in the interests of our children I have generally used joules as the appropriate unit for energy in this book, in accordance with the SI system. I hope this will not cause undue difficulty for grown-ups.

Energy consumed as food by a child can either be stored in body tissues as part of the growth process, or it can be utilised. The energy required for growth in infancy is quite small. According to one recent calculation (Butte, 1996) infant girls store on average 0.740 MJ (177 kcal) a day in the second month of life; this reduces rapidly to 0.150 MJ (36 kcal) a day from 9 months to 1 year. The figures are similar in boys but slightly higher, reflecting their faster growth. Soon after birth the growth of the child uses up about 40% of the energy they take in; at about a year this is reduced to about 5%. Very small amounts of energy are needed

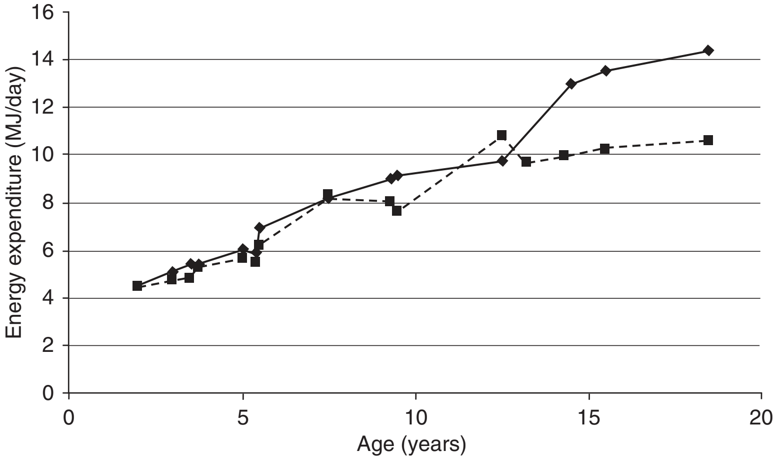

Figure 1.2 Energy expenditure of children of different ages. The data were derived from a variety of sources summarised in Torun *et al.* (1996). Males: ♦ Females: ■.

for growth thereafter. The utilisation of energy involves oxidative metabolism, in which oxygen is converted to carbon dioxide. This allows energy expenditure to be assessed via measurement of the extent of carbon dioxide production. There are a number of ways in which this can be done, which involve varying degrees of interference with normal behaviour. The one that interferes least is the doubly labelled water method. In this a small amount of water is drunk, labelled with two stable isotopes, deuterium ($^2H_2$) and oxygen-18 (^{18}O). The labelled oxygen is used in the production of both carbon dioxide (CO_2) and of water (H_2O), but the labelled hydrogen is used only for the production of water. So the difference in the rate at which the two isotopes disappear provides a measure of oxidative metabolism which very accurately reflects energy expenditure over extended periods of time (Prentice, 2002). This recently developed method has no known adverse effects, and has allowed the measurement of energy expenditure in children from birth (Davies *et al.*, 1994; Wells *et al.*, 1997; Wells & Davies, 1996). Energy expenditure in infancy has been measured in a longitudinal study by de Bruin *et al.* (1998). At 1 month of age average energy expenditure in girls in a day was 1.19 MJ. It rose to 1.78 MJ at 4 months, 2.56 MJ at 8 months and 3.08 MJ at a year. In boys these figures were 10–25% higher. Data summarising later energy expenditure up to the age of 19 are summarised in Turun *et al.* (1996) and are shown graphically in Figure 1.2.