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PUBLISHER

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VERSION

AM (Accepted Manuscript)

PUBLISHER STATEMENT

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Powell, Faye, Claire V. Farrow, Emma Haycraft, and Caroline Meyer. 2019. "Appetite Regulation in Early Childhood: The Impact of Parenting Behaviours and Child Temperament". figshare. <https://hdl.handle.net/2134/17055>.

Appetite regulation in early childhood: The impact of parenting behaviours and child temperament

Faye Powell, BSc., Claire Farrow, Ph.D., Emma Haycraft, Ph.D., & Caroline Meyer,
Ph.D.

Loughborough Centre for Research into Eating Disorders, School of Sport, Exercise & Health Sciences,
Loughborough University, UK.

Abstract

The ability to appropriately regulate appetite appears to be intrinsic from birth. However as children develop and become socialised, problems with the control and regulation of appetite are commonplace, as evidenced by the high prevalence of overweight and obesity in later childhood and adulthood. This chapter explores different theories of appetite regulation and discusses the various eating behaviour traits which have been identified during early childhood. Although there are several aspects of parenting behaviour that may contribute to a child's appetite regulation, or lack of regulation, this chapter focuses on the impact of the feeding practices that parents employ, and the feeding environment that parents provide when parenting their children, in influencing children's eating behaviours, appetite and weight. This chapter also explores the literature on child temperament and its contribution to eating behaviour and appetite regulation. Although the literatures on parenting influence and child temperament have been poorly integrated in relation to early child eating, some speculative suggestions are made about how these two aspects of behaviour may interact together to influence the regulation and control of appetite in young children.

Introduction

Appetite regulation is part of a feedback system that controls an individual's energy balance. It involves a complex interplay of hunger and satiety signals modulated by appetite centres in the hypothalamus and brain stem, and hormonal signals of energy status released by the gut and the periphery (Druce & Bloom, 2006). Appetite influences energy balance and weight regulation through its effect on energy intake (Finlayson, Halford, King & Blundell, 2007) as it affects frequency, volume, choice and termination of eating episodes. The worsening global obesity epidemic has prompted an increase in the level of research about appetite regulation, as researchers attempt to understand the mechanisms responsible for human energy intake. Of particular concern is the increased prevalence of overweight and obesity among children and adolescents (Lobstein, Baur & Uauy, 2004), raising alarm about future trends for cardiovascular disease, diabetes and cancer (e.g., Maziak, Ward & Stockton, 2008; Sorof, Poffenbarger, Franko, Bernard, & Portman, 2002).

Debates about the causes of obesity are at the forefront of research and government agendas. Obesity occurs when energy intake remains higher than energy expenditure for an extended period of time (British Nutrition Foundation, 1999). Changes to the gene pool are unlikely to explain the increased global prevalence of obesity and, in the absence of such changes, diet and exercise appear the most likely candidates to explain increases in fat mass (Goran & Treuth, 2001). A daily imbalance between intake and expenditure of just 2%, if it is sustained over time, can promote overweight in growing children (Goran & Treuth, 2001). However, whilst it is agreed that the energy intake of children who are overweight exceeds their energy expenditure

(Viana, Sinde & Saxton, 2008), less is known about the specific behaviours involved in weight gain. There is huge variability in population weight, and the mechanisms that cause some people to eat beyond their metabolic requirements and gain weight remains poorly understood (Carnell & Wardle, 2008a). Understanding the controls of energy intake within and beyond individual meals is an important priority as it may provide markers for overconsumption in children. This chapter will explore theories of appetite regulation and aims to elucidate some of the underlying behaviour traits that might contribute to differences in energy intake and weight status across children.

Whilst between 5% and 25% of weight variance has been attributed to genetic influences (Bouchard, Despres & Tremblay, 1991; Rayussin & Swinburn, 1992), the increasing prevalence of obesity suggests that environmental factors, such as the home environment and parental influence, are of particular importance (e.g., Carnell & Wardle, 2008a; McGarvey et al., 2004). Parents constitute one of the strongest influences on child development (Bugental & Goodnow, 1998), shaping children's eating environments and creating home environments that promote certain behaviours and social norms (Birch & Fisher, 1998; Rhee, 2008). Therefore, although many factors may contribute to an individual's eating behaviour appetite regulation and weight status, this chapter will discuss the impact of a broad range of parental factors. This incorporates the feeding environment that parents provide, parents' own eating behaviour and the feeding practices and styles that parents employ during food-based interactions with their children.

Interest in parental influences has also sparked interest into the feeding interactions between parents and their children, with research exploring the contribution

of the child as well as the caregiver in the development of children's eating behaviour, appetite and weight (e.g., Agras, Hammer, McNicholas & Kraemer, 2004; Anderssen, Wold & Torsheim, 2006). Children are not merely passive responders to parental influences; feeding is a dynamic bidirectional process where children contribute substantially to the feeding interaction (Satter, 1986). Therefore this chapter also explores the literature on child temperament and its contribution to feeding interactions and the development of children's eating behaviour and appetite regulation.

This chapter will focus on early childhood as it represents a critical period where eating behaviours are becoming established and embedded (Kelder et al., 1994). Research has indicated that whilst very young children appear to be able to self-regulate their energy intake quite successfully, this self-regulation is less operational in older children (McConahy, Smicklas-Wright, Mitchell & Picciano, 2002). The pre-school years have been identified as a time when children's innate ability to self-regulate energy intake seems to diminish and eating is no longer depletion driven but is influenced by a variety of environmental factors (e.g., Rolls, Engell & Birch, 2000). Therefore, identifying factors that may impact on children's eating behaviours, appetite regulation and weight status during early childhood, before traits become engrained, is likely to be beneficial.

Theories of appetite regulation

Despite huge rises in obesity levels over recent decades there is large variability in population weight and the mechanisms that cause some people to eat beyond their metabolic requirements and gain weight remains poorly understood (Carnell & Wardle,

2008a). Understanding the regulation of eating reflects a complex phenomenon as it is influenced by the integration of physical, psychological, genetic and environmental signals (Temple, Chappel, Shalik, Volcy & Epstein, 2008). Whilst there is no doubt that food intake is partially under homeostatic control, with hormonal and neural signals being critical to the regulation of intake (see, Woods, Schwartz, Baskin & Seeley, 2000), what is increasingly questioned is the importance of homeostatic regulation in the development of obesity and overweight (e.g., Lowe & Butryn, 2007; Lowe & Levine, 2005; Pinel, Assanand & Lehman, 2000). Within our modern food-rich environments, the effect of sensory and external stimulation on food intake has drawn attention to the hedonic dimensions of appetite, whereby external factors may have an overriding influence over our internal satiety cues.

Various different theories of appetite regulation have emerged over the decades and whilst our understanding of the physiological and homeostatic mechanisms underpinning appetite has greatly advanced (e.g., Schwartz, Woods, Seeley & Baskin, 2000), there is growing interest in the psychosocial and environmental influences on appetite regulation. Externality theory, a longstanding idea put forward by Schachter (1968), is based on the assumption that internal state is irrelevant to eating in overweight individuals and that instead, external, food-relevant cues trigger eating. Such cues could be the palatability of food or any aspect of the environment which signals palatable food, such as sight or smell of food, or learned associative factors such as time of day (Schachter, 1971). Schachter's work, along with various behavioural studies conducted in the 1960's and 1970's (e.g., Nisbett, 1972), highlighted that people who are obese may display a cluster of 'risky' appetite-related traits which people who

are normal-weight do not. Although Schachter's theory was increasingly criticised because effects were weak and findings could not always be replicated (Rodin, 1981), recent rejuvenation of interest in this area has provided increasing support for these ideas (e.g., Jansen et al., 2003; Temple et al., 2008).

Twenty-first century food environments provide ample opportunities for overconsumption, yet despite common characteristics within the nutritional environment there are notable individual differences between children in their energy intake and adiposity (Jolliffe, 2004; Romon, Duhamel, Collinet & Weill, 2005; Wardle & Boniface, 2008). This has raised questions about whether there may be individual differences in children's susceptibility to the obesogenic environment and their capacity to regulate energy intake (e.g., Carnell & Wardle, 2008a). The 'Behavioural Susceptibility Theory' has been proposed by Carnell and Wardle (2008a) and it suggests that substantial individual differences in population weight may be due to differing susceptibility to the obesogenic environment which, in turn, may be explained by variations in appetitive traits or eating behaviours. It is conceived as a continuum explaining variation across the spectrum of weight (Carnell & Wardle, 2008b).

Appetitive traits are clusters of behaviours related either to satiety responsiveness or hyper-responsiveness to food cues (Carnell, Haworth, Plomin & Wardle, 2008). These behaviours include poor caloric compensation after a preload of food (Faith et al., 2004), eating in the absence of hunger (Fisher & Birch, 2002), a lack of deceleration of eating during a meal (Barkeling, Ekman & Rossner, 1992), enhanced salivation at the presentation of food (Epstein, Paluch & Coleman, 1996), and a higher reinforcing value of food (Saelens & Epstein, 1996); behaviours which will be expanded

on later in the chapter. These behaviours have been observed in both children and adults who are overweight (e.g., Barkeling et al., 1992; Epstein et al., 1992) and preliminary research suggests that individuals' eating behaviour traits may influence energy intake, energy balance and body weight (Carnell & Wardle, 2008a), highlighting eating behaviour as a potentially modifiable predictor of weight gain in childhood. Associations have also been found between food approach behaviours (such as responsiveness to food, enjoyment of food and emotional overeating) and overweight in children, and between food avoidance behaviour (such as slowness in eating and good satiety responsiveness) and lower weights (e.g., Carnell & Wardle, 2008a, 2008b; Viana et al., 2008; Webber et al., 2009).

These theories suggest that external and environmental factors may exert a greater influence on appetite regulation and energy intake than homeostatic controls in some individuals. It is therefore essential to ascertain why some children seem able to successfully self-regulate their energy intake and maintain a stable, healthy weight yet others do not. Research investigating the behavioural correlates of obesity has begun to identify a variety of eating behaviour traits that may influence individuals' susceptibility to the obesogenic environment. These will be discussed in further detail in the following section.

Appetitive traits in children

Recent research considering the behavioural correlates of obesity has identified a variety of eating behaviour traits in children and adults who are overweight or obese (Blundell et al., 2005; Carnell & Wardle, 2008a, 2008b). In line with Schachter's ideas,

behavioural studies have shown that obese children have lower responsiveness to internal satiety signals (Fisher et al., 2007; Moens & Braet, 2007), and are more sensitive to external food cues (Jansen et al., 2003) than children with healthy weights. If such behavioural traits can be consistently linked to overconsumption, then they provide areas for potential modification and may be used to inform interventions to reduce overeating and thus obesity. The following section will discuss the roles of satiety responsiveness and hyper responsiveness to external cues and their relations with eating behaviours, appetite regulation and weight gain in early childhood.

Satiety responsiveness

Both within the adult and paediatric literature there is evidence that variations in satiety responsiveness may explain variations in energy intake and therefore adiposity. Satiation and satiety collectively inhibit food intake (Blundell & Rodgers, 1991) and are essential to successful appetite regulation. Satiety can be defined as “the effects of a food or meal after eating has ended” (Kral & Rolls, 2004, p. 132), whereby intake is inhibited after termination of a meal (Blundell & Rodgers, 1991). Satiety responsiveness reflects a sensitive response to internal satiety cues, and thus an efficient monitoring of energy intake, that protects against over-consumption (Viana et al., 2008).

Satiety responsiveness is often measured by assessing the effect of a preload on subsequent eating (Kral & Rolls, 2004). By comparing food intake after preloads of differing energy content, it is possible to calculate a compensation index (COMPX score), to assess how well individuals can compensate for higher or lower energy

preloads (Cecil et al., 2005). An individual who is responsive to internal satiety cues will adjust their intake at a subsequent meal according to the energy content of the pre-load (Carnell & Wardle, 2008a), with a COMPX score of 100% reflecting perfect compensation (Cecil et al., 2005). Of particular importance in terms of obesity prevention is research which has suggested that a child's body weight status is related to self-regulation, with higher levels of adiposity being associated with poorer compensation (e.g., Johnson & Birch, 1994). However results are not conclusive, for example, Faith et al. (2004) failed to find a relationship between compensation and weight in a sample of 64 children aged 3-7 years.

Within the paediatric literature exploring satiety responsiveness, age appears to be an important factor, with evidence for a developmental shift in children's satiety responsiveness. Whilst very young children appear to be able to self-regulate their energy intake quite successfully this seems to be less operational in older children (McConahy, Smicklas-Wright, Mitchell & Picciano, 2002). One study found that after 6 weeks, infants who were fed more concentrated milk decreased their intake in volume to consume the same amount of energy as the control group who were given less concentrated milk (Fomon, Filer, Thomas, Anderson & Nelson, 1975). Preschool children also appear to be sensitive to the energy density of foods and pre-load snacks (Cecil et al., 2005) and have been found to achieve COMPX scores between 50% (Birch & Fisher, 2000) and 80% (Hetherington, Wood & Lyburn, 2000). However, older children are less effective at compensating for high-energy snacks and have been shown to have COMPX scores of just 20% (Hetherington et al., 2000). In addition, whilst younger children have been found to be better able to discriminate between high

energy and low energy preloads, children rarely compensate accurately after the additional calories consumed through a preload or snack, thus contributing to a positive energy balance (e.g., Cecil et al., 2005).

Individual differences in appetite regulation are also often very prominent and research is striving to provide a comprehensive understanding of what predicts children's ability to self-regulate their appetites. It is not only important to detect appetitive traits such as a lower sensitivity to internal hunger and satiety cues, but also to discover the factors that relate to and predict the ability to regulate our appetites. An understanding of the complex interplay of factors that influence appetite could have far reaching implications for preventing the development of obesity. Such an understanding could be used to target interventions to prevent obesity in children with appetitive traits that place them at risk of weight gain. For instance, research with young children (aged 3–4 years) has shown that, with some training, including teaching children to focus on internal cues of hunger and satiety, the compensation index can be increased from 23% to 65% (Johnson, 2000). If we can understand and improve the controls of appetite and energy intake, appetite regulation could be utilised as a means to prevent obesity. In addition, satiety responsiveness tested within the preload paradigm has been found to be stable from childhood into adulthood (Zandstra, Mathey, Graaf, & van Staveren, 2000), highlighting the importance of focusing on its development within childhood. Some of the factors that may contribute to children's satiety responsiveness and self regulation will be discussed later.

Hyper-responsiveness to external cues and eating in the absence of hunger

As suggested by the increased prevalence of obesity worldwide, it seems that food consumption occurs for reasons other than acute energy deprivation and an increasing proportion of human food consumption appears to be driven by pleasure and the effect of sensory and external stimulation, not just by the need for calories (Brownell & Horgen, 2003). To explore the influence of these external factors on appetite regulation, research has investigated whether responses to these external influences vary between overweight and healthy individuals (e.g., Epstein et al, 1996; Jansen et al., 2003; Temple et al., 2008) and obese individuals have been found to have stronger appetitive responses to external cues than normal weight individuals (Epstein et al., 1996). Such behaviours included over-responsiveness to external food cues such as taste and smell (Jansen et al., 2003), overeating in response to emotional arousal (e.g., Slochower, 1976), finding food to have a high reinforcing value (Temple et al., 2008) and eating too fast thereby outpacing the onset of satiety during the course of the meal (Barkling et al., 1992), which can lead to eating in the absence of physiological hunger.

Eating in the absence of hunger (EAH) is a form of eating disinhibition initially described by Fisher and Birch (1999). It has been identified as one of the behavioural pathways implicated in the aetiology of childhood obesity (Birch, Fisher & Davison, 2003; Faith et al., 2006) and is indicative of a poor ability to self regulate energy intake. Within the EAH experimental paradigm, children consume ad libitum from a protocol meal in the laboratory setting, after which they rate themselves as feeling hungry, half-full, or full using age-appropriate silhouette scales. Immediately afterwards, children consume ad libitum from a variety of snack foods that vary in macronutrient content and

taste properties. Consumption of the snack foods after rating oneself as full is indicative of eating in the absence of hunger, and variation in this consumption can be measured. Notable variability in this trait has been found and a number of studies have now shown that, compared with lean children, children who are overweight or obese show greater intake of palatable snack foods in the absence of hunger (Birch & Fisher, 2000; Butte, Cai, Cole & Wilson, 2007; Fisher et al., 2007). This suggests that the presence of food overwhelms the opposing satiety signals which may be weaker or absent in obese individuals. In addition, Jansen et al., (2003) observed greater energy intake in obese or overweight, but not normal weight, individuals following exposure to the smell of palatable foods. This suggests that food consumption may be initiated and influenced by a range of environmental cues, effecting individuals ability to effectively self-regulate their energy intake. Such a behaviour trait can be referred to as food cue responsiveness (Carnell & Wardle, 2008a, 2008b), which in essence represents an over-responsive meal initiation system, whereby eating episodes may occur in response to the hedonic properties of food and not homeostatic hunger.

Another eating behaviour that has been identified as reflecting eating in the absence of physiological hunger is emotional eating. The normal response to emotional arousal is loss of appetite, followed by a decrease in food intake (Larsen, van Strein, Eisinga & Engeles, 2006). However, some individuals respond to emotional arousal by enlarging their food intake, thereby emotionally over-eating. Research with adults has suggested that individuals who are overweight display higher levels of emotional eating than normal weight controls (e.g., Van Strien, Frijters, Bergers & Defares, 1986). There has been less research conducted in child populations, however, emotional eating has

been associated with elevated BMI (Braet & Van Strein, 1997; Webber et al., 2009) and levels of emotional eating have been found to differ between obese children and adolescents and their normal weight counterparts (e.g., Snoek, Van Strein, Janssens & Engels, 2007). Another study has found evidence that emotional eating is related to greater caloric intake of sweet and salty foods in adolescence (Braet & Van Strein, 1997), suggesting it may play a role in affecting children's ability to regulate their energy intake.

Eating rate has also been linked to appetite regulation whereby a fast rate of eating and a lack of deceleration has been linked to poor self-regulation of energy intake and also to overweight (Carnell & Wardle, 2008b). In an observational study of 6 year old children at school mealtimes, obese children ate faster, took more bites and chewed each bite fewer times compared to children with healthy weights (Drabman et al., 1979). Similarly, in a laboratory study using a computerised eating monitor, obese 11 year olds were found to eat faster over two lunchtime meals and showed no deceleration towards the end of the meal, despite describing themselves as having less motivation to eat before lunch than normal weight children (Barkeling et al., 1992).

It is essential to ascertain why some children seem able to successfully self-regulate their energy intake and maintain a stable, healthy weight yet others seem to gradually become more responsive to external cues and drivers to eat. It seems that the challenge to discover the underlying behaviours that might contribute to differences in appetite regulation and weight status across children is becoming clearer, however less is known about the factors implicated in the development of these eating behaviours. If these factors could be better elucidated then the implications for

intervention and prevention are potentially colossal. Through the next section of this chapter some of the potential influences on children's ability to self-regulate their appetites will be discussed.

Influences on the development of appetite regulation

Although genetic factors are undoubtedly implicated in the development of appetite regulation and children's emerging eating behaviours (e.g., Bouchard et al., 1991) the increasing prevalence of obesity suggests that environmental factors, such as the home environment and parental influence, are of particular importance (e.g., Carnell & Wardle, 2008a; McGarvey et al., 2004). Interest in the feeding interactions of parents and their children has led to research exploring the contribution of the child and the caregiver in the development of children's eating behaviour, appetite and weight. As feeding is a dynamic bidirectional process, it is likely that both children and their caregivers will influence children's emerging eating behaviours, preferences and attitudes. Therefore this section will focus on the contribution of the parent and the child in the feeding process and the development of eating behaviours and appetite regulation.

Parental influences

Parents are generally believed to constitute one of the strongest socialising agents for children (e.g., Baumrind, 1993; Bugental & Goodnow, 1998) and are believed to play a role in influencing their children's health behaviours (Anderssen, Wold & Torsheim, 2006). Parents influence their children through the use of specific parenting practices

and by modelling specific behaviours and attitudes, which creates a home environment that promotes certain behaviours, expectations, beliefs, and social norms (Rhee, 2008). Due to this overarching influence, parents play an important role in the prevention and treatment of childhood overweight (Rhee, 2008), and parents of young children are now often the focus of public health interventions designed to reduce the prevalence of childhood obesity (Clark, Goyder, Bissell, Blank & Peters, 2007).

Research examining the influence of parents on childhood overweight has expanded in recent years (e.g., Moens, Braet, & Soetens, 2007; Zeller et al., 2007) and we have begun to understand the potential scope of parental influence on the development and treatment of childhood overweight. Parents are likely to influence children's eating behaviours and intake patterns through the feeding environment they provide and foods they make available to the child, their own eating behaviours, preferences and attitudes, and the parenting and feeding practices they employ. This section will therefore focus on the contribution of these parental factors to the development of children's eating behaviours and appetite regulation.

The impact of the feeding environment on appetite regulation

Parents create a home environment that promotes certain behaviours, expectations, beliefs, and social norms (Rhee, 2008) and are therefore central in shaping children's eating environments and the development of eating preferences and behaviours (Birch & Fisher, 1998). Particularly during early childhood, parental choices within the immediate home environment about the type, volume and frequency of eating episodes are likely to influence children's emerging ability to self-regulate their energy intakes.

Children's self-regulation can be challenged by external food cues, such as availability of highly palatable foods (Wilson, 2000), numerous opportunities to snack in the absence of hunger (Fisher & Birch, 2002; Jahns, Siega-Riz & Popkin, 2001) and portion size (Neilson & Popkin, 2003), which can override internal satiety signals. The ways in which environmental influences within the home contribute to children's emerging ability to self regulate and weight status will now be discussed.

As indicated by the growing prevalence of global obesity, it seems that food consumption occurs for reasons other than acute energy deprivation and an increasing proportion of human food consumption appears to be driven by pleasure. For instance, the availability and palatability of foods in the home can have a major effect on whether the foods will be desired and consumed (Blundell & Finlayson, 2004) and an individual's level of current caloric repletion can become relatively unimportant. The consumption of highly palatable foods has been linked to food hedonics and subjective reward experience which are likely to be powerful motivators for intake (Carnell & Wardle, 2008b; Epstein et al., 2007).

Food hedonics is the subjective pleasure derived from food (Cabanac, 1985) and the reinforcing value of food refers to how much someone is motivated to obtain food (Epstein et al., 2007). Given the opportunity to consume foods that are high or low in hedonic value, individuals will generally choose to consume foods that they find palatable and this has been considered to be a determinant of energy consumption or the amount of food consumed within a meal (Drewnowski & Hann, 1999). The reinforcing value of food has also been found to influence energy intake, whereby high levels of food reinforcement are related to greater energy intake (Epstein et al., 2007).

In addition, obese adults, who are likely to have higher energy intake than non-obese adults, have been found to find food more reinforcing than their slimmer counterparts (Epstein et al., 2007; Temple et al., 2007). This research suggests that if children are over exposed to highly palatable foods within their feeding environment, that this exposure may challenge their ability to respond to internal feelings of hunger and satiety and may instead teach them to respond to the hedonic properties of food.

Portion size, which is often determined by caregivers, reflects another important environmental factor that influences both energy intake and appetite regulation (e.g., McConahy, Smicklas-Wright, Birch & Picciano, 2002; Mrdjenovic & Levitsky, 2005). For example, numerous cross-sectional survey studies have reported positive associations between average food portions consumed and energy intake in children ranging from 6 months to 5 years (e.g., Fox, Devaney, Reidy Razafindrakoto & Ziegler, 2006; McConahy et al., 2002; McConahy et al., 2004). In a study of 2-5 year olds, portion size, frequency of eating and number of foods consumed were positively related to total energy intake, suggesting that these could be important predictors of energy intake as children transition from toddler to preschool years (McConahy et al., 2004). Similar results were found in a study of 4-6 year olds in which a strong positive correlation was observed between serving size and consumption over a 5-7 day period (Mrdjenovic & Levitsky, 2005). Rolls et al., (2000) observed a 60% increase in energy intake between large and small portion conditions (77g vs 123g) in 4-5 year olds, although no effect of portion size on intake was observed in 2-3 year old children.

The work of Rolls et al., (2000) and other studies in both controlled and natural everyday environments (e.g., Birch & Fisher, 1998; Shea, Stein, Basch, Contento &

Zybert, 1992), provide evidence of a developmental shift in children's susceptibility to portion size. It has been demonstrated that whilst infants and young children have an innate ability to self-regulate energy intake, with intake being driven primarily by responses to hunger and satiety cues (e.g., Birch & Fisher, 1998), by 3 or 4 years old, eating is no longer depletion driven but is influenced by a variety of environmental factors (e.g., Rolls et al., 2000). It is possible that during the preschool period children's increased responsiveness to the environmental cues may emerge as a factor that contributes to overweight; in children who have learned to be responsive to environmental cues, very large portion sizes may elicit over-eating and thus promote the development of overweight (Rolls et al., 2000).

Recent studies have also begun to examine the effect of the energy density of foods on satiation and satiety (e.g., Bell & Rolls, 2001; Kral, Roe & Rolls, 2004) and results have shown that the energy density of a diet can directly influence energy intake (e.g., Bell & Rolls, 2001; Stubbs, Johnstone, O'Reilly, Barton & Reid, 1998). In addition, there is evidence that energy density combined with volume of a first course or meal act together to significantly affect satiety and total energy intake in a meal (Rolls, Roe & Meengs, 2003). Overall findings in this area suggest that adults eat a similar amount of food day to day irrespective of energy density, and that the consumption of high energy dense foods typically results in an increase in energy intake (Kral & Rolls, 2004). Although less research has been carried out in young children, recent studies investigating the effects of energy density on satiation and satiety among young children have found similar results to those in adults. For instance, Leahy, Birch and Rolls (2008) found that when the energy density of the primary component of a main meal

(macaroni and cheese) was reduced by 30%, 2 to 5 year olds consumed 25% fewer calories. Similarly, a study of 5-6 year olds found that after increasing the energy density of a macaroni and cheese by 40% energy consumed increased by 33% (Fisher, Liu, Birch & Rolls, 2007). Collectively these findings suggest that energy density of a meal may affect children's ability to recognise internal feelings of satiety and satiation, therefore promoting the risk of overconsumption.

Unsurprisingly given the evident impact of these environmental cues, an important component of programs to prevent obesity and poor appetite regulation in young children is modifying the aforementioned environmental cues that can lead to positive energy balance (Epstein et al., 2001). Environmental factors such as the home milieu and parental influence are evidently highly important (McGarvey et al., 2004), yet the influence of parents stretches far beyond the food they make available in the home. With parents being such influential socialising agents for children (e.g., Baumrind, 1993; Bugental & Goodnow, 1998) it is likely that parents' eating behaviours and attitudes are also influential in the emergence of children's own eating behaviours (Nicklas et al., 2001). In line with Social Learning Theory (e.g., Bandura, 1977), some research has highlighted the role of observational learning and modelling in the development of a child's eating habits and behaviours (e.g., Contento et al., 1993; Olivera et al., 1992). The social contexts of the feeding environment, including the attitudes of and interactions with parents, are very important and therefore research has looked at associations between obesogenic eating behaviours and poor appetite regulation amongst children and their caregivers.

Disinhibited parental eating has been associated with lower child satiety responsiveness (Birch & Sullivan, 1991), eating in the absence of hunger (Cutting, Fisher, Grimm-Thomas & Birch, 1999; Francis, Ventura, Marini & Birch, 2007) and higher child body fat (Hood et al., 2000). Although there is evidence for the genetic transmission of disinhibited eating (e.g., de Castro & Lilenfield, 2005; Provencher et al., 2005), one study found 40% of the variance in disinhibited eating behaviour to be explained by a shared environmental component (de Castro & Lilenfield, 2005). Hood et al. (2000) suggest that this association may be mediated by direct parental role modelling of unhealthy eating behaviours, or through other indirect behavioural consequences that influence a child's innate regulation of dietary intake (Hood et al., 2000). Evidence seems to suggest that the family environment is particularly important and that these disinhibited eating behaviours are predominantly learned (Faith et al., 2007; Moens & Braet, 2007; Provencher et al., 2005). Support for this conception is provided by a recent longitudinal study which found that although mothers' disinhibited eating was not related to daughters' disinhibited eating style (eating in the absence of hunger; EAH) when daughters were 5 to 7 years old, it was related to girls' EAH at ages 9 to 13 years (Francis et al., 2007). It seems likely that disinhibited eating is a behavioural phenotype that may emerge during childhood as a result of environmental exposure, whereby parental displays of disinhibited eating can promote subsequent disinhibited eating in their children (Francis et al., 2007).

Parents of young children are key targets for interventions intended to reduce the prevalence of obesity in children (Clark et al., 2007). Increasing healthy eating behaviours in families and thus providing healthy role models has been suggested to be

an important step in improving child diet. For example, research suggests that if obese parents reduce access to low-nutrient dense foods available in the family environment, model healthier eating and activity habits, and share positive food-related family experiences that reinforce eating high-nutrient dense foods, the parents may reduce the risk of their child becoming obese (Epstein et al., 2001).

Research has also explored the impact of parental eating psychopathology upon the child's relationship with food. Whilst maternal eating psychopathology has been associated with the presence and persistence of feeding problems in childhood and children's poor self regulation of food intake (Ammaniti, Ambruzzi, Lucarelli, Cimino & D'Olimpio, 2004; Blissett, Meyer & Haycraft, 2007; Stein, Woolley & McPherson 1999), much of the research assessing the associations between maternal eating psychopathology and overconsumption in young children has focused on how parents' eating attitudes impact on their child feeding practices, which in turn may influence children's eating behaviour and weight. For instance, a parent is more likely to constrain and control a child within a domain that is of high importance to them (Goodnow, Knight & Cashmore, 1985) and parents' own child-irrelevant social values and concerns about a given domain can elevate concern and constraint in parenting (Costanzo & Woody, 1985). Mothers' preoccupation with their own weight and eating has been linked to higher restriction of daughters' food intake (Francis & Birch, 2005) and both mothers and fathers with non-clinical levels of eating psychopathology have been shown to be more controlling over their children's eating (Blissett, Meyer & Haycraft, 2006). These controlling feeding practices have been associated with negative outcomes, overconsumption and weight gain in children (e.g., Birch, Fisher &

Davison, 2003; Klesges, Klesges, Eck & Shelton, 1991) and appear to play an important role in the development of effective self-regulation in children. The impact of these feeding practices on children's eating behaviour will now be discussed.

The impact of parental feeding practices on child appetite regulation

In recent years, the influence that parents can have on their children's dietary behaviour through food-related parenting practices has received particular attention (Kremers, Brug, de Vries & Engles, 2003), and parents' child-feeding practices have been identified as a contributory environmental factor in childhood obesity (Birch & Fisher, 1998). Feeding practices are the specific strategies that parents use in an attempt to maintain or modify their child's eating style and diet (Ventura & Birch, 2008). Although parents may use child-feeding behaviours with the positive intention of modifying children's dietary intake (Klesges et al., 1991), research has suggested that overly controlling feeding practices, which may interfere with children's internal hunger and satiety cues, can be unintentionally detrimental by actually promoting overeating in young children (Fisher & Birch, 1998).

A variety of parental feeding practices have been linked to an increased risk of overeating. These include encouraging or pressuring a child to eat beyond satiety (Birch, McPhee, Shoba, Steinberg, & Krehbiel, 1987), restricting the amount and type of food a child can eat (Birch, Fisher & Davison, 2003) and using food as a reward for a behaviour (Birch et al., 1987). A central idea within the parental feeding practices literature is that parents who exert high levels of control over their child's eating may unintentionally effect their children's ability to regulate their appetites by encouraging

them to eat according to external rather than internal hunger cues (e.g., Savage, Fisher & Birch, 2007), such as the time of day or amount of food left on a plate (Johnson, 2000). For instance, adult prompts to eat increase the likelihood that children will eat (Klesges et al., 1983), but can over-ride their own fullness as a guide to terminate eating (Birch et al., 1987). In addition pressuring children to eat foods that are 'good for them' has been associated with lower preference for that food (Batsell et al., 2002) and lower fruit and vegetable intake (Galloway, Fiorito, Lee, & Birch, 2005), which are likely to influence children's food choices and their ability to effectively regulate their energy intake.

Restrictive feeding practices may also discourage adequate self-control of eating by increasing children's preference for restricted foods and desire to eat them when available (Birch & Fisher, 2000; Fisher & Birch, 1996), suggesting that these restrictive feeding practices may be implicated in the etiology of disinhibited eating (Birch & Fisher, 2000; Fisher & Birch, 1999). Given our current obesogenic eating environment there is concern about whether restrictive feeding practices may inadvertently teach children to ignore their own hunger and fullness when placed in eating environments where palatable, previously restricted foods are readily available (Birch et al., 2003). In support of this idea, highly restrictive feeding practices have been associated with eating in the absence of hunger and overweight among young girls (Birch & Fisher, 2000; Fisher & Birch, 2002).

There has been some discrepancy among the literature as to the degree of negative impact that excessive control has on child eating behaviour and weight (Montgomery, Jackson, Kelly & Reilly, 2006), and some studies have also found

favourable associations between these feeding practices and child food intake (e.g., Brown & Ogden, 2004; Zabinski et al., 2006) and links with lower child fat mass (Spruijt-Metz, Cohen, Birch & Goran, 2006). However, longitudinal research suggests that highly restrictive feeding practices have been most consistently associated with child weight gain (Clark et al., 2007) and less controlling practices, such as monitoring unhealthy snack intake, have been associated with slower weight gain (Faith et al., 2004).

Within the literature on feeding practices, the focus has been primarily on the use of control and there is very little research examining a broader range of child feeding practices, despite evidence that other feeding strategies influence children's eating (Orrell-Valente et al., 2007). However, interest is growing in dimensions of parental feeding practices which reflect parents' use of food to direct and manipulate behaviour, rather than only feeding their children in response to hunger and satiety, such as using food as a reward and to regulate emotions (Musher-Eizenman & Holub, 2007). For example, it is possible that if food is used for comfort, a child may develop a pattern of responding to emotional arousal with food intake (Bruch, 1973) and it has been proposed that the feeding practices employed by parents may unintentionally cause children to use food to address emotional arousal (Carper et al., 2000; Van Strein & Bazelier, 2007). If parents use food to regulate their child's emotional states, they may unintentionally 'teach' their child to respond to emotional states by eating thus leading to the development of emotional eating. Support for this premise is evident within a recent study that found maternal use of food to regulate emotions to be associated with cookie consumption in the absence of hunger (Blissett, Haycraft & Farrow, 2010). Carrying out

further research which encompasses a broader range of parenting practices is essential to better elucidate how they may influence children's emerging eating behaviours and appetite regulation.

The impact of parenting style on child appetite regulation

Parenting style is another aspect of parenting that has been explored in relation to parents' child-feeding practices with research suggesting that parents' feeding practices are broadly linked with their parenting styles (Blissett & Haycraft, 2008; Hughes, Power, Fisher, Mueller, & Nicklas, 2005). There are strong conceptual reasons to expect that parenting style should be related to the management of children's health behaviours (Kitzmann, Dalton III & Buscemi, 2008), and empirical evidence suggests that an authoritative parenting style promotes more positive health behaviours in children (Tinsley, Markey, Ericksen, Ortiz, & Kwasman, 2002). In fact, parenting styles have been found to predict children's BMI (Rhee, Lumeng, Appugliese, Kaciroti & Bradley, 2006), healthier eating (Kremers, et al., 2003; Patrick, Nikolas, Hughes, Morales, 2005) and also physical activity level (Schmitz et al., 2002).

The construct of parenting style is used to capture normal variations in parents' attempts to control and socialise their children (Baumrind, 1991), and parenting styles are conceptualised as descriptions of how parents vary on the dimensions of warmth and nurturance versus control (Darling & Steinberg, 1993). They tend to be categorised into authoritative, authoritarian and permissive styles and reflect different naturally occurring patterns of parental values, practices and behaviours (Baumrind, 1991). Authoritative parents balance clear, high parental demands with emotional

responsiveness, warmth and recognition of child autonomy (Baumrind, 1991). Authoritarian parents, however, are highly demanding and over-controlling and are also emotionally cold and unresponsive (Baumrind, 1991). Permissive parents impose little control, either through overly indulgent or neglectful and emotionally cold parenting (Baumrind, 1991).

Authoritative parenting has been consistently demonstrated to be associated with positive outcomes in children across many domains and has been identified as the most effective parental child-feeding modality (Kremers et al., 2003). However, the authoritarian style, where children are raised in a strict environment lacking in emotional responsiveness, has been associated with controlling feeding practices (Hughes et al., 2005), such as pressure to eat (Duke, Bryson, Hammer, & Agras, 2004) and an increased risk of childhood overweight (Rhee et al., 2006). It seems that authoritative parenting provides the structure and support needed for children to internalise and maintain positive behaviours, whereas non-authoritative parenting may interfere with children's ability to learn self-regulation (Grolnick & Farkas, 2002) including the self-regulation of eating (Davison & Birch, 2001). These ideas link back to early psychosomatic theory, where it was suggested that early life experiences characterised by a lack of parental regard for, and response to, children's real needs were implicated in the development of a lack of awareness of internal states and hunger cues in children (Bruch, 1973).

However, results are not conclusive and some researchers have not found support for the links between parenting style and feeding practices with child BMI (e.g., Brann & Skinner, 2005), highlighting the need for further research. In addition, the

focus has largely been on authoritarian directives, such as rewards, punishment and restriction (e.g., Johnson & Birch, 1993) whereas very little research has evaluated authoritative feeding, which encompasses behaviours such as encouragement, reasoning, rationales and praise (Hughes et al., 2005). Extending research to investigate authoritative, child-responsive feeding strategies in addition to overt control of feeding is likely to further illuminate the role of parental feeding in the development of child appetite. More research is clearly needed, as despite the discrepancies, parenting styles and practices represent potentially powerful influences on the development of children's eating behaviours and appetite regulation.

Whilst parents represent an essential influence on children's emerging eating behaviours through all of the aforementioned avenues, children are not merely passive responders to parental influences (Carnell & Wardle, 2008a). Feeding is a dynamic bidirectional process and children significantly contribute to the feeding interaction (Cabanac, 1987). It is important to remember that although parenting can influence children's eating and weight, individual child characteristics are likely to influence parenting and the way in which parents interact with their child. For example, parents have reported using different feeding practices in response to different characteristics between siblings (e.g., Brann & Skinner, 2005; Farrow, Galloway & Fraser, 2009). In addition, inherent child characteristics such as personality or temperament are also likely to directly influence children's eating behaviours and susceptibility to the obesogenic environment. There has therefore been a growing interest in individual difference variables that influence food intake (Franken & Muris, 2005) and recent developments have increased awareness of the impact that child temperament may

have on eating behaviour (e.g., Agras et al., 2004; Pulkki-Raback et al., 2005). The following section will discuss the contribution of temperamental dimensions such as emotionality and impulsivity to children's eating behaviours and will suggest how temperament traits may influence children's eating behaviours or moderate the effects of the obesogenic environment on individuals' appetite regulation.

Child temperament and its contribution to appetite regulation

Temperament refers to individual differences in a person's emotional reactivity and regulation (Goldsmith et al., 1987) and has been defined as "personal characteristics that are biologically based, are evident from birth onwards, are consistent across situations and have some degree of stability" (Schaffer, 2006, p.70). There are a wide variety of temperaments which a child may convey and evidence has suggested that individual differences in temperamental characteristics may influence children's eating behaviour, either directly or through their influence on parenting (Thomas & Chess, 1987). Several dimensions of temperament are associated with variations in children's eating behaviours such as impulsive (Hetherington, 2007), difficult and demanding (Hagekull, Bohlin & Rydell, 1997; Lindberg, Bohlin, Hagekull & Thrunstorm, 1994), emotional (Agras et al., 2004), and shy and unsociable temperaments (Pliner & Loewen, 1997).

Impulsivity is the tendency to respond instantaneously to external or internal cues, without thinking about the consequences (Gray, 1987). Features of impulsivity include disinhibited and thrill-seeking behaviours (Flory et al., 2006) and it is characterised by a preference for small, immediate rewards (Hetherington, 2007). The

Reinforcement Sensitivity Theory developed by Gray (1987) is one of the leading biological based models of personality and is useful in explaining individual differences in food consumption through differences in impulsivity. This theory suggests that there are two systems that control individuals' approach and avoidance behaviours: the Behavioural Activation System (BAS), which controls approach behaviours and is activated in the presence of a reward, guiding the individual towards appetitive stimuli; and, a Behavioural Inhibition System (BIS) which controls anxiety-based avoidance behaviours and inhibits responses in order to avoid punishment (Gray 1987). Impulsivity represents a lack of inhibitory control, and this may be attributed to heightened sensitivity to reward (Hetherington, 2007). Overeating may be characterised by an overdeveloped BAS, which may explain the exaggerated 'approach' response to food cues seen in some children, or it may be caused by an under developed BIS, as evidenced by an inability to resist situational cues to over-consume foods (Hetherington, 2007). Therefore individual differences in impulsivity or sensitivity reward may make some people more vulnerable to over-eating and weight gain than others.

So far, few studies have investigated the link between sensitivity to reward and relative body weight. However, initial evidence has suggested that individual difference variables, such as impulsivity, are associated with food intake (Kane, Loxton, Staiger, & Dawe, 2004; Nasser, Gluck, & Geliebter, 2004), relative body weight (Faith, Flint, Fairburn, Goodwin, & Allison, 2001), and obesity (Ryden et al., 2003). For example, people who are obese have been found to be more impulsive than people who are lean (e.g., Davis, Strachan, & Berkson, 2004; Ryden et al., 2003) and it has been suggested

that impulsive people may be less able to retain control over eating behaviour (Nedderkorn et al., 2007). For instance, it has been proposed that impulsive children seek immediate gratification and are less able to inhibit their responses making them more vulnerable to the temptation of tasty food (Nekerdoorn et al., 2007). In fact obese children have been found to overeat after exposure to tasty food, indicating that they are sensitive to the temptation of tasty food (Jansen et al., 2003). Reward sensitivity corresponds with a heightened sensitivity to unconditioned and conditioned rewarding stimuli (Dawe, Gullo & Loxton, 2004) and it seems that it may be an important individual difference in identifying those most vulnerable to overeating and weight gain.

A more wilful or difficult temperament, characterised by irritability, emotionality, slow adaptability and intensity (Hagekull et al., 1997), has also been associated with both over-eating and weight gain (e.g., Niegel, Ystorm & Vollrath, 2007) as well as with feeding-problems and underweight (e.g., Hagekull et al., 1997). This suggests that this temperament profile may affect children's ability to regulate their appetites, putting them at risk of maladaptive eating behaviours. Infants with difficult temperaments have shown more rapid weight gain up to the age of 3½, when compared with infants who do not display such patterns (Darlington & Wright, 2006; Niegel et al., 2007) and such temperament attributes in early childhood have also been associated with overweight in later childhood (Niegel et al., 2007). Similarly links have been found between an emotional child temperament and overweight (Agras et al., 2004; Darlington & Wright, 2006). Children with persistent tantrums over food during their first two years of life combined with a highly emotional temperament have been found to have elevated risk of becoming overweight than those children without that temperament profile (Agras et

al., 2004) and child emotionality has been linked to overweight in adulthood even after controlling for multiple recognised risk factors, such as birth weight and parental body mass index (Pulkki-Raback et al., 2005).

Explanations for these links remain unclear, however it could be hypothesised that children with a more difficult temperament may show heightened emotional reactivity within feeding interactions or be more difficult and demanding in terms of their food preferences and mealtime behaviour. Differences in children's emotional reactivity, persistence and wilfulness are likely to influence the parenting process within the feeding context (Bates, Pettit, Dodge & Ridge, 1988; Rothbart, 1989). Such traits can evoke negative feelings, insensitivity and coercive feeding by parents and dyadic feeding interactions may then be characterised by little reciprocity, more conflict and struggles for control (Chatoor, 1989; Chatoor & Egan, 1983). As previous sections of the chapter have highlighted, such feeding practices can be detrimental to children's emerging eating behaviours, with coercion and feeding for emotion regulation being associated with children's over-consumption and poor appetite regulation. Similarly, a more difficult or emotional child temperament may also influence how parents interact with and respond to behaviours outside the context of mealtimes. Parents of children who are harder to manage or sooth may feel they need to implement strategies such as using food as a reward or to regulate mood and emotional states, which may in turn interrupt and interfere with children's hunger and satiety cues.

There is some promising evidence for the mediatory role of temperament in the interaction between other factors and child weight and eating. For example, Agras et al. (2004) found, during a prospective study of 150 children from birth to 9 years of age,

that child temperament mediated the association between parent and child overweight. The influence of child temperament in the pathway to overweight strongly differed dependent on parental overweight. For the thinner parent, the highest incidence of childhood obesity was found in children who had persistent tantrums over food, perhaps suggesting that this behaviour leads parents to implement reactive overfeeding of the child. For the overweight parent, showing low concern about their child's thinness combined with a highly emotional child temperament was associated with the greatest risk of child overweight or obesity (Agras et al., 2004). Further research is essential to see how child temperament interacts with other factors, not only to influence weight, but more specifically the development of children's eating behaviours and appetite regulation.

Summary and future directions

A comprehensive understanding of controls of energy intake in children and the regulation of children's appetites is essential. This chapter has explored theories of appetite regulation and elucidated some of the underlying behaviour traits that might contribute to differences in children's energy intake and appetite regulation. It has also highlighted the contribution of environmental, parental and individual difference factors, in the development of children's eating behaviour traits, appetite regulation and weight status.

Understanding the regulation of eating reflects a complex phenomenon as it is influenced by the integration of physical, psychological, social, genetic and environmental factors (e.g., Bouchard, Despres & Tremblay, 1991; Lowe & Butryn,

2007; Pinel, Assanand & Lehman, 2000; Schwartz et al., 2000; Temple et al., 2008). However, given the increased global prevalence of obesity, this chapter has highlighted how an increasing proportion of human food consumption appears to be driven by the effect of sensory, external and environmental stimulation, not just by the need for calories (e.g., Brownell & Horgen, 2003; Carnell & Wardle, 2008a; Schachter, 1968).

Despite this there is huge variability in population weight and researchers have sought to discover the mechanisms that cause some people to eat more than their metabolic requirements and to gain weight when others do not. It has been suggested that individuals may differ in their susceptibility to the obesogenic environment, which may be explained by variations in appetitive traits or eating behaviours (e.g., Carnell & Wardle, 2008a, 2008b). Investigation into the behavioural correlates of obesity has identified a variety of eating behaviour traits that may be implicated in overconsumption and susceptibility to weight gain (e.g., Faith et al., 2004; Fisher & Birch, 2002; Saelens & Epstein, 1996). In particular this chapter has highlighted how individual differences in satiety responsiveness and responsiveness to external cues impact children's ability to regulate their energy intake (e.g., Cecil et al., 2005; Fisher & Birch, 1999; Fisher et al., 2007; Jansen et al., 2003; Hetherington et al., 2000).

Not only is it important to ascertain if certain eating styles can be consistently associated with childhood obesity and appetite regulation in community samples, but a focus on the factors that may be implicated in the development of these eating behaviour traits in young children is essential, particularly given evidence that early eating behaviours show stability into adolescence and adulthood (Ashcroft, Semmler, Carnell, Van Jaarsveld, & Wardle, 2008). Whilst genetic influences cannot be ignored

(Bouchard, Despres & Tremblay, 1991; Rayussin & Swinburn, 1992), environmental factors, such as the home environment and parental influence, seem to be particularly important (e.g., Carnell & Wardle, 2008a; McGarvey et al., 2004). Parents influence children's eating behaviours through the foods they make available to the child and the feeding environment they provide (e.g., Blundell & Finlayson, 2004; Kral & Rolls, 2004; McConahy et al., 2004), modelling their eating behaviours, preferences and attitudes (e.g., Francis et al., 2007; Hood et al., 2000), and through their parenting style (e.g., Tinsley et al., 2002) and the feeding practices they employ (e.g., Birch et al., 2003; Clark et al., 2007).

Children's self-regulation can be challenged by environmental influences within the home, such as the availability of highly palatable foods (Wilson, 2000), numerous opportunities to snack in the absence of hunger (Fisher & Birch, 2002; Jahns, Siega-Riz & Popkin, 2001), and portion size (Neilson & Popkin, 2003); all of which can override internal satiety signals. Parents also represent influential socialising agents for children (e.g., Baumrind, 1993; Bugental & Goodnow, 1998) and research has highlighted the role of observational learning and modelling of parents' eating behaviours and attitudes in the development of a child's eating habits and behaviours (e.g., Contento et al., 1993; Francis et al., 2007; Hood et al., 2000; Nicklas et al., 2001; Olivera et al., 1992). The important contribution that parents make to their children's eating behaviours is one of the main reasons why parents of young children are frequently targeted in public health interventions aimed at reducing the prevalence of childhood obesity (Clark et al., 2007). It has been suggested that reducing access to low-nutrient dense foods available in the family environment, modelling healthier eating and sharing positive food-related family

experiences are important steps in improving child diet and preventing weight gain (Epstein et al., 2001).

In addition, this chapter has highlighted that parents' use of controlling feeding practices, despite often being used with the positive intention of modifying children's dietary intake (Klesges et al., 1991), may interfere with children's internal hunger and satiety cues and can therefore be unintentionally detrimental by actually promoting overeating in young children (Fisher & Birch, 1998). Whilst other feeding practices, such as using food as a reward or to regulate emotions were touched upon (e.g., Blissett, Haycraft & Farrow, 2010), this area is under-researched within the literature, highlighting that further investigation is essential. In addition, research exploring the impact of more positive and adaptive feeding practices, such as encouraging balance and varied food intake (Musher-Eizenman & Holub, 2007), could provide a better understanding of how to promote more successful feeding interactions and prevent negative feeding outcomes.

Ventura and Birch (2008), in their recent review, also highlight the need to look at mediational effects when investigating the effect of parental influences. They argue "logically parenting cannot have direct effects on child weight.....the influence of parenting on child weight must be mediated by effects of parenting on child eating (or other child behaviors)" (pp. 14-15). This highlights the need for research which looks at how children's eating behaviour traits interact with other factors, such as parental eating behaviours and the feeding practices that parents employ, to influence child weight. Assuming that parents' child-feeding practices are modifiable and are directly related to children's eating behaviours and childhood obesity, then they present potentially

important avenues for interventions to prevent paediatric obesity to be focussed on. Parents could be targeted for education programmes to improve their knowledge of adaptive feeding strategies and healthy home environments, which may be directly transferrable to child eating.

Whilst parents clearly represent an essential influence on children's emerging eating behaviours, children are not merely passive responders to parental influences (Carnell & Wardle, 2008a). Feeding is a dynamic bidirectional process and this chapter has evaluated the significant contribution of child temperament to both the feeding interactions of parents and their children (Brann & Skinner, 2005; Cabanac, 1987; Farrow, Galloway & Fraser, 2009) and the emergence of children's eating preferences, behaviours and appetites (e.g., Agras et al., 2004; Franken & Muris, 2005; Pulkki-Raback et al., 2005). However, a better understanding of the role of individual differences in temperament, personality and behavioural traits in the development of appetite regulation and eating behaviour is essential as it may allow health professionals to identify children in early childhood who may be at risk for weight gain or future problems with appetite regulation.

Although the literatures on parenting influence and child temperament have been poorly integrated in relation to early child eating, it is likely that a complex relationship exists between parent and child factors, which interact together to influence children's emerging eating behaviours. Initial findings described by Agras et al. (2004) provide promising evidence for the mediatory role of temperament in the pathway to overweight, however, further research is essential to see how child temperament interacts with other

factors, not only to influence weight, but more specifically the development of children's eating behaviours and appetite regulation.

In addition, one of the widespread limitations within the research field is that evidence of the link between parent and child factors and child eating is largely cross-sectional. Future research should seek to utilise longitudinal designs to investigate whether parental factors, such as feeding practices, precede and predict the development of eating behaviour traits that reflect poor satiety responsiveness or whether these practices are used in response to eating behaviours and changes in weight. Given that eating behaviour traits have been shown to be relatively stable throughout childhood and into adulthood (Ashcroft et al., 2008), a focus on the early years should be maintained, as this is a critical period when eating preferences, attitudes and behaviours are becoming established, and when they may become embedded (Kelder et al., 1994). Future research is needed to further examine the unique and interactive contribution of parental and child factors, to better integrate knowledge and to provide further insight into the complex mechanisms involved in developmental of children's eating behaviour, appetite regulation and weight status.

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