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Predictors of children's eating behaviors: a prospective study

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Author note

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Abstract

Eating behaviors, notably eating behaviors conceptualized as *appetitive traits*, have been suggested as important determinants of individual differences in body weight and thus overweight and obesity. Such appetitive traits include emotional overeating, food responsiveness, enjoyment of food, satiety responsiveness and slowness in eating. Yet little is known about the factors that influence the development of these appetitive traits. Therefore, the current study prospectively investigated a range of predictors of appetitive traits related to both individual child characteristics and parent factors in a large population-based sample of children followed from age 6 to 8 years (N = 689). When adjusting for the initial levels of the specific appetitive trait in question at age 6 and the other predictors, the results showed that instrumental feeding and low levels of effortful control predicted emotional overeating at age 8, whereas instrumental feeding and parental restrained eating predicted food responsiveness at age 8. Enjoyment of food, satiety responsiveness and slowness in eating were not affected by any of the predictors investigated in this study. In conclusion, these findings support low effortful control and instrumental feeding as predictors of emotional overeating, and instrumental feeding and parental restrained eating as predictors of food responsiveness. These findings are relevant in providing a better understanding of the development of children's eating behaviors, in addition to informing prevention and treatment strategies for childhood obesity.

Keywords: eating behaviors, appetitive traits, childhood obesity, predictors, feeding practices, effortful control

Obesity is considered to be one of the greatest health threats of our time (WHO, 2000). The prevalence of overweight and obesity in school-aged children is increasing in almost all industrialized countries, and the prevalence doubled or tripled in large countries such as the United States, the UK, Australia and Brazil from the 1970's to the 1990's (Wang & Lobstein, 2006). The same trend is seen in Norway: In the last 30 years, there has been a significant increase in BMI among children (Juliusson et al., 2007). In the last decade, a plateau in obesity rates among school-aged children has also been reported (Lissner, Sohlstrom, Sundblom, & Sjoberg, 2010; Morgen et al., 2013; Norwegian Institute of Public Health, 2013).

Obesity is associated with a range of negative physical and psychological consequences for health, such as hypertension, diabetes, fatty liver disease (Han, Lawlor, & Kimm, 2010), depression, sleep problems, behavioral problems and low self-esteem (Pulgaron, 2013). In addition, the risk of becoming overweight as an adult is at least twice as high for children with overweight compared to children with normal weight (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008), and the persistence of overweight is greater with increasing levels of overweight (Singh et al., 2008). Due to these negative outcomes, early prevention and intervention are needed. Understanding the causes of obesity is thus of great importance in order to know what factors to address.

Environmental factors such as sedentary lifestyles and availability of cheap energydense food contribute to the observed increase in obesity rates (Hill, Wyatt, Reed, & Peters, 2003), but such factors alone can not explain the persistence of individual variation in body weight throughout the population (Carnell & Wardle, 2008). Individuals interact differently with the "obesogenic" environment, and individual differences in appetite and eating behaviors are thought to be crucial modifiers of environmental factors (van Jaarsveld, Johnson, Llewellyn, & Wardle, 2010). After all, obesity ultimately derives from excess energy intake, and energy intake is in turn influenced by eating behaviors in several different ways. We make decisions all the time about when and where to eat, how much to eat and when to start and stop eating. Obviously, such individual differences in eating behaviors may explain some of the weight variation throughout the population (French, Epstein, Jeffery, Blundell, & Wardle, 2012). Carnell and Wardle (2008) have developed the behavioral susceptibility theory of obesity, which states that several specific factors, both genetic and environmental, influence eating and weight in a complex interaction. According to this theory, some types of eating behaviors, conceptualized as appetitive traits, will place an individual at higher risk of obesity (Carnell & Wardle, 2008). Thus, knowledge about individual

differences in human eating behaviors and how they develop is important to shed light on how to understand and prevent obesity in children. Information about predictors of eating behaviors enables opportunities for addressing these predictors in order to change appetitive traits and consequently lower the risk of obesity. Targeted interventions that can alter these specific obesity-related eating behaviors, or alternatively modify their impact on weight, might be a promising new direction in managing obesity in children (Carnell & Wardle, 2008). Therefore, the current study aims to examine how individual child factors and parental factors predict eating behaviors from the age of six to eight years in a large and representative sample of children.

Conceptualization of eating behaviors and their relationship to obesity

Eating behaviors may be defined as biological and behavioral processes directed towards meeting requirements for health and growth, and they evolve during the first years of life (Savage, Fisher, & Birch, 2007). Eating behaviors include both food preferences and eating style. Food preferences represent children's food likes and dislikes, whereas eating style often is viewed as specific aspects of how a child eats (Ventura & Birch, 2008). According to this notion, appetitive traits represent aspects of eating style, not specific food preferences. Carnell and Wardle (2008) argue that eating behaviors determining the amount of food eaten rather than the type of food chosen are more discriminatory with regards to who will easily gain excess weight. In other words, appetitive traits may be more important in determining weight outcomes than food preferences (Carnell & Wardle, 2008). In the present research, I will therefore examine appetitive traits only.

Several studies have found a link between appetitive traits as measured by The Children's Eating Behaviour Questionnaire (CEBQ) and overweight and obesity in children (Spence, Carson, Casey, & Boule, 2011; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009). CEBQ was developed to capture dimensions of the normal range of eating behaviors, including dimensions that could lead to excess weight over time (Wardle, Guthrie, Sanderson, & Rapoport, 2001). One study of children aged 7 to 12 years found that eating behaviors were related to weight in a graded fashion, so that some eating behaviors were associated with lower weight whereas others were associated with higher weight. Satiety responsiveness, slowness in eating and food fussiness showed a graded negative association with weight and were therefore named avoidance-related appetitive traits (Webber et al., 2009). Satiety responsiveness refers to the ability to recognize and adjust eating in response to internal feelings of satiety or fullness (Carnell & Wardle, 2008). Behaviorally, it is similar to caloric compensation. Caloric compensation is a laboratory-based measure that assesses children's ability to adjust their food intake after eating a low versus high calorie preload (Faith, Carnell, & Kral, 2013). Children with high satiety responsiveness are better able to compensate for the preload (eating less afterwards) than those with low satiety responsiveness, exhibiting high self-regulation of food intake. Slowness in eating is a measure of eating rate. In behavioral measures, eating rate is operationalized as total energy intake or mouthfuls of food consumed within a given time interval during a meal (Faith et al., 2013). Faster eating rate tends to be associated with greater food intake in adults (Kaplan, 1980). Food fussiness has also been conceptualized as pickiness, and refers to being highly selective about which food to eat. Fussy eating is often viewed as problematic by parents, because it may be difficult to ensure that the child eats healthily and enough (Wardle et al., 2001). In contrast to these avoidancerelated appetitive traits, food responsiveness, enjoyment of food, desire to drink and emotional overeating showed a graded positive association with weight in the study of Webber et al. (2009). For this reason, those dimensions were named approach-related appetitive traits. Food responsiveness refers to the tendency to eat in response to food cues such as sight and smell of food, and children with high food responsiveness are therefore more responsive to the food environment than children with low food responsiveness. An eating behavior named external eating, which also involves eating in response to external food cues, is very similar to food responsiveness, but external eating is measured by another instrument (The Dutch Eating Behavior Questionnaire) and was originally developed for adults (Faith et al., 2013). Enjoyment of food is comparable to food responsiveness, but involves a more general interest in food and desire to eat (Wardle et al., 2001). Enjoyment of food may be observed around mealtimes, in terms of how much the child enjoys the meal. Desire to drink involves the desire for sweetened drinks, and is best illustrated by children wanting to have drinks to carry around with them (Wardle et al., 2001). Emotional overeating, the last approach-related appetitive trait, refers to overeating in emotional states, usually as a response to negative emotions (Wardle et al., 2001). It has been hypothesized that emotional eating occurs when individuals interpret their inner feelings of distress as hunger, consequently leading them to overeat (Slochower, 1987). Overall, these eating behavior dimensions show individual continuity comparable to stable personality traits, indicating that children have characteristic ways of interacting with their food environments that persist over

The study by Ashcroft et al. (2008) also showed an increase in eating behaviors related to

time (Ashcroft, Semmler, Carnell, van Jaarsveld, & Wardle, 2008; Farrow & Blissett, 2012).

obesity (e.g. food responsiveness) over time, whereas eating behaviors related to lower weight (e.g. slowness in eating) decreased over time.

Taken together, eating behaviors may be conceptualized as approach-related appetitive traits and avoidance-related appetitive traits quantitatively distributed in the population. In line with the behavioral susceptibility of obesity (Carnell & Wardle, 2008), some of these appetitive traits, namely high food responsiveness, high enjoyment of food and high emotional overeating, as well as low satiety responsiveness and low slowness in eating, make the individual more prone to excess weight gain over time and therefore constitute a risk of obesity in the current obesogenic environment (Webber et al., 2009). Other studies have reached similar conclusions: appetitive traits were found to prospectively predict increased weight gain in infants from 3 months to 15 months of age (van Jaarsveld, Llewellyn, Johnson, & Wardle, 2011). In addition, Spence et al. (2011) investigated a sample of 4-5 year olds and found positive associations between weight and emotional overeating, food responsiveness and enjoyment of food. They also found negative associations between weight and satiety responsiveness, slowness in eating and food fussiness (Spence et al., 2011). In contrast to the findings by Webber et al. (2009), desire to drink was not significantly associated with weight in the study of Spence et al. (2011). Yet, the results generally provide support for the existence of appetitive traits. Because of their significance for obesity risk, it is of great importance to identify factors affecting the development of these appetite traits.

Development of eating behaviors and predictors of appetitive traits

The development of eating behaviors is a complex process, and involves an interplay between biological tendencies and environmental influences (Ventura & Worobey, 2013). The development is influenced on multiple levels, including genetic factors, neural mechanisms, individual child characteristics, parent-child-interactions and social influences (Gahagan, 2012). In a prospective study of children from the age of 1 to 3 years, it was found noteworthy variation in children's development of eating patterns over time (Hittner & Faith, 2011), indicating that there is no single "blueprint" for developing eating behaviors that applies to all children. This research illustrates that individual differences in eating behaviors emerge from a very early age. In addition, evidence of shared genes between obesity and appetitive traits (Faith et al., 2013) indicate that the genetic influences on obesity might be partly mediated through appetitive traits. For example, the most common gene related to obesity is the fat mass and obesity-associated (FTO) gene, and children with the high-risk allele near or on the FTO-gene scored lower on a measure of satiety sensitivity than children with the low-risk allele in one study (Wardle et al., 2008).

The Ecological Systems Theory (EST) is a widely known theory of human development (Bronfenbrenner, 1986), and is a useful framework for understanding the development of eating behaviors. This theory states that development can not be fully understood without consideration of the context or ecological niche in which the person is embedded (Bronfenbrenner, 1986). For a child, this ecological niche includes the family and the school, which in turn are embedded in larger contexts such as the community or society in general. In addition, the individual characteristics of the child are important, and development occurs as a result of interactions within and between these different contexts. EST has been applied to predictors of overweight and obesity in children (Davison & Birch, 2001), and when taking this model into account, the development of appetitive traits is hypothesized to be influenced by a variety of factors. Consequently, children's eating behaviors are in all likelihood multidetermined. Besides the distal societal/structural influences on eating behaviors, two main sources of proximal influence have organized research during the latter decades, namely child characteristics in addition to parental characteristics and behavior. In the present study, I address these two proximal sources by examining effortful control and emotion regulation (child factors) in addition to parental feeding practices and parental restrained eating (parent factors). As will become evident through the review of the literature below on predictors of appetitive traits, researchers have mainly addressed either child factors or parent factors. To the best of my knowledge, the present study is the first to examine both child- and parents characteristics. Moreover, from research on children's general adaption and behavior, there is growing evidence that environmental factors affect different children differently (Belsky & Pluess, 2009). For example, it has been found that high parental restriction over children's eating in combination with low inhibitory control in children posed a greater risk of overweight in children than low inhibitory control alone (Anzman & Birch, 2009). Thus extending the Ecological Systems Theory by incorporating views and findings from interactional theories of child development, I will therefore examine to what extent such child x parent effects are evident with respect to the development of children's appetitive traits – a line of research that has, to the best of my knowledge, not been pursued before.

Child factors. Self-regulation skills and the temperamental aspect of effortful control have been implicated in both the development of obesity and eating behaviors, as low self-regulation skills predict weight gain in children (Francis & Susman, 2009; Graziano, Calkins, & Keane, 2010; Seeyave et al., 2009). Self-regulation is a multidimensional skill consisting of

several processes aimed at monitoring and modulating cognition, emotion and behavior to achieve a goal and/or adapt to demands in a specific situation (Berger, 2011), and effortful control reflects the self-regulatory aspect of temperament (Kochanska, Murray, & Harlan, 2000). In both the studies by Francis and Susman (2009) and Seeyave et al. (2009), the ability to self-regulate was measured by a delay of gratification task. Delay of gratification is considered to be a crucial aspect of effortful control (Rothbart, Ellis, Rueda, & Posner, 2003) and is defined as the ability to postpone the immediate available gratification in order to obtain delayed but more valued outcomes (Mischel, Shoda, & Rodriguez, 1989). In fact, the ability to delay gratification was found to be associated with lower BMI even 30 years later (Schlam, Wilson, Shoda, Mischel, & Ayduk, 2013).

Eating behaviors, especially external eating or food responsiveness, has been proposed as a mechanism through which low self-regulation causes obesity (Francis & Susman, 2009). Yet eating behaviors are rarely addressed in studies examining self-regulation or effortful control. To my knowledge, only one study has investigated the relationship between effortful control and appetitive traits, and this study reported high effortful control in children to be inversely related to emotional overeating (Pieper & Laugero, 2013). In addition, increased emotional arousal was associated with increased intake of calories consumed in the children with low effortful control (Pieper & Laugero, 2013). These findings indicate that low effortful control might predict emotional overeating, although the cross-sectional design of this study precludes causal inferences. Furthermore, the link to obesity makes it plausible that low effortful control should also predict the other approach-related appetitive traits - food responsiveness and enjoyment of food. On the other hand, it may also be that high effortful control similarly predicts the avoidance-related appetitive traits satiety responsiveness and slowness in eating. Therefore, the current study will explore low effortful control as a predictor of approach-related appetitive traits, and high effortful control as a predictor of avoidance-related appetitive traits in children.

Emotion regulation may be defined as behaviors, skills and strategies, both conscious and unconscious, aimed at modulating, inhibiting and enhancing emotional experiences and expressions (Calkins & Leerkes, 2011). Emotion regulation is thought to be an important developmental task (Calkins & Leerkes, 2011) considered to be a process of the broader construct of self-regulation (Berger, 2011). Graziano et al. (2010) found emotion regulation skills to be especially important in predicting later weight outcomes, and they postulated emotional eating as a possible mechanism for the association between poor regulation skills and higher BMI. If so, one would expect poor emotion regulation skills to predict emotional eating in children as well. Yet the relationship between emotion regulation skills and eating behaviors has not been well studied. To my knowledge, only one study has examined this relationship prospectively, reporting dysfunctional emotion regulation strategies in second grade to positively predict both external eating (or food responsiveness) and emotional eating in third grade (Harrist, Hubbs-Tait, Topham, Shriver, & Page, 2013). These results are in line with the findings of Graziano et al. (2010), indicating that both emotional eating and food responsiveness might be mediators of the link between low emotion regulation and obesity. Harrist et al. (2013) argue that both of these eating behaviors may be perceived as failures of regulation: in the case of emotional eating or food responsiveness might be seen as a result of powerful external cues overriding the internal physiological cues of hunger (Harrist et al., 2013). Notably, emotional eating has been reported to be rather unusual in children compared to external eating or food responsiveness (van Strien & Oosterveld, 2008).

In short, the study by Harrist et al. (2013) indicates that poor emotion regulation skills increase the likelihood of emotional eating and food responsiveness as maladaptive regulation strategies in children. However, Harrist et al. (2013) only investigated two different dysfunctional regulation strategies related to anger and worry. According to the authors, other emotions should also be included in future research. In addition, the follow-up period (second grade to third grade) was relatively short. Therefore, the present study will extend the findings of Harrist et al. (2013) by examining emotion regulation skills in general, not only related to selected emotions, as a predictor of both emotional eating and food responsiveness in a longer follow-up.

Parent factors. Parents are the primary caregivers and providers for their children, and parenting practices have evolved over many thousand years to promote child growth and health (Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011). Two different, but correlated, parenting constructs are usually studied in relation to children's eating behaviors: parenting style and parental feeding practices (Scaglioni et al., 2011). According to Rhee (2008), parenting style may be defined as the general pattern of parenting that provides the emotional background in which parent behaviors are expressed and interpreted by the child. Simply stated, parenting behaviors are what parents do (e.g. praise), while parenting style is how parents do it (e.g. warmth) (Rhee, 2008). Permissive and authoritarian parenting styles have been associated with overweight and obesity (Rhee, Lumeng, Appugliese, Kaciroti, & Bradley, 2006), whereas authoritative parenting style (characterized by warmth, sensitivity and responsiveness) is associated with lower risk of obesity (Rhee et al., 2006) and is also

inversely related to emotional overeating (Topham et al., 2011). Parental feeding practices are more specific than parenting styles, and are often conceptualized as deliberate strategies parents use to influence their children's eating behavior (Wardle & Carnell, 2007). The following four types of feeding style have often been examined (Wardle, Sanderson, Guthrie, Rapoport, & Plomin, 2002): Encouragement/prompting to eat more food, control over eating (in particular restricting access to unhealthy foods), instrumental feeding (use of food as rewards) and emotional feeding (offering foods to manage children's negative moods). Parental feeding practices, especially control over eating and instrumental feeding, have received most attention as a potential predictor of appetitive traits (Carnell & Wardle, 2008) and are therefore the focus of inquiry in the current study.

Restrictive feeding is considered to be a controlling approach to feeding, and has been shown to influence children's eating behaviors. A large number of studies show that restricting access to certain types of food may be counterproductive, and is associated with increased weight (Faith et al., 2004), increased caloric intake and disinhibited eating (Gahagan, 2012). Over-restricting access to some types of foods may actually increase the children's preferences for those foods (Ogden, 2010) and restriction may therefore increase the children's food responsiveness for the restricted foods (Carnell & Wardle, 2008). The mechanism proposed is that the unavailability of the foods paradoxically makes them more attractive to the child. Studies have demonstrated positive relationships between restriction and food responsiveness (Webber, Cooke, Hill, & Wardle, 2010) and between restriction and emotional eating (Kroller, Jahnke, & Warschburger, 2013). However, restriction has also been found to predict decreases in BMI (Campbell et al., 2010), suggesting that restriction may also be protective. Therefore, restriction is at least sometimes a response to parental concern about overweight, rather than a cause of child weight gain and appetitive traits per se (Carnell, Kim, & Pryor, 2012). Webber et al. (2010) also argue that an interactive perspective is important, acknowledging that children both influence and are influenced by their parents' feeding practices.

Instrumental feeding is characterized by the use of food as reward, for example if a child is promised ice-cream after dinner for eating all the vegetables on his/her plate (Carnell & Wardle, 2008). In that way, healthy foods may be used as means to obtain less healthy foods (Carnell & Wardle, 2008). Instrumental feeding has been positively associated with children's snacking behavior (Sleddens, Kremers, De Vries, & Thijs, 2010), enjoyment of food and food responsiveness (Ainuki & Akamatsu, 2011).

Although cross-sectional have demonstrated links between feeding practices and children's eating behaviors, few studies have explored these associations prospectively. One of the few exceptions is a recent study examining children from the age of 2 to 3 years, where restrictive feeding, emotional feeding and instrumental feeding turned out to predict children's eating behaviors and weight outcomes (Rodgers, Paxton, Massey, et al., 2013). Consistent with earlier cross-sectional studies (Gahagan, 2012), restricting food for weight purposes and overt control over eating were prospectively associated with children's tendency to overeat at follow-up. Instrumental feeding was cross-sectionally associated with child emotional overeating and prospectively related to greater child weight gain. Notably, instrumental feeding was the only feeding practice significantly predicting greater BMI increase in children compared to children whose parents did not engage in instrumental feeding. According to the authors, instrumental feeding may lead to increased preference and consumption of high-calorie snacks in response to external cues in children and thus to weight gain. These results might indicate a causal relationship between feeding practices and weight gain, although the reciprocal relation between instrumental feeding and weight gain was not examined. The findings of this study generally support the importance of feeding practices in the development of obesogenic eating behaviors and weight gain in children (Rodgers, Paxton, Massey, et al., 2013). Another longitudinal study found that maternal pressure to eat, also considered to be a controlling approach to feeding, positively predicted increased enjoyment of food in children from 3 to 4 years of age (McPhie et al., 2012). Unfortunately, this study did not measure any of the other appetitive traits.

In addition to parental feeding practices, parents' eating behaviors have been found to influence children's eating behaviors. For instance, several studies report that restrained eating among parents is related to use of restrictive feeding (Birch & Fisher, 2000; de Lauzon-Guillain, Musher-Eizenman, Leporc, Holub, & Charles, 2009). As restrictive feeding has been linked to increased child weight (Faith et al., 2004), this suggests a developmental trajectory where maternal restrained eating is mirrored in restrictive feeding, consequently leading to excessive child weight. Yet Rodgers, Paxton and McLean (2013) found no evidence to support such an assumption in their longitudinal study of 3-year olds. Neither did maternal BMI predict child weight gain. On the other hand, they did find that children of mothers with dietary restraint had significantly higher increases in BMI, but this association was not mediated by restrictive feeding (Rodgers, Paxton, McLean, et al., 2013).

Overall, parent factors, including parental feeding practices and parental restrained eating, may play an important role in the development of children's eating behaviors.

However, parental restrained eating has not been specifically examined as a predictor of appetitive traits longitudinally before, although it has been found to predict increased child BMI in prior research (Rodgers, Paxton, McLean, et al., 2013). Because appetitive traits in the child may be a logical pathway for this association, parental restrained eating will be investigated as a predictor of food responsiveness, emotional overeating and enjoyment of food in the current study. In addition, feeding practices are thought to be important determinants of children's appetitive traits, yet only two prospective studies currently exist regarding these relationships (McPhie et al., 2012; Rodgers, Paxton, Massey, et al., 2013). Both of these studies had relatively small samples (N=117 and N=222 respectively), and moderately short follow-up (12 months). Furthermore, both studies investigated preschoolers, and their findings should therefore be replicated in older children. The study by McPhie et al. (2012) used advertisement to recruit their sample, thus one may question the generalizability of their findings. To extend the contributions of earlier research, prospective studies should additionally include a variety of predictors related to both child characteristics and parent factors in order to examine the relative importance of the various predictors. Including several predictors also enables the opportunity for investigating interaction effects. Therefore, instrumental and controlling feeding practices will be examined as predictors of appetitive traits in the current investigation, and potential interactions between these feeding practices and child factors (effortful control and emotion regulation) will be explored.

Summary and aims of the current study

Some specific dimensions of children's eating behaviors, namely high emotional overeating, high food responsiveness and high enjoyment of food in addition to low satiety responsiveness and low slowness in eating, have been empirically linked to increased weight in children (Spence et al., 2011; van Jaarsveld et al., 2011; Webber et al., 2009) and are therefore conceptualized as appetitive traits. The research described above show that child factors such as effortful control and emotion regulation in addition to parent factors such as parental control over eating, instrumental feeding and parental restrained eating might predict appetitive traits in children. However, as mentioned, the majority of prior research is cross-sectional (Carnell & Wardle, 2008; Vollmer & Mobley, 2013). Causal inferences can therefore not be drawn. In addition, longitudinal studies should include information with several points of influence, which will make it possible to investigate a variety of variables in relation to each other (Vollmer & Mobley, 2013) and provide knowledge about the relative importance of different predictors of eating behaviors. If we are able to identify the driving

forces behind appetitive traits, it will be possible to selectively address these factors in prevention and treatment of childhood obesity.

The aim of the current study was therefore to explore predictors of appetitive traits from the age of 6 to 8 years in a large and representative sample of children. Thus, both child factors (i.e. effortful control and emotion regulation) and parental factors (i.e. instrumental feeding, controlling feeding practices and restrained eating) were examined as predictors of children's emotional overeating, food responsiveness, enjoyment of food, satiety responsiveness and slowness in eating (see Figure 1).

Based on the research reviewed above, it is hypothesized that: i) low levels of effortful control at age 6 will predict approach-related appetitive traits (food responsiveness, emotional overeating and enjoyment of food) at age 8 over and beyond the effect of the respective approach-related appetitive traits at age 6. In addition, high levels of effortful control at age 6 will predict avoidance-related appetitive traits (satiety responsiveness and slowness in eating) at age 8; ii) low emotion regulation skills at age 6 will predict emotional overeating and food responsiveness at age 8; iii) instrumental feeding will predict food responsiveness, emotional overeating and enjoyment of food at age 8; iv) controlling feeding practices will predict food responsiveness, emotional overeating and enjoyment of food at age 8; and v) parental restrained eating will predict food responsiveness, emotional overeating and enjoyment of food at 8 years of age. Moreover, as prior research has found evidence of differential susceptibility to environmental influences in children (Belsky & Pluess, 2009), interactions between child factors and parental feeding practices were to be additionally explored. Finally, since appetitive traits have been reported to be largely stable over time (Ashcroft et al., 2008; Farrow & Blissett, 2012), a secondary aim of the study was to explore the stability of eating behaviors, hypothesizing that the levels of appetitive traits at age 6 would significantly predict the respective appetitive traits at age 8. In addition, it is hypothesized that there will be differences between eating behavior scores at age 6 and age 8, with higher levels of approachrelated appetitive traits and lower levels of avoidance-related appetitive traits at age 8 compared to age 6.

Methods

Participants and procedure

Children born in 2003 and 2004 and their parents living in Trondheim, Norway, were invited to participate by an invitation letter sent to their homes. The letter included the

Strengths and Difficulties Questionnaire (SDQ) version 4-16 (Goodman, Ford, Simmons, Gatward, & Meltzer, 2000), which the parents completed and brought with them when attending the ordinary community health checkup for 4 year olds. During the health check-up, the nurse working at the health clinic obtained parents' written consent to participate in the study. Because the sample was population-based, there was a need to oversample for psychiatric problems. In order to do so, SDQ total difficulty scores were divided into four strata. Defined proportions of each stratum were further selected to participate, and the probability for selection increased with increasing SDQ scores in the four strata.

Later, the child and one of the parents visited the university clinic for testing and observation. Parents also filled out different forms concerning their child and their own functioning and mental health. Retesting took place two and four years later when the children were 6 and 8 years old, respectively. Recruitment and follow-up procedure is presented in Figure 2. Because children's eating behaviors were not measured at the first time point, the current analyses are based on data collected at the two latter measurement points. At age 6 there were 797 respondents (mean age = 6.7 years, SD = .17), whereas 689 children participated in the last data collection at age 8 (mean age = 8.8 years, SD = .24). See Table 1 for sample characteristics.

Because the sample was screen-stratified, weighted analyses had to be conducted. In order to do so, weights proportional to the inverse of the probability of selection of each subject were used. In that way, low screen scores were "weighted up" and high screen scores were "weighted down", yielding unbiased general population estimates. The Horwitz-Thompson estimator was applied to arrive at correct standard errors for the population.

The research procedures were approved by the Regional Committee for Medical and Health Research Ethics.

Measures

Outcomes.

Eating behaviors. The Children's Eating Behaviour Questionnaire (CEBQ) (Wardle et al., 2001) was used to measure appetitive traits. CEBQ is a parent-reported questionnaire that measures eight dimensions of eating behaviors and consists of 35 items. The dimensions included in the current study were Enjoyment of food (e.g. "My child enjoys eating"), Food responsiveness (e.g. "Given the choice, my child would eat most of the time"), Emotional overeating (e.g. "My child eats more when worried"), Slowness in eating (e.g. "My child takes more than 30 minutes to finish a meal") and Satiety responsiveness (e.g. "My child

cannot eat a meal if she/he has had a snack just before") (Wardle et al., 2001). Response options are measured on a 5-item Likert scale ranging from "never" to "always". CEBQ has previously shown good test-retest reliability, with correlations (Pearson r) between .52 and .87 in preschool children (Wardle, et al., 2001). In the current inquiry, the internal reliability (Cronbach's alpha) at ages 6 and 8 respectively, were .75 and .77 for emotional overeating, .65 and .67 for food responsiveness, .81 at both time points for enjoyment of food, .70 and .74 for satiety responsiveness, and .71 at both time points for slowness in eating. In addition, CEBQ has shown good validity by comparing the eating behavior dimensions with different behavioral tests of eating behavior. For example, higher score on food responsiveness has been associated with faster eating rate and greater total energy intake (Carnell & Wardle, 2007).

Predictors: child factors.

Effortful control. Effortful control was measured by the short version of The Children's Behavior Questionnaire (CBQ) (Putnam & Rothbart, 2006; Rothbart, Ahadi, Hershey, & Fisher, 2001). CBQ is a caregiver report measure of temperament for children aged 3 to 7 years, and the entire questionnaire covers three main factors: negative affectivity and extraversion/surgency in addition to effortful control. The effortful control factor consists of 4 subscales: Attentional focusing (6 items, e.g. "Is easily distracted when listening to a story"), Inhibitory control (6 items, e.g. "Can wait before entering into new activities if she/he is asked to"), Perceptual sensitivity (6 items, e.g. "Seems to listen to even quiet sounds") and Low-intensity pleasure (8 items, e.g. "Likes being sung to"). The following estimates of internal reliability (Cronbach's alpha) have been reported for these scales: α ranging from .70 to .75 for attentional focusing, .62 to .72 for inhibitory control, .60 to .73 for perceptual sensitivity, and .60 to .82 for low-intensity pleasure (Putnam & Rothbart, 2006). However, the lowest levels of internal consistency were obtained in samples characterized by poverty and low socioeconomic status. The short form of the CBQ has also shown good stability and continuity consistent with the standard form (Putnam & Rothbart, 2006).

Emotion regulation. Emotion regulation skills were assessed through parent report using the emotion regulation subscale of the Emotion Regulation Checklist (ERC) (Shields & Cicchetti, 1997). The emotion regulation scale consists of 8 items (e.g. "My child can say when he or she is feeling sad, angry or mad, fearful or afraid"), and each item is rated on a 4-point Likert scale. The emotion regulation scale has previously shown good internal consistency (mean $\alpha = .83$) (Shields & Cicchetti, 1997), it correlates with other established measures of emotion regulation, and it has been shown to discriminate well between well-

regulated and dysregulated groups of children, thus exhibiting good validity (Shields & Cicchetti, 1997).

Predictors: parent factors.

Parental feeding practices. Parental feeding practices were measured by the Parent Feeding Style Questionnaire (PFSQ) (Wardle et al., 2002), a caregiver report measure of feeding practices consisting of four dimensions of feeding: Instrumental feeding, Emotional feeding, Encouragement and Control over eating. All items are rated on a 5-point Likert scale from 1 (never) to 5 (always). In the current inquiry, only the Instrumental feeding (e.g. "I reward my child with something she/he is well-behaved") and Control over eating (e.g. "I decide how many snacks my child should have") scales were included. The PFSQ scales have previously demonstrated good test-retest reliability (Pearson r) of .83 and .76 for Control over eating and Instrumental feeding, respectively. The internal consistency (mean α) has been estimated to .81 for Control and .67 for Instrumental feeding (Wardle, et al., 2002).

Parental restrained eating. Restrained eating was measured by The Eating Disorder Examination Questionnaire (EDE-Q), which is a 32 item self-report measure based on the Eating Disorder Examination Interview (Fairburn & Cooper, 1993). The EDE-Q consists of four subscales: Dietary Restraint, Weight Concern, Shape Concern, and Eating Concern (Luce & Crowther, 1999). Only the Restraint subscale (e.g. "Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight (whether or not you have succeeded)?") was used for the purposes of this study. The Restraint subscale has previously shown high internal consistency (mean $\alpha = .84$) and high test-retest reliability (Pearson r =.81) (Luce & Crowther, 1999).

Results

Stability of appetitive traits

All analyses were performed using SPSS version 21 (IBM, 2012), and weighted analyses were conducted through the Complex Samples module. To examine the stability of appetitive traits from age 6 to 8 years, General Linear Modelling (GLM) was applied. Each of the appetitive traits at age 8 (emotional overeating, enjoyment of food, food responsiveness, slowness in eating and satiety responsiveness) were regressed on the scores on the same appetitive trait at age 6. This yielded estimates indicating to what extent appetitive traits at age 6 predicted appetitive traits at age 8. Table 2 displays the stability of eating behaviors from 6 to 8 years of age. As expected, the eating behavior scores at age 6 significantly predicted the same scores at age 8, indicating that all of the appetitive traits were stable over time. In addition, two-tailed t-tests were performed to investigate differences between eating behaviors at age 6 and age 8. As can be further seen in Table 2, the results showed significant decreases in slowness in eating and satiety responsiveness from age 6 to age 8 (p<.001), in addition to an increase in enjoyment of food from age 6 to age 8 (p<.05).

Predictors of appetitive traits at age 8

To initially explore the associations between predictors and outcome variables, correlations (Pearson *r*) were estimated. The correlations are presented in Table 3. As can be seen, there were significant positive correlations (p<.001) between instrumental feeding and both emotional overeating and food responsiveness at both ages. In addition, parental control over eating was negatively associated with emotional overeating at age 6 (p<.001) and positively associated with enjoyment of food at age 6 (p<.001). Moreover, effortful control was negatively associated (p<.01) with emotional overeating and food responsiveness at age 8, whereas enjoyment of food at age 8 was positively related to effortful control (p<.01). Parental restrained eating was positively associated (p<.01) only with food responsiveness at both ages.

To test the predictive value of the different child factors and parent factors, a two-step procedure was applied. First, all of the predictors were initially tested as bivariate predictors of appetitive traits at 8 years of age. In order to do so, GLM was applied in a series of bivariate analyses where each of the appetitive trait scores were regressed on each of the five predictors (effortful control, emotion regulation, instrumental feeding, control over eating and parental restrained eating). The analyses were adjusted for CEBQ scores at age 6 and gender. Secondly, again using GLM, multivariate analyses were performed where each appetitive trait score was regressed on all five predictors. These multivariate models yielded estimates indicating the unique contributions of each of the predictors in explaining each of the five appetitive traits. Notably, each model was adjusted for gender and the respective eating behavior score at age 6. This procedure was applied for all of the five eating behavior dimensions. Analyses were conducted on complete cases, hence the resulting N in the multivariate analyses varied between 618 and 620.

Child factors. In the bivariate analyses, effortful control at age 6 negatively predicted food responsiveness and emotional overeating at age 8 (see Table 4). In addition, effortful control positively predicted slowness in eating at age 8. The association with emotional overeating remained significant in the multivariate analysis, whereas the relationships between effortful

control and food responsiveness and slowness in eating were no longer significant when adjusting for the other predictors. Furthermore, lower emotion regulation skills significantly predicted emotional overeating at 8 years of age, but the relationship was no longer significant when adjusting for the other predictors.

Parent factors. As further shown in Table 4, emotional overeating and food responsiveness were significantly predicted by instrumental feeding even after controlling for the other predictors. However, none of the eating behavior dimensions were predicted by controlling feeding practices. Food responsiveness was the only eating behavior dimension predicted by parental restrained eating. Neither satiety responsiveness nor enjoyment of food was predicted by any of the predictors.

The multivariate regression models had the following estimates (R squares) of explained variance in eating behaviors at 8 years of age: .33 for emotional overeating, .41 for food responsiveness, .40 for satiety responsiveness, .47 for enjoyment of food and .46 for slowness in eating.

Interactions between child factors and parent factors

To examine possible interactions between parent factors and child factors, GLM was applied in a series of analyses to test such interactions as predictors of appetitive traits at age 8. Four possible parent-child-interactions were investigated: effortful control x control over eating, effortful control x instrumental feeding, emotion regulation x control over eating, and emotion regulation x instrumental feeding. Similar to the bivariate analyses, each of the possible interactions (e.g. effortful control x parental control over eating) were regressed on each of the appetitive traits scores, adjusting for main effects. Three interactions turned out to be significant: effortful control x parental control over eating positively predicted both food responsiveness and enjoyment of food, whereas emotion regulation x instrumental feeding negatively predicted slowness in eating (see Table 4). To explore the nature of these parentchild-interactions further, the predictive value of feeding practices were investigated depending on whether the children had high or low levels of effortful control (EC) and emotion regulation (ER) in the sample. In order to do so, the sample was split in half with respect to EC and ER. When children were high on EC, parental control positively predicted enjoyment of food at age 8 (B = .10; S.E. = .05; β = .06; p = .033), adjusting for enjoyment of food at age 6. However, among children with low effortful, parental control was unpredictive of enjoyment of food. The same procedure was applied in predicting food responsiveness depending on levels of effortful control, but parental control over eating predicted food

responsiveness neither in high nor low scorers on EC. Children were also divided into two equal groups with respect to ER. The results from these regressions showed that parental instrumental feeding positively predicted slowness in eating at 8 years of age (B = .12; S.E. = .05; $\beta = .10$; p = .018) among children low on emotion regulation. No significant effects were found when ER scores were high.

Discussion

The main objective of the current study was to explore predictors of eating behaviors in a large and representative sample of school-aged children. Two important sources of individual differences in eating behaviors have been suggested; child characteristics and parent characteristics. Importantly, children's appetitive traits may influence parents as well as being influenced by parents (Carnell et al., 2012), and parent and child characteristics are therefore often interwoven. For this reason, predictors of children's eating behaviors need to be studied prospectively and multivariately in order to discern the unique effects of parent and child factors. To the best of my knowledge, no prior studies have provided such data. As hypothesized, the current results show that low effortful control and instrumental feeding at age 6 predicted emotional overeating at age 8. The assumption that parental restrained eating and instrumental feeding at age 6 would predict food responsiveness in the child at age 8 was also confirmed. Note that these results were obtained adjusting for initial levels of the various eating behaviors at age 6. In addition, the secondary hypothesis that the appetitive traits would be stable from age 6 to age 8 was also supported. However, contrary to what was expected, enjoyment of food, slowness in eating and satiety responsiveness were not predicted by any of the factors investigated in the current study.

The finding that the appetitive traits were highly stable from age 6 to 8 years is in accordance with previous studies (Ashcroft et al., 2008; Farrow & Blissett, 2012), indicating that children have persisting typical ways of interacting with the food environment. As expected, the avoidance-related appetitive traits (satiety responsiveness and slowness in eating) were also significantly lower at age 8 compared to age 6, whereas the approach-related appetitive trait enjoyment of food was significantly higher at age 8 compared to age 6. These results are in line with a model of children developing increasingly obesogenic eating behaviors as they grow older (Ashcroft et al., 2008). However, the present results did not suggest increases in emotional overeating and food responsiveness as indicated by the findings of Ashcroft et al. (2008). Farrow and Blissett (2012) investigated a younger sample

than Ashcroft et al. (2008) and did not find any differences in eating behaviors in children from to 2 to 5 years of age. According to the authors, this indicates that the patterns of change in eating behaviors start later than 5 years of age. The current findings might therefore suggest that patterns of change in food responsiveness and emotional overeating start later compared to satiety responsiveness, slowness in eating and enjoyment of food.

Earlier studies have linked effortful control to the development of emotional overeating. In their cross-sectional study, Pieper and Laugero (2013) reported that high effortful control was inversely associated with emotional overeating. The authors further found that increased emotional arousal was related to increased consumption of calories in children who had low scores on a delay of gratification task. The results of the current study extend the findings of Pieper and Laugero (2013), by showing that low effortful and emotional overeating are linked longitudinally, not only cross-sectionally. Earlier research has linked self-regulation skills to the development of overweight and obesity in children (Francis & Susman, 2009; Graziano et al., 2010; Seeyave et al., 2009). Thus, the present results suggest that emotional overeating may mediate the effect of poor global self-regulation skills on obesity development. However, because weight was not included in the present inquiry, investigating whether such an indirect mechanism is indeed operative is a task awaiting future studies.

The assumption that low levels of effortful control would predict food responsiveness and enjoyment of food whereas high levels of effortful control would predict satiety responsiveness and slowness in eating, was not supported. Initially, there was a significant effect of effortful control negatively prediciting food responsivness and positively predicting slowness in eating, but the effects did not remain significant in the multivariate analyses. These results indicate that effortful control might share some variance with parent factors, possibly restrained eating and instrumental feeding, as these factors were the ones uniquely and directly predicting food responsiveness. Furthermore, it may also be that the effect of low effortful control on appetitive traits mainly is expressed through emotional overeating, and not the other approach-related traits.

The results showed that low emotion regulation skills predicted emotional overeating (but not food responsiveness) in the bivariate analyses, which is partly in line with the findings of Harrist et al. (2013), who found poor emotion regulation skills in second grade to predict emotional eating and external eating in third grade. However, when accounting for the other predictors in the multivariate analysis, the effect of emotion regulation on emotional overeating disappeared. A multivariate model was not tested in the study by Harrist et al.

(2013), and the results of this study thus extend their results. Furhermore, because low effortful control was found to be a significant predictor of emotional overeating in the current study, the finding that low emotion regulation did not multivariately predict emotional overeating may not necessatily be at odds with the study by Harrist et al. (2013). As both effortful control and emotion regulation are seen as processes of the multidimensional skll of self-regulation (Berger, 2011), it might be that emotion regulation and effortful control overeating.

Instrumental feeding or use of food as reward has previously been linked to both food responsiveness (Ainuki & Akamatsu, 2011) and emotional overeating (Rodgers, Paxton, Massey, et al., 2013), and this study provide further support for these relationships. It may be that instrumental feeding has a detrimental effect on the development of eating behaviors by reinforcing the positive association to the food reward (Carnell & Wardle, 2008), leading to increased preference for and attention towards food cues in the child – and thus higher food responsiveness. In addition, such associative learning may also lead to reinforced associations between food and emotions, for example if a child is being rewarded and encouraged with food for doing something he/she did not want to do initially. In that way, the child may learn to use food as a regulation strategy by engaging in emotional eating. In addition, the present research indicate that targeting instrumental feeding practices might be a promising way to reduce the risk of developing obesogenic appetitive traits and thus obesity in children. Such an intervention has proven to be possible, as a recent randomized controlled trial found a significant effect of targeting feeding practices in first-time mothers (Daniels, Mallan, Nicholson, Battistutta, & Magarey, 2013). Consisting of guidance on early feeding practices, the intervention led to a reduction in instrumental feeding and restrictive feeding, in addition to increased levels of protective feeding practices (e.g. responsiveness and sensitivity) in mothers who had undergone the intervention compared to a control group (Daniels et al., 2013). It may be that the reduction of instrumental feeding in the study by Daniels et al. (2013) also reduced the risk of developing food responsiveness and emotional overeating in children. However, currently this is only speculation, and such a hypothesis remains to be tested. Besides, longer follow-up periods are needed to find out whether the protective effects of the intervention will last.

Contrary to what was expected, controlling feeding practices did not predict any of the appetitive traits in the current study. These results are surprising considering that previous research has reported cross-sectional links between parental restriction and food responsiveness (Webber, et al., 2010) and emotional eating (Kroller, et al., 2013), in addition

to a prospective link between parental control and tendency to overeat in the child (Rodgers, Paxton, Massey, et al., 2013). However, this field of research is characterized by inconsistent results, possibly due to the use of different measures. Research using the Child Feeding Questionnaire (CFQ) (Birch et al., 2001) more often find a positive link between controlling approaches and obesogenic eating behaviors (Birch, Fisher, & Davison, 2003) compared to studies using the Parent Feeding Style Questionnaire (PFSQ) (Ogden, 2010). For example, Wardle et al. (2002) found no association between child weight and use of control, but rather found that mothers of children with obesity reported use of less control (Wardle et al., 2002). Another reason for the inconsistent findings may be the conceptualization of parental control, which has been criticized for being too narrow (Ogden, Reynolds, & Smith, 2006). The concept of control measured by PFSQ and CFQ is a form of overt control, but control may also be covert, for instance by avoiding places that sell unhealthy foods (Ogden et al., 2006). Rodgers, Paxton, Massey et al. (2013), who found parental control over eating to have a detrimental effect on children's eating behaviors, used more elaborated measures of feeding practices than the current study, as they included several aspects of control obtained through initial factor analysis of five different measures of feeding practices. Therefore, the results do not necessarily mean that parental control is unimportant; they merely reflect the general trend of inconsistent results. Researchers would probably benefit from agreement on the best method to measure parental control.

Although no main effects of parental control were found in the current study, effects of parental control did emerge in combination with child effortful control. In line with the differential susceptibility model (Belsky & Pluess, 2009), these results suggest that parental control over eating has differential impact on children depending on their level of effortful control. For children with high levels of effortful control, parental control over eating positively predicted enjoyment of food and may thus contribute to overweight and obesity. No such effect of parental control on enjoyment of food was found in children with high levels of effortful are highly capable of self-regulating their food intake, and that parental control might override their internal control by causing an increased interest in food. With regards to food responsiveness, the effortful control x parental control over eating interaction turned out to be significant as an interaction term, but not when the sample was split in two. When the sample was split in terms of high and low levels of emotion regulation, it was found that parental instrumental feeding positively predicted slowness in eating in children with low levels of emotion regulation, a finding that is surprising as one would have expected instrumental

feeding to be linked to approach-related appetitive traits. However, it should be acknowledged that several interactions were run, and one can not exclude the possibility that some of these interactions appeared by chance. It is also possible that the effect of parental control and instrumental feeding appeared in ranges of effortful control and emotion regulation that was not optimally covered when the sample was split in the way it was. In summary, these findings imply that parents should be careful in exercising too much control over eating with children high in effortful control. To my knowledge, no previous studies have investigated such differential susceptibility in children to the influence of parental feeding practices in the development of eating behaviors. In addition, these results highlight the possibility that previous inconsistent findings concerning parental control may partly be due to different levels of effortful control in children.

Because earlier studies show food responsiveness to be closely associated with increased weight gain in children (Spence et al., 2011; van Jaarsveld et al., 2011; Webber et al., 2009), the current finding that parental restrained eating predicted food responsiveness is in line with the study by Rodgers, Paxton and McLean et al. (2013), who found maternal restrained eating to predict increased child BMI. The results of the current study might indicate that food responsiveness, and not enjoyment of food and emotional overeating, is a plausible mediator of the association between parental restrained eating and excess weight in children, but this assumption needs to be tested. It is largely unknown how restrained eating in parents may influence food responsiveness in children. Rodgers, Paxton and McLean (2013) speculated that parents may perceive the food they are trying to restrict as especially rewarding (usually palatable snack foods), and that they might model this perception to their children via their attitudes and behaviors (Rodgers, Paxton, McLean, et al., 2013). As modelling also influences children's eating behaviors (Kral & Rauh, 2010), this explanation is plausible. Another possible explanation is shared genes, as restrained eating in parents may be a response to being susceptible to weight gain. If food responsiveness and risk of obesity are linked genetically, the observed association between restrained eating and food responsiveness could be due to a genetically transmitted risk of both food responsiveness and weight gain. This hypothesis is in accordance with the findings from a large population-based study reporting that the obesity-related FTO gene is significantly associated with food responsiveness in children (Velders et al., 2012). Taken together, the association between parental restrained eating and child food responsiveness may be a result of parental modelling, or it may be a byproduct of a shared genetic disposition towards obesity.

Enjoyment of food, satiety responsiveness and slowness in eating were not predicted by any of the factors examined in the current inquiry. As mentioned earlier, a small but significant positive effect was found for effortful control on slowness in eating in the bivariate analyses. However, when adjusting for the other predictors in the multivariate analysis, there were no significant predictors of slowness in eating either. One explanation might be that these appetitive traits are determined by genetic factors to a larger degree than the other appetitive traits, and are thus less influenced by environmental factors such as those examined in the current study. A twin study investigating appetitive traits in a population-based sample partly supports this notion: High heritability estimates were found for satiety responsiveness (72%) and slowness in eating (84%), whereas only moderate estimates were found for enjoyment of food (52%) and food responsiveness (59%) (Llewellyn, van Jaarsveld, Johnson, Carnell, & Wardle, 2010). In addition, moderate effects of shared environment were found for food responsiveness and enjoyment of food, but not for satiety responsiveness and slowness in eating. No effect was found for slowness in eating, and only a small effect was found for satiety responsiveness (Llewellyn et al., 2010). As the heritability estimates for food responsiveness and enjoyment of food were quite similar, these estimates can not account for the lack of significant predictors of enjoyment of food in the current study. However, another twin study with older children found high heritability (75%) and low shared environment estimates for enjoyment of food (Carnell, Haworth, Plomin, & Wardle, 2008), indicating that the genetic expression of this trait might increase with age.

Limitations

Although this study has many strengths, including a large population-based sample and prospective analyses, some limitations should be noted. First, the sole reliance on parental report may be a limitation. Hence, co-variation between measures can to a certain degree be explained by common method variance. Yet, it is less clear how common method variance could explain these prospective results because the initial co-variation between measures was partialled out in the analyses. In addition to the use of parent-reported questionnaires, experimental tasks measuring eating behaviors would have been an advantage, but are unfortunately too time - and cost-consuming in large samples such as this one. According to Faith et al. (2013), experimental laboratory-based assessments of eating behaviors are the gold standard because they are observable measures obtained under controlled conditions. However, eating behavior dimensions as measured by the Children's Eating Behaviour Questionnaire (CEBQ) have been demonstrated to correlate with laboratory-based tests of eating behavior (Carnell & Wardle, 2007). In addition, CEBQ has the advantage of characterizing children's eating behaviors across a range of situations (Faith et al., 2013). Furthermore, although this study included far more predictors of eating behavior than earlier research, the number of factors could have been even more extensive. Hence, taking into account additional parent and child factors, genetic factors in particular (Carnell et al., 2008; Llewellyn et al., 2010), this study could probably have explained more of the variations in appetitive traits. Expanding the model in such a way is one line of research that may shed additional light on the development of children's eating behaviors. Finally, it should be acknowledged that General Linear Modelling (GLM) is not the optimal way to analyze prospective data. Ideally, mixture modelling/growth modelling would have been more appropriate. However, weighted analyzes had to be conducted due to the oversampling in the recruitment phase to arrive at correct population estimates, and therefore the Complex Samples module of SPSS had to be used. Unfortunately, the only available statistical program for the present study, the SPSS, does not allow for mixture modelling in its Complex Samples module.

Conclusions

Instrumental feeding and low effortful control were found to predict emotional overeating, whereas instrumental feeding and parental restrained eating predicted food responsiveness in children from 6 to 8 years of age. As parental control over eating interacted with child effortful control in predicting enjoyment of food, the findings additionally indicate that the impact of environmental influences might depend on child characteristics to some extent. In conclusion, this study provides support for an ecological view of eating behaviors in the sense that both individual child factors and parent factors served as predictors of children's eating behaviors. The soundness of these conclusions was supported by the use of a large and representative community sample, and that the analyses were adjusted for initial levels of the eating behavior in question. The findings might suggest that targeting instrumental feeding practices through early guidance on feeding practices to parents (Daniels et al., 2013) may decrease the risk of high food responsiveness and emotional overeating, eating behaviors that are associated with obesity and known as appetitive traits. Notably, though, such an assumption needs to be tested in future studies. Further research is warranted to examine possible mediators of the prospective associations observed in the current study. Such studies should include information about both child weight and genetic factors in addition to predictors at different levels to test specific mediation hypotheses.

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Table 1

Sample characteristics

Characteristics	%
Gender of child	
Male	49.8
Female	50.2
Gender of parent informant	
Male	18.9
Female	81.1
Ethnic origin of biological mother	
Norwegian	93.0
Western	6.7
Other countries	.3
Ethnic origin of biological father	
Norwegian	93.0
Western	6.3
Other countries	.7
Parents living together (> 6 months)	85.7
Socioeconomic status of parent (highest)	
Leader	12.5
Professional, higher level	36.7
Professional, lower level	36.2
Formally skilled worker	14.1
Unskilled worker	.6

Table 2

Eating behavior mean scores, differences between eating behaviors at age 6 and age 8, stability in eating behaviors from age 6 to age 8.

	Ag	e 6	Ag(8	Differenc scores age	e between 3 6 – age 8	Stability	/ in eating b	ehaviors
	Mean	S.E.	Mean	S.E.	t	df	В	S.E.	β
Emotional overeating	1.44	.01	1.44	.02	.05	651	.58***	.03	.54
Food responsiveness	1.90	.02	1.87	.02	-1.62	654	.68***	.04	.64
atiety responsiveness	2.93	.02	2.81	.02	-5.94***	655	.67***	.03	.62
Enjoyment of food	3.44	.02	3.48	.02	2.24*	655	***69'	.03	.67
Slowness in eating	2.55	.02	2.42	.02	-6.11***	655	.65***	.03	.67

Note: Stability in eating behaviors was analyzed using GLM (general linear modelling), adjusting for gender. Difference between eating behavior score at age 6 and age 8 was investigated using a two-tailed T test.

* = p < .05; ** = p < .01; *** = p < .001

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ess in eating	Age 8	*60`	.04	.06	.06	.03
Slowne	Age 6	*60	.02	.05	.06	.02
ent of food	Age 8	.13**	.02	02	.12**	.04
Enjoyme	Age 6	.19**	.12**	05	.15***	.04
onsiveness	Age 8	.01	03	*60'	04	.01
Satiety resp	Age 6	.03	05	.11**	11**	02
onsiveness	Age 8	11**	05	.22***	05	.12**
Food respo	Age 6	06	*60	.31***	09*	.10**
overeating	Age 8	15***	11**	.31***	12**	.06
Emotional	Age 6	10**	10**	.40***	20***	.05
		Effortful control	Emotion regulation	Instrumental feeding practices	Controlling feeding practices	Parental restrained eating

Note. Correlation estimates = Pearson r.

* = p < .05; ** = p < .01; *** = p < .001.

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Predictors at age 6		В	S.E.	β	В	S.E.	β	В	S.E.	β	В	S.E.	β	В	S.E.	β
Effortful control	Unadjusted	07**	.03	08	05*	.03	05	001	.03	001	.01	.03	.01	.07*	.03	.05
	Adjusted	06*	.03	07	05	.03	05	003	.03	003	.01	.03	.01	90.	.03	.05
Emotion regulation	Unadjusted	13*	90.	06	.04	90.	.02	.01	.07	.01	10	.07	04	.14	.08	.05
	Adjusted	12	90.	05	.04	90.	.02	003	.07	001	12	.07	05	.10	.08	.04
Instrumental feeding	Unadjusted	.14***	.03	.15	*70.	.03	.07	.02	.03	.02	.03	.03	.03	.02	.03	.01
practices	Adjusted	.14***	.03	.14	*70.	.03	.07	.02	.03	.02	.04	.03	.03	.04	.03	.03
Controlling feeding	Unadjusted	01	.04	01	.01	.03	.01	.05	.04	.03	.06	.04	.04	.08	.05	.05
practices	Adjusted	.03	.04	.02	.03	.03	.02	90.	.04	.04	.08	.04	.05	.07	.05	.04
Parental restrained	Unadjusted	.02	.01	.04	.03*	.01	90.	.02	.01	.03	.01	.01	.03	.01	.02	.02
eating	Adjusted	.02	.01	.04	.03*	.01	.06	.01	.01	.03	.01	.01	.03	.01	.02	.01
Effortful control X parental control	Unadjusted	.10	.07	.04	.16*	.07	.05	07	.07	02	.17*	.07	.05	04	60.	01
instrumental feeding	Unadjusted	.07	.05	.04	.04	90.	.02	02	.07	01	002	90.	001	.03	.08	.01
Emotion regulation A parental control Emotion regulation V	Unadjusted	17	.15	03	06	.15	01	.24	.18	.03	20	.18	03	01	.23	001
Entrotion regulation A instrumental feeding	Unadjusted	.04	.13	.01	.25	.16	.05	16	.16	03	.12	.14	.02	32*	.15	06
	•	- -		-	-	-	•	-			-	-	-			

Note. All analyses are adjusted for eating behavior scores at age 6 and gender. Unadjusted = bivariate analyses of the predictors. Adjusted = adjusted for all other predictors.

* = p < .05; ** = p < .01; *** = p < .001.



Figure 1. Conceptual model illustrating predictors of appetitive traits: child factors and parent factors.



Figure 2. Recruitment and follow up.