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Eating behavior in young children: the role of individual and contextual characteristics

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Chapter 1

Eating Behavior in Young Children: an Introduction

The first chapter provides an overview of the literature on eating behavior in young children. The overview is subdivided in two sections in accordance with the two research lines of the current doctoral dissertation. In the first section, we present literature on eating behavior and related weight status, as well as on influencing factors. The second section focuses on existing literature on stimulating healthy eating in young children. Finally, an overview is presented of the empirical studies and research questions of the present doctoral dissertation.

Research Line 1: Exploring Eating Behavior in Young Children

Healthy eating habits contribute to an overall sense of well-being (Blanchflower, Oswald, & Stewart-Brown, 2013) and the prevention of diseases (U.S. Department of Health and Human Services, 2010; U.S. Department of Health and Human Services/ U.S. Department of Agriculture, 2005; World Health Organisation, 2003). Although important at all ages, good nutrition is particularly essential during childhood, as this period is critical for children's healthy development (e.g. age-adequate growth, normal cognitive development) (du Plessis, Naude, & Swart, 2016). Indeed, dietary intake in the first years of life is associated with risk factors for chronic diseases such as overweight and increased cholesterol levels (Ernst & Obarzanek, 1994). Furthermore, childhood is an important period for shaping children's food preferences and eating habits, which may continue into adulthood (Nicklaus, Boggio, Chabanet, & Issanchou, 2004; Nicklaus & Remy, 2013). Indeed, frequently observed eating problems in early childhood, such as struggle over eating, food neophobia (i.e. the rejection of novel or unknown foods), eating little, pickiness (i.e. the rejection of familiar foods), eating slowly and low interest in food (Jacobi, Agras, Bryson, & Hammer, 2003; Marchi & Cohen, 1990; McDermott et al., 2008; Stice, Agras, & Hammer, 1999), constitute a risk factor for developing parallel pathological problems (e.g. eating disorders) in childhood and adolescence (Marchi & Cohen, 1990).

In Flanders, the Active Food Triangle has been constructed to promote a balanced, healthy diet (Flemish institute for Health Promotion and Disease Prevention, 2016; Vanhauwaert, 2012). This food triangle provides recommendations, including age-appropriate daily portion sizes, for each of seven major food groups (i.e. non-sugared beverages; bread, cereals, potatoes, and grains; vegetables; fruit; milk products & calcium-enriched soy products; meat, fish, eggs and meat substitutes; fat & oils) (Flemish institute for Health

Promotion and Disease Prevention, 2004). For example, children between 3 and 6 years of age should eat a daily portion of 100-150 grams of vegetables and 100-200 grams of fruit. Despite the importance to eat healthy and the information available on recommended daily consumption, the overall diet of preschool Flemish children does not meet the recommended food-based dietary guidelines (Huybrechts et al., 2008). The consumption of vegetables, fruits and non-sugared beverages in particular was far below the recommended guidelines of the Active Food Triangle, while the consumption of snacks and sugared drinks was too high (Huybrechts et al., 2008).

Parallel to children's failure to meet the recommended daily food guidelines, an increase in childhood overweight and obesity prevalence has been observed in the last three decades (Hedley et al., 2004; Ng et al., 2014). Obesity is defined as a condition where a pathological excess of body fat is present in an individual (Wabitsch, 2000). Overweight is conceptualized as an increased body weight in relation to height - when compared to established standards - without a pathological excess of body fat (Field, Barnoya, Colditz, Wadden, & Stunkard, 2002). The most problematic region regarding weight problems is the United States, where 22.8% of children between 2 to 5 years and 34.2% of children between 6 to 11 years have overweight or obesity (Ogden, Carroll, Kit, & Flegal, 2014). Europe is heading in the same direction, with 19.9% of all children aged 2 to 10 years being classified as overweight or obese (Ahrens et al., 2014). Overweight and obesity is the result of a long-term imbalance between energy intake an expenditure, influenced by a variety of processes and variables (Brug, van Lenthe, & Kremers, 2006). Understanding the etiology of this imbalance in young children is critical, since childhood obesity causes a wide range of medical (e.g. Type 2 diabetics, orthopedic problems) and psychosocial complications (e.g. low self-esteem, poor body image), both concurrently and in the long term (Daniels, 2009; Lee, 2009;

Strauss, 2000), and tends to persist in adolescence and adulthood (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997).

Influencing factors

According to the bio-psycho-social models (Davison & Birch, 2001; Story, Neumark-Sztainer, & French, 2002), eating habits and related weight status are influenced by a variety of factors originating from multiple contexts at the contextual and individual level, and interactions between both levels.

Contextual level

Home environment. As young children are dependent on their parents, the latter exert a strong influence on their children's lifestyle, including eating habits. The influence of parents on children's eating behavior can be organized into three categories, in line with the comprehensive model of Rhee (2008), which describes three categories of parental influences: specific parent feeding practices, general parent behaviors, and global parenting influences. The first category, specific parent feeding practices, is defined as "targeted toward the child, with the intent to shape eating behaviors and intake" (p. 13) (e.g. prompting the child to eat, rewarding it, encouraging it). The second category contains general parent behaviors that are not directly targeted toward the child's eating, but still have an indirect influence on its eating behavior (e.g. exposing the child to food, making foods available, modeling behavior) (Bere & Klepp, 2005; Cullen et al., 2003). Finally, the third category refers to global parenting influences, which include parenting style and family functioning. These are responsible for the emotional climate at home in which the two first categories of parental influences are expressed and interpreted by the child. While parenting style is defined as the general pattern of parenting, family functioning is a broader dimension representing how the family manages daily routines, connects with each other, communicates and fulfills parenting roles

(Rhee, 2008). Within parenting style, two major dimensions can be distinguished, reflecting how parents interact with their children during feeding situations: responsiveness and demandingness (Hughes, Power, Fisher, Mueller, & Nicklas, 2005; Maccoby & Martin, 1983). In the feeding domain, responsiveness is conceptualized as the extent to which parents provide affective warmth, acceptance and support and the extent to which they are positively involved in the child's eating behavior. Previous research showed that responsiveness during feeding situations was positively associated with positive general parenting behaviors such as support and following through on discipline, and negatively associated with negative feeding practices and negative general parenting behaviors, including inconsistency, restriction and pressure to eat (Hennessy, Hughes, Goldberg, Hyatt, & Economos, 2010). Therefore, high responsive parents, compared to low responsive parents, may be able to create a warm, supportive atmosphere which might facilitate healthy eating habits. In the feeding domain, demandingness refers to the extent to which parents show control, monitor and supervise the child's eating. Both over-controlling (Birch, Fisher, & Davison, 2003; Farrow & Blissett, 2006; Wardle, Carnell, & Cooke, 2005) and under- controlling parental practices (Robinson, Kiernan, Matheson, & Haydel, 2001) were found to be associated with negative child outcomes. Instead, parents should apply a moderate level of control (e.g. monitoring healthy food consumption) in helping children establish healthy eating habits. The three broad dimensions (i.e. specific parent feeding practices, general parent behaviors, and global parenting influences) are obviously interconnected (see Figure 1); for example, children are more inclined to accept specific parent feeding practices in a positive family climate, created by positive family interactions or order in the household (Rhee, 2008). Some influences are positive and create a healthy eating environment for children, while others are negative and may contribute to unhealthy eating habits and overweight (Rhee, 2008).

Societal characteristics. Besides proximal environments influencing children's development, such as the home environment, more distal environments, such as the society, also exert an influence on children. The society has recently changed into an obesogenic environment in which sedentary behavior is promoted and energy-dense palatable, and thus highly rewarding, foods are highly advertised, readily available, and served in larger portions (Lowe & Butryn, 2007; Young & Nestle, 2002). These environmental changes discourage physical activity and facilitate increased energy intake, which in turn contribute to overweight or obesity (Rolls, 2011). In children, positive associations have been found between "screen time" (i.e. sedentary behavior) and weight status (Falbe et al., 2013). Furthermore, negative associations have been reported between children's weight status and their physical activity (Chaput et al., 2014). A significant positive relation between the consumption of sweet food and weight status was documented in adults (Te Morenga, Mallard, & Mann, 2013).

Concurrently, the society increasingly promotes the ideal thin body image (Brownell, 1992) which is accompanied by a perceived pressure to be thin and a heightened body dissatisfaction, especially among adolescent girls (Cash, Morrow, Hrabosky, & Perry, 2004; Striegel-Moore & Bulik, 2007; Striegel-Moore, Silberstein, & Rodin, 1986). Body dissatisfaction is positively related to restrained eating (Gerner & Wilson, 2005) and constitutes a risk factor for the development of eating disorders (Smolak & Thompson, 2009; Stice & Agras, 1998). However, not all individuals are susceptible to these environmental influences as not everyone living in the current environment develops eating problems or gain weight. This observation suggests that, in addition to environmental factors, *individual characteristics* might also be involved in eating habits and weight control, an assumption that fits well with the biopsychosocial models (Davison & Birch, 2001).

Individual level

Since food is a primary reinforcer (Berridge, 1996), it usually acts as a positive, appetitive reward activating pleasant thoughts and approach behavior (Berridge, 1996; Saper, Chou, & Elmquist, 2002) which facilitates energy intake. However, food may sometimes act as a negative, aversive stimulus, activating disgust and avoidance behavior (Batsell, Brown, Ansfield, & Paschall, 2002; Rozin & Fallon, 1980). In the field of eating behavior, different concepts have been used to describe adaptive and maladaptive movements towards or away from food. In the current thesis, eating behaviors that involve a movement towards food or thoughts that imply a desire for food, even in the absence of hunger, are labeled as food approach. Examples of food approach are overeating, emotional eating (i.e. eating in response to negative affect, regardless of hunger or satiety) (Van Strien, Frijters, Bergers, & Defares, 1986), external eating (i.e. eating in response to food-related stimuli, regardless of hunger or satiety) (Van Strien et al., 1986) and food responsive behavior (i.e. the extent to which the child wants to eat, regardless of hunger or satiety) (Wardle, Guthrie, Sanderson, & Rapoport, 2001). Eating behaviors that involve a movement away from food or thoughts that imply an aversion for food are labeled as food avoidance. Examples of food avoidance are the refusal to eat, picky/fussy eating (i.e. the rejection of familiar foods) (Dovey, Staples, Gibson, & Halford, 2008), food neophobia (i.e. the rejection of novel or unknown foods) (Birch & Fisher, 1998), slowness in eating (Wardle et al., 2001) and emotional undereating (i.e. the tendency to eat less in response to negative affect) (Wardle et al., 2001). Not surprisingly, food approach and avoidance were found to be implicated in weight gain and loss respectively (for review see French, Epstein, Jeffery, Blundell, & Wardle, 2012; Sleddens, Kremers, & Thijs, 2008). For example, there was a significantly positive relation between children’s disinhibited eating (i.e. eating behaviors involving a lack of control over food consumption) and their adiposity (Hill et al., 2008;

Zocca et al., 2011). Furthermore, an increased Body Mass Index in young children correlated with a higher degree of food responsiveness, enjoyment of food and emotional overeating (Carnell & Wardle, 2008; Sleddens et al., 2008; Viana, Sinde, & Saxton, 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009). Similarly, in a clinical study, children with obesity tend to show more external eating compared to non-obese children (Braet & Van Strien, 1997). Regarding scales measuring food avoidance; higher scores on satiety responsiveness and slowness in eating were significantly related to decreased Body Mass Index in young children (Sleddens et al., 2008).

The difference in how individuals respond to food might depend on genes. For example, food preferences, which strongly influence children's eating patterns and consumption (Baxter & Thompson, 2002; Cullen et al., 2003; Domel et al., 1996; Drewnowski, 1997; Gibson, Wardle, & Watts, 1998; Resnicow et al., 1997) are partially genetically determined (Breen, Plomin, & Wardle, 2006; Falciglia & Norton, 1994). Although humans have an innate preference for sweet tastes, and an inherited aversion for bitter and sour tastes (Schwartz, Issanchou, & Nicklaus, 2009; Steiner, 1979), research has identified genes related to individual differences in sweet taste perception (Fushan, Simons, Slack, Manichaikul, & Drayna, 2009) and bitter taste perception (Bufe et al., 2005). Genes were also shown to be an important determinant of inter-individual differences in body weight. For example, it is estimated that 25% to 40% of the body mass index is heritable (Pérusse, Chagnon, Dionne, & Bouchard, 1997; Wieting, 2008). More research is needed to examine the underlying psychological mechanisms that explain *how* genes affect weight. Therefore, the current doctoral thesis explores the sensitivities of two basal neuropsychological systems (i.e. the Behavioral Activation System and the Behavioral Inhibition System) that might explain the difference in how individuals respond to food, which in turn affects weight status.

The Behavioral Activation System (BAS) and the Behavioral Inhibition System (BIS) originate from Gray's Reinforcement Sensitivity Theory and are described as two biologically grounded motivational systems that regulate behavior (Gray, 1970, 1981, 1987a, 1987b; Gray & McNaughton, 2003). Each system is assumed to result in a dimensional temperamental trait that varies between people: *reward sensitivity* (i.e. reward-related approach motivation) is assumed to reflect the sensitivity of BAS, *punishment sensitivity* (i.e. punishment-related avoidance motivation) the sensitivity of BIS. The BAS is thought to respond to rewarding environmental stimuli by activation of the dopaminergic system (Depue & Collins, 1999; Gray, 1981, 1987a, 1994) in the brain regions implicated in reward processing (i.e. mesocorticolimbic pathways) (Di Chiara et al., 2004; Risinger, Freeman, Rubinstein, Low, & Grandy, 2000). This triggers the initiation of "approach" behavior aimed at obtaining the reward (Kane, Loxton, Staiger, & Dawe, 2004). People high in reward sensitivity are assumed to have a highly sensitive BAS-system, easily activated by rewards and exhibiting stronger appetitive responses compared to people low in reward sensitivity. The brain does not seem to differentiate whether the reward is provoked by natural rewards (e.g. palatable food), behavior (e.g. winning a bet) or pharmacologic agents (e.g. illicit drugs) (Kelley, Schiltz, & Landry, 2005). The BIS is assumed to react on signals of conditioned aversive events (e.g. punishment or non-reward), novelty, and innate fear stimuli. Brain structures considered to be involved in the BIS system are the septohippocampal system and its monoaminergic afferents from the brainstem (Gray, 1987b, 1994; Gray & McNaughton, 2003). The activation of the BIS in response to these stimuli causes inhibition of ongoing behavior or avoidance of aversive stimuli. People high in punishment sensitivity are assumed to have a highly sensitive BIS-system, easily activated when confronted with punishment and exhibiting stronger inhibitory or avoidant responses, compared with people scoring lower on punishment sensitivity

(Carver & White, 1994; Gray, 1978, 1987b, 1990; Gray & McNaughton, 2003). Variations in punishment sensitivity and reward sensitivity can explain individual differences in affectivity, personality and behavior in different domains of life (Bijttebier, Beck, Claes, & Vandereycken, 2009; Corr, 2004).

Not surprisingly, reward and punishment sensitivity are also implicated in eating behavior, eating difficulties and weight status (Bijttebier et al., 2009; Davis, Strachan, & Berkson, 2004; Van den Berg et al., 2011; Verbeken, Braet, Lammertyn, Goossens, & Moens, 2012). Various studies demonstrated a significant positive relation between reward sensitivity and body weight in normal and overweight adults and elementary school children, with high reward sensitive individuals reporting higher body weight compared to low reward sensitive individuals (Davis & Fox, 2008; Van den Berg et al., 2011; Verbeken et al., 2012). For individuals with obesity, this correlation was sometimes found to be positive (Van den Berg et al., 2011), and sometimes found to be negative (Davis & Fox, 2008; Verbeken et al., 2012). Therefore, research is needed to explore the underlying mechanisms. In a sample of adult women (Davis et al., 2007) and elementary school children (Van den Berg et al., 2011), a model has been described in which food approach behaviors mediated the relation between reward sensitivity and weight status. In that model, reward sensitivity was considered a risk factor for enhanced food approach. Reward sensitivity was indeed found to be related to overeating (e.g. binge eating, emotionally driven eating and external eating), with individuals higher in reward sensitivity reporting more overeating compared to individuals lower in reward sensitivity (Davis et al., 2004; Loxton & Dawe, 2001; Van den Berg et al., 2011). Reward sensitivity was also thought to be a determinant of food preferences (Davis et al., 2007). Consistently, adults with high reward sensitivity, compared to low reward sensitivity, showed a preference for sweet taste (Saliba, Wragg, & Richardson, 2009) and spicy foods (Byrnes & Hayes, 2013). Not only preference for sweet food, but also intake of high energy products was found to be determined by reward sensitivity (De Cock et al., 2016; De Cock et al., 2015; De Decker et al., 2016). Daily intake of snacks and sugar sweetened beverages was higher in individuals with higher reward sensitivity, especially in adolescent girls (De Cock et al., 2015).

The role of reward sensitivity in eating behavior and related body weight is well described in both adolescents and adults. However, the implications of punishment sensitivity in this domain are less studied. Nevertheless, punishment sensitivity has been conceptually and empirically linked to eating disorders (Beck, Smits, Claes, Vandereycken, & Bijttebier, 2009; Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006). Since punishment sensitivity is related to inhibition or avoidance behavior (Gray & McNaughton, 2003), it might be assumed that individuals with an eating disorder characterized by food avoidance behavior are more sensitive to punishment compared to healthy controls. Indeed, individuals with eating disorders involving purging or chronic self-starvation were found to be more sensitive to punishment compared to healthy controls (Claes et al., 2006; Harrison, O'Brien, Lopez, & Treasure, 2010; Matton, Goossens, Vervaet, & Braet, 2015).

Research gap

As documented above, eating habits and body weight outcomes are found to be influenced by a variety of factors originating from the environmental and individual level. However, until now, research investigating the link between punishment sensitivity, reward sensitivity and eating behavior and related body weight has mainly focused on adolescents and adults. This is surprising, as temperamental differences and eating behaviors develop early, and may track into adolescence and adulthood (Nicklaus & Remy, 2013). Furthermore, eating problems in early childhood are common in young children (Jacobi et al., 2003; Marchi & Cohen, 1990; McDermott et al., 2008;

Stice et al., 1999) and constitute a risk factor for developing parallel pathological problems in childhood and adolescence (Marchi & Cohen, 1990). Despite the importance of studying eating behaviors in early age, research investigating the link between punishment sensitivity and reward sensitivity on the one hand, and eating behavior and weight on the other hand in this crucial developmental period is scarce. Based on theoretical considerations and previous research, high punishment sensitive children, compared to low punishment sensitive children, are hypothesized to display more food avoidance behavior. Furthermore, high reward sensitive children, compared to low reward sensitive children, are expected to display more food approach behavior, which increases the odds to develop overweight and obesity.

Given the development of eating problems and the increasing prevalence of overweight and obesity in the early years (Ng et al., 2014), childhood is an important period for establishing healthy eating habits and preventing overweight or obesity. While the first research line of the doctoral dissertation focuses on correlates of unhealthy eating behaviors and related body weight, the second research line focuses on stimulating the consumption of healthy food, and more specifically, vegetables. For young children, healthy food is particularly essential to achieve age-adequate growth and cognitive development (du Plessis et al., 2016). We specifically focus on vegetables as research shows that (a) the consumption of vegetables is far below minimum food based dietary guidelines, (b) vegetables happen to be the least-liked food category (Cashdan, 1998; Perez-Rodrigo, Ribas, Serra-Majem, & Aranceta, 2003; Skinner, Carruth, Bounds, & Ziegler, 2002), (c) micronutrients contained in vegetables are helpful in protecting children against illnesses (Antova et al., 2003) and (d) vegetables are rich in fibers, which promote satiety, and might in turn decrease energy intake by reducing the consumption of energy dense (i.e. high in sugar and fat) products (Spill, Birch, Roe, & Rolls, 2011).

Research Line 2: Stimulating the Consumption of Vegetables in Young Children

As described above, eating habits are determined by a wide range of factors (Blissett & Fogel, 2013; Rasmussen et al., 2006). Of these, preferences or the liking of food, is repeatedly identified as a strong and important determinant of children's consumption (Baxter & Thompson, 2002; Cullen et al., 2003; Domel et al., 1996; Gibson et al., 1998). In line with this statement, children's consumption of sweet, energy-dense foods (i.e. foods that are more frequently liked) is too high, whereas children's consumption of vegetables (i.e. foods that are less frequently liked) is too low (Cowart, 1981; Huybrechts et al., 2008; Schwartz et al., 2009; Steiner, 1979). Repeated Exposure, in which children are repetitively exposed to the taste of food items, is the most basic learning strategy for establishing liking of initially disliked food items. Repeated Exposure is in line with the "mere exposure hypothesis", which states that repeatedly making a stimulus available enhances liking for that stimulus (Zajonc, 1968). Multiple studies proved Repeated Neutral Exposure (i.e. Repeated Exposure through neutral instructions) to be effective in increasing liking and consumption of an initially disliked vegetable (Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Birch & Marlin, 1982; Birch, Mcphee, Shoba, Pirok, & Steinberg, 1987; Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010; Wardle, Cooke, et al., 2003; Wardle, Herrera, Cooke, & Gibson, 2003). However, no consensus has been reached on the amount of taste exposure necessary to increase liking. Despite this discrepancy, it has been generally agreed that at least one taste exposure is necessary. In other words, children can never benefit from the Repeated Exposure effect if they refuse to taste. Since *willingness to taste* is needed to obtain exposure, and thus, a perquisite to establish liking (Birch, Mcphee, Shoba, Pirok, et al., 1987), a major pitfall of Repeated Neutral Exposure is the absence of a motivational component to encourage tasting. Such motivation is advisable, given the high prevalence of food neophobia (i.e. the rejection of novel or unknown foods) (Birch & Fisher, 1998), picky/fussy eating (i.e. the rejection of familiar foods) (Galloway, Lee, & Birch, 2003) and given public health concerns on decreased vegetable consumption in preschool children (Dovey et al., 2008; Huybrechts et al., 2008). In the current doctoral thesis, we see willingness to taste as an initial approach behavior with specific antecedents and consequences, while considering liking as a more cognitive affective correlate of learning. Although past research has taken considerable interest in how to improve overall liking and consumption of vegetables, relatively little information is available concerning the strategies that can help children to enhance their willingness to taste. Therefore, the current thesis investigates the effect of strategies on willingness to taste, as well as on liking and consumption of vegetables.

Strategies to improve willingness to taste

Modelling

One possible way to improve willingness to taste is providing a good role model. Children are more likely to eat vegetables when they witness someone consuming them (Greenhalgh et al., 2009). Not only do adults (familiar as well as unfamiliar) seem to be effective role models (Hendy & Raudenbush, 2000), peers (Greenhalgh et al., 2009; Hendy, 2002) and even cartoon characters also have a positive influence on children’s eating behavior (Harris & Baudin, 1972). After all, the Social Cognitive Theory (Bandura, 1977) has suggested that modelling can be very influential in establishing learning and behavioral change. Although modelling is more likely to be effective in the presence of a similar (e.g. peers), or familiar (e.g. parent or teacher) model (Bandura, 1977), adult strangers were also found to have a positive influence on children’s food acceptance (Harper & Sanders, 1975). Within the model of Rhee (2008), modelling can be categorized as a general (parent) behavior.

Verbally encouraging

Verbal encouragement can be seen as a second possible strategy to enhance willingness to taste. It is a commonly used strategy to positively encourage individuals to provide an optimal effort in different types of behavior (Andreacci et al., 2002), including eating behavior. Verbal encouragement by food service staff is associated with higher fruit and vegetable consumption in elementary school children (Perry et al., 2004). Even at younger ages (12-17 months), children are more likely to accept food when their caregivers provide positive verbal encouragement (Dearden et al., 2009). Within the model of Rhee (2008), verbal encouragement can be considered a specific (parent) feeding practice. Verbal encouragement needs to be differentiated from verbal coercion or pressure, which is inversely related to the consumption of fruit and vegetables (Brown, Ogden, Vögele, & Gibson, 2008; Galloway, Fiorito, Francis, & Birch, 2006). While verbal coercion is a negative form of verbal prompting in which the child feels pressured to eat, verbal encouragement is a less intrusive form of verbal instruction in which precautions are made to prevent the child from feeling obligated to taste (e.g. child-friendly tone).

Rewarding

Thirdly, providing a reward might also be effective to encourage children to taste a disliked food item. Similar to verbal encouragement, rewarding can be classified as a specific (parent) feeding practice (Rhee, 2008). Although this strategy has been broadly studied in the context of liking and consumption of vegetables, opinions are divided when it comes to the consequences of using rewards. According to the Self Determination Theory, a reward serves as an extrinsic motivator and it can undermine the intrinsic motivation (Deci, Koestner, & Ryan, 1999). Indeed, some studies have shown that the preference and liking of food decreases when children are offered a reward (Birch, Marlin,

& Rotter, 1984; Newman & Taylor, 1992). However, the relation between rewards and liking or consumption of food seems more complex than originally stated in the Self Determination Theory. Rewards can become powerful tools in the process of developing the liking for healthy food provided they are used appropriately. It has indeed been shown that exposure+reward parings have positive short and long term effects on liking and consumption (Cooke, Chambers, Anez, Croker, et al., 2011). Similar to Repeated Neutral Exposure, no consensus has been reached on the number of exposure+reward parings necessary to change liking and consumption. Overall, the effectiveness of rewards seems to depend on the outcome variable (consumption vs. liking), the extent to which the child originally liked the food item, the behavior being rewarded and the type of reward (for review see Cooke, Chambers, Anez, & Wardle, 2011). In most studies, rewards are found to have positive effects on *consumption* (e.g. Horne et al., 2009; Horne et al., 2004; C. F. Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). However, their effects on *liking* can be counterproductive, when the food item was already liked prior to the administration of the reward (Birch, Birch, Marlin, & Kramer, 1982; Birch et al., 1984). Furthermore, rewarding children for *clearing their plate* may undermine their internal regulation system and lead to overweight (Birch et al., 1982; Birch, Mcphee, Shoba, Steinberg, & Krehbiel, 1987; Birch, Zimmerman, & Hind, 1980). Conversely, rewarding children for *tasting* a food item they dislike might eventually have positive effects on liking and consumption (Cooke, Chambers, Anez, Croker, et al., 2011). Furthermore, the *type of reward* is also important. Offering sweets as a reward seems to provoke negative effects: it enhances the preference for the sweets (Newman & Taylor, 1992). On the other hand, various studies have demonstrated that both non-food tangible rewards (e.g. stickers) and non-tangible rewards (e.g. praise) enhance children's liking and consumption of disliked food items (Lowe et al., 2004; Nicklas et al., 2001; Vereecken, Keukelier, & Maes, 2004). However, compared to a non-tangible reward (i.e. praise), tangible rewards seem to be more powerful in facilitating tasting (Cooke, Chambers, Anez, Croker, et al., 2011).

The use of evidence-based strategies in practice

Despite the knowledge on evidence-based strategies to stimulate healthy eating behavior and the various attempts of several organizations to disseminate nutritional advice among parents, their translation into children's consumption of healthy food has not been observed (Huybrechts et al., 2008; Kim et al., 2014; Storey & Anderson, 2016). This may suggest that the effectiveness of an intervention does not solely depend on strategy-related characteristics, even though these are generally proven to be effective in an artificial situation (e.g. researcher-led). The current doctoral thesis examines whether the effectiveness of an intervention additionally depends upon child characteristics, parent characteristics (i.e. demandingness and responsiveness, as already discussed under '*Home environment*'), and how it is communicated to parents.

The role of child characteristics

Previous studies mainly examined the *general* effectiveness of different strategies on improving liking, consumption or acceptance of vegetables. However, children may react differently to different strategies, depending on their personal characteristics (Blissett, Bennett, Fogel, Harris, & Higgs, 2016). Recently, it was shown that the effectiveness of strategies to facilitate the acceptance of a novel fruit depended on food responsiveness: physical prompting strategies in combination with modelling facilitated the acceptance of a novel fruit, but only in children who showed high food responsive behavior (Blissett et al., 2016). It was also shown that the effectiveness of strategies to increase consumption of a moderately-liked vegetable is linked to bitter-sensitivity: bitter-sensitive preschoolers consumed significantly more broccoli after being repeatedly exposed to broccoli with dressing than when served plain. In contrast, the dressing did not promote consumption among bitter-insensitive preschoolers (Fisher et al., 2012). This differential sensitivity to different strategies highlights the importance of taking into account *child characteristics* when selecting a strategy aimed at improving healthy eating.

While research has suggested that we take into account a child's individual reward sensitivity as a biological predisposition that guides human learning and behavior (Beaver et al., 2006), little is known about the specific role of a child's reward sensitivity in learning to like and consume vegetables. As mentioned above, individuals with a high reward sensitivity are thought to be vulnerable to developing overweight and obesity, due to their preference for foods high in fat and sugar (Davis et al., 2007). In order to address their susceptibility to overweight, it is possible that enhancing their preference for healthy food may help them to forego temptations and keep healthy weight (for review of the link between consumption of healthy food and Body Mass Index see Tohill, Seymour, Serdula, Kettel-Khan, & Rolls, 2004). In following the definition of reward sensitivity (Gray, 1981, 1987a), children high in reward sensitivity are expected to respond more strongly to rewarding environmental stimuli compared to those lower in reward sensitivity. Consequently, a strategy with a rewarding aspect is probably most effective in children with higher reward sensitivity. Another child characteristic that might influence the effectiveness of a strategy is food neopbobia, which is, due to its 'avoidance' nature, theoretically related to punishment sensitivity. Due to their fear for unfamiliar foods, high food neophobic children consume less fruit and vegetables than low food neophobic children (Cooke, Carnell, & Wardle, 2006; Coulthard & Blissett, 2009; Wardle et al., 2005). Since the former experience more difficulties with tasting new food items, more patience and efforts are needed to conquer their fear of tasting. Thus, food neophobia may hamper or slow down the process of liking, which might reduce the effectiveness of a strategy.

The role of communication

Another factor that might influence the effectiveness of strategies is how they are communicated to parents. Recently, it was shown that Flemish caregivers, including parents, do not seem to have adequate knowledge on how to correctly apply strategies to stimulate healthy eating behavior (Vandeweghe, Moens, et al., 2016). Since erroneously performed strategies might elicit detrimental effects, it seems crucial that parents receive detailed information on how to apply a strategy correctly. Indeed, it was shown that specific instructions on how to apply an intervention, in contrast to general information (i.e. a leaflet with nutritional advice), were effective in improving children's liking and consumption of a vegetable (Wardle, Cooke, et al., 2003). Therefore, in the present thesis, it is assumed that more extensive information will lead to enhanced parental learning, which in turn, should be reflected in a better outcome of the intervention. The multimedia principle states that "people learn more deeply from words and pictures than from words alone" (p. 31) (Mayer, 2002). Moreover, multimedia instructional messages should take into account the modality principle, which posits that learning will be facilitated when different modalities are addressed (e.g. visual and auditory) (Mayer, 2009). Based on both principles, it might be assumed that visually demonstrating the strategy accompanied by verbal information, is more effective than communicating the strategy through the phone (i.e. verbal instructions only). The assumption that adding visual demonstration will provide stronger effects is further strengthened by the Social Cognitive Theory (Bandura, 1977), which posits that people learn by observing the actions of others. Recently Remington, An, Croker, Wardle, and Cooke (2012) showed that a strategy explained and demonstrated during a home visit increased children's liking and consumption of a vegetable compared to no intervention. However, as the study did not examine interventions delivered in different ways, it was unable to assess the relative effectiveness of the delivery method. The present thesis fills this gap in the research literature by comparing two delivery methods. Besides hypothesized general positive effects of a multimedia and multimodal approach, it might additionally reduce the influence of child and parent characteristics on the effectiveness of the intervention. Indeed, more extensive information might reduce or even eliminate the differential influence of high and low food neophobic children, and high and low responsive and demanding parents.

Research Questions and Overview of the Empirical Studies

The current doctoral dissertation consists of seven chapters, including an introduction, five empirical studies and a general discussion. The first two studies (i.e. chapter 2 and 3) are related to the first research line in which correlates of eating behaviors and related body weight are investigated in a community sample of young children (i.e. 2.5 to 9 years old). The last three studies (i.e. chapter 4, 5 and 6) are related to the second research line and focus on stimulating vegetable consumption in a community sample of preschool children (i.e. 2.5 to 6 years old), taking into account individual and/or contextual characteristics. In the following paragraphs, a brief overview is provided of the five empirical studies, and their added value to research on eating behavior in young children.

Study 1

As already mentioned in the introduction, research investigating the link between punishment sensitivity, reward sensitivity and eating behavior has mainly focused on adolescents and adults. This is surprising, as temperamental differences and eating behaviors develop early, and may track into adolescence and adulthood (Nicklaus & Remy, 2013). Furthermore, eating problems in early childhood are common in young children (Jacobi et al., 2003; Marchi & Cohen, 1990; McDermott et al., 2008; Stice et al., 1999) and constitute a risk factor for developing parallel pathological problems in childhood and adolescence (Marchi & Cohen, 1990). Research on the relation between reward sensitivity, punishment sensitivity and eating behaviors in preschool children is highly relevant, since knowledge on the determinants of eating behavior in childhood increases the understanding of both normal and problematic eating behavior, and the development of eating disorders later on. Despite the importance of studying eating behaviors in early age, research investigating the link between punishment sensitivity and reward sensitivity, and eating behavior in this crucial developmental period is scarce.

The first study (i.e. chapter 2; cross-sectional parent-report survey study) aims to examine the relation between reward sensitivity, punishment sensitivity, food approach, and food avoidance in a sample of 98 preschool children (*M*=4.87; *SD*=1.13). We predict that reward sensitivity will be positively correlated with food approach, while punishment sensitivity will be positively correlated with food avoidance. This study is one step in understanding how general basic temperamental traits (i.e. reward sensitivity and punishment sensitivity) are related to more proximal factors (i.e. specific food approach and avoidance) determining eating habits.

Study 2

Compared to the first study, study 2 (i.e. chapter 3) is less exploratory in nature (i.e. including less questionnaires and only focusing on the part with reward sensitivity). The second study attempts to replicate some of the results of study 1 in a sample with a broader age range (i.e. children aged 2.5 to 9 years), and additionally links the constructs under investigation with body weight.

Despite the relevance of reward sensitivity and food approach behaviors as determinants of weight gain, only few studies in this age group have investigated its underlying mechanisms, such as the assumption that food approach behavior might constitute the pathway through which reward sensitivity influences body weight. It is important to find evidence for underlying mechanisms such as these, which can help to guide prevention programs. So far, only one cross-sectional study with adult women showed that reward sensitivity predicted overeating, which in turn predicted body mass (Davis et al., 2007). A second cross-sectional study with elementary school children found that overeating indeed mediated the relationship between reward sensitivity and body mass (Van den Berg et al., 2011). To our knowledge, the small number of studies investigating this relationship did not include preschool children. Moreover, a direct relation between reward sensitivity and body weight has not yet been evidenced in preschool children.

The first aim of the second study (i.e. chapter 3; cross-sectional parent-report survey study) is to examine the relation between reward sensitivity and body weight in a sample of 211 children aged 2.5 to 9 years (*M*= 6.27; *SD*=1.60). We expect that reward sensitivity correlates significantly positively with body weight. The second aim is to investigate the intervening role of two operationalisations of food approach behavior (i.e. food responsive behavior and external eating) in the association between reward sensitivity and body weight. We expect that high reward sensitivity is related to an enhanced display of food approach behavior, which in turn is associated with increased body weight.

Study 3

Given the development of eating problems and the increasing prevalence of overweight and obesity in the early years (McDermott et al., 2008; Ng et al., 2014), childhood is an important period for establishing healthy eating habits and preventing overweight and obesity. Past research has examined different strategies to increase the liking and consumption of healthy foods such as modeling, reward learning and verbal encouragement (Cooke, Chambers, Anez, & Wardle, 2011; Greenhalgh et al., 2009). Willingness to taste, however, has been less researched, even though it is a first crucial step in the process of developing liking for healthy food. The third study (i.e. chapter 4) is a laboratory experiment in which 204 preschool children (*M*=4.48, *SD*=1.01) were exposed to one taste session. We aim to investigate which strategy is effective in increasing children's willingness to taste a disliked vegetable. We expect that modelling, rewarding and verbal encouragement are more effective to improve willingness to taste than neutral instructions. Furthermore, as previously mentioned, little is known about the specific role of individual characteristics, such as a child's reward sensitivity, in learning to like and consume vegetables. Therefore, we aim to explore whether willingness to taste depends on children's reward sensitivity under different conditions. The child's reward sensitivity was assessed via a parent-report questionnaire. We expect that children high in reward sensitivity have a higher willingness to taste in a reward strategy than children low in reward sensitivity. More specifically, we believe that children's reward sensitivity will predict their willingness to taste only when a reward is given.

Study 4

Similar to study 3 (i.e. chapter 4), study 4 (i.e. chapter 5) is an experimental study conducted with children between 4 and 6 years old. In the fourth study however, children are repeatedly exposed to a disliked vegetable instead of having one single tasting trial. Besides examining willingness to taste, the design additionally enables us to investigate the effect of strategies on liking and consumption. Moreover, while study 3 is conducted in the lab, study 4 is conducted at school, which is a more ecologically valid context.

Study 4 (i.e. chapter 5) aims to further investigate the effectiveness of different strategies (i.e. Repeated Neutral Exposure (RNE), Repeated Exposure (RE)+token reward and RE+social reward) in preschool children (*N*=154; age: *M*=5.08, *SD*=.61). The effectiveness of the strategies was determined by willingness to taste and liking after having tasted the vegetable during the intervention period (i.e. when the strategy is applied), and change in liking and consumption after versus before the intervention period compared to a control condition in which no strategy was provided. Based on previous research (Cooke, Chambers, Anez, Croker, et al., 2011), it was hypothesized that children in the three intervention conditions (i.e. RNE, RE+token reward, RE+social reward) would show increased liking and consumption of an initially disliked vegetable after the intervention period compared to children in the control condition. Because of the motivational component in the reward conditions, we additionally expected a stronger increase in liking and consumption after the intervention as well as an enhanced willingness to taste and higher odds of obtaining liking during the intervention in both RE+reward conditions compared to the RNE condition. Second, the study investigated whether the effectiveness of the different conditions depended on reward sensitivity. The child's reward sensitivity was assessed via a parent-report questionnaire. With respect to RE+token reward condition, it was expected that, based on theory (Gray, 1981, 1987a; Gray & McNaughton, 2003) and previous research (Vandeweghe, Verbeken, Moens, Vervoort, & Braet, 2016), children high in reward sensitivity, compared to children low in reward sensitivity, would show a stronger increase in liking and consumption after the intervention, and a higher willingness to taste and higher odds of obtaining liking during the intervention. With respect to RE+social reward, opposite hypotheses were formulated based on theoretical conceptualizations on the one hand (Gray, 1981, 1987a) and previous findings on the other (Vandeweghe et al., 2016). In line with the theoretical conceptualization of reward sensitivity

(Gray, 1981, 1987a), children high in reward sensitivity, compared to children low in reward sensitivity, are expected to show a stronger increase in liking and consumption after the intervention and a higher willingness to taste and higher odds of obtaining liking during the intervention in the RE+social reward condition. However, in line with a previous study showing that verbal encouragement, which announces a social reward, is most effective in low reward sensitive children (Vandeweghe, Verbeken, et al., 2016), it is expected that children low in reward sensitivity, compared to high reward sensitivity, would show a stronger increase in liking and consumption after the intervention, and a higher willingness to taste and higher odds of obtaining liking during the intervention in the RE+social reward condition.

Study 5

Although study 3 and 4 provide valuable information on stimulating healthy food in young children, they do not provide evidence that the strategies will be successful in daily life (e.g. home environment), as they are both research-led. Therefore, study 5 (i.e. chapter 6; experimental study) investigated the effectiveness of a parent-led home based intervention (i.e. the Taste Kit) in preschool children (N=147; age: M=4.58; SD=.93). The Taste Kit is based on a reward strategy and evaluated as change in liking and consumption of an initially disliked vegetable. It was hypothesized that children in the intervention conditions (i.e. conditions in which the Taste Kit was conducted), compared to children receiving no intervention, would show increased liking and consumption of an initially disliked vegetable. We additionally investigated whether the way in which the Taste Kit is delivered affects the effectiveness of the intervention. It was expected that demonstrating and explaining the Taste Kit at *home* (i.e. multimodal approach; visual and verbal instructions) would enhance parent's learning performance more than delivering information through the *phone* (i.e. verbal instructions only), which would be reflected in enhanced liking and consumption scores in the home visit condition compared to the phone condition. We further examined the moderating role of child characteristics (i.e. reward sensitivity and food neophobia) and parent characteristics (i.e. demandingness and responsiveness). As the Taste Kit involves a tangible reward-based intervention, it was hypothesized that high reward sensitive children, compared to low reward sensitive children, would show a stronger increase in liking and consumption in the intervention conditions. We further expected that there would be a difference between the extent of food neophobia and responsiveness in the phone condition, with lower food neophobia and higher responsiveness associated with a stronger increase in liking and consumption. We expected these effects to be smaller or extinguished in the home visit condition, as these parents are more extensively informed on how to conduct the strategy. Furthermore, the moderating effects of demandingness were explored. No specific hypotheses were formulated as both ends of the construct might negatively affect the intervention outcomes.

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Figures

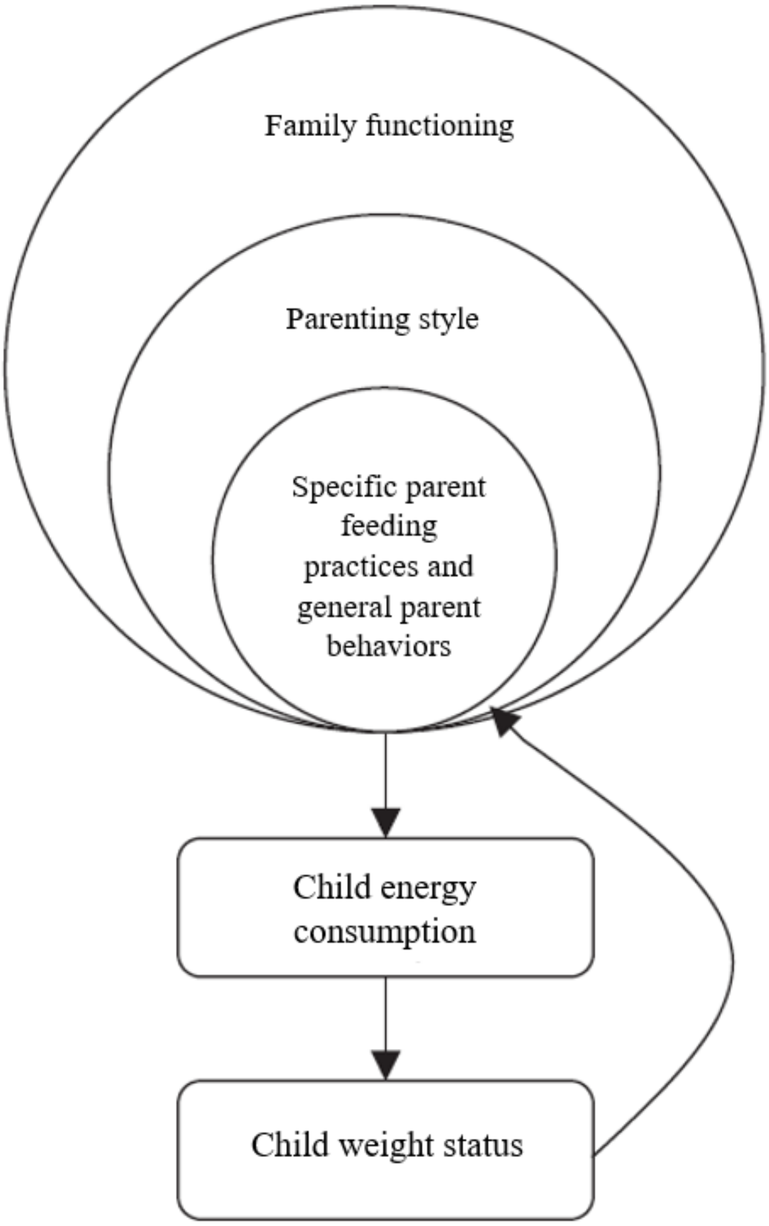

Figure 1. Influence of specific parent feeding practices and general parent behaviors, parenting style and family functioning on children's eating behavior and related weight status (Rhee, 2008).

Chapter 2

Food Approach and Food Avoidance in Young Children: Relation with Reward Sensitivity and Punishment Sensitivity[1]

Abstract

It has recently been suggested that individual differences in Reward Sensitivity and Punishment Sensitivity may determine how children respond to food. These temperamental traits reflect activity in two basic brain systems that respond to rewarding and punishing stimuli respectively with approach and avoidance. Via parent-report questionnaires, we investigate the associations of the general motivational temperamental traits Reward Sensitivity and Punishment Sensitivity with Food Approach and Food Avoidance in 98 preschool children. Consistent with the conceptualization of Reward Sensitivity in terms of approach behavior and Punishment Sensitivity in terms of avoidance behavior, Reward Sensitivity was positively related to Food Approach, while Punishment Sensitivity was positively related to Food Avoidance. Future research should integrate these perspectives (i.e. general temperamental traits Reward Sensitivity and Punishment Sensitivity, and Food Approach and Avoidance) to get a better understanding of eating behavior and related body weight.

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[1] Vandeweghe, L., Vervoort, L., Verbeken, S., Moens, E., & Braet, C. (2016). Food Approach and Food Avoidance in Young Children: Relation with Reward Sensitivity and Punishment Sensitivity. *Frontiers in Psychology, 7*, 928. doi: 10.3389/fpsyg.2016.00928

Introduction

Food is a primary reinforcer, shaping behavior through learning processes (Berridge, 1996). Sometimes, food acts as a positive, appetitive reward activating pleasant thoughts and approach behavior (Berridge, 1996; Saper, Chou, & Elmquist, 2002). Sometimes, food acts as a negative, aversive punishment, activating disgust and avoidance behavior (Batsell, Brown, Ansfield, & Paschall, 2002; Rozin & Fallon, 1980). In the field of eating behavior, different concepts have been used to describe movements towards or away from food. In the current study, eating behaviors and thoughts that involve a movement towards or desire for food are labeled as Food Approach (e.g. overeating, emotional eating, external eating, eating in the absence of hunger, enjoyment of food), while eating behaviors that involve a movement away from food are labeled as Food Avoidance (e.g. food neophobia, picky/fussy eating, slowness in eating, emotional undereating). Since people differ in their response to food, the present study investigates the relation between general individual temperamental traits that may determine one's susceptibility to the appetitive/rewarding or aversive/punishing properties of food and specific eating-related behaviors.

The difference in how individuals respond to food might depend on their individual trait differences in automatic responding to a broad range of environmental cues, namely Reward Sensitivity (i.e. reward-related approach motivation) and Punishment Sensitivity (i.e. punishment-related avoidance motivation) (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003). Reward Sensitivity and Punishment Sensitivity are indeed implicated in eating behavior and eating difficulties (Bijttebier, Beck, Claes, & Vandereycken, 2009; Davis, Strachan, & Berkson, 2004). Davis et al. (2007) described a model with two pathways linking Reward Sensitivity to eating behavior in a sample of adult women. First, Reward Sensitivity was considered a risk factor for overeating (i.e. binge eating, emotionally driven eating and external eating). Reward Sensitivity was indeed found to be related to overeating, with individuals higher in Reward Sensitivity reporting more overeating compared to individuals lower in Reward Sensitivity (Davis et al., 2004; Loxton & Dawe, 2001). Second, Reward Sensitivity was thought to be a determinant of food preferences (Davis et al., 2007). Consistently, adults with high Reward Sensitivity, compared to low Reward Sensitivity, showed a preference for sweet taste (Saliba, Wragg, & Richardson, 2009) and spicy foods (Byrnes & Hayes, 2013). Not only preference for sweet food, but also intake of high energy products was found to be determined by Reward Sensitivity (De Cock et al., 2016; De Cock et al., 2015; De Decker et al., 2016). Daily intake of snacks and sugar sweetened beverages was higher in individuals with higher Reward Sensitivity, especially in adolescent girls (De Cock et al., 2015). Furthermore, Reward Sensitivity has been considered a risk factor for eating disorders (Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006; Kane, Loxton, Staiger, & Dawe, 2004). Since Reward Sensitivity is related to approach behavior (Gray, 1981, 1987a), it might be assumed that individuals with eating disorders characterized by a food approach behavior are more sensitive to reward compared to healthy controls (Harrison, O'Brien, Lopez, & Treasure, 2010; Loxton & Dawe, 2001). Consistent with this assumption, patients with eating disorders involving binge eating were found to be more sensitive to reward compared to healthy controls (Harrison et al., 2010; Kane et al., 2004).

The role of Reward Sensitivity in eating behavior is well described in both adolescents and adults. However, the implications of Punishment Sensitivity in this domain are less studied. Nevertheless, Punishment Sensitivity has also been conceptually and empirically linked to eating disorders (Beck, Smits, Claes, Vandereycken, & Bijttebier, 2009; Claes et al., 2006). Since Punishment Sensitivity is related to inhibition or avoidance behavior (Gray, 1987b; Gray & McNaughton, 2003), it might be assumed that individuals with an eating disorder characterized by food avoidance behavior are more sensitive to punishment compared to healthy controls. Indeed, individuals with eating disorders involving purging or chronic self-starvation were found to be more sensitive to punishment compared to healthy controls (Claes et al., 2006; Harrison et al., 2010; Matton, Goossens, Vervaet, & Braet, 2015).

Punishment Sensitivity and Reward Sensitivity are derived from Gray's Reinforcement Sensitivity Theory (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003). This neuropsychological theory describes two motivational systems that control behavior: the Behavioral Activation System (BAS) and the Behavioral Inhibition System (BIS) respectively, resulting in two dimensional temperamental traits that vary between people: Reward Sensitivity and Punishment Sensitivity. *Reward Sensitivity* is assumed to reflect the sensitivity of BAS, *Punishment Sensitivity* the sensitivity of BIS. The BAS is thought to respond to rewarding environmental stimuli by activation of the dopaminergic system (Depue & Collins, 1999; Gray, 1981, 1987a) in the brain regions implicated in reward processing (i.e. mesocorticolimbic pathways) (Di Chiara et al., 2004; Risinger, Freeman, Rubinstein, Low, & Grandy, 2000). This triggers the initiation of "approach" behavior aimed at obtaining the reward (Kane et al., 2004). People high in Reward Sensitivity are assumed to have a highly sensitive BAS-system, easily activated by rewards and exhibiting stronger appetitive responses compared to people low in Reward Sensitivity. Interestingly, the brain does not seem to differentiate whether the reward is provoked by natural rewards (e.g. palatable food), behavior (e.g. winning a bet) or pharmacologic agents (e.g. illicit drugs) (Kelley, Schiltz, & Landry, 2005). The BIS is assumed to react on signals of conditioned aversive events (e.g. punishment or non-reward), novelty, and innate fear stimuli. Brain structures considered to be involved in the BIS system are the septohippocampal system and its monoaminergic afferents from the brainstem (Gray & McNaughton, 2003). The activation of the BIS in response to these stimuli causes inhibition of ongoing behavior or avoidance of aversive stimuli. People high in Punishment Sensitivity are assumed to have a highly sensitive BIS-system, easily activated when confronted with punishment and exhibiting stronger inhibitory or avoidant responses, compared with people scoring lower on Punishment Sensitivity (Carver & White, 1994; Gray, 1987b; Gray & McNaughton, 2003).Variations in Punishment Sensitivity and Reward Sensitivity can explain individual differences in affectivity, personality and behavior in different domains of life (Bijttebier et al., 2009; Corr, 2004).

Until now, research investigating the link between Punishment Sensitivity, Reward Sensitivity and eating behavior has mainly focused on adolescents and adults. This is surprising, as both temperamental differences and eating behaviors develop early, and may track into adolescence and adulthood (Nicklaus & Remy, 2013). Furthermore, eating problems in early childhood (e.g. unpleasantness at meals, struggle over eating, eating little, pickiness, eating slowly and low interest in food) are common in young children (Jacobi, Agras, Bryson, & Hammer, 2003; Marchi & Cohen, 1990; McDermott et al., 2008; Stice, Agras, & Hammer, 1999) and constitute a risk factor for developing parallel pathological problems in childhood and adolescence (Marchi & Cohen, 1990). Despite the importance of studying eating behaviors in early age, research investigating the link between Punishment Sensitivity and Reward Sensitivity, and eating behavior in this crucial developmental period is scarce. One notable exception is a recent study investigating the effect of Reward Sensitivity and feeding strategies on willingness to taste disliked food items in preschool children (Vandeweghe, Verbeken, Moens, Vervoort, & Braet, 2016). Research on the relation between Reward Sensitivity, Punishment Sensitivity and eating behaviors in preschool children is highly relevant, since knowledge on the determinants of eating behavior in childhood increases the understanding of both normal and problematic eating behavior, and the development of eating disorders later on. The current study therefore examines the relation between Reward Sensitivity, Punishment Sensitivity, Food Approach, and Food Avoidance in young children. We predict that Reward Sensitivity will be positively correlated with Food Approach, while Punishment Sensitivity will be positively correlated with Food Avoidance. The present study is one step in understanding how general basic temperamental traits (i.e. Reward Sensitivity and Punishment Sensitivity) are related to more proximal factors (i.e. specific food approach and avoidance behavior or thoughts) determining eating habits.

Method

Participants

In total, 98 mothers (age: *M*=35.03; *SD*=4.89) of preschool children (56,1% boys; age: *M*=4.87; *SD*=1.13) completed the questionnaires as part of a larger research project. According to the adjusted Body Mass Index (BMI) for children (Actual BMI/Percentile 50 of BMI for age and gender × 100) (Roelants & Hauspie, 2004), children had a mean adjusted BMI of 97.34 (*SD*=11.60) ranging between 67.38 – 134.28. According to the Highest Household Educational Attainment (HHEA, as a proxy for Socio Economic Status), 18,4% of the households have completed high school and 80,6% have a bachelor's degree or higher. Data on HHEA were missing in 1% of the cases.

Procedure

Participants were recruited by third-year psychology students of Ghent University as partial fulfillment of course requirements. Each student had to find two families with a preschool child (via relatives, friends, acquaintances, school,..) that were willing to participate. The students were thoroughly informed about the content of the questionnaires and trained to administer them. They were instructed to visit the participants at home, administer the questionnaire in a quiet place, and be available when questions arise. Active informed consent was obtained from each mother prior to completing the questionnaires. The study procedure was approved by the Institutional Ethical Committee.

Materials

Punishment Sensitivity and Reward Sensitivity

Behavioral Inhibition System/ Behavioral Activation System (BIS/BAS) scales. The Dutch parent version of the BIS/BAS-scales (Vervoort et al., 2015) is based on an age-downward adaptation (Muris, Meesters, de Kanter, & Timmerman, 2005) of the original self-report scales for adults (Carver & White, 1994). Twenty items are scored on a 4-point Likert Scale from 1 (not true) to 4 (very true), with higher scores indicating higher Punishment Sensitivity and Reward Sensitivity. Punishment Sensitivity is measured with the BIS-scale (BIS_Total, 7 items), which includes statements such as “My child is very fearful compared to his/her friends”. Reward Sensitivity is measured with the BAS-scale (BAS_Total, 13 items) and can be further subdivided in 3 subscales. The Reward Responsiveness subscale (BAS_RR, 5 items) includes statements such as “It would excite my child to win a contest”. The Fun Seeking subscale (BAS_FS, 4 items) includes statements such as “My child craves excitement and new sensation”. The Drive subscale (BAS_D, 4 items) includes statements such as “When my child wants something, he or she usually goes all out to get it”. The BIS and BAS scales of the Dutch BIS/BAS parent version have meaningful relations with other Punishment Sensitivity / Reward Sensitivity instruments (Vervoort et al., 2015). Internal consistency in the present sample was good for the BAS_Total scale (Cronbach’s α=.85) and BAS_D subscale (Cronbach’s α=.84); acceptable for BAS_RR subscale (Cronbach’s α=.74) and BIS_Total scale (Cronbach’s α=.77), but poor for BAS_FS subscale (Cronbach's α=.46). Similar to previous studies excluding scales with low internal consistency, (e.g. Buchholz et al., 2007; Horan, Green, Kring, & Nuechterlein, 2006; Scott, Hauenstein, & Coyle, 2015), the BAS_FS subscale was not included in the analyses.

Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). The SPSRQ is a Dutch parent report questionnaire (Luman, van Meel, Oosterlaan, & Geurts, 2012), measuring Punishment Sensitivity and Reward Sensitivity (Colder & O'connor, 2004). The SPSRQ consists of 33 items, scored on a 5-point Likert Scale from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating higher Punishment Sensitivity and Reward Sensitivity. The items can be divided in two scales: a Punishment Sensitivity scale (SPSRQ-PS; 15 items) and a Reward Sensitivity scale (SPSRQ-RS; 18 items). SPSRQ-PS includes statements such as "Your child is a shy person". SPSRQ-RS includes statements such as "Your child does a lot of things for approval". The Dutch parent report version of the SPSRQ was found to be a valid instrument to assess Reward and Punishment Sensitivity in children (Luman et al., 2012). Internal consistency in the present sample was good for both the SPSRQ-PS scale (Cronbach's α=.81) and the SPSRQ-RS scale (Cronbach's α=.84).

Food Approach and Food Avoidance

Child Food Neophobia Scale (CFNS). The CFNS (Pliner, 1994) assesses the extent to which children reject novel or unknown foods (i.e. Food Avoidance) and originally consists of 10 items, including statements such as "My child does not trust new foods". The items are scored on a 4-point Likert Scale from 1 (strongly disagree) to 4 (strongly agree). Higher scores indicate a stronger display of food neophobia. We used the 6-item version that is more adapted to the age range of our sample (Cooke, Wardle, & Gibson, 2003; Cooke et al., 2004). The Dutch 6-item version (Goossens & Braet, 2012) has shown good convergent validity (Vandeweghe et al., 2016). Internal consistency in the present sample was good (Cronbach's α=.89).

Child Eating Behavior Questionnaire (CEBQ). The Dutch version of the CEBQ (Sleddens, Kremers, & Thijs, 2008) is a 35- item parent-report questionnaire that assesses eating-approach as well as eating-avoidance behaviors, scored on a 5-point Likert Scale from 1 (never) to 5 (always), with higher scores indicating a stronger display of food approach or food avoidance behavior. Food Approach Behavior (FApB, 16 items) is measured with 4 subscales: Food Responsiveness (FR, 5 items), Desire to Drink (DD, 3 items), Emotional Over-Eating (EOE, 4 items) and Enjoyment of Food (EF, 4 items). Food Avoidance Behavior (FAvB, 19 items) is measured with 4 subscales: Satiety Responsiveness (SaR, 5 items), Food Fussiness (FF, 6 items), Slowness in Eating (SE, 4 items) and Emotional Under-Eating (EUE, 4 items) (Wardle, Guthrie, Sanderson, & Rapoport, 2001). The questionnaire is found to be a psychometrically sound tool to measure these eating behaviors (Sleddens et al., 2008). Internal consistency in the present sample was excellent for FF (Cronbach's α=0.94); good for FAvB (Cronbach's α=0.89), EF (Cronbach's α=0.89), EUE (Cronbach's α=0.81); acceptable for FApB (Cronbach's α=0.79), SaR (Cronbach's α=0.76), FR (Cronbach's α=0.74); and questionable for SE (Cronbach's α=0.69) and EOE (Cronbach's α=0.63).

Dutch Eating Behavior Questionnaire (DEBQ). A parent version of the DEBQ (Braet & Van Strien, 1997) was used to measure two different types of eating behavior: emotional eating and external eating. Both behaviors can be seen as a Food Approach. The emotional eating scale (EMO, 13 items) includes statements such as "Does your child feel like having food when he/she feels restless?" and the external eating scale (EXT, 10 items) includes statements such as "When your child sees or smells delicious food, does he/she feels like having some?". The items are scored on a 5-point Likert Scale from 1 (never) to 5 (very often) with higher scores indicating more external eating. Studies on the parent version of the DEBQ (Braet et al., 2007; Braet & Van Strien, 1997) revealed convergent validity and sufficient internal consistency. Internal consistency in the present sample was excellent for EMO (Cronbach's α=0.93) and good for EXT (Cronbach's α=0.82).

Power of Food Scale (PFS). The Dutch parent version of the PFS (Verbeken & Braet, 2014) is based on an age-downward adaptation (Lowe, 2006) of the original self-report scales for adults (Cappelleri et al., 2009). The scale (PFS, 15 items) assesses the appetitive responsiveness to today's food-abundant environment by means of appetite-related thoughts, feelings and motivations, and is, therefore, a proxy for Food Approach. The three subscales within the questionnaire differentiate between three levels of food proximity: (1) when food is readily available but not present (AnP, 4 items), (2) when food is present, but not tasted (PnT, 5 items) and (3) when food is tasted, but not eaten (TnE, 6 items). The items are scored on a 5-point Likert Scale from 1 (I don't agree at all) to 5 (I strongly agree) with higher scores indicating greater appetitive responsiveness to rewarding properties of the food environment. AnP includes statements such as "My child thinks about food even when he/she is not truly hungry.", PnT includes statements such as "If my child sees or smells a food it likes, he/she gets a very strong desire to have some" and TnE includes statements such as "My child enjoys eating a lot more than most other kids". Internal consistency in the present sample was good for PFS (Cronbach's α=0.86) and acceptable for AnP (Cronbach's α=0.74), PnT (Cronbach's α=0.71) and TnE (Cronbach's α=0.75).

Data analytical plan

The Missing Completely At Random test (MCAR; Little, 1988) was performed to determine whether the missing values were likely to be missing at random. If $p > .05$ for the normed χ^2 test statistic, values will be imputed for the missing data, following the Expectation Maximization algorithm available in SPSS (Schafer, 1997).

Then, correlations were calculated between measures of Reward and Punishment Sensitivity, and Food Approach and Food Avoidance. Even if the scales are not normally distributed, we can proceed with deviations from normality because of the central limit theorem (Field, 2009). As our sample is fairly big (N=98), Pearson's r was used to examine the correlations between the measures of Reward Sensitivity and the Food Approach scales of the CEBQ, DEBQ and PFS; and the measures of Punishment Sensitivity and the Food Avoidance scales of the CEBQ and CFNS. Effect sizes of these associations were evaluated as small if r = .10, medium if r = .30 and large if r = .50 (Cohen, 1977).

In order to assess the relative importance of Reward Sensitivity and Punishment Sensitivity for Food Approach and Food Avoidance, two multiple linear regression analyses were conducted. Four principal component analyses were first performed to compute a component score for Reward Sensitivity, Punishment Sensitivity, Food Approach and Food Avoidance. The component scores of Reward Sensitivity, Punishment Sensitivity, Food Approach and Food Avoidance were then used as variables in the multiple regression analyses. Two independent hierarchical regression analyses for each of the two components Food Approach and Food Avoidance were conducted. Control variables Age, Sex and adjusted BMI as well as one of the two predictors (i.e. Reward Sensitivity or Punishment Sensitivity) were entered in the first step of the analyses, while the other predictor was entered in the second step. The explained variance was considered small if R^2 = 1%, moderate if R^2 = 9% and large if R^2 = 25% (Cohen, 1977). The present study, with 98 participants, α=.05 and β=0.20, was sufficiently powered to detect small effects.

Results

Missing values

In total, 81 mothers filled out the questionnaires completely, resulting in 20 of 8232 missing data points (0,2 % of the data). A normed χ^2 of 1, p=.45 (χ^2= 1149.26/df = 1145) indicated that missing values were missing completely at random (MCAR; Little, 1988). Following the Expectation Maximization algorithm, values for the missing data were imputed (Schafer, 1997).

Correlations

Food Approach

Concerning the CEBQ scales measuring Food Approach, BAS_Total and BAS_D correlated significantly positively with FApB and Food Responsiveness, but not with Enjoyment of Food, and Emotional Overeating. BAS_RR correlated significantly positively with FApB, Enjoyment of Food, Food Responsiveness, but not with Emotional Overeating. SPSRQ-RS positively correlated with FApB, Food Responsiveness and Emotional Overeating, but nut with Enjoyment of Food. All Reward Sensitivity indices correlated significantly positively with all PFS scales and External Eating. Only SPSRQ-RS, but not the other Reward Sensitivity indices, correlated significantly positively with Emotional Eating. The significant correlations between Reward Sensitivity indices and Food Approach scales were small to large with effect sizes ranging from .20 to .46. Furthermore, BIS_Total correlated significantly positively with Emotional Overeating, Emotional Eating, PFS and AnP. SPSRQ-PS was significantly positively correlated with Emotional Eating. The significant correlations between Punishment Sensitivity indices and scales measuring Food Approach were small to moderate with effect sizes ranging from .20 to .26. Besides these scales, no other scales measuring Food Approach were correlated with Punishment Sensitivity indices.

Food Avoidance

Both Punishment Sensitivity indices significantly positively correlated with FAvB. Furthermore, BIS_Total significantly positively correlated with Satiety Responsiveness and Slowness in Eating, but not with Emotional Undereating, Food Fussiness and CFNS. SPSRQ-PS correlated significantly positively with Food Fussiness and CFNS, but not with Satiety Responsiveness, Slowness in Eating and Emotional Undereating. The significant correlations between Punishment Sensitivity indices and Food Avoidance scales were small to moderate with effect sizes ranging from .20 to .27. None of the Reward Sensitivity indices correlated significantly with any of the scales measuring Food Avoidance.

Regression analyses

First, four principal component analyses were performed to compute a component score for Reward Sensitivity, Punishment Sensitivity, Food Approach and Food Avoidance. A first principal component analysis on BAS_Total and SPSRQ-RS resulted in loadings of .90 on the component Reward Sensitivity, explaining 81.05% of the variance. A second principal component analysis on BIS_Total and SPSRQ-PS resulted in loadings of .87 on the component Punishment Sensitivity, explaining 77.15% of the variance. A third principal component analysis on FApB, External Eating and Emotional Eating (of the DEBQ) and PFS resulted in loadings of > .68 on the component Food Approach, explaining 63.44% of the variance. A fourth principal component analysis on FAvB and CFNS resulted in loadings of > .93 on the component Food Avoidance, explaining 88.40% of the variance. The component scores of Reward Sensitivity, Punishment Sensitivity, Food

Approach and Food Avoidance were used as variables in the multiple regression analyses.

Second, two independent hierarchical regression analyses for each of the two components Food Approach and Food Avoidance were conducted. Control variables Age, Sex, adjusted BMI as well as one of the two predictors (i.e. Reward Sensitivity or Punishment Sensitivity) were entered in the first step of the analyses, while the other predictor was entered in the second step. Standardized betas (β) revealed that Reward Sensitivity ($\beta = .41$, $p < .001$) and Punishment Sensitivity ($\beta = .24$, $p = .01$) were significantly related to Food Approach while Punishment Sensitivity ($\beta = .27$, $p = .01$) and not Reward Sensitivity ($\beta = .02$, $p = .84$) were significantly related to Food Avoidance (see Figure 1). After controlling for Age, Sex, adjusted BMI and Punishment Sensitivity, Reward Sensitivity explained 16,8% of the variance in Food Approach (F change $(1,92) = 20.50$, $p < .001$), indicating a moderate to large effect. After controlling for Age, Sex, adjusted BMI and Reward Sensitivity, Punishment Sensitivity explained 6,5% of the variance in Food Avoidance (F change $(1,92) = 6.46$, $p = .01$), indicating a small to moderate effect.

Discussion

We investigated the association between the general temperamental traits Reward and Punishment Sensitivity, and the more specific eating related concepts Food Approach and Avoidance in a large sample of healthy preschool children. Our results largely confirmed our hypotheses that Reward Sensitivity and Punishment Sensitivity are positively linked with Food Approach and Food Avoidance respectively, although some surprising findings emerged.

Reward Sensitivity and Food Approach

As expected, the temperamental trait Reward Sensitivity is implicated in Food Approach. All Reward Sensitivity indices were significantly positively correlated with the combined CEBQ subscales measuring food approach behavior (i.e. FApB). By looking more closely at the different Reward Sensitivity scales and the different FApB subscales, we can unravel which specific aspects of Reward Sensitivity are embedded in each of the specific food approach behaviors. Reward Responsiveness (i.e. BAS_RR) was positively related with Enjoyment of Food and Food Responsiveness, but not with Emotional Overeating. The items of Enjoyment of Food (e.g. “my child loves food”, “my child enjoys eating”) and Food Responsiveness (e.g. “My child is always asking for food”, “If allowed to, my child would eat too much”) cover indeed the anticipation or reaction on (food) reward, which is consistent with the conceptualization of BAS_RR as described by Carver and White (1994). The unexpected null-finding for Emotional Overeating can be explained by the content of the items; they do not contain this anticipation, but rather refer to an emotion regulation strategy in which eating is a reaction to bad feelings. Furthermore, SPSRQ-RS was positively related with Food Responsiveness and Emotional Overeating, but surprisingly not with Enjoyment of Food. We assume that these findings might be due to the different levels of generalization in the scales: Enjoyment of Food items refer to general situations, while SPSRQ-RS (and Food Responsiveness and Emotional Overeating) refer to more specific concrete situations (e.g. SPSRQ-RS: “your child enjoys being the center of attention”; Food Responsiveness: “My child is always asking for food”; Emotional Overeating: “My child eats more when annoyed”).

The BAS_D subscale was significantly correlated with Food Responsiveness, but contrary to our expectations, not with the other Food Approach scales of the CEBQ. Moreover, the significant effect was small. These findings might suggest that the general drive component of Reward Sensitivity is less captured by these specific Food Approach indices. This is unfortunate, because this particular aspect of Reward Sensitivity (i.e. persistent pursuit of desired goals) was repeatedly found to be an important determinant of eating behavior and overweight (Dawe & Loxton, 2004; Verbeken, Braet, Lammertyn, Goossens, & Moens, 2012). Thus, given that the drive component is important, it might be valuable to measure it when assessing eating behavior. Therefore, it might be valuable to add a drive component to the CEBQ including items such as “My child would do anything to get the food (s)he wants”.

Conform our hypotheses, all Reward Sensitivity indices were positively related to the External Eating scale of the DEBQ, which suggests that children with higher Reward Sensitivity, compared to lower Reward Sensitivity, are more susceptible to eating based on external stimuli (i.e. hedonic eating) rather than on internal homeostatic signals. Furthermore, all Reward Sensitivity indices were positively related to all scales of the Power of Food Scale (i.e. the subscales as well as the total score). These findings support the idea that the Power of Food Scale can be used as a valid index of a child’s specific sensitivity to the rewarding value of food (Lowe & Butryn, 2007). Children with higher trait Reward Sensitivity in general, seem to be highly sensitive to food reward, not only when food is tasted but not eaten (i.e. TnE) or present but not tasted (i.e. PnT), but also when food is available but not present (i.e. AnP). As such, high reward sensitive children, characterized by these appetite-related motives, might be more prone to maladaptive eating behavior, such as overeating or eating in absence of hunger, compared to low reward sensitive children.

Unexpectedly, sensitivity to food reward (as measured with the Power of Food Scale) was also determined by Punishment Sensitivity, as shown by the significant positive correlations of BIS_Total with the Power of Food Scale (i.e. composite score of the subscales) and AnP. This might be explained by the semantics of the items; while items of PnT and TnE clearly indicate that food is seen as a reward, items of the AnP are largely about how preoccupied the child is with food (e.g. “My child thinks about food, even when (s)he is not physically hunger”). These items refer to the general motivational salience of food, irrespective of its rewarding or punishing character. Unlike the unambiguous PnT and TnE items, the items of AnP can be understood in two ways: the child can think about food because (s)he wants it and (s)he sees food as a reward, or the child can think about food in a negative way. We assume that children having a negative relation with food, such as food neophobics or food restrictive children, might also be preoccupied or controlled by food (e.g. “It seems like food controls my child rather than the other way around”), but in a negative way.

Punishment Sensitivity and Food Avoidance

As expected, Punishment Sensitivity is implicated in Food Avoidance. Most Punishment Sensitivity indices were significantly positively correlated with the Food Avoidance scales of the CEBQ and with the CFNS. More specifically, the combined CEBQ subscales measuring food avoidance behavior (i.e. FApB) were significantly positively related to both Punishment Sensitivity indices (i.e. BIS_Total and SPSRQ-PS). Noteworthy, the other Food Avoidance scales were related to either BIS_Total or to SPSRQ-PS, but not to both: Food Fussiness and Food Neophobia (indexed by CNFS) were only related to SPSRQ-PS, while Satiety Responsiveness and Slowness in Eating were only related to BIS_Total. Almost all items of Food Fussiness and CFNS reflect fear for unknown or new food items (e.g. Food Fussiness: “My child refuses new foods at first”; CFNS: “My child does not trust new foods”), which is captured by SPSRQ-PS, and not BIS_Total, as the former but not the latter includes items regarding fear for novelty (e.g. “My child is afraid of new or unexpected situations”). Items of Satiety Responsiveness and Slowness in Eating do not contain this novelty-factor; they rather refer to hunger and satiety.

The responses on hunger and satiety are possibly influenced by stress and fear in general, which is rather captured by BIS than by SPSRQ-PS.

Punishment Sensitivity and Food Approach

Our hypotheses that Punishment Sensitivity and Reward Sensitivity are associated with Food Avoidance and Approach, respectively, are based on Gray's Reinforcement Sensitivity Theory, linking Punishment Sensitivity with avoidance and Reward Sensitivity with approach (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003). Therefore, we did not formulate hypotheses concerning Punishment Sensitivity and Food Approach. However, exploratively, we found that Punishment Sensitivity might also be a determinant of approach behavior, as suggested by the significant correlation between Punishment Sensitivity and Food Approach in the regression analyses. This finding might be related to a specific kind of approach behavior, namely (over)eating as a reaction to emotional situations, given the significant positive correlations between Punishment Sensitivity indices and Emotional Overeating and Emotional Eating. In such emotional situations, food can be seen as a way of coping with negative emotions (e.g. Heatherton & Baumeister, 1991; Herman & Polivy, 1988); in other words, a means to reach a goal (i.e. comfort) instead of the goal itself. The link between Punishment Sensitivity and emotional eating in response to negative events is consistent with the findings that Punishment Sensitivity is strongly associated with negative affect (Watson, Wiese, Vaidya, & Tellegen, 1999).

Limitations and future research

Based on the theoretical background of Reward Sensitivity and Punishment Sensitivity, we might assume that Reward Sensitivity and Punishment Sensitivity determine the extent to which someone approaches or avoids food and not the other way around. However, due to the cross-sectional nature of the results, we cannot be certain of the direction of the associations. Furthermore, since the variables were assessed concurrently, a longitudinal design might be interesting to get more insight in the developmental course of Food Approach or Avoidance and the link with temperament. Next, the current study was conducted in a community sample. It might also be interesting to investigate the role of temperamental traits in children with severe eating problems. In the present study, we used parent report instruments to assess the concepts of Reward Sensitivity, Punishment Sensitivity, Food Approach and Food Avoidance. Validity of these instruments is well-established in Dutch speaking samples except for the Power of Food Scale for which validity reports in this population are lacking. Furthermore, although parent report is found to be a valid method for child temperament assessment (Copeland, Landry, Stanger, & Hudziak, 2004; Vervoort et al., 2015), it would be valuable to replicate the current findings with behavioral measures of Food Approach and Food Avoidance.

In spite of finding evidence for a positive relation between Reward Sensitivity and Food Approach, and Punishment Sensitivity and Food Avoidance, the explained variance was at best moderate (Cohen, 1977). The effect sizes are slightly smaller compared to other studies in this age group (De Pauw, Mervielde, & Van Leeuwen, 2009; Vervoort et al., 2015). These results suggest that, in addition to Reward Sensitivity and Punishment Sensitivity, other factors may determine whether certain appetite related behaviors or thoughts will be present. This is consistent with biopsychosocial models describing multiple determinants of eating behavior (e.g. (Davison & Birch, 2001), such as learning processes, parental feeding styles and the obesogenic environment (e.g. Eertmans, Baeyens, & Van Den Bergh, 2001; Savage, Fisher, & Birch, 2007; Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011). Moreover, while not all Reward Sensitivity indices were systematically correlated with CEBQ Food Approach scales, they were so with all scales of the Power of Food Scale. Different from the other Food Approach scales, the Power of Food Scale measures appetite-related thoughts, motivations and feelings instead of actual food (over)consumption. Since thoughts and motives are less controllable and more automatically generated than behavior (Ajzen, 1985), it might be assumed that they are more directly linked to basic bottom-up personality factors like Punishment Sensitivity and Reward Sensitivity, and less influenced by top-down controlled processes (Appelhans, 2009). It would be interesting to investigate whether the thoughts and motives moderate the relation between Reward Sensitivity and actual food consumption, for example in an ad libitum taste test. It might further be interesting to investigate whether Food Approach mediates the relation between Reward Sensitivity and overweight, and as such replicating the full model of Davis et al. (2007) in preschool children.

Conclusions

Gray’s Reinforcement Sensitivity Theory assumes individual differences in the sensitivity of two basic brain systems that are supposed to react on reward and punishment, being Reward and Punishment Sensitivity. In the current study, these differences are found to have relevance for eating behavior and thoughts in preschool children. This insight substantially enhances our understandings of eating behavior in children. The current study is one step in understanding how basic temperamental traits, such as Reward Sensitivity and Punishment Sensitivity, have an influence on more proximal eating behaviors (i.e. specific food approach and avoidance behavior or thoughts) determining eating habits. We are convinced that, consistent with a biopsychosocial framework, studies investigating eating behavior should not focus on proximal factors alone, but instead combine multiple perspectives to examine how the interactions between these proximal behaviors and distal factors (such as child characteristics) contribute to adaptive and maladaptive eating behaviors.

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Tables

Table 1

Descriptive statistics and correlations (Pearson's r) between Reward Sensitivity, Punishment Sensitivity , Food Approach and Food Avoidance in preschoolers

					RS-indices				PS-indices	
					BAS_Total	BAS_D	BAS_RR	SPSRQ-RS	BIS_Total	SPSRQ-PS
			M (SD)		33.19 (6.32)	9.30 (2.88)	14.79 (2.52)	52.12 (8.67)	15.36 (3.71)	33.48 (8.99)
				Range	34	12	12	50	17	59
Food Approach	CEBQ	FApB	38.42 (6.97)	39	.30**	.22*	.32**	.35**	.08	-.03
		EF	13.42 (2.97)	15	.14	.07	.23*	.04	-.07	-.11
		FR	10.62 (3.25)	17	.26**	.21*	.26**	.44**	.07	.05
		EOE	6.66 (2.04)	8	.03	.13	-.03	.30**	.26**	.17
		DD	7.84 (2.69)	12	.25*	.11	.24*	.10	.02	-.15
	DEBQ	EMO	21.14 (7.20)	26	.00	.05	.00	.20*	.24*	.21*
		EXT	30.58 (5.16)	25	.29**	.31**	.25**	.46**	.10	.06
	PFS	PFS▪	32.06 (9.47)	38	.36**	.34**	.35**	.40**	.20*	.11
		AnP	12.32 (4.17)	18	.23*	.21*	.25*	.29**	.22*	.12
		PnT	12.96 (3.84)	16	.33**	.31**	.32**	.35**	.17	.08
		TnE	6.72 (2.93)	13	.35**	.32**	.32**	.37**	.11	.06
Food Avoidance	CEBQ	FAvB	54.66 (11.03)	58	.03	.04	.03	.08	.21*	.23*
		SaR	14.88 (3.12)	14	.05	.06	.05	.08	.26**	.15
		SE	11.64 (2.69)	14	-.07	.00	-.10	.01	.20*	.05
		EUE	10.75 (3.38)	16	.12	.13	.12	.17	.18	.11
		FF	17.39 (5.76)	23	-.00	-.03	.01	.01	.05	.27**
	CFNS		13.86 (4.11)	18	-.01	.01	-.02	.02	.08	.24*

Note: * $p < .05$, ** $p < .01$

▪ Composite score of the Power of Food Scale

CEBQ, Child Eating Behavior Questionnaire; DEBQ, Dutch Eating Behavior Questionnaire; PFS, Power of Food Scale; CFNS, Child Food Neophobia Scale; FApB, Food Approach Behavior, EF, Enjoyment of Food; FR, Food Responsiveness; EOE, Emotional Overeating; DD, Desire To Drink; EMO, Emotional Eating; EXT, External Eating; AnP, Available but not Present; PnT, Present but not Tasted; TnE, Tasted but not Eaten; FAvB, Food Avoidance Behavior; SaR, Satiety Responsiveness; SE, Slowness in Eating; EUE, Emotional Undereating; FF, Food Fussiness; RS, Reward Sensitivity; PS, Punishment Sensitivity; BAS, Behavioral Activation System; BAS_D, Drive; BAS_RR, Reward Responsiveness; SPSRQ, Sensitivity to Punishment and Sensitivity to Reward Questionnaire; BIS, Behavioral Inhibition System.

Figures

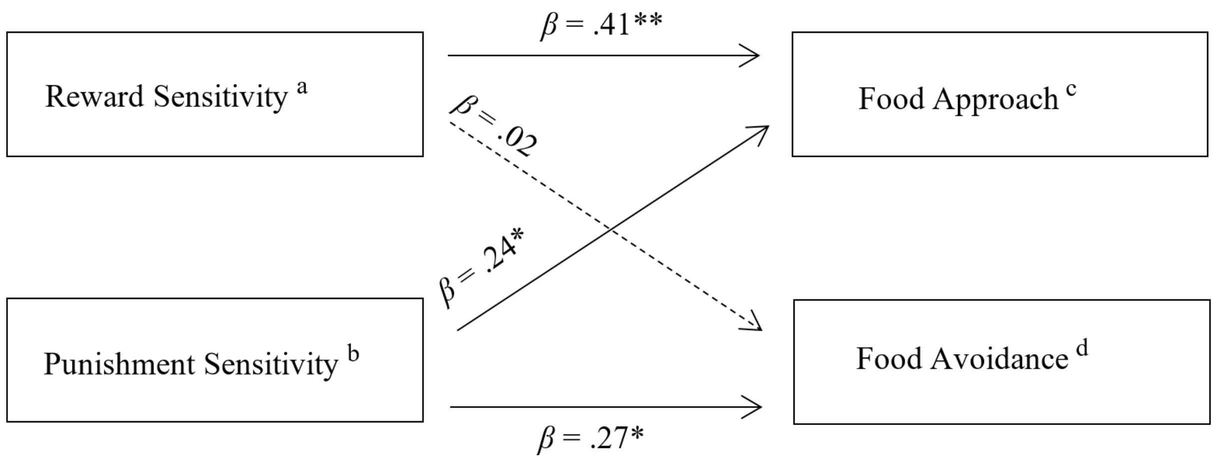

Figure 1. Summary of independent hierarchical regression analyses for Reward and Punishment Sensitivity predicting Food Approach and Food Avoidance.

Note: * $p < .05$, ** $p < .01$

[a] Component score of BAS_Total and SPSRQ-RS

[b] Component score of BIS_Total and SPSRQ-PS

[c] Component score of FApB, External Eating, Emotional Eating and the Power of Food Scale

[d] Component score of FAvB and CFNS

Chapter 3

Reward Sensitivity and Body Weight: the Intervening Role of Food Responsive Behavior and External Eating[2]

Abstract

During the last three decades, the prevalence of childhood overweight and obesity has increased worldwide. It is well established that different child-related factors such as food approach behaviors (i.e. eating behaviors that imply movements towards food) contribute to the development of overweight. However, research is lacking on the underlying mechanisms leading to food approach behaviors, which in turn lead to overweight. Via parent-report questionnaires, we investigated the relation between the personality trait reward sensitivity and body weight in a community sample of 211 children aged 2.5 to 9 years. We further investigated the intervening role of food approach behaviors in the association between reward sensitivity and body weight. Unexpectedly, there was no direct association between reward sensitivity and body weight. Despite the absence of a direct effect, a significant indirect association was found between reward sensitivity and body weight through the intervening food approach variables (i.e. food responsive behavior and external eating). These results highlight the importance of the focus on eating behaviors as well as trait characteristics in prevention programs for overweight.

[2] Vandeweghe, L., Verbeken, S., Vervoort, L., Moens, E., & Braet, C. (2017). Reward sensitivity and body weight: the intervening role of food responsive behavior and external eating. *Appetite*, *112*, 150-156. doi:10.1016/j.appet.2017.01.014

Introduction

During the last three decades, the prevalence of childhood overweight and obesity has increased worldwide (Hedley et al., 2004; Ng et al., 2014). Despite various prevention efforts, weight problems remain a prevalent health issue; the United States holds childhood overweight and obesity numbers of 22.8% of 2-5-year-olds and 34.2% of 6-11 year-olds, while in Europe, 19.9% of 2-10-year-olds are overweight or obese (Ahrens et al., 2014; Ogden, Carroll, Kit, & Flegal, 2014). Understanding the etiology of weight problems in young children is critical, since childhood overweight tends to persist in adolescence and adulthood, and is likely to progress to obesity (Schokker, Visscher, Nooyens, Van Baak, & Seidell, 2007; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997), which increases the risk of a wide range of medical (e.g. Type 2 diabetics, orthopedic problems) and psychosocial complications (e.g. low self-esteem, poor body image), both concurrently and in the long term (Daniels, 2009; Lee, 2009; Strauss, 2000).

Parallel to the rise in overweight and obesity prevalence, the current food environment has evolved into an obesogenic environment in which energy-dense, palatable, and thus strongly rewarding foods are highly advertised, readily available, and served in larger portions (Young & Nestle, 2002). These environmental changes facilitate an augmented energy intake and contribute to overweight or obesity (Rolls, 2011). However, not all individuals are susceptible to these environmental influences as not all individuals living in this obesogenic environment gain weight. This observation suggests that, in addition to environmental factors, individual characteristics and related eating behaviors might also be involved in weight control, an assumption that fits well with biopsychosocial models (Davison & Birch, 2001).

One such individual characteristic that has been proposed as a determinant of body weight is reward sensitivity (Davis & Fox, 2008; Franken & Muris, 2005; Verbeken, Braet, Lammertyn, Goossens, & Moens, 2012). A positive relationship between reward sensitivity and Body Mass Index has been found in normal and overweight adults (Franken & Muris, 2005) and children aged 5-12 years (De Decker et al., 2016; Verbeken et al., 2012). Individuals high in reward sensitivity are considered profoundly sensitive to the rewarding aspects of appetitive stimuli, for example palatable foods. This individual characteristic is assumed to reflect the sensitivity of a neuropsychological system, the Behavioral Activation System (BAS). The BAS reacts to positive, rewarding environmental stimuli by activation of the dopaminergic system (Gray, 1981, 1987a), which initiates approach behavior in order to obtain the rewarding goal (Kane, Loxton, Staiger, & Dawe, 2004). Following the neuropsychological conceptualization of reward sensitivity, it is assumed that individuals high in reward sensitivity would exhibit more approach behavior to consume rewarding food items, which in turn, would contribute to weight gain (Davis et al., 2007).

Consistent with the first part of this assumption, namely that reward sensitivity may lead to food approach behaviors, it appears that reward sensitivity is implicated in different types of food approach behavior (i.e. eating behaviors that imply a movement towards food). Cross-sectional empirical evidence in adults, as assessed by self-report questionnaires, has indeed shown that reward sensitivity is positively related to binge eating (i.e. the consumption of an unusually large amount of food, accompanied by a sense of loss of control over eating), emotionally driven eating (i.e. eating in response to emotional states) and external eating (i.e. eating in response to food-related stimuli, regardless of hunger or satiety) (Davis et al., 2007; Davis, Strachan, & Berkson, 2004). In children and adolescents, a positive cross-sectional association has been demonstrated between reward sensitivity and the consumption of palatable foods (De Cock et al., 2016; De Cock et al., 2015; De Decker et al., 2016). Even in preschool children, reward sensitivity has been cross-sectionally related to food approach, as assessed by parent-report questionnaires. More specifically, higher reward sensitivity was associated with a stronger enjoyment of food (i.e. the extent to which the child likes and enjoys eating), higher food responsiveness (i.e. the extent to which the child wants to eat, regardless of hunger or satiety) and more external eating (Vandeweghe, Vervoort, Verbeken, Moens, & Braet, 2016).

In line with the second part of the assumption, namely that food approach behavior may lead to weight status, food approach behaviors are found to be implicated in weight gain (for review see French, Epstein, Jeffery, Blundell, & Wardle, 2012). For example, there was a significantly positive relation between children's disinhibited eating (i.e. eating behaviors involving a lack of control over food consumption), assessed by interview and self-report questionnaire, and their adiposity (Hill et al., 2008; Zocca et al., 2011). Furthermore, an increased Body Mass Index in young children correlated with a higher degree of food responsiveness, enjoyment of food and emotional overeating (i.e. the extent to which the child eats more when feeling negative emotions), as assessed by parent-report questionnaires (Carnell & Wardle, 2008; Sleddens, Kremers, & Thijs, 2008; Viana, Sinde, & Saxton, 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009). Similarly, in a clinical study, children with obesity tend to display more external eating, as assessed by a parent-report questionnaire, compared to non-obese children (Braet & Van Strien, 1997).

Despite the relevance of reward sensitivity and food approach behaviors as determinants of weight gain, only few studies in this age group (i.e. children aged 2.5 to 9 years) have investigated its underlying mechanisms, such as the assumption that food approach behavior might constitute the pathway through which reward sensitivity influences body weight. It is important to find evidence for underlying mechanisms such as these, which can help to guide prevention programs. So far, only one cross-sectional study with adult women showed that reward sensitivity predicted overeating, which in turn predicted body mass (Davis et al., 2007). A second cross-sectional study with elementary school children found that overeating indeed mediated the relationship between reward sensitivity and body mass (Van den Berg et al., 2011). To our knowledge, the small number of studies investigating this relationship did not include preschool children. Moreover, a direct relation between reward sensitivity and body weight has not yet been evidenced in preschool children.

The first aim of the current study is to examine the relation between reward sensitivity and body weight in a community sample of young children aged 2.5 to 9 years. We expect that reward sensitivity correlates significantly positively with body weight. The second aim is to investigate the intervening role of two operationalisations of food approach behavior (i.e. food responsive behavior and external eating) in the association between reward sensitivity and body weight. We expect that high reward sensitivity is related to an enhanced display of food approach behavior, which in turn is associated with increased body weight.

Method

Participants

The participant sample consisted of 211 mothers of young children (55.5% boys; age: *M*=6.27; *SD*=1.60; range: 2.43-9.22). Of these participants, data provided by 98 mothers of preschool children (56.1% boys; age: *M*=4.87; *SD*=1.13) have been used in a different paper in which reward sensitivity proved to be related to several types of food approach (Vandeweghe, Vervoort, et al., 2016). According to the Highest Household Educational Attainment (HHEA, as a proxy for Socio Economic Status), 87.6% of the households have a bachelor's degree or higher and 12.4% have completed high school. Data on HHEA were missing in 0.5% of the cases.

Procedure

This study was conducted as part of the Reward project. In October 2013, 98 mothers of preschool children were recruited by third-year psychology students of Ghent University for a partial fulfillment of course requirements. Each student had to find two families with a preschool child (via relatives, friends, acquaintances, school,..) that were willing to participate. The students were thoroughly informed about the content of the questionnaires and trained to administer them. They were instructed to visit the participants at home, administer the questionnaire in a quiet place, and be available when questions arose. Prior to completing the questionnaires, active informed consent was obtained from each mother. In April 2015, 113 mothers of 1st and 2nd year elementary-school children were recruited in cooperation with a fourth-year psychology student via elementary schools in the neighborhood of Ghent, Belgium. The recruitment letter referred to a website where mothers could complete the questionnaires online. Both the recruitment letter and the homepage of the website included informed consent information. The study procedure was conducted in accordance with the ethical guidelines of the institutional Ethical Committee.

Materials

Adjusted Body Mass Index (adjBMI)

The mothers were asked to report weight (in kg) and height (in cm) of their child. The study uses adjusted BMI instead of BMI because it is more appropriate and reliable for children, as this formula takes age and sex into account. First, BMI was calculated by dividing weight (in kg) through squared height (in m^2). Then, adjBMI was calculated by (BMI/ the 50th percentile of BMI for age and sex) x 100. The data on 50th percentiles were based on normative data in a Flemish sample (Roelants & Hauspie, 2004). Adjusted BMI $\leq$ 85 is considered underweight, adjBMI>86 and < 119 constitutes normal weight, adjBMI $\geq$ 120 is overweight, and adjBMI $\geq$ 140 classifies as obese (Van Winckel & Van Mil, 2001). In the current sample, this calculation resulted in 13.3% of the children being classified as underweight, 83.4% as average weight, 2.8% as overweight and finally 0.5% as obese.

Behavioral Inhibition System/ Behavioral Activation System (BIS/BAS) scales

In order to assess reward sensitivity, mothers completed the BAS scale of the Dutch BIS/BAS scales adapted for parent report (Vervoort et al., 2015). The Dutch parent version was based on an age-downward adaptation, which involved making the items more appropriate for children aged 8 to 12 years (e.g. “Nobody can stop me when I want something” instead of “When I go after something I use a “ho-holds-barred” approach”), (Muris, Meesters, de Kanter, & Timmerman, 2005) of the original scales for adults (Carver & White, 1994). The BAS scale consists of 13 items scored on a 4-point Likert Scale ranging from 1 (not true) to 4 (very true), with higher scores indicating stronger reward sensitivity. The BAS scale includes statements such as “It would excite my child to win a contest”, “My child craves excitement and new sensation”, “When my child wants something, he or she usually goes all out to get it”. The BAS scales of the Dutch BIS/BAS parent version have meaningful relations with other instruments assessing reward sensitivity (Vervoort et al., 2015). Internal consistency in the present sample was good for the BAS scale (Cronbach’s α=.83).

Child Eating Behavior Questionnaire (CEBQ)

A first proxy for food approach behavior is food responsive behavior, which is the behavioral expression of the trait food responsiveness, and is defined as the extent to which the child wants to eat, regardless of hunger or satiety. In order to assess food responsive behavior, mothers completed the Food Responsiveness Scale of the Dutch version of the CEBQ (Sleddens et al., 2008), which is based on the original English version (Wardle, Guthrie, Sanderson, & Rapoport, 2001). The scale consists of 5 items, scored on a 5-point Likert Scale from 1 (never) to 5 (always), with higher scores indicating a stronger food responsiveness and more food responsive behavior. The Food Responsiveness Scale includes statements such as “If allowed to, my child would eat too much” or “My child’s always asking for food”. The questionnaire is found to be a psychometrically sound tool to measure eating behaviors (Sleddens et al., 2008). Internal consistency in the present sample was acceptable (Cronbach’s α=.77).

Dutch Eating Behavior Questionnaire (DEBQ)

A second proxy for food approach behavior is external eating, which is defined as eating in response to food-related stimuli, regardless of hunger or satiety. A parent version of the DEBQ (Braet & Van Strien, 1997) was used to measure external eating. The External Eating Scale consists of 10 items, scored on a 5-point Likert Scale from 1 (never) to 5 (very often) with higher scores indicating more external eating. The scale includes statements such as “When your child sees or smells delicious food, does he/she feel like having some?” or “Is your child inclined to eat when food is being prepared?”. Studies on the parent version of the DEBQ (Braet et al., 2007; Braet & Van Strien, 1997) revealed convergent validity and sufficient internal consistency. Internal consistency in the present sample was good (Cronbach’s α=.82).

Data analyses

Missing values

Missing value analysis indicated that missing data ranged between 0.9 and 13.7% per variable. The Missing Completely At Random test (MCAR; Little, 1988) was performed to determine whether the missing values were likely to be missing at random. A normed χ^2 of .87, p=.58 (χ^2= 12.262/df = 14) indicated so (Bollen, 1989); consequently, we imputed values for the missing data, following the expectation maximization algorithm (i.e. iterative method for producing maximum likelihood estimates) available in SPSS (Schafer, 1997).

Data analytic plan

Descriptive analyses were conducted for the study variables reward sensitivity, food responsive behavior, external eating and adjBMI. Then, the SPSS macro “mediate” developed by Hayes and Preacher (2011) was performed to test the relation between reward sensitivity and adjBMI, as well as the intervening role of food responsive behavior and external eating, adjusted for age and HHEA. This bootstrapping procedure was chosen over alternative methods such as the procedure of Baron and Kenny (1986) as the former is robust to violations of normality, able to control for possible confounding variables and able to test the significance of indirect effects (Preacher & Hayes, 2008). In the current study, we carried out 5000 bootstrap resamples to derive bias-corrected 95% confidence intervals for the indirect effects, with alpha set at $p = 0.05$.

The literature suggests two types of intervening variables: mediated effects and indirect effects (Holmbeck, 1997). For a *mediated effect* to occur, three conditions need to be fulfilled. First, the relation between reward sensitivity and adjBMI should be significant (c-path) (see Figure 1). Second, significant associations should be found between the hypothesized mediators (i.e. food responsive behavior and external eating) on the one hand and reward sensitivity (a-path) and adjBMI (b-path) on the other hand. Third, a significant effect should be found for the indirect ab-path (i.e. the relation between reward sensitivity and adjBMI through the mediator). Adding this indirect effect to the model should undo (i.e. complete mediation) or decrease (i.e. partial mediation) the significant direct association between reward sensitivity and adjBMI (c' path). For an *indirect effect* to occur, no initial relationship between reward sensitivity and adjBMI is expected. Instead, a significant relation should be found between reward sensitivity and adjBMI through the intervening variable (Zhao, Lynch, & Chen, 2010).

Results

Descriptive statistics

Descriptive statistics and associations between the study variables are depicted in Table 1. Reward sensitivity did not significantly correlate with adjBMI. Food responsive behavior and external eating correlated significantly positively with reward sensitivity and adjBMI. Further significant positive correlations were observed between food responsive behavior and external eating. Since reward sensitivity did not significantly correlate with adjBMI, it is inadequate to examine a mediated effect of food responsive behavior or external eating. However, an indirect effect may still be present, and will therefore be tested.

Regarding possible confounding variables, reward sensitivity related significantly negatively to age but significantly positively to HHEA. More specifically, the higher reward sensitivity we observe, the younger the child is and the higher the socio economic status. As no significant correlations were found with sex, we will only control for age and HHEA.

Intervening analyses

In the current study, two models were investigated in which food responsive behavior and external eating respectively were hypothesized to intervene in the relation between reward sensitivity and adjBMI. Each model included HHEA and age as control variables. In both models, the direct effect between reward sensitivity and adjBMI (c-path) was not significant ($p > .79$).

Reward sensitivity, food responsive behavior, and adjusted BMI

It was examined whether food responsive behavior positively correlates with reward sensitivity (a-path) and adjBMI (b-path). Results showed a significant positive correlation between reward sensitivity and food responsive behavior ($\beta = .19$, $t = 4.73$, $p < .001$), and food responsive behavior and adjBMI ($\beta = .87$, $t = 3.54$, $p < .001$). Then, it was examined whether the indirect effect of reward sensitivity on adjBMI through food responsive behavior (ab-path) was significant. The indirect effect was significant as indicated by the bias corrected bootstrap 95% confidence intervals of [.08, .31], $SE = .06$, $p < .05$.

Reward sensitivity, external eating, and adjusted BMI

It was examined whether external eating positively correlates with reward sensitivity (a-path) and adjBMI (b-path). Results showed a significant positive correlation between reward sensitivity and external eating ($\beta = .32$, $t = 5.47$, $p < .001$), and external eating and adjBMI ($\beta = .53$, $t = 3.10$, $p = .002$). Then, the indirect effect of reward sensitivity on adjBMI through external eating (ab-path) was measured for significance. The indirect effect proved to be significant as indicated by the bias corrected bootstrap 95% confidence intervals of [.06, .33], $SE = .07$, $p < .05$.

Discussion

The aim of the current study was to examine the relation between reward sensitivity and body weight, and the intervening role of food approach behaviors in a sample of children aged 2.5 to 9 years. Unexpectedly, there was no direct correlation between reward sensitivity and body weight. Although a direct effect was not uncovered, the data did reveal a significant indirect association between reward sensitivity and body weight through the intervening food approach variables (i.e. food responsive behavior and external eating).

Reward sensitivity and body weight

Recently, the relation between reward sensitivity and body weight has gained considerable attention (e.g. Davis & Fox, 2008; Davis et al., 2004; De Decker et al., 2016; Van den Berg et al., 2011; Verbeken et al., 2012). Since highly reward-sensitive individuals are more susceptible to the reinforcing value of palatable foods (Rollins, Loken, Savage, & Birch, 2014), they might be more prone to become overweight or obese (Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008). However, as previous research has shown (Davis & Fox, 2008; Stice, Spoor, Ng, & Zald, 2009;

Van den Berg et al., 2011; Verbeken et al., 2012), the relation between reward sensitivity and body weight seems more complex. Various studies demonstrated a significant positive relation between reward sensitivity and body weight in both normal and overweight adults, as well as in elementary school children; highly reward-sensitive individuals reported higher body weight compared to low reward sensitive individuals (Davis & Fox, 2008; De Decker et al., 2016; Verbeken et al., 2012). For individuals with obesity, this correlation sometimes proved to be positive (Van den Berg et al., 2011), and was sometimes found to be negative (Davis & Fox, 2008; Verbeken et al., 2012). As the current study contained only one child with obesity, we expected a positive significant relation between reward sensitivity and body weight. However, no such relation could be found in the present study. A first possible explanation is the limited range of BMI scores in the sample; more than 80% of the children showed normal weight, and only 2.8% of the children were classified as overweight. A second possible explanation is related to the age of the participants. An observable influence of reward sensitivity on body weight might be harder to detect with decreasing age. It seems plausible that it takes some time before a heightened reward sensitivity manifests in weight gain. Furthermore, body weight is determined by a variety of factors such as physical activity (Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003), eating behaviors (Sleddens et al., 2008) and, for children in particular, parental feeding practices (Moens, Braet, & Soetens, 2007; Rhee, 2008) such as parental feeding restriction (Faith, Scanlon, Birch, Francis, & Sherry, 2004). For example, it is possible that the temperamental characteristic reward sensitivity was not directly related to weight in preschool children, because the food environment is mainly controlled by parents. Future research should incorporate measures of parental feeding practices to confirm this speculation.

Food approach behavior as an intervening variable in the relation between reward sensitivity and body weight

The second aim was to examine whether a relation existed between reward sensitivity and body weight through food approach behaviors. Although previous research pinpointed overeating (as measured with a combination of the original food responsiveness and emotional overeating scales of the CEBQ) as a mediator in the relation between reward sensitivity and body weight (Davis et al., 2007; Van den Berg et al., 2011), no such studies included preschool children. Moreover, the study with elementary school children investigated the role of overeating in general (Van den Berg et al., 2011), while we specifically focused on food responsive behavior and additionally investigated eating behavior that is especially relevant in the current obesogenic environment: eating in response to food-related stimuli, regardless of hunger or satiety (i.e. external eating). Despite the absence of a direct relation between reward sensitivity and body weight, both were indirectly related through food responsive behavior and external eating. The indirect effect suggests that reward sensitivity is primarily associated with concrete food approaching behaviors, such as external eating and food responsive behavior, rather than with the development of overweight per se. This finding is line with the Reinforcement Sensitivity Theory (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003), positing that the Behavioral Activation System (BAS), which reflects an individual's reward sensitivity, is activated when confronted with rewarding stimuli (Depue & Collins, 1999), thereby eliciting approach behavior toward the rewarding stimuli (Kane et al., 2004). High-energy products, which are highly rewarding stimuli (Epstein, Leddy, Temple, & Faith, 2007), elicit a stronger BAS activation in individuals high in reward sensitivity. Consequently, this study reveals that even in younger children, reward sensitivity is associated with a heightened sensitivity to palatable foods, and thus with a higher tendency to approach and consume them, which is in turn related to weight status.

The absence of a direct effect is intriguing because it suggests that a high sensitivity to rewards in *general* might not necessarily lead to overweight. Although it has been shown that individuals at risk for obesity showed increased responsivity of the reward circuitry in general (Stice, Yokum, Burger, Epstein, & Small, 2011), a recent longitudinal study demonstrated that neural responses on cues signaling food receipt predicted body fat gain, but not the receipt and anticipated receipt of monetary reward (Stice, Burger, & Yokum, 2015). This suggests that, only when children are highly sensitive to the rewarding aspects of palatable foods, they will exhibit more food approach behavior, which affects weight gain. In the current study, highly reward-sensitive children (as measured with the broad personality measure BAS scale) might be profoundly sensitive to different types of reward such as palatable foods, non-food rewards, or both. The use of a broad measure might have reduced the relation between reward sensitivity and food approach behavior, and might have eliminated the direct relation between reward sensitivity and body weight. Future research should include food specific reward sensitivity measures to investigate this hypothesis.

Strengths, limitations and future research

A few limitations of this study deserve consideration. Due to the cross-sectional nature of our design, no conclusions can be drawn regarding causal inferences or directions of the associations. Future research should replicate the current study in a longitudinal design to confirm that reward sensitivity influences external eating and food responsive behavior, which in turn influence body weight. Secondly, the body-mass distribution of the study sample slightly differed from the Belgian population in that normal weight children were overrepresented. This discrepancy may indicate selection bias associated with the recruitment procedure. Participating parents are probably interested in the topic “eating behavior”, and might have made efforts to establish healthy eating habits. Moreover, it is possible that these parents exert more control on their children’s food environment, which might have contributed to the absence of a direct relation between reward sensitivity and body weight. Despite potential concerns about the representativeness based on body mass distribution, scores on reward sensitivity (Vandeweghe, Verbeken, Moens, Vervoort, & Braet, 2016; Vervoort et al., 2015), food responsiveness (Sleddens et al., 2008; Viana et al., 2008) and external eating (Braet & Van Strien, 1997) resemble to those found in past studies of comparable samples. Thirdly, all measures were parent-report questionnaires, including children’s height and weight. Although previous studies have shown that parent-report is generally a valid and reliable way to obtain information about young children (Copeland, Landry, Stanger, & Hudziak, 2004; Vervoort et al., 2015), other studies found that parent-reported height and weight may not be completely accurate (Huybrechts, De Bacquer, Van Trimpont, De Backer, & De Henauw, 2006; Huybrechts et al., 2011). Therefore, multi-informant assessment, the use of behavioral measures or objective measures (e.g. height and weight measured by a trained experimenter) would certainly strengthen the conclusions of the current study and are recommended for future research.

Implications

Our results provide information that can be used when developing prevention programs for overweight in young children. Overweight and obesity prevention programs primarily focus on changing dietary or physical activity behaviors (e.g. Baranowski et al., 2000; Reilly & McDowell, 2003). However, our results suggest that eating behaviors as well as individual characteristics also play a significant role. More specifically, food approach behaviors vary in accordance with the child's reward sensitivity. As long as both aspects are not addressed, the child may relapse into previous eating habits, and long-term weight control might remain a challenge. In line with this assumption, a meta-analytic review of obesity prevention programs for children and adolescents demonstrated that, of 21% of the effective prevention programs, only 5% produced effects that persisted over a substantial follow-up period (Stice, Shaw, & Marti, 2006). Therefore, prevention programs should not only focus on proximal factors influencing weight, such as food intake, but also incorporate more distal factors, such as food approach behaviors and reward sensitivity. To our knowledge, training programs to enhance self-regulation of reward sensitivity are scarce and used for a purpose other than overweight prevention. For example, reward sensitivity training has been proposed as part of ADHD treatment, and focuses on the reward circuitry by increasing tolerance for delay (Schweitzer & McBurnett, 2012; Weissman, Lichtin, & Danzig, 2015). After this training, preschoolers were more inclined to choose the delayed reward, rather than the immediate (Schweitzer & Sulzer-Azaroff, 1988). Future research might explore the malleability of reward sensitivity implicated in various behavioral domains, including eating behavior. For example, it should be investigated whether reward sensitivity training alters the tendency of high reward-sensitive individuals to choose for an immediate reward (e.g. approach and consume high energy products) instead of a delayed reward (e.g. a healthy body weight). Besides focusing on alteration of individual characteristics and behaviors, prevention programs should also consider adjusting the environment. Highly reinforcing palatable foods, which are omnipresent in the current obesogenic environment, are very tempting for highly reward-sensitive individuals. A leptogenic environment which promotes healthy food choices (Swinburn, Egger, & Raza, 1999) would probably help to display less food approach behavior.

Conclusions

As the prevalence of overweight and obesity increased rapidly and remains high (Ng et al., 2014), it is crucial to comprehend the pathways involved in weight gain. The current study suggests that the temperamental characteristic reward sensitivity may indirectly play a role in weight gain via food approach behaviors including food responsive behavior and external eating. This is an important finding in a society where food is omnipresent. Evidence-based programs for the prevention of overweight and obesity should not focus on proximal factors alone (i.e. food intake), but should also incorporate more distal factors such as eating behavior and reward sensitivity.

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Tables

Table 1

Relationships between study variables, and means (M) and standard deviations (SD) for continuous variables. Associations are described by Pearson coefficients (for relations between continuous variables), F statistics (for relations between categorical and continuous variables) and Chi Square statistics (for relations between categorical variables)

Variable	1	2	3	4	5	6	*M*	*SD*
1. Reward Sensitivity							32.15	5.76
2. adjusted BMI	.08						97.77	11.84
3. Food Responsive Behavior	.30***	.24***					11.20	3.42
4. External Eating	.36***	.22**	.58***				29.98	5.04
5. Age	-.17*	-.05	.08	-.09			6.27	1.60
6. Sex	.05	.84	.00	.88	.00			
7. HHEA	10.61**	1.81	.61	.56	5.20*	.02		

*$p < .05$, **$p < .01$, ***$p < .001$; BMI = Body Mass Index; HHEA = Highest Household Educational Attainment

Figures

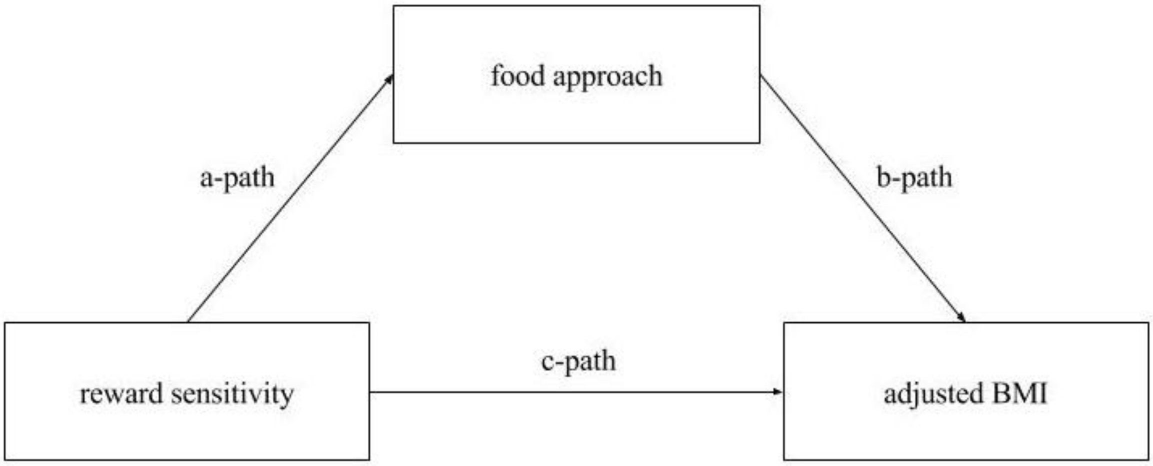

Figure 1. Mediation model.

Chapter 4

Strategies to Improve the Willingness to Taste: the Moderating Role of Children's Reward Sensitivity[3]

Abstract

The present study investigates the effectiveness of different strategies to improve Willingness to Taste disliked vegetables and the moderating role of Reward Sensitivity. Preschool children (*N*=204; age: *M*=4.48, *SD*=1.01) were randomly allocated to one of four different Willingness to Taste strategies. The findings indicate that first, Willingness to Taste is higher in the modelling and reward strategies compared to neutral instructions. Second, there is a differential effect of Willingness to Taste strategies dependent upon individual differences: children high in Reward Sensitivity were more likely to taste immediately when rewarded, while children low in Reward Sensitivity were more willing to taste when verbally encouraged, but with hesitation. This article thus highlights the roles of both individual differences and behavioral techniques for promoting a healthy diet in children.

[3] Vandeweghe, L., Verbeken, S., Moens, E., Vervoort, L., & Braet, C. (2016). Strategies to improve the Willingness to Taste: The moderating role of children's Reward Sensitivity. *Appetite, 103*, 344-352. doi:10.1016/j.appet.2016.04.017

Introduction

It has been shown that the intake of healthy food contributes to an overall sense of well-being (Blanchflower, Oswald, & Stewart-Brown, 2013) and the prevention of diseases (U.S. Department of Health and Human Services, 2010; U.S. Department of Health and Human Services/ U.S. Department of Agriculture, 2005; World Health Organisation, 2003). For young children, healthy food is particularly essential to achieve age-adequate growth and cognitive development (du Plessis, Naude, & Swart, 2016), and may help to decrease energy intake by reducing the consumption of energy dense (i.e. high in sugar and fat) products (Spill, Birch, Roe, & Rolls, 2011). Furthermore, childhood is an important period for shaping children's food preferences and eating habits, which may continue into adulthood (Nicklaus, Boggio, Chabanet, & Issanchou, 2004; Nicklaus & Remy, 2013). Nevertheless, the consumption of vegetables in preschool children is far below the minimum food-based dietary guidelines (Huybrechts et al., 2008; Kim et al., 2014; Storey & Anderson, 2016).

Two frequently identified obstacles to achieve the recommended amount of vegetables in childhood are food neophobia (i.e. the rejection of novel or unknown foods) (Birch & Fisher, 1998) and picky/fussy eating (i.e. the rejection of familiar foods) (Galloway, Lee, & Birch, 2003). Irrespective of these psychological determinants of food rejection and their underlying mechanisms (for review see Lafraire, Rioux, Giboreau, & Picard, 2016), children are generally not eager to consume foods they dislike (Baxter & Thompson, 2002; Birch & Fisher, 1998; Cullen et al., 2003). Since vegetables happen to be the least-liked food category (Cashdan, 1998; Skinner, Carruth, Bounds, & Ziegler, 2002), methods are needed to improve children's liking for vegetables. The most common strategy for developing liking is Repeated Exposure with which children are repetitively exposed to the taste of certain food items. Several studies have proven this strategy to be effective in increasing children's liking and consumption of an initially disliked vegetable (Ahern, Caton, Blundell, & Hetherington, 2014; Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Caton et al., 2013; de Wild, de Graaf, & Jager, 2013; Hausner, Olsen, & Moller, 2012). However, no consensus has been reached on the amount of taste exposure necessary to increase liking. Despite this discrepancy, it has been generally agreed that at least one taste exposure is necessary. In other words, children can never benefit from the Repeated Exposure effect if they refuse to taste. Since it has been shown that a large proportion of children might be unwilling to taste vegetables in a Repeated Exposure intervention (Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010), willingness to taste seems a crucial first step in the process of learning to like a food item. In the current study, we see Willingness to Taste as an initial approach behavior with specific antecedents and consequences, while considering liking as a more cognitive affective correlate of learning. Although past research has taken considerable interest in how to improve overall liking and consumption of vegetables, relatively little information is available concerning the strategies that can help children to enhance their Willingness to Taste.

Possible strategies to improve Willingness to Taste can be derived from evidence-based strategies for developing liking and increasing the consumption of vegetables. One possible way to improve Willingness to Taste is providing a good role model. Children are more likely to eat vegetables when they witness someone consuming them (Greenhalgh et al., 2009). Not only do adults (familiar as well as unfamiliar) seem to be effective role models (Hendy & Raudenbush, 2000), peers (Greenhalgh et al., 2009; Hendy, 2002) and even cartoon characters also have a positive influence on children's eating behavior (Harris & Baudin, 1972). After all, the Social Cognitive Theory (Bandura, 1977) has suggested that modelling can be very influential in establishing learning and behavioral change. Although modelling is more likely to be effective in the presence of a similar (e.g. peers), or familiar (e.g. parent or teacher) model (Bandura, 1977), adult strangers were also found to have a positive influence on children's food acceptance (Harper & Sanders, 1975).

Secondly, providing a reward might also be effective to encourage children to taste a disliked food item. Although this strategy has been broadly studied in the context of liking and consumption of vegetables, opinions are divided when it comes to the consequences of using rewards. According to the Self Determination Theory (SDT), a reward serves as an extrinsic motivator and it can undermine the intrinsic motivation (Deci, Koestner, & Ryan, 1999). Indeed, some studies have shown that the preference and liking of food decreases when children are offered a reward (Birch, Marlin, & Rotter, 1984; Newman & Taylor, 1992). However, the relation between rewards and liking or consumption of food is more complex than stated in the SDT. Rewards can become powerful tools in the process of developing the liking for healthy food provided they are used appropriately. It has indeed been shown that exposure+reward parings have positive short and long term effects on liking and consumption (Cooke, Chambers, Anez, Croker, et al., 2011). Similar to Repeated Exposure, no consensus has been reached on the number of exposure+reward parings necessary to change liking and consumption. Overall, the effectiveness of rewards depends on the outcome variable (consumption vs. liking), the extent to which the child originally liked the food item, and the type of reward (for review see, Cooke, Chambers, Anez, & Wardle, 2011). In most studies, rewards are found to have positive effects on *consumption*.

However, their effects on liking can be counterproductive, when the food item was already liked prior to the administration of the reward (Birch, Birch, Marlin, & Kramer, 1982; Birch et al., 1984). Furthermore, the type of reward is important. Offering sweets as a reward seems to provoke negative effects: it enhances the preference for the sweets (Newman & Taylor, 1992). On the other hand, various studies have demonstrated that both non-food tangible rewards (e.g. stickers) and non-tangible rewards (e.g. praise) enhance children's liking and consumption of disliked food items (Lowe, Horne, Tapper, Bowdery, & Egerton, 2004; Nicklas et al., 2001; Vereecken, Keukelier, & Maes, 2004). However, compared to a non-tangible reward (i.e. praise), tangible rewards seem to be more powerful in facilitating tasting (Cooke, Chambers, Anez, Croker, et al., 2011).

Verbal encouragement can be seen as a third possible strategy to enhance Willingness to Taste. It is a commonly used strategy to positively encourage individuals to provide an optimal effort in different types of behavior (Andreacci et al., 2002), including eating behavior. Verbal encouragement by food service staff is associated with higher fruit and vegetable consumption in elementary school children (Perry et al., 2004). Even at younger ages (12-17 months), children are more likely to accept food when their caregivers provide positive verbal encouragement (Dearden et al., 2009). Verbal encouragement needs to be differentiated from verbal coercion or pressure, which is inversely related to the consumption of fruit and vegetables (Brown, Ogden, Vögele, & Gibson, 2008; Galloway, Fiorito, Francis, & Birch, 2006). While verbal coercion is a negative form of verbal prompting in which the child feels pressured to eat, verbal encouragement is a less intrusive form of verbal instruction in which precautions are made to prevent the child from feeling obligated to taste (e.g. child-friendly tone).

Child characteristics

Previous studies mainly examined the effectiveness of different strategies in improving *liking*, *consumption* or *acceptance* of vegetables in general. However, children may react differently to different strategies, depending on their personal characteristics (Blissett, Bennett, Fogel, Harris, & Higgs, 2016). Personality theories assume that unique individual characteristics play a role in the expression of (eating) behavior (Block, 1993; Davis et al., 2007). Recently, it was shown that the effectiveness of strategies to facilitate the acceptance of a novel fruit depended on food responsiveness: physical prompting strategies in combination with modelling facilitated the acceptance of a novel fruit, but only in food-responsive children (Blissett et al., 2016). It was also shown that the effectiveness of strategies to increase consumption of a moderately-liked vegetable is linked to bitter-sensitivity: bitter-sensitive preschoolers consumed significantly more broccoli after being repeatedly exposed to broccoli with dressing than when served plain. In contrast, the dressing did not promote consumption among bitter-insensitive preschoolers (Fisher et al., 2012). This differential sensitivity to different strategies highlights the importance of individual characteristics.

While research has suggested that we take into account a child's individual Reward Sensitivity as a biological predisposition that guides human learning and behavior (Beaver et al., 2006), little is known about the specific role of a child's Reward Sensitivity in learning to like and consume vegetables. Reward Sensitivity is assumed to reflect the sensitivity of a neuropsychological system referred to as the Behavioral Activation System (BAS) (Gray, 1981, 1987a). The BAS responds to positive, rewarding environmental stimuli by activation of the dopaminergic system (Depue & Collins, 1999; Gray, 1994), which causes the initiation of "approach" behavior in order to obtain the rewarding goal (Kane, Loxton, Staiger, & Dawe, 2004). In following the definition of Reward Sensitivity, children high in Reward Sensitivity are expected to respond more strongly to rewarding environmental stimuli compared to those lower in Reward Sensitivity. Consequently, a Willingness to Taste strategy with a rewarding aspect is probably most effective in children higher in Reward Sensitivity.

The current research

Past research has examined different strategies to increase the liking and consumption of healthy foods such as modelling, reward learning and verbal encouragement. Willingness to Taste, however, has been less researched, even though it is a first crucial step in the process of developing liking for healthy food. Thus, the current study first aims to investigate which strategy is effective in increasing children's Willingness to Taste a disliked vegetable. We expect that modelling, rewarding and encouragement are more effective to improve Willingness to Taste than neutral instructions.

Second, we aim to explore whether Willingness to Taste depends on children's characteristics under different conditions. We expect that children high in Reward Sensitivity have a higher Willingness to Taste in a reward strategy than children low in Reward Sensitivity. More specifically, we believe that children's Reward Sensitivity will predict their Willingness to Taste only when a reward is given.

Method

Participants

A total of 214 preschool children were recruited via kindergartens in the neighborhood of Ghent, Belgium. The recruitment letter specifically requested the participation of children who disliked at least one vegetable. Upon arrival in the laboratory, 10 children did not want to participate. The final dataset comprised 204 participants. Demographics were obtained via parent self-report and included child age, sex and highest household educational attainment (see Table 1). Data were collected in May 2014 and May 2015.

Material

Behavioral Inhibition System / Behavioral Activation System (BIS/BAS) scales

In order to assess Reward Sensitivity, mothers completed the BAS scale of the BIS/BAS scales (Carver & White, 1994) adapted for parent report (Vervoort et al., 2015). The parent version was based on an age-downward adaptation of the original scales (Muris, Meesters, de Kanter, & Timmerman, 2005). The BAS scale (BAS_Total) consists of 13 items on 4-point Likert Scale from 1 (not true) to 4 (very true) and can be further subdivided in 3 subscales. The Reward Responsiveness subscale (BAS_RR, 5 items) includes statements as “Your child gets very excited when s/he would win a contest”. The Fun Seeking subscale (BAS_FS, 4 items) includes statements as “Your child craves for excitement and new sensations”. The Drive subscale (BAS_D, 4 items) includes statements as “When your child wants something, s/he usually goes all the way to get it”. The BAS-scales of the BIS/BAS parent version were found to have meaningful relations with other instruments assessing Reward Sensitivity (Vervoort et al., 2015): the SR-scale of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) positively correlated with BAS_Total (r=.61, p<.001), BAS_RR (r=.43, p<.001) and BAS_D (r=.59, p<.001). Secondly, the associations between BAS scales and Child

Behavior Questionnaire (CBQ) are generally consistent with RST assumptions on temperament and personality: higher levels of parent-reported Reward Sensitivity were related to higher levels of Surgency/Extraversion (BAS_Total: r=.58, p<.001; BAS_RR: r=.39, p<.001; BAS_D: r=58, p<.001). Internal consistency in the present sample was good for the BAS_D subscale (Cronbach's α=.83) and the BAS_Total score (Cronbach's α=.80), but poor for BAS_FS subscale (Cronbach's α=.52) and BAS_RR subscale (Cronbach's α=.60). Therefore, the individual subscales BAS_FS and BAS_RR were not included in the analyses.

Vegetable Liking List (VLL)

The VLL was developed by our research group and assesses children's liking of 10 vegetables in steamed or boiled form. The selection of vegetables is based on literature concerning taste development (e.g. Ventura & Worobey, 2013); vegetables with higher chance to be disliked (i.e. bitter or sour flavor, distinct flavor, difficult texture) were included in the list. The mother indicated the extent to which her child likes each of the vegetables. The response options were: "Like", "Just OK", "Dislike", "Never ate it or I don't know". The vegetable used in the taste experiment was one the child dislikes. Descriptive statistics for the VLL are depicted in table 2.

Child Food Neophobia Scale (CFNS)

The CFNS (Pliner, 1994) assesses the extent to which children reject novel or unknown foods and originally consists of 10 items, including statements as "My child does not trust new foods" and "My child is afraid to eat things s/he has never had before". The items are scored on a 4-point Likert Scale from 1 (strongly disagree) to 4 (strongly agree). Higher scores indicate higher food neophobia. We used the 6-item version, as this version is more adapted to the age range of our sample (Cooke, Wardle, & Gibson, 2003; Cooke et al., 2004). The scale has been validated against a behavioral measure of food neophobia (i.e. children's actual Willingness to Taste when confronted with ten unfamiliar foods) (Pliner, 1994). Internal consistency in the present sample was good (Cronbach's α=.80).

Hunger Rating Scale

At the start of the taste experiment, the degree of hunger was assessed by means of three cartoon faces: the child had to indicate whether he or she was very hungry, slightly hungry or not hungry.

Procedure

After the informed consent was obtained and the questionnaires were filled out, mother and child were invited to the Tasting Lab at Ghent University for participation on any of the 17 days with 16 moments on each day. In advance, each day was assigned to a specific condition through simple randomization (by throwing a dice). The Randomized Controlled Design permitted between-group analyses of the different strategies. Each child was tested individually without the mother's presence by a trained research assistant following a standardized protocol (protocol available upon request). To put the child at ease, the experimenter first socialized with him or her for 5 minutes. Then, the child was seated at a children's table and the child's degree of hunger was assessed. In every condition, the child was offered a small portion (±4 g) of bite-sized steamed or boiled vegetable that he or she dislikes. The vegetable was unseasoned and was served on a neutral plate. The way in which the instruction to taste was given differed according to four different strategy conditions: in the neutral instructions condition which was a control condition, the experimenter asked the child neutrally to taste the vegetable ("If you want, you are allowed to taste"). In the modelling condition, the tasting behavior was modelled by the experimenter along with the words "Mmm! This vegetable is delicious! If you want, you are also allowed to taste". In the reward condition, the experimenter promised the child a small tangible reward worth approximately 1 dollar (e.g. a toy of choice such as stickers, toy bears, colored pencils, jumping ropes, bubble blowers, coloring books, toy cars, balls, colored chalk, paint) if he or she tasted ("If you taste, you can choose a toy from this box!"). In the encouragement condition, the experimenter verbally encouraged the child to taste ("Come on, you can do it!"). The sentences were voiced in a positive, child-friendly tone. Furthermore, in every condition, we made efforts to prevent children from feeling obligated to taste ("You can choose whether you taste or not. I won't be angry if you don't taste"). An important note is that no verbal encouragement was offered in the reward and the modelling conditions. To control for visual exposure, the child was exposed to the food 1 minute before he or she was allowed to taste. After 1 minute during which the child was supplied with the relevant instructions, the experimenter gave the child a spoon and a fork, along with the words: "Now you can taste". Each session was video recorded and lasted approximately 10 minutes. Afterwards, the children and the parents were thanked for their cooperation and debriefed by e-mail; each child received a small toy and the parent(s) were given two information brochures about healthy food. This procedure was approved by the Institutional Ethical Committee.

Video scoring

Based on the video recordings, Willingness to Taste was assessed by two independent raters who were blinded to the purpose of the study. The children were classified in one of three categories: "tasted immediately", "tasted after hesitation" and "did not taste". The taste session was rated as "tasted immediately" if the child deliberately took the fork or spoon, and put the food in the mouth without hesitation. The taste session was rated as "tasting after hesitation" when the child was observed to play with the food and/or go slower or stop the motion before putting the food in the mouth. The taste session was rated as "did not taste" if the child refused to taste. Since preschool children can differ in motor reactions, it was considered important to measure the time till the child was willing to taste instead of how long it took until the food reached his or her mouth.

Plan of analysis

In order to check if Willingness to Taste was reliably assessed, we computed interrater reliability with kappa statistics. Discrepancies were discussed until total agreement was reached.

Variables of interest (i.e. condition, BAS_D and BAS_Total), demographic variables (i.e. age, sex, highest household educational attainment) and food-related variables (i.e. degree of hunger, food neophobia and vegetable type) were summarized: categorical and continuous variables were expressed as frequency (percentage) and mean (*SD*) respectively. The relation between Willingness to Taste and possible confounding variables (i.e. demographic and food-related variables) was examined using chi-squared tests for categorical variables and analysis of variance for continuous variables. Besides standard demographic variables (i.e. age, sex, and highest household educational attainment), three food related variables (i.e. food neophobia, degree of hunger and vegetable type) were a priori selected as possible confounding variables. Food neophobia was selected because it peaks in this age group (Dovey, Staples, Gibson, & Halford, 2008), and because it is inversely related to food consumption

(Cooke, Carnell, & Wardle, 2006). Degree of hunger was selected because the experiments were conducted on different times of the day. It seems logical to assume that children who have eaten very recently, might be less eager to taste. Previous research also showed a link between degree of hunger and eating behavior (Brunstrom & Fletcher, 2008; Guerrieri, Stanczyk, Nederkoorn, & Jansen, 2012). Vegetable type was selected as a possible confounding variable because it is an experimental manipulation that varies between children. Variables with $p<.10$ were considered confounding variables and included in the main analyses.

In order to confirm that the randomization procedure resulted in comparable groups, between-group baseline differences on all independent variables included in the main analyses were examined using one-way ANOVAs.

To examine the research questions, 3 Multinomial Logistic Regressions (MLRs) were conducted. An MLR breaks the regression up into a series of binary regressions comparing each group to a baseline group, which we determined to be the "did not taste" group. In order to examine our first research question, we conducted an MLR with strategy (with 4 conditions: modelling, reward, encouragement, neutral instructions) as factor, Willingness to Taste (with 3 levels: tasted immediately, tasted after hesitation, did not taste) as dependent variable and age and food neophobia as control variables. Two more MLRs building upon the first MLR were conducted to examine whether the effectiveness of each strategy depends on Reward Sensitivity; BAS_D and BAS_Total were added as continuous predictors in the second and third MLR respectively. If Odds Ratio (OR) > 1, effect sizes of the associations were evaluated as small if OR = 1.68, medium if OR = 3.47 and large if OR = 6.71. If OR < 1, effect sizes were evaluated as small if OR = 0.59, medium if OR = 0.28 and large if OR = 0.14 (Chen, Cohen, & Chen, 2010).

Results

Preliminary analyses

Regarding the assessment of Willingness to Taste, a substantial agreement was found between the two raters (κ=0.84, p<.001).

Table 1 shows that age, $F(2,198)=8.42$, $p<.001$; and food neophobia, $F(2,201)=8.43$, $p<.001$, were significantly related to Willingness to Taste. Therefore, they were placed in the MLR models as control variables.

Analyses on baseline differences showed that the four conditions did not significantly differ on age, $F(3,197)=.49$, $p=.68$; food neophobia, $F(3,200)=.85$, $p=.46$; BAS_D, $F(3,200) = 1.73$, $p=.16$; or BAS_Total, $F(3,200) =.94$, $p=.42$ (see Table 3 for descriptives).

Effect of strategy

The first MLR was conducted to examine which strategy is more effective than neutral instructions to improve children's Willingness to Taste (see Table 4 for descriptives, and Table 5 for the analysis).

Regarding the control variables; with increasing age, children were more likely to taste immediately (b=.86, Wald$\chi^2(1)=14.78$, $p<.001$) or taste after hesitation (b=.72, Wald$\chi^2(1)=9.55$, $p=.002$) compared to not taste at all. Furthermore, with decreasing food neophobia, children were more likely to taste immediately (b=-.21, Wald$\chi^2(1)=11.36$, $p=.001$) compared to not taste at all. The magnitude of the significant associations were small for age and food neophobia with effect sizes ranging from .80 to 2.37. No significant difference was found regarding food neophobia when comparing "tasting after hesitation" with "not tasting" (p=.45).

Regarding the factor strategy; the MLR made comparisons between neutral instructions (i.e. the control condition) and the three other strategies. There was a main effect of reward when comparing "tasting immediately" with "not tasting" (b=1.55, Wald$\chi^2(1)$=6.78, p=.009) and "tasting after hesitation" with "not tasting" (b=2.04, Wald$\chi^2(1)$=10.09, p=.001), indicating that children in the reward condition were more willing to taste (i.e. immediately and after hesitation) compared to the control condition. The magnitude of the significant associations of the reward condition were moderate to large with effect sizes ranging from 4.74 to 10.18. There was also a main effect of modelling when comparing "hesitating to taste" with "not tasting" (b=1.20, Wald$\chi^2(1)$=3.99, p=.04), indicating that children in the modelling condition (vs. control condition) were more willing to taste after hesitation than not tasting. There was a trend approaching significance for modelling when comparing "tasting immediately" with "not tasting" (b=1.00, Wald$\chi^2(1)$=3.46, p=.06). The magnitude of the significant associations of the modelling condition were moderate with effect sizes ranging from 3.31 to 3.43. We found no differences on Willingness to Taste when comparing the encouragement strategy with the control condition (all p's>.1) (See Figure 1 for percentages of Willingness to Taste in each strategy). Overall, this MLR model explained a small to moderate amount of the variance in Willingness to Taste, as indicated by Cox & Snell R^2 = .20 and Nagelkerke R^2 = .23 (see Table 5).

Effect of strategy x Reward Sensitivity

Next, two MLRs were conducted to examine whether the effectiveness of the strategy depends on children's Reward Sensitivity. The difference between the latter two MLRs is the inclusion of either BAS_D or BAS_Total as measures of Reward Sensitivity (see Table 4 for descriptives, and Table 5 for the analyses). We expected a moderating role of Reward Sensitivity in the reward condition. A significant interaction effect was found between the reward strategy and Reward Sensitivity (BAS_D: b=.55, Wald$\chi^2(1)=4.79$, $p=.02$; BAS_Total: b=.26, Wald$\chi^2(1)=4.83$, $p=.02$), indicating that children with a higher Reward Sensitivity were more likely to taste immediately in the reward condition compared to the control condition. This interaction effect could not be found when comparing "tasting after hesitation" with "not tasting". Additionally, an interaction effect was found between the encouragement strategy and BAS_D (b=-.65, Wald$\chi^2(1)=5.05$, $p=.02$), suggesting that children with a lower BAS_D were more willing to taste after hesitation when encouraged compared to the control condition. This interaction effect could not be found with BAS_Total or when comparing "tasting immediately" with "did not taste". No further interaction effects of Reward Sensitivity x strategy were observed. The significant interaction effects were small with effects sizes ranging from 1.30 to 1.74. Overall, the second and third MLR model explained a moderate amount of the variance in Willingness to Taste, as indicated by Cox & Snell R^2 values of .28 and .25 and Nagelkerke R^2 values of .32 and .29 (see Table 5).

Discussion

The first aim of the current study was to investigate which strategies are effective in improving preschool children's Willingness to Taste disliked vegetables. The results suggest that, compared to neutral instructions, children were more willing to taste ("tasting immediately" and "tasting after hesitation" vs. "not tasting") when they are rewarded for tasting with a non-food token (i.e. reward) and taste more after hesitation (compared to not tasting) when the tasting behavior is modeled by a stranger (i.e. modelling). A trend approaching significance in the same direction was further found in the modelling condition when we compared “tasting immediately” with “not tasting”. The size of the effects were moderate to large for the reward condition and moderate for the modelling condition. The findings thus confirm that non-food rewards can be useful in convincing children to engage in the rewarded behavior (Cooke, Chambers, Anez, & Wardle, 2011). The effectiveness of modelling supports the Social Cognitive Theory (Bandura, 1977) stating that a role model motivates children to imitate behavior. On the whole, the results imply that the modelling and the reward strategies are more effective than giving neutral instructions in encouraging children to taste.

We could not demonstrate that, in comparison to neutral instructions, children are more willing to taste (“tasting immediately” and “tasting after hesitation” vs. “not tasting”) when verbally encouraged by a stranger. As a result, we are unable to confirm the idea that verbal encouragement convinces individuals to make an effort (Andreacci et al., 2002). The absence of significant effects might suggest that the motivational aspect in the encouragement strategy is not strong enough to make children taste more than when neutral instructions are given. An alternative explanation of the null findings is that the children were verbally encouraged by a stranger instead of a familiar adult which might have less impact.

Our second aim was to examine whether the effectiveness of strategies depends on children’s Reward Sensitivity. We found the expected moderating effect of Reward Sensitivity: children higher in Reward Sensitivity were more likely to taste immediately when given a tangible non-food reward compared to the control condition (i.e. neutral instructions). It should however be noted that the size of this effect was small. This significant interaction effect is consistent with Gray's RST (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003), which says that individuals with a more active BAS tend to react more heavily to rewards and they are more likely to activate behavior in order to obtain rewards. However, we could not find the interaction effect when comparing "tasting after hesitation" with "did not taste". This unexpected finding might be explained by impulsivity, as this personality factor is positively correlated with Reward Sensitivity (Torrubia, Avila, Molto, & Caseras, 2001). Put another way, children high in Reward Sensitivity are more likely to be impulsive: if their BAS is activated, they will not hesitate to obtain their reward, which means they taste immediately. Future research should incorporate impulsivity to confirm this speculation.

To sum up, our results suggest that a tangible non-food reward can convince children to taste immediately, but only if they are highly sensitive to reward. In this sense, it is not impulsivity, but indeed Reward Sensitivity that drives their Willingness to Taste, because if impulsivity were the main determinant, children high in Reward Sensitivity would be more likely to taste immediately in all conditions, not only when a reward is presented. This finding is of paramount importance, since Reward Sensitivity has been previously shown to be a significant predictor of preferences for palatable foods (Davis et al., 2007), intake of high energy products (De Cock et al., 2015) and overeating (Davis et al., 2007; Davis, Strachan, & Berkson, 2004; Loxton & Dawe, 2001; Small, 2009). In order to address the unhealthy eating habits of high reward sensitive children, it is possible that enhancing their preference for healthy food may help them to forego temptations and move towards more healthy eating patterns. Therefore, it might be important to find effective strategies to enhance the Willingness to Taste disliked vegetables for those children high in Reward Sensitivity.

Rather unexpectedly, children lower in Reward Sensitivity (i.e. BAS_D) were more willing to taste after hesitation when verbally encouraged compared to the control condition. The size of this interaction effect was small. A possible explanation is that children low in Reward Sensitivity might be less extravert and less impulsive, compared to those high in Reward Sensitivity (Muris et al., 2005; Torrubia et al., 2001); they may need verbal encouragement as a motivation to react in an unknown situation. This explanation concurs with our finding that the interaction effect was only present when “tasting after hesitation” was compared with “not tasting”. In other words, low reward sensitive children needed some time and encouragement to overcome their shyness. It is possible that this effect would not be present when a familiar adult would feed the child. Future research should replicate the design with a familiar adult to shed light on this issue.

Another noteworthy result is that the interaction effect with verbal encouragement was found in relation to BAS_D and not to BAS_Total. It could be that BAS_Total captures more than we intended to measure (i.e. Reward Sensitivity). According to several studies (Dawe, Gullo, & Loxton, 2004; Dawe & Loxton, 2004; Verbeken, Braet, Lammertyn, Goossens, & Moens, 2012), BAS_D is, in comparison to the other BAS scales, the best predictor of appetitive motivation and approach behavior, and it purports to closely reflect individual differences in the activity of brain reward circuitry (Pickering & Gray, 1999).

We believe our results have contributed to broadening the understanding of Willingness to Taste, as a first step in improving children’s liking for vegetables and consumption. Past research has hardly studied Willingness to Taste in the context of disliked foods. The importance of the concept is nevertheless crucial; children who refuse to taste can never benefit from the effects of Repeated Exposure, a strategy proven to be very effective in learning to like vegetables (Ahern et al., 2014; Anzman-Frasca, Savage, et al., 2012; Caton et al., 2013; Hausner et al., 2012). Our study, however, does not explore the underlying reason for disliking vegetables. Although this issue is beyond the scope of the study, it is interesting to make some speculation. It might be that a child dislikes the vegetable because of the food texture (i.e. picky/fussy eater), which might indicate over-responsivity to tactile stimuli. It might also be that he or she is highly food neophobic. It could also be the case that the child is not a picky/fussy eater and has no food neophobia, but simply does not like a particular vegetable. Irrespective of the underlying reason for disliking vegetables, our investigation on how children can be motivated to taste holds a key to promoting a balanced diet in children.

Our study focus on Willingness to Taste has unveiled a number of strategies which can be employed to increase healthy eating behavior in toddlers. Moreover, the current results show that children differ regarding time of tasting; some children are immediately convinced to taste (i.e. immediate tasters), while other children need some more time to be convinced (i.e. tasters after hesitation). These results underscore the importance of not giving up when your child does not want to taste immediately. Another innovative aspect of this study is that we addressed an individual factor by linking the effectiveness of strategies to encourage tasting to children’s Reward Sensitivity. Within some strategies, time of tasting (i.e. immediate or after hesitation) seems to depend on the child characteristic Reward Sensitivity. These findings imply that we cannot make a general intervention in encouraging all children to taste. Instead, interventions need to be adapted to individual child characteristics. Future research should extend the current research by investigating, next to Reward

Sensitivity, the moderating role of other individual factors that are predictive of obesity, such as poor self-regulation (Francis & Susman, 2009), low negative affectivity (Darlington & Wright, 2006) and high emotionality (Haycraft, Farrow, Meyer, Powell, & Blissett, 2011) (for a review of these factors see, Anzman-Frasca, Stifter, & Birch, 2012).

We investigated Willingness to Taste in an experimental laboratory setting. By doing so, we maximized the likelihood that the effects have been produced by our manipulations. Despite our cautiousness to ensure the rigor of such an experimental procedure, the external validity of the findings might be challenged because the children were not in their natural eating environment in which a familiar adult asks them to taste. This might account for the high number of children who were willing to taste a disliked vegetable, even in the control condition. Despite our efforts to prevent children from feeling obligated to taste, children might have been overwhelmed or felt under pressure, which might have had an effect on their tasting behavior. Also, shyness could be a confound since children have different levels of socialization with strangers (Kagan, Reznick, & Snidman, 1988). We further acknowledge that the vegetable consumption history of the children might have been constrained by the Vegetable Liking List which did not inform us about the frequency of tasting the vegetable or about pickiness. Furthermore, we do not have validity coefficients of the Hunger Rating Scale. Also, it is possible that parents of children with higher levels of food neophobia were more likely to participate, which would suggest that the sample is not representative of Flemish preschool children. Based on these limitations, it is certainly recommended that future research set up a more ecologically valid study involving, for instance, home meals, school meals, meals in child care centers, with a broader assessment using validated measures for preschool children.

The participants in our study were preschool children without previously known problems in their eating behavior. However, individually tailored Willingness to Taste strategies might also be particularly applicable to clinical groups with maladaptive eating behavior (i.e. children with a restrictive or selective eating disorder). In addition, our findings on the differential sensitivity might have implications for developing strategies to improve *liking* and *consumption* of vegetables. One could investigate whether liking and consumption of an initially disliked vegetable increases faster in high Reward Sensitivity children when offered repeatedly the vegetable with a reward strategy. Furthermore, future research could explore these Willingness to Taste strategies within the domain of the reinforcing value of food. This concept refers to how hard an individual is willing to work to obtain food (Epstein, Leddy, Temple, & Faith, 2007). It is plausible that the reinforcing value of a disliked vegetable increases after a Willingness to Taste strategy has been (repeatedly) applied. Eventually, the initially disliked vegetable might be able to compete with a more intrinsically liked food. Since the reinforcing value of food is higher in high Reward Sensitivity children (Rollins, Loken, Savage, & Birch, 2014), this learning process might occur faster with the reward strategy in these children.

Based on the current results, it can be concluded that modelling and rewarding are effective strategies to improve Willingness to Taste in preschool children. However, as presented earlier, the effectiveness of the reward and encouragement strategies depends on Reward Sensitivity, which suggests that based on a child's Reward Sensitivity, an individually tailored approach is needed for helping children to taste disliked vegetables. When these findings are incorporated in the existing evidence-based guidelines to increase liking for and consumption of healthy food and translated comprehensively to caregivers of young children, they will contribute to promoting healthy eating. Finally, we maintain that the principal process to teach and train children to like and consume a new vegetable has proven to be repeated taste exposure. To facilitate the tasting process, we summarize and recommend the strategies as follows: (1) modelling and reward generally increase the likelihood that a child tastes, and (2) if the child still refuses to taste, a strategy in accordance with the Reward Sensitivity of the child is proposed: a low Reward Sensitivity child may benefit from a verbal encouragement strategy, while a high Reward Sensitivity child may benefit more from a reward strategy.

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Tables

Table 1

Descriptive statistics and association of demographic and food-related variables to Willingness To Taste

	All (*N*=204)	Tasted Immediately (*n*=98)	Tasted after hesitation (*n*= 61)	Did not taste (*n*=45)	
Variable	*N* (%) or *M* (*SD*)	*n* (%) or *M* (*SD*)	*n* (%) or *M* (*SD*)	*n* (%) or *M* (*SD*)	*p*
Demographic variables					
Age in years	4.48 (1.01)	4.69 (1.05)	4.53 (.97)	3.95 (.80)	.00
Sex					.22
Male	104 (51.0)	46 (44.2)	30 (28.8)	28 (26.9)	
Female	100 (49.0)	52 (52.0)	31 (31.0)	17 (17.0)	
HHEA					.38
Bachelor or higher	162 (86.2)	75 (46.3)	52 (32.1)	35 (21.6)	
High school graduate	25 (13.3)	13 (52.0)	6 (24.0)	6 (24.0)	
Not a high school graduate	1 (0.5)	0 (0.0)	0 (0.0)	1 (100.0)	
Food-related variables					
Degree of hunger					.33
Not hungry	82 (40.8)	33 (40.2)	28 (34.1)	21 (25.6)	
Slightly hungry	43 (21.4)	25 (58.1)	12 (27.9)	6 (14.0)	
Very hungry	76 (37.8)	39 (51.3)	21 (27.6)	16 (21.1)	
Food Neophobia	14.79 (3.46)	13.79 (3.21)	15.65 (3.33)	15.80 (3.61)	.00
Vegetable Type					.11

Note. HHEA = Highest Household Educational Attainment

Table 2

Descriptive statistics for the Vegetable Liking List

Vegetables	Like (%)	Just OK (%)	Dislike (%)	Never ate it/ I don't know (%)	Selected for the study (%)
Brussels Sprouts	7.8	39.2	44.6	8.3	4.9
Broccoli	64.2	22.1	11.7	2.0	2.5
Cauliflower	44.1	38.7	16.2	1.0	2.5
Chicory	13.2	19.1	61.8	5.9	23.2
Fennel	13.7	18.6	23.0	44.7	6.4
Leek	28.9	31.9	33.8	5.4	20.2
Mushrooms	23.0	17.2	55.4	4.4	20.2
Peas	58.3	23.5	13.7	4.5	8.9
Spinach	58.3	22.5	16.7	2.5	3.9
Zucchini	31.4	31.9	25.0	11.7	7.4

Table 3

Descriptive statistics for control variables and variables of interest in each condition

	Modelling	Reward	Encouragement	Neutral Instructions
Variable	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Age in years	4.35 (.98)	4.50 (1.07)	4.55 (.97)	4.57 (1.04)
Food Neophobia	15.01 (3.65)	15.16 (3.67)	14.13 (3.40)	14.62 (2.91)
BAS_D	10.63 (2.69)	9.46 (2.75)	9.86 (3.14)	9.83 (2.86)
BAS_Total	34.57 (5.93)	33.05 (5.57)	32.91 (5.71)	33.45 (5.75)

Table 4

Descriptive statistics for the variables of interest

Variable	All (N = 204)	Tasted Immediately (n =98)	Tasted after Hesitation (n = 61)	Did not taste (n =45)
	N (%) or M (SD)	n (%) or M (SD)	n (%) or M (SD)	n (%) or M (SD)
Strategy				
Modelling (%)	58 (28.4)	29 (50.0)	17 (29.3)	12 (20.7)
Reward (%)	60 (29.4)	30 (50.0)	23 (38.3)	7 (11.7)
Encouragement (%)	43 (21.1)	20 (46.5)	13 (30.2)	10 (23.3)
Neutral instructions (%)	43 (21.1)	19 (44.2)	8 (18.6)	16 (37.2)
BAS_D	9.96 (2.86)	10.18 (2.78)	9.14 (2.62)	10.57 (3.15)
BAS_Total	33.54 (5.74)	33.85 (5.96)	32.31 (5.03)	34.54 (5.99)

Table 5

Association between Willingness to Taste and the variables of interest – adjusting for confounding variables – as described by Odds Ratios (ORs) for Multinomial Logistic Regression (MLR) Models

	MLR1		MLR2		MLR3	
	Tasted Immediately vs. not tasting	Tasted after Hesitation vs. not tasting	Tasted Immediately vs. not tasting	Tasted after Hesitation vs. not tasting	Tasted Immediately vs. not tasting	Tasted after Hesitation vs. not tasting
Variable	OR (95% Confidence Interval)					
Age	2.37 (1.52 - 3.68)***	2.06 (1.30 - 3.27)***	2.29 (1.45 - 3.60)***	1.95 (1.20 - 3.16)***	2.26 (1.45 - 3.53)***	1.94 (1.22 - 3.10)***
Food Neophobia	.80 (.71 - .91)***	.95 (.84 - 1.07)	.81 (.71 - .92)***	.97 (.85 - 1.10)	.80 (.71 - .91)***	.96 (.84 - 1.08)
Strategy						
Modelling	2.72 (.94 - 7.79)*	3.34 (1.02 - 10.91)**	2.79 (.94 - 8.26)*	3.43 (1.03 - 11.32)**	2.76 (.93 - 8.13)*	3.31 (1.00 - 10.95)**
Reward	4.74 (1.46 - 15.29)***	7.74 (2.19 - 27.38)***	7.17 (1.74 - 29.47)***	10.18 (2.29 - 45.25)***	5.61 (1.56 - 20.18)***	8.62 (2.21 - 33.58)***
Encouragement	1.83 (.58 - 5.78)	3.06 (.87 - 10.72)	2.80 (.77 - 10.18)	2.79 (.62 - 12.48)	2.17 (.64 - 7.34)	2.52 (.63 - 10.11)
Neutral Instructions	-	-	-	-	-	-
RS			.88 (.67 - 1.15)	.98 (.71 - 1.35)	.91 (.79 - 1.04)	.96 (.82 - 1.13)
Strategy x RS						
Modelling x RS			1.09 (.75 - 1.57)	.89 (.58 - 1.36)	1.07 (.89 - 1.29)	.99 (.81 - 1.22)
Reward x RS			1.74 (1.06 - 2.86)**	1.22 (.73 - 2.05)	1.30 (1.02 - 1.64)**	1.11 (.87 - 1.41)
Encouragement x RS			.84 (.54 - 1.30)	.51 (.29 - .91)**	.98(.78 - 1.22)	.80 (.61 - 1.05)
Neutral Instructions x RS			-	-	-	-

Note: * $p < .1$, ** $p < .05$, *** $p < .01$
RS = Reward Sensitivity
In MLR2, BAS_D is included as a measure of RS; in MLR3, BAS_Total is included as a measure of RS
MLR1: $R^2 = .20$ (Cox & Snell), .23 (Nagelkerke). Model $\chi 2$ (10) = 45.28, $p < .001$
MLR2: $R^2 = .28$ (Cox & Snell), .32 (Nagelkerke). Model $\chi 2$ (18) = 66.31, $p < .001$
MLR3: $R^2 = .25$ (Cox & Snell), .29 (Nagelkerke). Model $\chi 2$ (18) = 59.95, $p < .001$

Figures

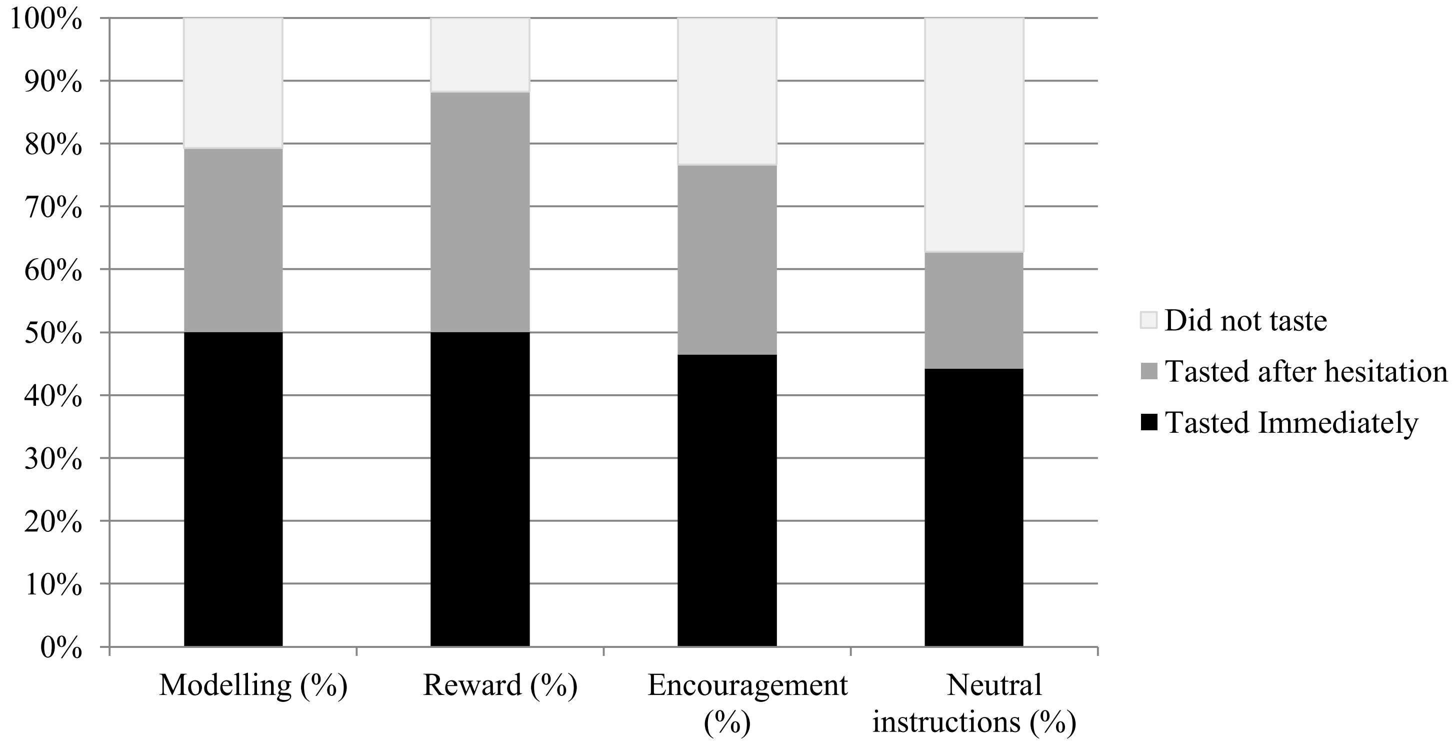

Figure 1. Percentages of Willingness to Taste in each strategy.

Chapter 5

Strategies to Increase Preschool Children's Willingness to Taste, Liking and Consumption of a Disliked Vegetable: the Role of Reward Sensitivity[4]

Abstract

The present study aimed to investigate the effectiveness of different strategies to increase the willingness to taste, liking and consumption of a disliked vegetable in preschool children, and the moderating role of reward sensitivity. Kindergarten classes (*N*=8; preschool children: *N*=154, 46,8% boys, age: *M*=5.08, *SD*=.61) were semi-randomly assigned to one of four different conditions, counterbalancing for age. In every condition, except for the control condition, the child was repeatedly (i.e. 8 times on 8 different days) offered a vegetable that the majority of children disliked (i.e. chicory), presented either with neutral instructions (i.e. Repeated Neutral Exposure; RNE), or with a social (i.e. Repeated Exposure (RE)+social reward) or token reward (i.e. RE+token reward). During this intervention period, children's willingness to taste and child-reported liking was registered. Before (i.e. pre-test) and twice after the intervention period (i.e. post-test and follow-up-test), the child's liking and consumption of the chicory was measured. The results demonstrated that children's liking and consumption of the chicory significantly increased when repeatedly exposed to the

[4] Vandeweghe, L., Verbeken, S., Braet, C., Loeys, T., De Henauw, S., & Moens, E. (submitted). Strategies to increase preschool children's willingness to taste, liking and consumption of a disliked vegetable: the role of Reward Sensitivity.

vegetable through neutral instructions, or when promised a social or tangible reward for tasting, compared to no taste exposures. No significant differences were found between the three active strategies (i.e. RNE, RE+social reward, RE+token reward) for all dependent variables. We found some evidence for the moderating role of the individual characteristic reward sensitivity: (a) children high in reward sensitivity had higher odds of obtaining liking during the intervention period in the RE+token reward condition, compared to children low in reward sensitivity and (b) children low in reward sensitivity, compared to children high in reward sensitivity, showed a stronger increase in liking the chicory in the RE+social reward condition at post-test. As these moderating effects could not be replicated with other outcome variables, the results concerning the moderating role of reward sensitivity need to be treated with caution.

Introduction

In young children, healthy eating habits are essential to achieve a healthy growth and development (Conners, 1989; Pipes, 1989) and are recommended to prevent overweight and obesity (World Health Organisation, 2016). Furthermore, food preferences as well as eating habits in childhood may continue into adulthood (Nicklaus, Boggio, Chabanet, & Issanchou, 2004). Despite the necessity to eat healthy and the numerous efforts of health promotion interventions, the consumption of vegetables in preschool children is far below the minimum food-based dietary guidelines (Huybrechts et al., 2008). The regular consumption of vegetables is determined by a wide range of personal and family-related factors (Jackie Blissett & Fogel, 2013; Rasmussen et al., 2006), including preferences (Bere & Klepp, 2005), genes (Jackie Blissett & Fogel, 2013), parental consumption (Bere & Klepp, 2004), parental feeding practices (Mitchell, Farrow, Haycraft, & Meyer, 2013), availability and accessibility of vegetables (Bere & Klepp, 2005; Cullen et al., 2003). Of these, preferences or the liking of food, is repeatedly identified as a strong and important determinant of consumption (Baxter & Thompson, 2002; Cullen et al., 2003; Domel et al., 1996; Gibson, Wardle, & Watts, 1998). Therefore, the present study focused on strategies to improve liking of vegetables in preschool children. Additionally, previous research highlighted the influence of individual characteristics on the effectiveness of these strategies (Jackie Blissett, Bennett, Fogel, Harris, & Higgs, 2016; Vandeweghe, Verbeken, Moens, Vervoort, & Braet, 2016), suggesting that individually tailored strategies may be more helpful in nudging children towards healthy eating habits. Therefore, the child’s trait reward sensitivity in relation to the success of the strategies was investigated as well.

Repeated Exposure, in which children are repetitively exposed to the taste of food items, is the most basic learning strategy for establishing liking. Repeated Exposure is in line with the “mere exposure hypothesis”, which states that repeatedly making a stimulus available enhances liking for that stimulus (Zajonc, 1968). Multiple studies proved Repeated Neutral Exposure (i.e. Repeated Exposure through neutral instructions) to be effective in increasing liking and consumption of an initially disliked vegetable (Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Birch & Marlin, 1982; Birch, Mcphee, Shoba, Pirok, & Steinberg, 1987; Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010; Wardle, Cooke, et al., 2003; Wardle, Herrera, Cooke, & Gibson, 2003). However, since willingness to taste is needed to obtain exposure, and thus, a perquisite to establish liking (Birch et al., 1987), a major pitfall of Repeated Neutral Exposure is the absence of a motivational component to encourage tasting. Such motivation is advisable, given the high prevalence of food neophobia (i.e. the rejection of novel or unknown foods) (Birch & Fisher, 1998) and picky/fussy eating (i.e. the rejection of familiar foods) (Galloway, Lee, & Birch, 2003) in preschool children (Dovey, Staples, Gibson, & Halford, 2008).

Previous research evaluated various motivational strategies to enhance children’s tasting behavior, such as modelling (Addessi, Galloway, Visalberghi, & Birch, 2005; Hendy, 2002), teaching (Jackie Blissett et al., 2016), role-playing (Jacqueline Blissett, Bennett, Donohoe, Rogers, & Higgs, 2012) or rewarding (Cooke, Chambers, Anez, Croker, et al., 2011). The current study focuses on reward: a child given a tangible or non-tangible reward after tasting should be motivated to taste again. This reasoning follows the principle of operant or instrumental conditioning which states that behavior is modified by its consequences (Skinner, 1938). The frequency of behavior will decrease or increase if it is followed by a punishment or reward respectively. However, research suggests that the effect of rewards within the food domain is more complex than the basic principle of operant conditioning as formulated by Skinner (1938). The success of reward-based strategies seems to depend upon (a) the rewarded behavior, (b) the outcome variables, (c) the extent to which the child originally liked the vegetable and (d) the type of reward (for review see Cooke, Chambers, Anez, & Wardle, 2011). (a) Research shows that it is important not to reward *how much* children eat, as this "clean up your plate" - strategy undermines their internal regulation system and increases the preference for larger portions (Colapinto, Fitzgerald, Taper, & Veugelers, 2007), which may in turn lead to overweight and obesity (for review see Fisher & Kral, 2008). In contrast, rewarding children for *tasting* does not affect their intern regulation system. Instead, it enables them to benefit from repeated taste exposures (Cooke, Chambers, Anez, Croker, et al., 2011). (b) In general, the combination of exposure and rewards for tasting were found to have positive effects on *consumption* (Horne et al., 2009; Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). However, inconsistent results were found when *liking* was measured (Hendy, Williams, & Camise, 2005). (c) More specifically, reward-strategies seem to have an adverse effect on liking when the food item was already liked (Birch, Birch, Marlin, & Kramer, 1982; Birch, Marlin, & Rotter, 1984). (d) The type of reward also determines whether rewards have positive or negative effects. Using food as a reward, such as sweets or deserts, is found to have negative effects (Newman & Taylor, 1992). Non-food rewards can further be subdivided in token or non-food tangible rewards, such as stickers or little toys, and social or non-tangible rewards, such as praise. The repeated use of either type of reward causes short- and long-term increases in children's liking and consumption of disliked food items (Cooke, Chambers, Anez, Croker, et al., 2011; Lowe et al., 2004).

Besides their proper use, the success of these strategies might also depend on child characteristics (Jackie Blissett et al., 2016; Vandeweghe et al., 2016). It was recently found that the effectiveness of strategies to enhance children's willingness to taste disliked food items depended on individual differences in reward sensitivity (Vandeweghe et al., 2016). Reward sensitivity is assumed to reflect the sensitivity of the Behavioral Activation System, defined by the Reinforcement Sensitivity Theory (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003). The Behavioral Activation System responds to positive, rewarding environmental stimuli with "approach" behavior in order to obtain the rewarding goal (Depue & Collins, 1999; Gray, 1981, 1987a; Kane, Loxton, Staiger, & Dawe, 2004). In line with this theory, it was found that, compared to providing neutral instructions, children high in reward sensitivity were more willing to taste a disliked vegetable when they were rewarded for tasting with a token. An unexpected result emerged as well: compared to giving neutral instructions, children lower in reward sensitivity were more likely to taste after hesitation when verbally encouraged (Vandeweghe et al., 2016). These differential sensitivities underscore the importance of taking into account individual characteristics when applying strategies to improve liking and consumption of vegetables; while some children may benefit more from strategy X, other children might benefit more from strategy Y. As this study was conducted in an experimental laboratory setting, the external validity of the findings might be challenged because the children were not in their natural eating environment. Therefore, it is important to replicate and extend these results in a more ecologically valid study.

The present study aims to further investigate the effectiveness of different strategies (i.e. Repeated Neutral Exposure (RNE), Repeated Exposure (RE)+token reward and RE+social reward) in preschool children in an ecologically valid context. The effectiveness of the strategies was determined by *willingness to taste* and *liking after having tasted the vegetable* during the intervention period (i.e. when the strategy is applied), and *change in liking and consumption* after versus before the intervention period compared to a control condition in which no strategy was provided. Based on previous research, it was hypothesized that children in the three intervention conditions (i.e. RNE, RE+token reward, RE+social reward) would show increased liking and consumption of an initially disliked vegetable after the intervention period compared to children in the control condition. Because of the motivational component in the reward conditions, we additionally expected a stronger increase in liking and consumption after the intervention as well as an enhanced willingness to taste and higher odds of obtaining liking during the intervention in both RE+reward conditions compared to the RNE condition. Second, the study investigated whether the effectiveness of the different conditions depended on reward sensitivity. With respect to RE+token reward condition, it was expected that, based on theory (Gray, 1981, 1987a) and previous research (Vandeweghe et al., 2016), children high in reward sensitivity, compared to children low in reward sensitivity, would show a stronger increase in liking and consumption after the intervention, and a higher willingness to taste and higher odds of obtaining liking during the intervention. With respect to RE+social reward, opposite hypotheses were formulated based on theoretical conceptualizations on the one hand (Gray, 1981, 1987a) and previous findings on the other (Vandeweghe et al., 2016). In line with the theoretical conceptualization of reward sensitivity, children high in reward sensitivity, compared to children low in reward sensitivity, are expected to show a stronger increase in liking and consumption after the intervention and a higher willingness to taste and higher odds of obtaining liking during the intervention in the RE+social reward condition. However, in line with a previous study showing that verbal encouragement, which announces a social reward, is most effective in low reward sensitive children (Vandeweghe et al., 2016), it is expected that children low in reward sensitivity, compared to high reward sensitivity, would show a stronger increase in liking and consumption after the intervention, and a higher willingness to taste and higher odds of obtaining liking during the intervention in the RE+social reward condition.

Method

Participants

The study was conducted in two Flemish nursery schools in Deinze (77 children; 50,6% boys; age: *M*=5.18; *SD*=.60) and in Bevere (77 children; 42,9% boys; age: *M*=5.01; *SD*=.60). No one was allergic to the target vegetable. In total, the dataset comprised 154 children (46,8% boys; age: *M*=5.08; *SD*=.61).

Material

Behavioral Inhibition System / Behavioral Activation System (BIS/BAS) scales

In order to assess reward sensitivity (RS), mothers completed the BAS scale of the BIS/BAS scales (Carver & White, 1994) adapted for parent report (Vervoort et al., 2015), which was based on an age-downward adaptation of the original scales (Muris, Meesters, de Kanter, & Timmerman, 2005). The BIS/BAS-scales parent version is found to be a useful and valid index of a child's RS (Vervoort et al., 2015). The BAS scale consists of 13 items on 4-point Likert Scale from 1 (not true) to 4 (very true) and can be further subdivided in 3 subscales. The Reward Responsiveness subscale (5 items) includes statements as "It would excite my child to win a contest". The Fun Seeking subscale (4 items) includes statements as "My child craves excitement and new sensation". The Drive subscale (4 items) includes statements as "When my child wants something, he or she usually goes all out to get it". In the current study, RS refers to sum of the 13 BAS items (Cronbach's α=.87).

Vegetable Liking List

The Vegetable Liking List (VLL) assesses children's liking of 10 vegetables in steamed or boiled form (i.e. fennel, chicory, zucchini, mushrooms, peas, leek, Brussels sprouts, beetroot, spinach and cauliflower). The choice of items in this self-developed questionnaire was based on the least liked vegetables in a previous study (Vandeweghe et al., 2016). The mother indicated the extent to which her child likes each of the vegetables. The response options were: "Like", "Just OK", "Dislike", "Never ate it or I don't know". The vegetable chosen for the taste experiment was disliked by the majority of the children (i.e. chicory; like: 8,4%; just OK: 24,4%; dislike: 60,5%; "Never ate it or I don't know": 6,7%).

Procedure

The study procedure is approved by the Ethical Committee of the Faculty of Psychology and Educational Sciences, Ghent University. Random schools in the neighborhood of Ghent were called. Permission to conduct the study in Basisschool Erasmus and Katholiek Basisonderwijs Bevere were granted by their respective principal. The institutions and kindergarten teachers were thoroughly informed about the study through face-to-face meetings. Furthermore, all parents were informed about the study through passive consents. Parents received the passive consents, BIS/BAS scales and the VLL via the children, and were asked to return the completed questionnaires to the kindergarten teacher. The procedure of the intervention is based on the procedure described by Anzman-Frasca et al. (2012) and consists of four phases: pre-test on liking and consumption, tasting trials, post-test on liking and consumption and follow-up-test on liking and consumption (see Table 1 for the schedule).

Pre-test on liking and consumption

After playtime (at 10:30 AM), children were seated in the refectory. To ensure that hunger levels were similar for each child, children were not allowed to eat their snack until after the test was completed. In order to minimize peer influence and facilitate seclusion, they were asked to sit next to each other (facing the same direction) with one chair in between. Once seated, all children received a bowl of steamed chicory (60g) and were given the following instructions, voiced in a child-friendly tone: “You have just received a bowl of chicory. You can choose how much you eat. You are not allowed to share food with anyone else. Please remain silent and seated.”. After 8 minutes, children had to indicate the degree to which they liked the chicory by means of cartoon drawings of facial expressions: ‘‘yummy’’ (liked), ‘‘just okay,’’ or ‘‘yucky’’ (disliked). In order to reliably assess liking, the kindergartner teachers repeatedly explained the meaning of each facial expression in the week prior to the experiment. Spilled food was returned to its respective bowl before weighing. Vegetable consumption is determined by the difference in weight between the initial amount of chicory (60 g) and the amount of chicory after the test.

Tasting trials

In total, eight kindergarten classes of two different schools and two different age categories (2nd and 3th grade of preschool) participated in the experiment. The four classes of every grade were randomly assigned to four different conditions: RE+token reward condition, RE+social reward condition, RNE condition and control condition. In every condition (except for the control condition), we repeatedly (i.e. 8 times on 8 different days) offered each child individually a small portion (±4 g) of steamed chicory (see Table 1 for the schedule). Each time, the child was seated at a small table next to the classroom across the research assistant who provided the instructions. The way the chicory was offered differed dependent on the allocated condition. In the RE+token reward condition, the child could earn a sticker if he or she tasted. When the child had collected enough stickers, he or she would receive a toy. In the RE+social reward condition, the child received social approval when he or she tasted. This social reward was announced through the experimenters' verbal encouragement. In the RNE condition, the experimenter asked the child very neutrally to taste the vegetable. After tasting, the child had to indicate the degree to which he or she liked the chicory by means of cartoon drawings of facial expressions. Besides these liking assessments during the tasting trials, we also assessed the willingness to taste (i.e. whether or not the child tasted on each tasting trial). Each tasting trial lasted approximately 3 minutes. The tasting trials begun after playtime (at 10:30 PM) and were finished before noon. The tasting trials took place twice a week during 4 weeks (see Table 1): Monday and Thursday in Deinze, Tuesday and Friday in Bevere. We included a ninth tasting trial for children who were absent on a previous tasting trial. In the control condition, no tasting trials took place.

Post-test and follow-up-test on liking and consumption

After the tasting trials, the post-test and 8-week-follow-up-test on liking and consumption took place (see Table 1). These assessments were identical to the pre-test on liking and consumption.

Plan of analysis

The results were analyzed separately for the tests and the tasting trials.

Pre-, post-, and follow-up-test on liking and consumption

To assess the effect of different strategies (i.e. RNE, RE+token reward, RE+social reward) on consumption during the course of the study, a linear mixed model is fitted with condition (4 levels: control, RNE, RE+token reward, RE+social reward), time (3 levels: pre-test, post-test and follow-up-test) and their interaction, and school (2 levels) as fixed effects, and a random intercept for each child to account for the correlation of outcomes within each child. Liking is dichotomized into two categories ("yummy" and "just okay" versus "yucky"). To assess change in liking measured during the pre-, post-, and follow-up-test, a generalized linear mixed model for liking is fitted with a logit link using the same fixed and random effects as for consumption. The moderating effects of reward sensitivity (RS) are explored by adding the predictor RS as main effect as well as in interaction with all fixed effects (except school) in the above described models.

Tasting trials

To assess the effects of strategy on the willingness to taste (measured as the percentage of trials during which a child tasted the chicory) and on liking during the tasting trials (measured as the percentage of trials during which the child liked the chicory after having tasted), a linear regression model with strategy (3 levels: RNE, RE+token reward and RE+social reward) and school (2 levels) is fitted for each of those two outcomes separately. To explore whether those effects differ between children with high or low RS, a regression model with strategy, RS, and the interaction of RS with strategy, and factor school is fitted next.

Results

In total, 22 parents did not return the BIS/BAS scales and 34 parents did not return the VLL. Analyses on baseline differences showed that the four conditions did not significantly differ on age, $F(3,147)=.34$, $p=.80$; sex, $\chi^2(3)=.80$, $p=.85$ or RS, $F(3,117)=.16$, $p=.92$ (see Table 2 for descriptives). Furthermore, age and sex were neither significantly related to liking or consumption at pre-test, post-test or follow-up-test, nor to the percentage of trials that a child tasted or liked the vegetable after having tasted during the tasting trials (all p's $> .05$). Therefore, age and sex were not included as confounding variables in the subsequent analyses.

Pre-, post-, and follow-up-test on consumption

Figure 1 presents the average consumption under each condition at each of the three tests. Based on the linear mixed model for consumption, we find no evidence for differences in consumption between the four conditions at baseline ($F(3,277)=0.41$, $p=.747$). There is a significant condition-by-time interaction ($F(6,277)=6.12$, $p<.001$). Both at post-test and follow-up-test, the average consumption on all three strategies (i.e. RNE, RE+token reward, RE+social reward) is significantly higher as compared to the control condition (p's for all pairwise comparisons were smaller than .028). There are no significant differences between any of the three strategies at any time point (all p's $>.24$). No moderating effects of RS are found in any of the conditions.

Pre-, post-, and follow-up-test on liking

The percentage of children that liked the chicory at each of three tests under each condition is presented in Figure 2. Based on the generalized linear mixed model for liking, we find no evidence for differences in liking between the four conditions at baseline ($F(3,278)=0.84$, $p=.473$). There is a significant condition-by-time interaction ($F(6,278)=2.51$, $p<.020$). Both at post-test and follow-up-test, the probability of liking on all three strategies (i.e. RNE, RE+token reward, RE+social reward) is significantly higher as compared to the control condition (p's for all pairwise comparisons were smaller than .006). There are no significant differences between any of the three strategies at any time point (all p's >.47). There is evidence of a moderating effect of RS in the RE+social reward condition at post-test. More specifically, the higher the RS, the smaller the positive effect of RE+social reward versus control condition on liking: for every unit increase in RS the odds of liking on RE+social reward versus control condition decreases with a factor 0.67 (95% CI: 0.51 to 0.88, $p=.006$).

Tasting trials

During the tasting trials, no significant differences are found between the three strategies (i.e. RNE, RE+token reward, RE+social reward) in the percentage of trials that a child tasted (i.e. willingness to taste) or liked the chicory ($F(2,110)=0.72$, $p=.487$ and $F(2,110)=0.83$, $p=.438$ for tasting and liking, respectively). Percentages of children that tasted and, after having tasted, liked the vegetable at each of the tasting trials in each of the three strategies are presented in Figure 3 and 4 respectively. There are no moderating effects of RS on the associations between strategy and tasting. The effect of RE+token reward on liking during the tasting trials on the other hand is moderated by RS ($p=.047$): a one-unit increase in RS is associated with a 1.8% increase in the percentage of liking on RE+token reward.

Discussion

As the vegetable consumption of Flemish preschool children is below the recommendations (Huybrechts et al., 2008), research is needed to enhance insights in how to increase the consumption of healthy food. The present study first aimed to investigate different strategies intended to enhance willingness to taste, liking and consumption of a disliked vegetable. In line with previous research (Anzman-Frasca et al., 2012; Birch & Marlin, 1982; Cooke, Chambers, Anez, Croker, et al., 2011), the results demonstrated that children's liking and consumption of a disliked vegetable significantly increased when repeatedly exposed to the vegetable, either through neutral instructions, or by promising a tangible or social reward for tasting, compared to no taste exposures. Moreover, enhanced liking and consumption remained stable at follow-up-test in all three strategies.

In contrast to what was expected based on theoretical approaches (Benabou & Tirole, 2003; Bindra, 1978; Thorndike, 1912) and previous research (Vandeweghe et al., 2016), we found no significant differences between the three strategies (i.e. RNE, RE+token reward and RE+social reward) on the four outcome variables. Stated differently, we could not confirm that children in strategies with a motivational component (e.g. a reward) were more willing to taste or showed enhanced liking and consumption scores compared to children in a strategy without such motivational component (i.e. RNE). A possible explanation for not being able to replicate the results of Vandeweghe et al. (2016) relates to the recruitment method, which may have affected the sample being studied. In contrast to the current study, parents of children in Vandeweghe et al. (2016) had to actively subscribe to participate, which may have attracted parents of *children with eating difficulties*; children who *did* get extra benefit from the additional motivation (e.g. providing a reward, modeling). From these results, we may conclude that rewarding provides no additional advantages over RNE in a sample of children from the *general population*. On the other hand, the present results do not provide evidence for possible detrimental effects of rewarding, which is in contrast to studies showing negative effects of using a reward and theories against the use of rewards (Cameron & Pierce, 1994; Deci, Koestner, & Ryan, 1999; Lepper, Greene, & Nisbett, 1973). Indeed, willingness to taste and the increase of liking and consumption of children in the RE+reward conditions is not inferior to that of children in the RNE condition, which suggests that rewards can be effective when used appropriately.

The current study further aimed to explore the influence of the individual characteristic reward sensitivity on the effectiveness of these strategies. Opposite hypotheses were formulated; (a) based on previous findings and theoretical conceptualizations positing that high reward sensitive children are more motivated to obtain a reward (Gray, 1981, 1987a), we expected that both RE+reward strategies would be more effective in high reward sensitive children. (b) Based on a previous study showing that verbal encouragement, which announces a social reward, is more effective in children low in reward sensitivity (Vandeweghe et al., 2016), it was expected that a social reward strategy would be most effective in low reward sensitive children compared to high reward sensitive children. Mixed results were found; in line with the first hypothesis, children high in reward sensitivity had higher odds of obtaining liking during the tasting trials in the RE+token reward condition compared to children low in reward sensitivity. The theoretical underpinning of this finding is that the Behavioral Activation System (BAS) is triggered by the presence of the rewarding stimulus. The arousal and emotional changes elicited by the activation of BAS strengthens the relation between the reward and the initially disliked vegetable in the working memory (Corr, 2001). Since children high in reward sensitivity are expected to respond more strongly to rewarding environmental stimuli, they should obtain liking more quickly in a learning strategy with a rewarding aspect compared to children with low reward sensitivity. However, this interaction-effect could neither be found for the liking variable when comparing pre-test to post-test or follow-up-test (when no rewards were provided), nor be found for the consumption or willingness to taste variable. As this interaction-effect was only present during the tasting trials in the RE+token reward strategy, it suggests that children high in reward sensitivity were more eager to indicate that they liked the chicory when a token reward was promised for tasting. In line with the second hypothesis, it was found that low compared to high reward sensitive children showed a stronger increase in liking the chicory in the RE+social reward condition at post-test. These results suggest that the RE+social reward condition is more beneficial for low reward sensitive children. A possible explanation is emotional involvement of the research assistant in the RE+social reward condition, which is less present in the RE+token reward or RNE condition. This social component could be more beneficial for low reward sensitive children, as these are less extravert and less impulsive (Muris et al., 2005; Torrubia, Avila, Molto, & Caseras, 2001); they may need this social support to facilitate the process. However, this interaction-effect could neither be found in the follow-up-test, nor for the consumption variable at each of the three tests, or during the tasting trials. Taken together, limited evidence was found for the moderating role of reward sensitivity in strategies to increase liking and consumption of a disliked vegetable. Therefore, the assumptions regarding reward sensitivity should be treated with caution.

The study has some potential limitations and strengths. Although the study included a follow-up-test, it would be interesting to investigate whether the effects persisted over a longer period of time. Furthermore, we did not investigate whether the positive effects generalize to other contexts, such as the home environment, or to other disliked vegetables. A strength of the study is that it was conducted in nursery schools, which gave us the opportunity to conduct the study in an ecologically valid context and reach a wide range of children. Indeed, the current design allowed us to involve children from parents who probably would not have participated otherwise. The drawback of this method is the difficulty to obtain data from parents of participating children. In order to obtain information on demographics and eating behavior of children, parents were asked to fill in additional questionnaires online. Unfortunately, less than one third of the parents completed these additional questionnaires. Future research should extend the current study design by actively involving parents, which may increase the response rate. Moreover, improvements in children's dietary behaviors are more likely to sustain when parents are involved (Sisson, Krampe, Anundson, & Castle, 2016).

In sum, the results of the current study confirm the conclusions of previous research that liking and consumption of an initially disliked vegetable can be improved through repeated taste exposures. In a general sample of preschool children, rewarding provides neither detrimental effects, nor additional advantages over Repeated Neutral Exposure. We found some evidence for the moderating role of the individual characteristic reward sensitivity: (a) children high in reward sensitivity had higher odds of obtaining liking during the tasting trials in the RE+token reward condition, compared to children low in reward sensitivity and (b) the lower the reward sensitivity, the stronger the increase of liking the vegetable in the RE+social reward condition at post-test. As these effects could not be replicated with other outcome variables, more research is needed to further investigate the moderating role of individual characteristics in strategies to improve liking and consumption of vegetables.

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Tables

Table 1

Schedule of pre-, post-, and follow-up-test on liking and consumption, and tasting trials

Week:	1	3	4	5	6	7	9	17
Pre-test on liking and consumption								
Tasting Trials		Tasting 1 & 2	Tasting 3 & 4	Tasting 5 & 6	Tasting 7 & 8	Tasting 9		
Post-test on liking and consumption								
Follow-up-test on liking and consumption								

Table 2

Descriptive statistics for age, sex and reward sensitivity within each condition and overall

	RE+token reward (*N*=41)	RE+social reward (*n*=46)	RNE (*n*=31)	Control (*n*=36)	Total (*n*=154)
Age in years *M* (*SD*)	5.00(6.0)	5.08(.65)	5.11(.63)	5.14(.55)	5.08 (.61)
Sex (% boys)	48,8%	41,3%	48,4%	50%	46,8%
Reward sensitivity *M* (*SD*)	33.16(7.23)	33.35(8.06)	34.42(7.55)	33.32(6.06)	33.50 (7.24)

Note. RE = Repeated Exposure; RNE = Repeated Neutral Exposure; M = Mean; SD = Standard Deviation

Figures

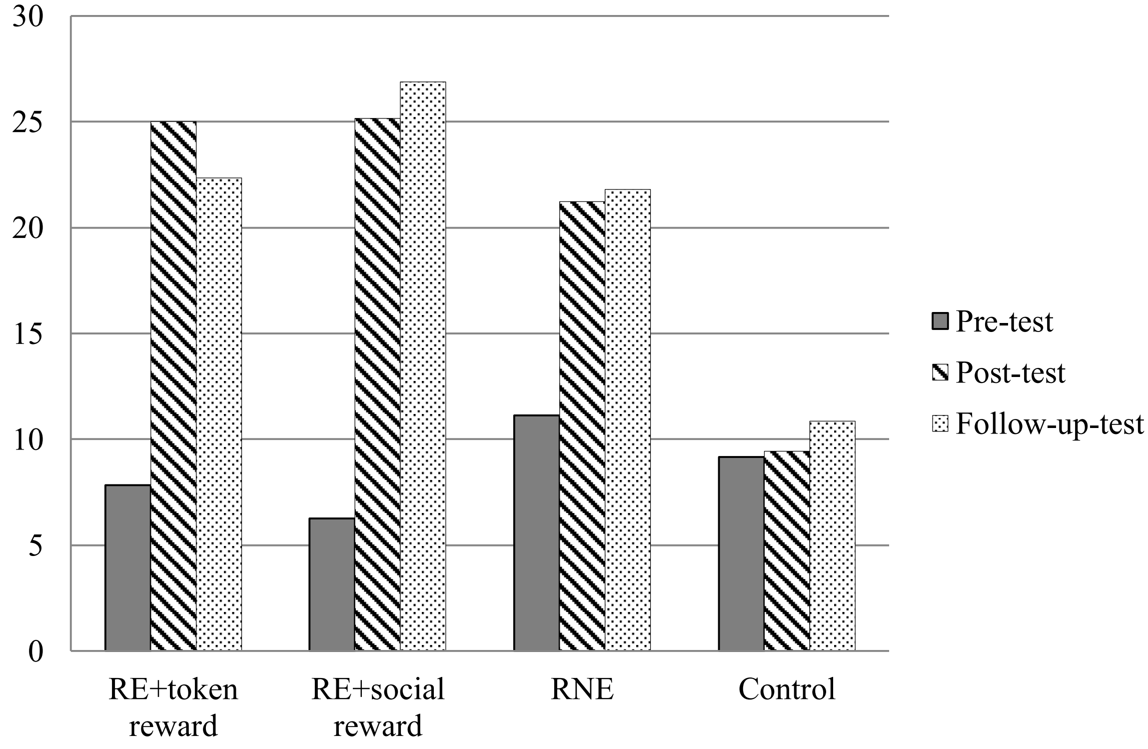

Figure 1. The average consumption (in grams) of chicory under each condition at each of the three tests.

Note. RE = Repeated Exposure; RNE = Repeated Neutral Exposure

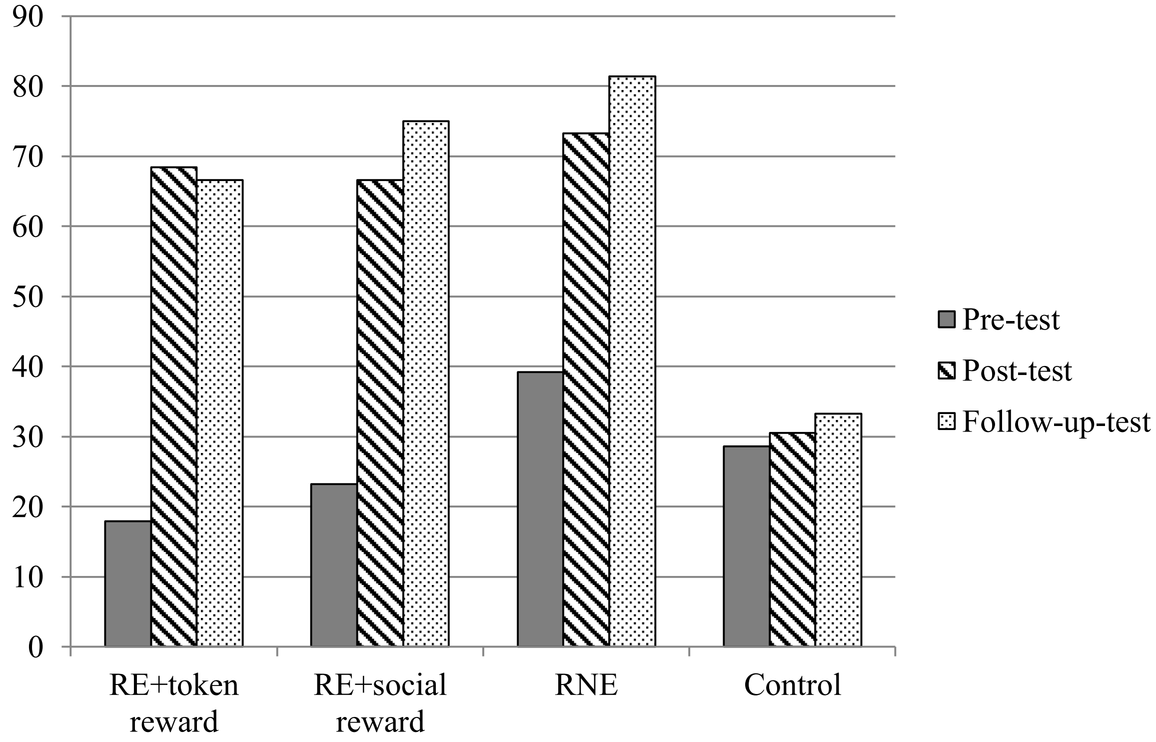

Figure 2. The percentage of children that liked the chicory under each condition at each of three tests.

Note. RE = Repeated Exposure; RNE = Repeated Neutral Exposure

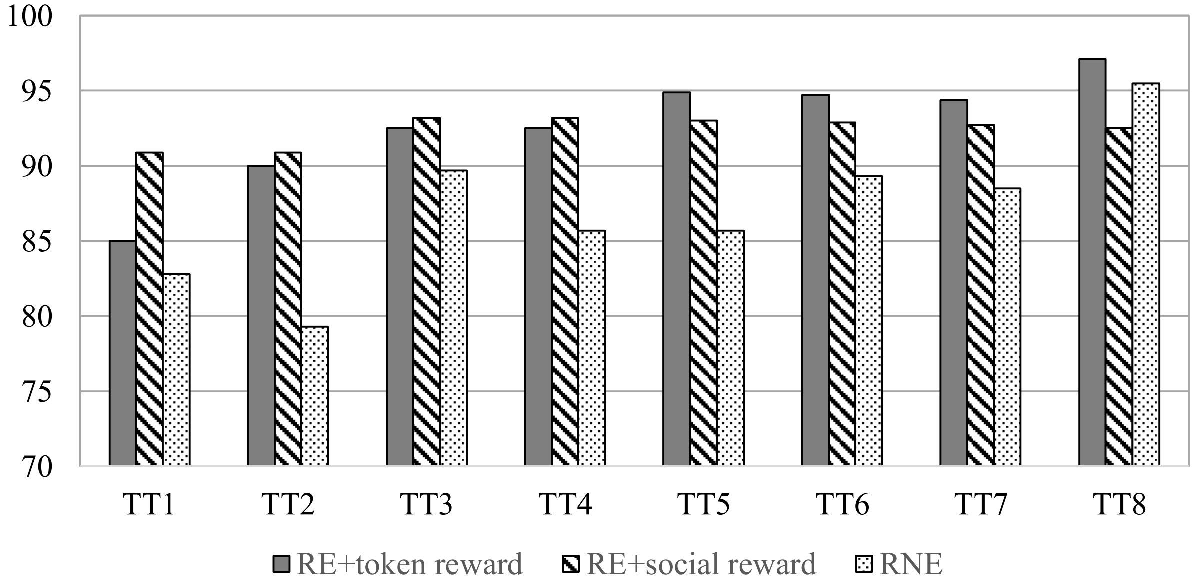

Figure 3. The percentage of children that tasted the chicory at each of the eight tasting trials under each strategy.

Note. TT = Tasting Trial; RE = Repeated Exposure; RNE = Repeated Neutral Exposure

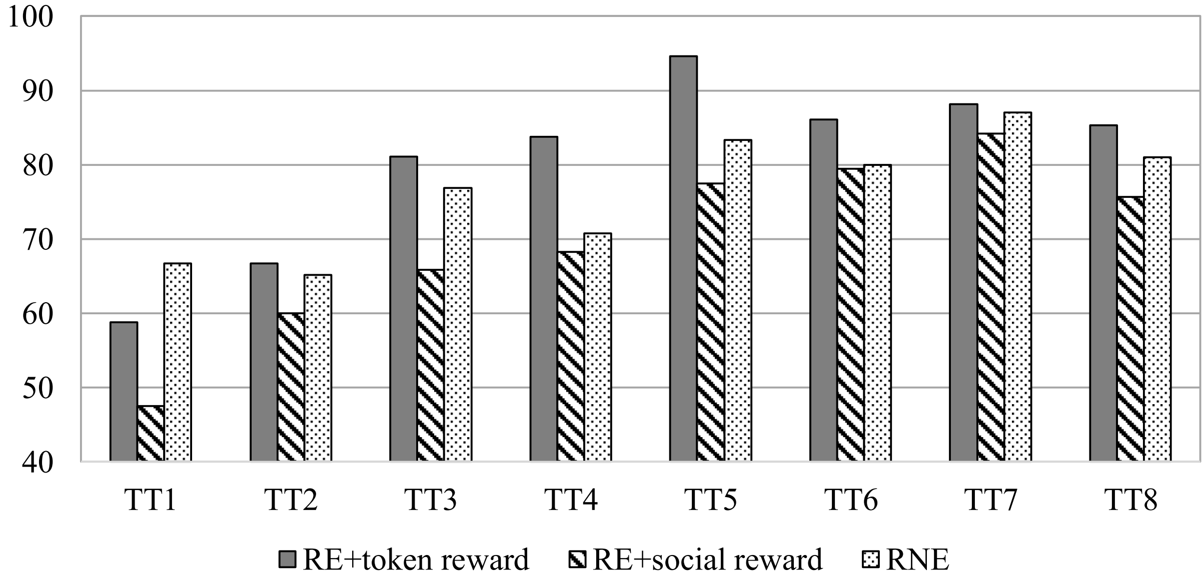

Figure 4. The percentage of children that liked the chicory, after having tasted, at each of the eight tasting trials under each strategy.

Note. TT = Tasting Trial; RE = Repeated Exposure; RNE = Repeated Neutral Exposure

Chapter 6

Home based Parent-led Reward Intervention to increase Preschoolers' Liking and Consumption of a disliked vegetable (Taste Kit): Effectiveness and Influencing Factors[5]

Abstract

The current study investigated the effectiveness of the Taste Kit; a reward-based intervention conducted at home by the parent, aiming to improve a preschool child's liking and consumption of an initially disliked vegetable. Besides investigating general effectiveness, it was examined whether the effectiveness of the Taste Kit depended on child characteristics (i.e. food neophobia and reward sensitivity), parent characteristics (i.e. responsiveness and demandingness in the feeding domain) and delivery method. In total, 147 parents and their preschool child participated in the study, and were randomly allocated to one of three different conditions: home visit condition (i.e. Taste Kit is explained and demonstrated at home), phone condition (i.e. Taste Kit is explained through the phone and delivered via the post) and control condition (i.e. parents do not receive the Taste Kit during the intervention period). Before (i.e. pre-test) and two times after the intervention period (i.e. post-test and follow-up-test), the child's liking and

[5] Vandeweghe, L., Verbeken, S., Moens, E., & Braet, C. (submitted). Home based Parent-led Reward Intervention to increase Preschoolers' Liking and Consumption of a disliked vegetable (Taste Kit): Effectiveness and Influencing Factors

consumption of the initially disliked vegetable was measured. When comparing change in liking and consumption from pre-test to post-test and follow-up-test between the three conditions, the results demonstrated that the Taste Kit, either delivered through the phone or via a home visit, is a successful tool for parents that want to enhance their children’s liking and consumption of an initially disliked vegetable. However, the current study also demonstrated that the effectiveness of the Taste Kit depends on the delivery method, parental demandingness, parental responsiveness and children’s food neophobia, which supports the need for interventions tailored to the needs and characteristics of children and parents.

Introduction

The regular consumption of vegetables contributes to children's adequate growth, healthy body weight and cognitive development (Conners, 1989; du Plessis, Naude, & Swart, 2016; Pipes, 1989; World Health Organisation, 2015). Moreover, micronutrients contained in vegetables are helpful in protecting children against illnesses (Antova et al., 2003). Additionally, healthy eating at a young age provides benefits later on, as children's eating habits and food preferences are likely to continue into later adolescence and adulthood (Nicklaus, Boggio, Chabanet, & Issanchou, 2004; Nicklaus & Remy, 2013). Despite the numerous advantages, preschool children fail to consume the recommended daily amount of vegetables (Huybrechts et al., 2008; Kim et al., 2014; Storey & Anderson, 2016). The current study aims to add to the growing literature on how to enhance children's consumption of vegetables.

Various strategies that aim to increase children's consumption of vegetables have been designed (e.g. Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Hausner, Olsen, & Moller, 2012; Horne et al., 2004). Most of these strategies have in common that they focus on increasing liking, which is based on the findings that food liking is an important determinant of food consumption (Baxter & Thompson, 2002; Cullen et al., 2003; Domel et al., 1996; Gibson, Wardle, & Watts, 1998) and that vegetables are commonly disliked food items in childhood (Cashdan, 1998; Skinner, Carruth, Bounds, & Ziegler, 2002). The most basic strategy is labeled Repeated Exposure, in which children are repetitively exposed to the taste of food items. The effectiveness of Repeated Exposure in increasing children's liking and consumption of vegetables is well-established (Ahern, Caton, Blundell, & Hetherington, 2014; Anzman-Frasca et al., 2012; Caton et al., 2013; de Wild, de Graaf, & Jager, 2013;

Hausner et al., 2012). Despite the promising conclusions of previous research on the examination of this strategy, parents often fail to continue offering a vegetable once it has been rejected by the child (Birch, Mcphee, Shoba, Pirok, & Steinberg, 1987). As a consequence, many children may not reach the number of taste exposures needed to change food preferences. The use of rewards in combination with Repeated Exposure might provide a motivation for both parent and child to increase children's willingness to taste and achieve the recommended amount of taste exposures. Although the use of rewards in feeding strategies is controversial, several studies have shown that rewards can yield positive effects if properly applied (e.g. Cooke, Chambers, Anez, Croker, et al., 2011; Horne et al., 2009; Horne et al., 2004; Lowe, Horne, Tapper, Bowdery, & Egerton, 2004; Vandeweghe et al., 2017). Indeed, the effectiveness of reward-based strategies is found to depend upon a variety of factors, such as the rewarded behavior (e.g. tasting behavior should be rewarded instead of how much children eat (Birch, Mcphee, Shoba, Steinberg, & Krehbiel, 1987)), the extent to which the child originally liked the vegetable (i.e. only use rewards when the child dislikes the vegetable) and the type of reward (i.e. non-food tangible or non-tangible rewards were found to be effective while food rewards evoke negative effects (Lowe et al., 2004; Newman & Taylor, 1992; Nicklas et al., 2001)) (for review, see Cooke, Chambers, Anez, & Wardle, 2011).

Despite the current knowledge on evidence-based strategies to stimulate healthy eating behavior and the various attempts of several organizations to disseminate this knowledge among parents, their translation into children's consumption of healthy food has not been observed (Huybrechts et al., 2008; Kim et al., 2014; Storey & Anderson, 2016). This may suggest that the effectiveness of an intervention does not solely depend on strategy-related characteristics, even though these are generally proven to be effective in an artificial situation (e.g. researcher-led). The effectiveness of an intervention might additionally depend upon characteristics of individuals involved when applying the strategy (e.g. child and parent characteristics) (Vandeweghe, Verbeken, Moens, Vervoort, & Braet, 2016). Recently, it was shown that the effectiveness of a reward strategy was dependent upon the child's characteristic reward sensitivity: when offered a disliked vegetable, high reward sensitive children were more likely to taste immediately when promised a tangible reward compared to low reward sensitive children (Vandeweghe, Verbeken, et al., 2016). Thus, an intervention with a tangible reward component might be more effective for high reward sensitive children. Reward sensitivity, which is assumed to reflect the sensitivity of the Behavioral Activation System, is conceptualized as enhanced cognitive and physiological reactivity to the prospect of obtaining rewarding stimuli (Carver & White, 1994; Gray, 1981, 1987). Another child characteristic that might influence the effectiveness of an intervention is food neopbobia, which is defined as the rejection of novel or unknown foods (Dovey, Staples, Gibson, & Halford, 2008). Due to their fear for unfamiliar foods, high food neophobic children consume less fruit and vegetables than low food neophobic children (Cooke, Carnell, & Wardle, 2006; Coulthard & Blissett, 2009; Wardle, Carnell, & Cooke, 2005). Since the former experience more difficulties with tasting new food items, more patience and efforts are needed to conquer their fear of tasting. Thus, food neophobia may hamper or slow down the process of liking, which might reduce the effectiveness of the intervention.

Besides child characteristics, it seems logical to assume that parent characteristics, such as feeding styles, influence whether or not an intervention elicits positive effects. Within the parenting context, two major dimensions can be distinguished, reflecting how parents interact with their children: responsiveness and demandingness (Hughes, Power, Fisher, Mueller, & Nicklas, 2005; Maccoby & Martin, 1983; Van Leeuwen & Vermulst, 2004). In the feeding domain, *responsiveness* is conceptualized as the extent to which parents provide affective warmth, acceptance and support, and the extent to which they are positively involved in the child's eating behavior. Previous research showed that responsiveness during feeding situations was positively associated with positive general parenting practices such as support and following through on discipline, and negatively associated with negative feeding and general practices, including inconsistency, restriction and pressure to eat (Hennessy, Hughes, Goldberg, Hyatt, & Economos, 2010). Therefore, high responsive parents, compared to low responsive parents, may be able to create a warm, supportive atmosphere which might improve the effectiveness of the intervention. In the feeding domain, *demandingness* refers to the extent to which parents show control, monitor and supervise the child's eating. Both over-controlling (Birch, Fisher, & Davison, 2003; Farrow & Blissett, 2006; Wardle et al., 2005) and under-controlling parental practices (Robinson, Kiernan, Matheson, & Haydel, 2001) were found to be associated with negative child outcomes. Instead, parents should apply a moderate level of control (e.g. monitoring healthy food consumption) in helping children establish healthy eating habits. As our intervention offers a certain level of control, it might be interesting to investigate which parents, in terms of demandingness, achieve better intervention outcomes; those who are used to exert a lot of control on their child's eating behavior, or those who lack rules about the quality or quantity of their child's diet? Being too rigid or too lax in applying the intervention might both evoke reduced intervention outcomes. Therefore, the effect of demandingness on the intervention was explored without formulating a priori hypotheses.

Another factor that might influence the effectiveness of interventions is how they are communicated to parents. Recently, it was shown that Flemish caregivers, including parents, do not seem to have adequate knowledge on how to correctly apply strategies to stimulate healthy eating behavior (Vandeweghe, Moens, et al., 2016). Since erroneously performed strategies might elicit detrimental effects, it seems crucial that parents receive detailed information on how to apply a strategy correctly. Indeed, it was shown that specific instructions on how to apply an intervention, in contrast to general information (i.e. a leaflet with nutritional advice), were effective in improving children's liking and consumption of a vegetable (Wardle et al., 2003). Therefore, in the present study, it is assumed that more extensive information will lead to enhanced parental learning, which in turn, should be reflected in a better outcome of the intervention. The multimedia principle states that "people learn more deeply from words and pictures than from words alone" (p. 31) (Mayer, 2002). Moreover, multimedia instructional messages should take into account the modality principle, which posits that learning will be facilitated when different modalities are addressed (e.g. visual and auditory) (Mayer, 2009). Based on both principles, it might be assumed that visually demonstrating the strategy accompanied by verbal information, is more effective than communicating the strategy through the phone (i.e. verbal instructions only). The assumption that adding visual demonstration will provide stronger effects is further strengthened by the Social Cognitive Theory (Bandura, 1977), which posits that people learn by observing the actions of others. Recently, Remington, An, Croker, Wardle, and Cooke (2012) showed that a strategy explained and demonstrated during a home visit increased children's liking and consumption of a vegetable compared to no intervention. However, as the study did not examine interventions delivered in different ways, it was unable to assess the relative effectiveness of the delivery method. The present study fills this gap in the research literature by comparing two delivery methods. Besides hypothesized general positive effects of a multimedia and multimodal approach, it might additionally reduce the influence of child and parent characteristics in the effectiveness of the intervention. Indeed, more extensive information might reduce or even eliminate the differential influence of high and low food neophobic children, and high and low responsive and demanding parents.

The current study investigated the effectiveness of the Taste Kit, which is a parent-led home based intervention in preschool children. The Taste Kit is based on a reward strategy and evaluated as change in liking and consumption of an initially disliked vegetable. It was hypothesized that children in the intervention conditions (i.e. conditions in which the Taste Kit was conducted), compared to children receiving no intervention, would show increased liking and consumption of an initially disliked vegetable. We additionally investigated whether the way in which the Taste Kit is delivered affects the effectiveness of the intervention. It was expected that demonstrating and explaining the Taste Kit at *home* (i.e. multimodal approach; visual and verbal instructions) would enhance parent's learning performance more than delivering information through the *phone* (i.e. verbal instructions only), which would be reflected in enhanced liking and consumption scores in the home visit condition compared to the phone condition. We further examined the moderating role of child characteristics (i.e. reward sensitivity and food neophobia) and parent characteristics (i.e. demandingness and responsiveness). As the Taste Kit involves a tangible reward-based intervention, it was hypothesized that high reward sensitive children, compared to low reward sensitive children, would show a stronger increase in liking and consumption in the intervention conditions. We further expected that there would be a difference between the extent of food neophobia and responsiveness in the phone condition, with lower food neophobia and higher responsiveness associated with a stronger increase in liking and consumption. We expected these effects to be smaller or extinguished in the home visit condition, as these parents are more extensively informed on how to conduct the strategy. Furthermore, the moderating effects of demandingness were explored. No specific hypotheses were formulated as both ends of the construct might negatively affect the intervention outcomes.

Method

Participants

Of the 216 parents who showed initial interest, 147 participated in the study. Most of the parents who decided not to participate, declined because of practical reasons. Children were excluded from the analyses if they indicated that they liked the vegetable at pre-test (*n*=9). The final dataset comprised 138 children. Demographics were obtained via parent self-report and included child age, sex and highest household educational attainment (HHEA) (see Table 1).

Material

Taste Kit

The taste kit is developed by our research team and consists of a manual, a sticker chart, stickers, and three feathers. It serves as a tool for parents to learn their children to like vegetables. The manual, printed as a folded booklet, provides the information needed to properly carry out the Taste Kit. The manual describes (a) the rationale, (b) what the Taste Kit offers, (c) the goal, (d) the theoretical principles and (g) how to apply the Taste Kit. (a) The manual first describes the importance for children to regularly consume healthy food. Then, the difficulty to comply with these recommendations due to children's pickiness is mentioned, which should facilitate recognition among parents. In order to reassure parents, it is stated that most preschoolers show some level of pickiness at some point in their early years. In spite of pickiness being a normal development phase in childhood, it should be treated appropriately. (b) In the manual, we further state that the Taste Kit offers an enjoyable, non-coercive and scientifically supported method for helping children to like disliked food items. (c) The purpose of the Taste Kit is to make children eat vegetables without grumbling or complaining, so that mealtime can be a healthy and cozy family moment. (d) We explain the scientific theory behind the Taste Kit by stating that repeated taste exposures lead to familiarization, which eventually, leads to increased liking and consumption of the food item. The critical aspect of "tasting" in the process of liking a food item is familiarizing children with the taste by bringing the food item in contact with taste buds. Children should not be obligated to swallow the food item, as this is usually the hardest part. Small rewards (i.e. stickers) are used to motivate children to taste. The orange, yellow and green feather should be given after the 4th, 8th and 12th taste session respectively, irrespective of the child's tasting behavior. The purpose of the three feathers included in the Taste Kit is to motivate child and parent to go through with it during two weeks. Even if the child did not taste, (s)he made efforts, which is worth recognizing (e.g. sitting at the table, having the intention to taste). (e) In the manual, it is further specified how the Taste Kit should be carried out. A small portion of bite-sized steamed or boiled vegetable that the child dislikes should be offered 12 times during two weeks, not more than once a day, preferably on a quiet moment (e.g. no children are playing around) when the child is already a bit hungry (e.g. just before noon). The vegetable should be unseasoned or slightly seasoned, and offered without sauce. The child should be seated a table and the vegetable should be offered by an adult (i.e. parent or guardian). The adult should name the vegetable and explain what is meant by tasting. Then, the adult is instructed to say: "*If you want, you are allowed to taste this vegetable. If you taste, you earn a sticker to stick on your sticker chart. Next time, you can earn another sticker. If you do not taste, I will not be angry, but you will not earn a sticker*". If the child does not want to taste immediately, parents are instructed to keep them seated for one minute. Parents are asked not to become angry or frustrated if the child does not want to taste. If the child tastes, (s)he immediately earns a sticker after tasting.

Behavioral Inhibition System / Behavioral Activation System (BIS/BAS) scales

In order to assess reward sensitivity (RS), mothers completed the BAS scale of the BIS/BAS scales (Carver & White, 1994) adapted for parent report (Vervoort et al., 2015), which was based on an age-downward adaptation of the original scales (Muris, Meesters, de Kanter, & Timmerman, 2005). The BIS/BAS-scales parent version is found to be a useful and valid index of a child's RS (Vervoort et al., 2015). The BAS scale consists of 13 items on 4-point Likert Scale from 1 (not true) to 4 (very true) and can be further subdivided in 3 subscales. The Reward Responsiveness subscale (5 items) includes statements as "It would excite my child to win a contest". The Fun Seeking subscale (4 items) includes statements as "My child craves excitement and new sensation". The Drive subscale (4 items) includes statements as "When my child wants something, he or she usually goes all out to get it". In the current study, we only use the BAS scale (Cronbach's α=.79).

Child Food Neophobia Scale (CFNS)

The CFNS (Pliner, 1994) assesses the extent to which children reject novel or unknown foods and originally consists of 10 items, including statements such as "My child does not trust new foods". The items are scored on a 4-point Likert Scale from 1 (strongly disagree) to 4 (strongly agree). Higher scores indicate a stronger display of food neophobia. We used the 6-item version that is more adapted to the age range of our sample (Cooke, Wardle, & Gibson, 2003; Cooke et al., 2004). The Dutch 6-item version (Goossens & Braet, 2012) has shown good convergent validity (Vandeweghe, Verbeken, et al., 2016). Internal consistency in the present sample was good (Cronbach's α=.82).

Caregiver Feeding Style Questionnaire (CFSQ)

The CFSQ (Hughes et al., 2005) is a 19-item parent report questionnaire, measuring two dimensions of parental feeding: demandingness and responsiveness. Demandingness refers to *how much* the parent encourages eating, while responsiveness refers to *how* eating is encouraged (i.e. in a responsive or a non-responsive way). Both dimensions are derived from 7 child-centered feeding items (i.e. promotes child autonomy through for example complimenting or reasoning) and 12 parent-centered feeding items (i.e. controls children's eating behavior through pressure such as demands or threats). The items are scored on a 5-point Likert Scale from 1 (never) to 5 (always), with higher scores indicating a stronger display of responsiveness or demandingness. Based on the scores on these two dimensions, parents can be assigned to one of four feeding styles. In the current analyses, we only use the continuous responsiveness and demandingness scores. The CFSQ is found to be a reliable and valid instrument (Hughes et al., 2006; Hughes et al., 2005). Internal consistency in the present sample was acceptable (Cronbach's α=.75).

Procedure

The study procedure is approved by the Institutional Ethical Committee.

Method of recruitment

Data were collected in three different phases from September 2015 until April 2016. In each phase, random schools were called; for each phase, a different geographical area of Flanders (Belgium) was selected. After permission of the school principal, recruitment letters were distributed by the kindergarten teachers to their respective preschoolers. The recruitment letter specifically requested the participation of preschool children who dislike at least one vegetable. In every phase, parents were asked to fill in contact details if they were willing to participate. Parents who were willing to participate received information on the study via mail and were orally informed.

Information

The information participants received prior to the study contained background and practical information on the study as well as standardized instructions on how to apply the tests on liking and consumption (see below). In order to limit the variety of vegetables included in the study, parents were asked to choose a vegetable in steamed or boiled form, and preferably from a given list: chicory, mushrooms, Brussels sprouts or leek. If the child liked all of the vegetables listed, they were allowed to choose another vegetable. After active informed consent was obtained, parents in all phases were randomly assigned to three different conditions: home visit condition, phone condition and control condition. Parents were also asked to fill out questionnaires online, including the BIS/BAS Scales, the CFNS and the CFSQ.

Tests on liking and consumption

In total, three tests on liking and consumption were conducted according to standardized written and oral instructions parents received prior to the study. These tests were based on the procedure of Anzman-Frasca et al. (2012). The pre-test on liking and consumption was conducted prior to the intervention period, and allowed us to assess how much the child likes and eats the vegetable at baseline. Post-test and follow-up-test on liking and consumption were conducted 3 or 4 days after finishing the Taste Kit, and 4 weeks after the post-test respectively. The parents were instructed to (a) conduct the tests on a quiet moment (e.g. no other children are playing around), when the child is already a bit hungry (e.g. just before noon), (b) offer their child 60 grams of the vegetable, (c) tell the child the name of the vegetable and that (s)he can choose how much (s)he eats, and (d) tell the child you will not be angry if (s)he does not want to taste or eat. As we wanted to assess usual vegetable consumption, we stressed that parents were not allowed to encourage their children in any way. After eight minutes, children had to indicate the degree to which they liked the vegetable by means of cartoon drawings of facial expressions: ‘‘yummy’’ (liked), ‘‘just okay,’’ or ‘‘yucky’’ (disliked). In order to reliably assess liking, parents were asked to explain the meaning of each facial expression prior to the tests. Parents were instructed to online report the vegetable they choose, the extent to which the child liked the vegetable at each test (options: yummy, just ok, yucky, my child did not taste, my child does not understand the meaning of the faces) and how much grams of the vegetable remained on the plate at each test. In order to remind parents of the pre-, post- or follow-up-test, reminder text messages were send one day before the tests should take place.

Intervention

Between 2 and 7 days after the pre-test, the two experimental groups (i.e. home visit condition and phone condition) started with the Taste Kit. The home visit condition and phone condition differ in the way the Taste Kit is communicated to the parents. Participants assigned to the home visit conditions were visited at home by a research assistant. During this home visit, the Taste Kit was explained in detail, and the researcher demonstrated how the strategy should be applied. As the child was also involved in this demonstration, it counted as the first taste session. Participants in the phone condition received the Taste Kit by post. Further information regarding the Taste Kit was given on the phone. Parents were asked to start with the Taste Kit the day after they received the explanation. Participants in the control condition did not receive the Taste Kit during the intervention period.

Plan of analysis

In order to confirm that the randomization procedure resulted in comparable groups, between-group baseline differences on variables at interest (i.e. consumption, liking, food neophobia, reward sensitivity, demandingness, responsiveness) and on possible confounding variables (i.e. age, sex and HHEA) were examined. Additionally, the relation between possible confounding variables (i.e. age, sex and HHEA) and liking and consumption scores on the three tests was investigated.

To assess the effect of different conditions on consumption during the course of the study, a linear mixed model is fitted with condition (3 levels: control condition, home visit condition, phone condition), time (3 levels: pre-test, post-test and follow-up-test) and their interaction as fixed effects, and a random intercept for each child to account for the correlation of outcomes within each child. Liking is dichotomized into two categories ("yummy" and "just okay" versus "yucky") and is analyzed using a generalized linear mixed model with a logit link using the same fixed and random effects as for consumption. The moderating effects of food neophobia, reward sensitivity, responsiveness and demandingness are explored by adding these predictors as main effect as well as in interaction with all fixed effects in the above described models.

Results

Demographic variables (i.e. age, sex, HHEA), and moderators (i.e. reward sensitivity, food neophobia, responsiveness, demandingness) were summarized: categorical and continuous variables were expressed as frequency (percentage) and mean (SD) respectively (see Table 1).

Analyses revealed no significant group differences in age, sex, HHEA, vegetable type (i.e. vegetable used for the intervention), reward sensitivity, food neophobia, demandingness and responsiveness (see Table 1). Furthermore, age, sex, HHEA and vegetable type were not significantly related to liking or consumption at pre-test, post-test or follow-up-test (all p's $> .05$). Therefore, age, sex, HHEA and vegetable type were not included as confounding variables in the subsequent analyses.

Consumption

Figure 1 presents the average consumption under each condition at each of the three tests. Based on the linear mixed model for consumption, we found no evidence for differences in consumption between the three conditions at baseline ($F(2,186)=1.30$, $p=.276$). There was a significant condition-by-time interaction ($F(4,186)=4.15$, $p=.003$). Both at post-test ($t(186)=4.19$, $p<.001$) and at follow-up-test ($t(186)=4.41$, $p<.001$), the average consumption in the home visit condition was significantly higher as compared to the control condition. Similarly, both at post-test ($t(186)=2.02$, $p=.045$) and at follow-up-test ($t(186)=2.69$, $p=.008$), the average consumption in the phone condition was significantly higher as compared to the control condition. At post-test, the average consumption in the home visit condition was significantly higher as compared to the phone condition ($t(186)=2.12$, $p=.035$). At follow-up-test, trend significant differences in the same direction were found between the home visit condition and the phone condition ($t(186)=1.68$, $p=.095$).

There is evidence of a moderating effect of food neophobia in the phone condition at post-test. More specifically, the higher the food neophobia, the smaller the positive effect of the phone condition versus the control condition on consumption ($b=-3.389$, $t(163)=-2.11$, $p=.036$). In the home visit condition (versus control condition), a trend significant moderating effect of food neophobia at post-test was found ($t(163)=-1.85$, $p=.066$): a one-unit increase in food neophobia was associated with a 3.074-unit decrease in consumption. No moderating effects of reward sensitivity were found in any of the conditions.

There was further evidence of a moderating effect of demandingness in the phone condition versus the control condition at post-test ($b=-35.262$, $t(163)=-2.49$, $p=.014$) and in the home visit condition versus control condition at follow-up-test ($b=-29.487$, $t(163)=-2.12$, $p=.035$). More specifically, the higher the demandingness, the smaller the positive effect of the phone condition at post-test and of the home visit condition at follow-up-test on consumption. Trend significant moderating effects of demandingness in the same direction were found in the phone versus control condition at follow-up-test ($b=-25.009$, $t(163)=-1.72$, $p=.087$) and in the home visit versus control condition at post-test ($b=-23.685$, $t(163)=-1.74$,

p=.084). When comparing home visit condition with control condition, there was evidence of a moderating effect of responsiveness at post-test (b=96.859, $t(164)$=2.30, p=.023) and a trend significant effect of responsiveness at follow-up-test (b=73.795, $t(164)$=1.69, p=.092): the higher the responsiveness, the greater the positive effect of the home visit condition versus the control condition. No moderating effects of responsiveness were found when comparing the phone condition with the control condition.

Liking

The percentage of children that liked the vegetable at each of three tests under each strategy is presented in Figure 2. Based on the generalized linear mixed model for liking, we found no evidence for differences in liking between the three conditions at baseline ($F(2,183)$=1.56, p=.213). Although there was no significant condition-by-time interaction ($F(4,183)$=0.71, p=.587), post-hoc contrasts were conducted (a) for each condition separately to examine the significant time effect ($F(2,183)$=13.04, p<.001) more closely (b) for each time assessment separately to examine the significant condition effect ($F(2,183)$=11.31, p<.001) more closely. (a) Significant differences were found in the home visit condition and the phone condition when comparing pre-test to post-test (home visit condition: $t(183)$=3.91, p<.001; phone condition: $t(183)$=3.28, p=.001) and pre-test to follow-up-test (home visit condition: $t(183)$=3.92, p<.001; phone condition: $t(183)$=3.45, p=.001). No significant differences were found in the control condition when comparing pre-test to post-test and pre-test to follow-up-test (all p's >.1). (b) Both at post-test ($t(183)$=3.68, p<.001) and follow-up-test ($t(183)$=3.89, p<.001), the probability of liking in the home visit condition was significantly higher as compared to the control condition. Similarly, both at post-test ($t(183)$=2.47, p=.015) and at follow-up-test

($t(183)=2.94$, $p=.003$), the probability of liking in the phone condition was significantly higher as compared to the control condition. No significant differences were found between the phone condition and the home visit condition (all *p*'s>.176). Furthermore, we observed a moderating effect of food neophobia in the home visit condition at follow-up-test. More specifically, for every unit increase in food neophobia the odds of liking in the home visit condition versus control condition at follow-up-test increases with a factor 3.67 (95% CI: 1.20 to 11.25, $p=.023$). No moderating effects of reward sensitivity, demandingness or responsiveness on liking were found in any of the conditions.

Discussion

At present, children still fail to achieve the recommended daily amount of vegetables (Huybrechts et al., 2008; Kim et al., 2014; Storey & Anderson, 2016). Therefore, new interventions are needed that help parents to establish healthy eating habits in their children. The current study first aimed to investigate the general effectiveness of the Taste Kit. As hypothesized, the intervention resulted in a significantly higher liking and consumption (i.e. both at post-test and follow-up-test), compared to the control condition. From these results, we may conclude that the Taste Kit in its current form, either delivered through the phone or during a home visit, is an effective tool for parents to improve their child's liking and consumption of an initially disliked vegetable. These findings are in line with studies who confirm the favorable effects of Repeated Exposure in combination with the appropriate use of rewards (Cooke, Chambers, Anez, Croker, et al., 2011; Lowe et al., 2004). Furthermore, the results indicate that these strategies are able to produce the desired effects in an ecologically valid situation (i.e. parent-led and conducted at home), which is in line with previously investigated parent-led home based interventions (Remington et al., 2012).

The present study further aimed to examine whether the delivery method influences the effectiveness of the Taste Kit. As expected, the liking and consumption of children in the home visit condition (i.e. visual and verbal instructions) was higher at post-test and follow-up-test as compared to the phone condition (i.e. verbal instructions only). Although these differences were not significant for the liking variable, they were found to be significant and marginally significant for the consumption variable at post-test and follow-up-test respectively. In accordance with the modality principle, positing that people learn better when different modalities are addressed (Mayer, 2009), parents might have better knowledge and skills on how to conduct the Taste Kit, when it has been explained and demonstrated at home compared to an explanation on the phone. Enhanced knowledge and skills might in turn have resulted in better intervention outcomes. The findings are further in line with the Social Cognitive Theory, stating that people learn from observing others (Bandura, 1977). According to this theory, the adequate reproducibility of the model's behavior (i.e. the experimenter) by the observer (i.e. the parent) is further dependent upon determinants such as outcome expectancies (i.e. does the behavior produce the desired effect?) or self-efficacy (i.e. does the person feel competent to correctly complete the behavior). It seems plausible that parents in the home visit condition had more self-efficacy and better outcome expectancies after it was successfully conducted with their child. However, from the current study, we could not infer the underlying processes that may have contributed to a higher consumption in the home visit condition compared to the phone condition. Future research should include measures of outcome expectancies, self-efficacy, skills and knowledge to determine the underlying mechanisms.

The current study additionally investigated the role of two child characteristics (i.e. reward sensitivity and food neophobia) and two parent characteristics (i.e. responsiveness and demandingness) in the effectiveness of the Taste Kit. In contrast to our expectations, the child's reward sensitivity did not predict the effectiveness of the Taste Kit. The success of the Taste Kit was expected to depend upon the child's reward sensitivity, since a crucial component of the Taste Kit is the reward strategy (i.e. children are promised a small tangible reward if they taste). The Reinforcement Sensitivity Theory states that high reward sensitive children react more strongly to rewards, meaning that their Behavioral Activation System is more activated in the presence of a reward (Gray, 1981, 1987). A higher activation may be beneficial for their willingness to taste as well as for the operant learning process, as it may strengthen the relation between the reward and the initially disliked vegetable, and hence, facilitate the liking process. However, previous studies (Vandeweghe et al., 2017; Vandeweghe, Verbeken, et al., 2016) showed to some degree that high reward sensitive children benefited from a tangible reward strategy while low reward sensitive children benefited from a social reward strategy. Although the Taste Kit consists primarily of tangible rewards, it seems plausible that parents additionally provided a social reward after the child tasted (i.e. praise). Combining both strategies might have cancelled out the influence of reward sensitivity.

The child's food neopbobia was also expected to affect the success of the Taste Kit. The results on consumption were largely in line with the expectations. As expected, the higher the child scored on food neopbobia, the smaller the positive effect of the Taste Kit on consumption in the phone condition at the post-test. High neophobic children's reluctance to taste might have hampered the tasting process during the intervention. While this effect was significant in the phone condition, it was only trend-significant in the home visit condition. Indeed, we did expect the differential influence of high and low food neophobic children on the outcome variables to be less apparent in the home visit condition, as these parents are probably more aware of how to correctly conduct the Taste Kit. At follow-up-test, no moderating effects of food neopbobia were found, which suggests that the difference in consumption between high and low food neophobic children disappears after some time, in both conditions. A surprising effect emerged as well; high food neophobic children had higher odds of liking the vegetable in the home visit condition at follow-up-test. A possible explanation is that these high neophobic children gave socially desirable answers. It is plausible that these children hope to avoid another part of the Taste Kit by simply indicating that they like the vegetable. The results on consumption are in line with this speculation, as we could not find that highly neophobic children had a higher consumption at follow-up-test compared to low neophobic children.

It was also investigated whether the effectiveness of the Taste Kit depended on parental responsiveness and demandingness. In line with our hypotheses, significant moderating effects of responsiveness showed that the intervention was most effective for high compared to low responsive parents. This suggests that high responsive parents were able to create a warm, supportive climate which ameliorated the effect of the intervention. However, in contrast to our expectations, influences of responsiveness only emerged in the home visit condition on consumption and not in the phone condition. Thus, parents who are used to act in a responsive way benefited more from the explanation and demonstration of the Taste Kit at home. In other words, both are needed to produce most favorable effects.

Regarding demandingness, the results on consumption showed that the intervention, either delivered through the phone or via a home visit, was less effective for high demanding parents, compared to low demanding parents. A possible explanation relates to the amount of control offered by the Taste Kit, which might have been more useful for parents who lack rules about the quality or quantity of diet (i.e. low demanding parents) compared to parents who already have (too) strict rules (i.e. high demanding parents). As the Taste Kit does not remove maladaptive levels of control, it was probably less effective for high demanding parents. Another possible explanation for the finding that the intervention was less effective when applied by high demanding parents, compared to low demanding parents, is because of the positive association between demandingness during feeding situations and negative parenting behaviors such as scolding, pressure to eat and inconsistency (Hennessy et al., 2010). These behaviors may create a negative atmosphere which might have reduced the effectiveness of the intervention.

A general observation that emerged from the study results is that most of the hypothesized effects could not be found for the liking variable. These findings are in line with previous studies showing that positive effects were consistently found for consumption but not for liking (Cooke, Chambers, Anez, & Wardle, 2011; Hendy, Williams, & Camise, 2005). Liking may be seen as less objective and less reliable compared to consumption, as the former is child reported. Misreporting by children may have reduced the ability to observe moderating effects of child and parent characteristics, and the method of delivery.

The current study provides evidence that the Taste Kit, either delivered through the phone or during a home visit, is an effective tool for parents to improve their child's liking and consumption of an initially disliked vegetable. However, further exploration of these effects showed that the degree of effectiveness depended on different factors, such as child and parent characteristics and the method of delivery. This implies that future research should create and investigate other versions of the Taste Kit, tailored to the needs of parents and children. For example, the Taste Kit was most effective for high responsive parents who were visited at home, and for low demanding parents in both intervention conditions, which might imply that the Taste Kit in its current form is less adequate for low responsive parents and high demanding parents. A Taste Kit for low responsive parents should probably include more information on how to encourage eating behavior in a responsive way while highly controlling parents should be made aware of the negative effects of maladaptive control. Besides parent characteristics, the effectiveness of the Taste Kit was dependent on child characteristics. Indeed, the Taste Kit was most effective for low neophobic children. For highly neophobic children who experience considerable difficulties with tasting new and disliked food items, the promise of a reward for tasting may not suffice, which might impede the learning process. Smaller steps (e.g. touch or smell the vegetable), and providing tangible or social rewards for these steps, might first be needed to reach the point at which the highly neophobic child is ready to taste. It was further demonstrated that the method of delivery affects the effectiveness of the Taste Kit. Demonstrating and explaining the Taste Kit at home produces better scores on outcome measures. However, an important disadvantage of this method is its time- and money-consuming nature. Therefore, a trade-off should be made between benefits and costs, based on the needs of the families. For example, as the differential influence of high and low neophobic children on consumption was less apparent in the home visit condition than in the phone condition, it might be assumed that a home visit during which the Taste Kit is explained and demonstrated is more important for high compared to low neophobic children. Furthermore, the Taste Kit evaluated in the current study was based on a reward system. However, it cannot be denied that the use of rewards in shaping children's behavior is controversial (Deci, Koestner, & Ryan, 1999). Although general positive effects were found on the outcome variables, some children might not need a tangible reward to enhance their willingness to taste. For these children, installing a rule (e.g. taste at least once of the vegetable) might suffice to enhance their willingness to taste and, eventually, produce the desired effects (i.e. enhanced liking and consumption of the initially disliked vegetable). Furthermore, a considerable amount of parents dropped out for practical reasons. The Taste Kit in its current form may have been too demanding (i.e. offering the vegetable 12 times in two weeks) for some parents. Further studies on feasibility are required to confirm this speculation. In sum, new versions of the Taste Kit should be developed, tailored to the needs of parents and children. Additionally, a suitable cost-effective delivery method should be chosen in order to produce optimal effects.

Besides some potential limitations described above, the current study has several strengths. The study presents a first evaluation of the effectiveness of the Taste Kit in a sample of Flemish parents. The study design was a randomized controlled trial, which maximized the likelihood that the effects have been produced by the intervention. Besides a relatively high level of internal validity, external validity is expected to be high as well, as the study was conducted in an ecologically valid setting (i.e. at home). Furthermore, most research or interventions aimed at increasing the consumption of healthy food, or more broadly, the prevention of obesity, mainly focused on the general population without considering differences between individuals. The present study is innovative as it investigated the general effectiveness of the Taste Kit as well as the influence of individual characteristics.

In conclusion, the Taste Kit is found to be an effective tool for parents to help their children in enhancing children's liking and consumption of an initially disliked vegetable. However, the current study also demonstrated that the effectiveness of the Taste Kit depends on various factors such as the delivery method as well as parent and child characteristics, which supports the need for interventions tailored to the needs of children and parents. Future research and implementation of the Taste Kit should take these insights into account.

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Tables

Table 1

Descriptive statistics and differences between conditions. Categorical and continuous variables were expressed as frequency (percentage) and mean (SD) respectively

	All (N = 138)	Home visit condition (n = 46)	Phone condition (n = 49)	Control condition (n = 43)	
Variable	N (%) or M (SD)	n (%) or M (SD)	n (%) or M (SD)	n (%) or M (SD)	p
Age in years	4.58 (.93)	4.59 (.89)	4.60 (.95)	4.52 (.98)	.91
Sex					.92
Male	57 (46.3)	20 (35.1)	20 (35.1)	17 (29.8)	
Female	66 (53.7)	21 (31.8)	25 (37.9)	20 (30.3)	
HHEA					.13
Bachelor or higher	111 (90.2)	36 (32.4)	38 (34.2)	37 (33.3)	
High school graduate	11 (8.9)	5 (45.5)	6 (54.5)	0 (0.0)	
Not a high school graduate	1 (0.8)	0 (0.0)	1 (100.0)	0 (0.0)	
Reward Sensitivity	33.76 (5.53)	33.33 (5.56)	32.88 (5.57)	35.22 (5.31)	.15
Food Neophobia	16.70 (3.24)	16.38 (3.23)	17.23 (3.32)	16.47 (3.17)	.45
Demandingness	3.04 (.38)	3.08 (.41)	3.03 (.38)	3.01 (.37)	.70
Responsiveness	1.13 (.13)	1.12 (.12)	1.14 (.13)	1.14 (.15)	.66
Vegetable type					.92

Note. HHEA = Highest Household Educational Attainment

Figures

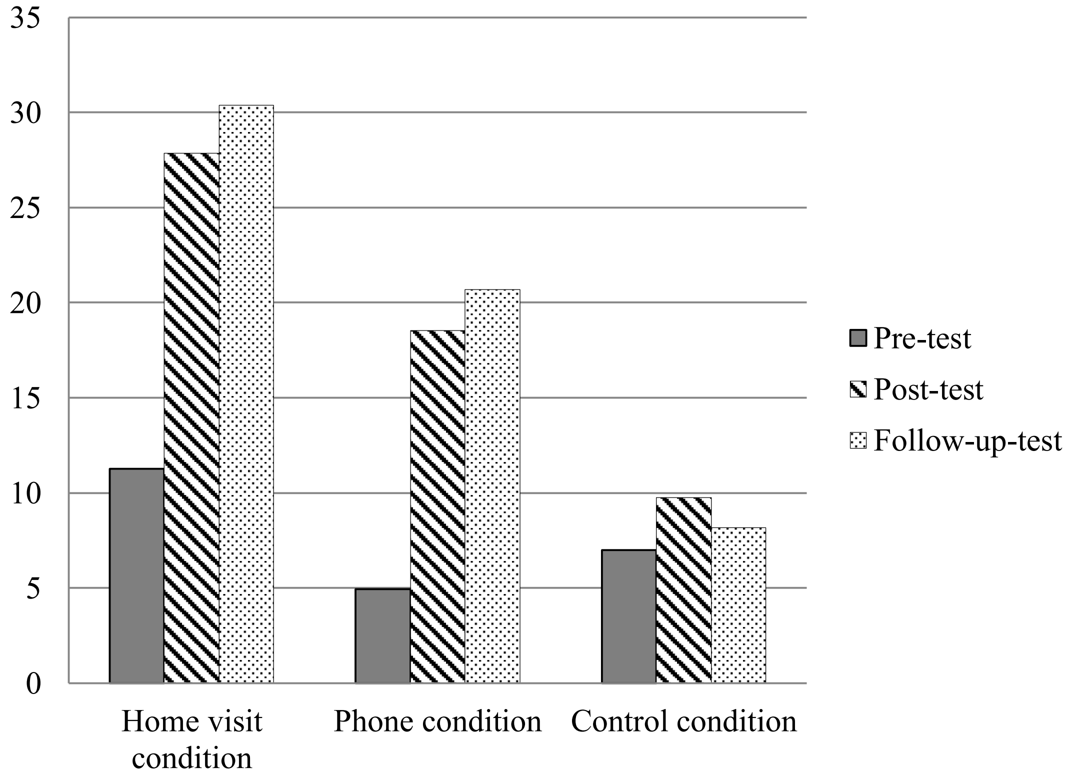

Figure 1. *The average consumption (in grams) of the vegetable under each condition at each of the three tests*.

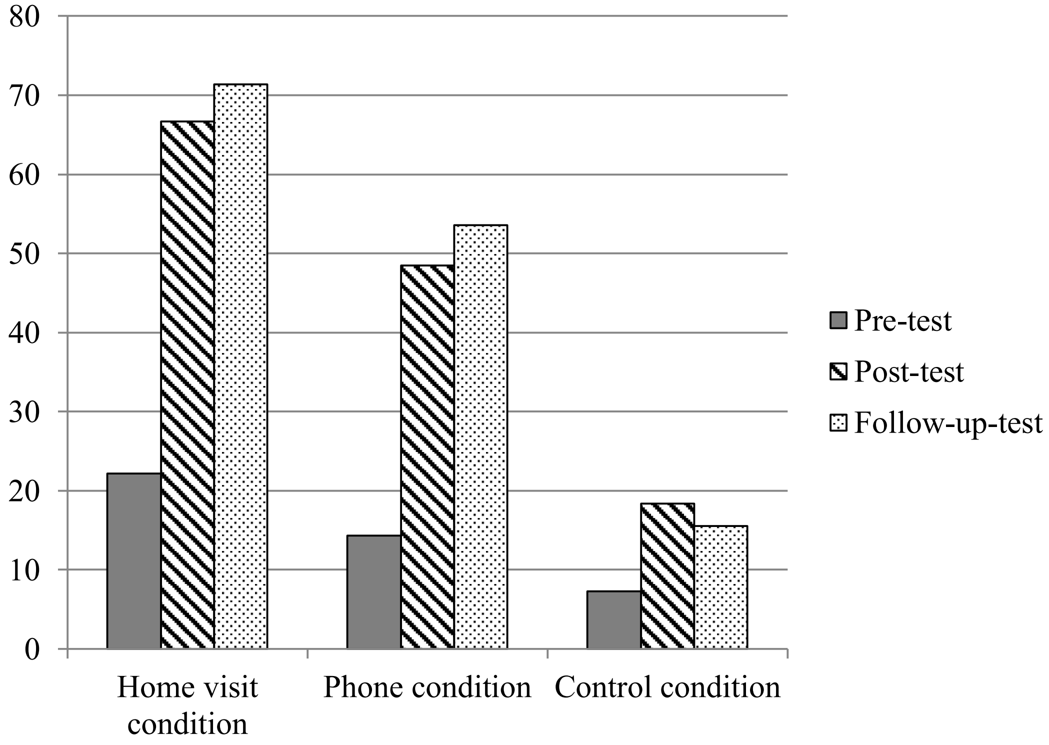

Figure 2. The percentage of children that liked the vegetable under each condition at each of three tests.

Chapter 7

General Discussion

The final chapter first summarizes the main findings of each study. Then, the results are discussed in terms of the main research questions. In addition, strengths, limitations, directions for future research and general conclusions are presented.

Research Overview

The doctoral dissertation comprises two main research lines. The first research line contains 2 cross-sectional survey studies (i.e. chapter 2 and 3) and investigates the relation between basal child characteristics and different types of eating behavior, and related body weight in a community sample of children aged 2.5 to 9 years. The second research line contains 3 experimental studies (i.e. chapter 4, 5 and 6) and focuses on stimulating vegetable consumption in a community sample of preschool children (i.e. 2.5 to 6 years old), taking into account individual and/or contextual characteristics.

Via parent-report questionnaires, the first study (i.e. chapter 2) investigated the association between the general temperamental traits reward and punishment sensitivity, and the more specific eating related concepts food approach and avoidance in preschool children. The results largely confirmed the hypotheses that reward sensitivity and punishment sensitivity are positively linked with food approach and food avoidance respectively.

Similar to the first study, study 2 (i.e. chapter 3) examined the relation between reward sensitivity and food approach behavior, but additionally investigated the relation between both concepts and body weight. The aim of study 2 was to examine the relation between reward sensitivity and body weight, and the intervening role of food approach behaviors in children aged 2.5 to 9 years via parent-report questionnaires. Unexpectedly, there was no direct significant correlation between reward sensitivity and body weight. Although a direct effect was not uncovered, the data did reveal a significant indirect association between reward sensitivity and body weight through the intervening food approach variables (i.e. food responsive behavior and external eating).

The first aim of study 3 (i.e. chapter 4) was to investigate which strategies are effective in improving preschool children's willingness to taste disliked vegetables. The results suggested that, compared to neutral instructions, children were more willing to taste ("tasting immediately" and "tasting after hesitation" vs. "not tasting") when they were rewarded for tasting with a non-food token (i.e. reward) and tasted more after hesitation (compared to not tasting) when the tasting behavior was modeled by a stranger (i.e. modelling). A trend approaching significance in the same direction was further found in the modelling condition when we compared "tasting immediately" with "not tasting". We could not demonstrate that, in comparison to neutral instructions, children were more willing to taste ("tasting immediately" and "tasting after hesitation" vs. "not tasting") when verbally encouraged by a stranger. The second aim of study 3 was to examine whether the effectiveness of strategies depended on children's reward sensitivity. We found the expected moderating effect of reward sensitivity: children higher in reward sensitivity were more likely to taste immediately when given a tangible non-food reward compared to the control condition (i.e. neutral instructions). Rather unexpectedly, children lower in reward sensitivity were more willing to taste after hesitation when verbally encouraged compared to the control condition.

In contrast to study 3, in which children were once exposed to a disliked vegetable in the laboratory, preschool children in study 4 (i.e. chapter 5) were repeatedly exposed to a disliked vegetable at school. Study 4 aimed to investigate different strategies intended to enhance willingness to taste, liking and consumption of a disliked vegetable. The results demonstrated that children's liking and consumption of a disliked vegetable significantly increased when repeatedly exposed to the vegetable, either through neutral instructions, or by promising a social or tangible reward for tasting, compared to no taste exposures. Moreover, enhanced liking and consumption remained stable at follow-up-test in all three strategies. No significant differences on willingness to taste, liking and consumption were found between the three strategies (i.e. Repeated Neutral Exposure, Repeated Exposure (RE)+token reward and RE+social reward). Study 4 further aimed to explore the influence of the individual characteristic reward sensitivity on the effectiveness of these strategies. Mixed results were found; children high in reward sensitivity had higher odds of obtaining liking during the tasting trials in the RE+token reward condition compared to children low in reward sensitivity. However, this interaction-effect could neither be found for the liking variable when comparing pre-test to post-test or follow-up-test (when no rewards were provided), nor be found for the consumption or willingness to taste variable. Furthermore, it was found that low compared to high reward sensitive children showed a stronger increase in liking the chicory in the RE+social reward condition at post-test. However, this interaction-effect could neither be found in the follow-up-test, nor for the consumption variable at each of the three tests, or during the tasting trials.

The fifth study (i.e. chapter 6) first aimed to investigate the general effectiveness of the Taste Kit. The Taste Kit is an intervention conducted at home by the parent, and aims to improve the preschool child's liking and consumption of an initially disliked vegetable. It provides evidence-based information and material which should help parents in translating this information into practice. As hypothesized, the intervention resulted in a significantly higher consumption and improved liking (i.e. both at post-test and follow-up-test), compared to the control condition. Study 5 further aimed to examine whether the delivery method influences the effectiveness of the Taste Kit. As expected, consumption of children in the home visit condition (i.e. visual and verbal instructions) was higher at post-test and follow-up-test as compared to the phone condition (i.e. verbal instructions only). Study 5 additionally investigated the role of two child characteristics (i.e. reward sensitivity and food neophobia) and two parent characteristics (i.e. responsiveness and demandingness) in the effectiveness of the Taste Kit. In contrast to our expectations, the child's reward sensitivity did not predict the effectiveness of the Taste Kit. As expected, the higher the food neopbobia, the smaller the positive effect of the Taste Kit on consumption in the phone condition at the post-test. While this effect was significant in the phone condition, it was only trend-significant in the home visit condition. In both conditions at follow-up-test, we did not find moderating effects of food neopbobia. The influence of parental responsiveness and demandingness on the effectiveness of the Taste Kit was investigated as well. Influences of responsiveness only emerged in the home visit condition; as expected, higher responsiveness of parents was associated with enhanced consumption after the intervention. Regarding demandingness, the results on consumption showed that the intervention, either delivered through the phone or via a home visit, was less effective for high demanding parents, compared to low demanding parents. A general observation that emerged from the results of study 5 is that most of the hypothesized effects could not be found on liking.

Methodological Issues

Food approach and food avoidance

Before discussing the results, issues regarding conceptualization and assessment should first be addressed. During our search through the literature, we noticed a lack of consistency in how concepts are defined and measured. Therefore, two broad general names (i.e. food approach and food avoidance) were chosen to cover the variety of scales referring to a similar concept. More specifically, food approach is an umbrella term for scales measuring eating behaviors that involve a movement towards food or thoughts that imply a desire to approach food, even in the absence of hunger. Some of these scales are defined in the literature as appetite for palatable foods (e.g. Power of Food Scale) and include items assessing thoughts (e.g. “My child thinks about food, even when (s)he is not truly hungry”) as well as behavior (e.g. “When your child eats delicious food, (s)he focuses a lot on how good it tastes”) (Lowe & Butryn, 2007), while other are defined as behaviors (e.g. external eating) or traits (e.g. food responsiveness) and include items assessing behavior (e.g. external eating: “When your child sees or smells delicious food, does (s)he feel like having some?”; food responsiveness: “My child’s always asking for food”) (Braet & Van Strien, 1997; Sleddens, Kremers, & Thijs, 2008). Despite this inconsistency, all categories (e.g. traits, behaviors, thoughts) are theoretically connected to each other, which makes it acceptable to classify them under the same term. Indeed, a personality trait is defined as an individual characteristic that pervasively influences an extensive range of trait-relevant responses, such as behaviors or thoughts (Ajzen, 2005). For example, the items that were used to measure the trait food responsiveness (e.g. “If allowed to, my child would eat too much”, “My child’s always asking for food”, “Given the choice, my child would eat most of the time”) refer to, and thus also measure behavior. In other words, food responsiveness is the trait or underlying construct of food responsive behavior.

Reward sensitivity and punishment sensitivity

Other methodological issues relate to the assessment of reward and punishment sensitivity. Although reflecting the sensitivities of two important motivational systems underlying behavior and affect (i.e. BAS and BIS) (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003), there is a lack of consensus on how both concepts should be measured. First of all, several different questionnaires have been constructed and used to measure BAS and BIS sensitivity (Vervoort, Jonker, & Vandeweghe, 2017), with the BIS/BAS scales (Carver & White, 1994) and the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia, Avila, Molto, & Caseras, 2001) being most frequently used. For the current doctoral thesis, BIS/BAS parent version was chosen instead of the SPSRQ parent version (except for the exploratory study described in chapter 2 in which the SPSRQ was included as well) because the items of the BIS/BAS scales refer to general cues of punishment and reward, which is more in line with the general trait reward sensitivity that we aim to measure, compared to the SPSRQ, in which the items are related to specific cues of punishment and reward (Matthews & Gilliland, 1999; Torrubia et al., 2001).

Secondly, even when using the same questionnaire, variations exist in how reward and punishment sensitivity are assessed. For example, in studies using the BIS/BAS scales, reward sensitivity is sometimes measured with (a) a subscale of the BAS scale (De Decker et al., 2016; Verbeken, Braet, Lammertyn, Goossens, & Moens, 2012), (b) the total BAS scale (Schienle, Schäfer, Hermann, & Vaitl, 2009) or (c) with the subscales as well as with the total BAS scale (Jonker, Bennik, & de Jong, 2016). These assessment inconsistencies may be related to indistinctness regarding the factor structure of the scales. Although the validity of the SPSRQ and the BIS/BAS scales, originally developed for adult populations, is well-established in adults (Jorm et al., 1998; Torrubia et al., 2001) and in elementary school children (Luman, van Meel, Oosterlaan, & Geurts, 2012; Muris, Meesters, de Kanter, & Timmerman, 2005), they have rarely been psychometrically evaluated among adolescents and preschool children. This is surprising given (a) that variations in BAS and BIS sensitivity can explain individual differences in personality and psychopathology (e.g. Harrison, Treasure, & Smillie, 2011; Heym, Kantini, Checkley, & Cassaday, 2015; Soler et al., 2014) and (b) that the Reinforcement Sensitivity Theory (RST; Gray, 1970, 1981, 1987a, 1987b; Gray & McNaughton, 2003) is a frequently used theoretical framework for explaining motivated behavior and emotion (Smillie, Pickering, & Jackson, 2006). A recent examination of the facture structure of the BIS/BAS scales parent version showed evidence for a four-factor structure (Vervoort, De Caluwé, et al., 2017), which is consistent with the four-factor structure of the initial BIS/BAS scales developed for an adult population; one BIS scale and three BAS subscales, namely BAS drive (i.e. the persistent pursuit of desired goals), BAS fun seeking (i.e. the desire for new rewards and a willingness to approach potentially rewarding events) and BAS reward responsiveness (i.e. the positive response to anticipation or occurrence of reward) (Carver & White, 1994). However, the subdivision of the BAS scale in three subscales is in contrast with (a) the early formulation of Gray’s RST positing that both BIS and BAS are unidimensional constructs (Gray, 1987a, 1987b) and (b) studies on the child version of the BIS/BAS scales that provide evidence for a two-factor structure (i.e. BIS and BAS) (Muris et al., 2005). All studies of the current doctoral thesis measured reward sensitivity using the total BAS scale, which is most in line with Gray’s RST. Due to its exploratory nature, the first study additionally included the different subscales. Furthermore, the third study additionally reported differences between the total BAS scale and BAS drive, as the latter is frequently reported in food-related studies (Dawe, Gullo, & Loxton, 2004; Dawe & Loxton, 2004; Verbeken et al., 2012).

First Research Line

The relation between reward sensitivity and eating behaviors

The present doctoral dissertation aimed to investigate the relation between reward sensitivity and food approach in young children. In general, both studies (i.e. study 1 and 2) provided evidence for the positive relation between reward sensitivity and food approach. However, study 1 included more indices of reward sensitivity and food approach compared to study 2, which led to some surprising findings too. Conform our hypotheses, reward sensitivity was positively related to external eating, which suggests that children with higher reward sensitivity, compared to lower reward sensitivity, are more susceptible to eating based on external stimuli (i.e. hedonic eating) rather than on internal homeostatic signals. Furthermore, reward sensitivity was positively related to all scales of the Power of Food Scale (i.e. the subscales as well as the total score). These findings suggest that children with higher reward sensitivity in general, seem to be highly sensitive to food reward as well. As such, high reward sensitive children, characterized by these appetite-related motives, might be more prone to maladaptive eating behavior, such as overeating or eating in absence of hunger, compared to low reward sensitive children. As expected, reward sensitivity was significantly positively correlated with the combined subscales of the Child Eating Behavior Questionnaire measuring food approach behavior, which supports the idea that high reward sensitive children display more food approach behavior.

However, not all indices of food approach were clearly and strongly related to all indices of reward sensitivity. First of all, *enjoyment of food* was significantly correlated with BAS reward responsiveness, but not with the other reward sensitivity indices. This might suggest that the trait reward sensitivity is less involved in how much someone enjoys food. In that respect, we might want to refer to Berridge, Ho, Richard, and DiFeliceantonio (2010) who discriminated between different dissociable brain reward processes elicited by a reward, such as liking and wanting. Liking refers to the hedonic impact or a state of pleasure generated by the presence of a reward (Berridge, 1996), and is, in our opinion, comparable to what is measured with BAS reward responsiveness. In contrast, wanting refers to the motivational drive that is generated to obtain the reward (Berridge, 1996), and is thought to be measured with BAS drive. In other words, besides liking, reward sensitivity also includes a wanting component, being the need or urge to pursue a reward, which is not reflected in the items measuring enjoyment of food (e.g. “my child loves food”, “my child enjoys eating”). Secondly, although *emotional eating* and *emotional overeating* involve a movement toward food, they were related to only one index of reward sensitivity (i.e. SPSRQ-RS: Sensitivity to Reward scale of the SPSRQ). This might suggest that, besides the rewarding value of food and homeostatic motives, other important factors may determine why someone approaches food. Negative affect might be one of these motives, as emotional eating is a response to negative emotions (Van Strien, Frijters, Bergers, & Defares, 1986). Even though negative affect is assumed to be the main reason for displaying emotional (over)eating (Van Strien et al., 1986), the rewarding value of food might also be involved. Indeed, palatable energy-dense high rewarding foods provide more comfort (i.e. “comfort” foods) compared to low-calorie foods, which might be an explanation for why a relation was found between emotional (over)eating and one of the reward sensitivity indices.

In sum, a certain type of food approach (e.g. food responsive behavior, external eating) is more closely related to reward sensitivity than other types of food approach (e.g. enjoyment of food, emotional overeating, emotional eating). The former might have in common that they are primarily displayed because of the rewarding aspects of food. Although not consistently or clearly specified in the items (e.g. “My child’s always asking for food”), we have convincing reasons to assume that they are referring to palatable, energy-dense, and thus highly rewarding foods. In a sample of preschool children, it was demonstrated that high food responsive behavior was significantly positively correlated to noncore (i.e. energy dense and nutrient poor) food preference, but not to fruit and vegetable preference (Fildes et al., 2015). Similarly, in a sample of 12-year-old children, external eating was significantly positively related to consumption of sweets, but unrelated to vegetable and fruit consumption (Elfhag, Tholin, & Rasmussen, 2008). In contrast, enjoyment of food in preschool children was significantly positively related to preference for noncore foods, as well as to fruit and vegetable preference (Fildes et al., 2015). Thus, high reward sensitive individuals may be more prone to develop overweight (Verbeken et al., 2012), not because they display approach behavior toward all kinds of food, but because of their enhanced approach behavior towards noncore foods. Indeed, in a sample of children aged 5.5-12 years, no association was found between reward sensitivity and the consumption of fruit or vegetables, while a significant positive association was found between reward sensitivity and the consumption of fast food (De Decker et al., 2016).

The relation between reward sensitivity, eating behaviors and body weight

In study 2 (i.e. chapter 3), the relation between reward sensitivity and Body Mass Index (BMI) was additionally investigated. The relation between reward sensitivity and body weight has gained considerable attention during the last decade (Davis & Fox, 2008; Davis, Strachan, & Berkson, 2004; De Decker et al., 2016; Van den Berg et al., 2011; Verbeken et al., 2012). Since highly reward-sensitive individuals are more susceptible to the reinforcing value of palatable foods (Rollins, Loken, Savage, & Birch, 2014), they might be more prone to become overweight or obese (Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008). However, as previous research has shown (Davis & Fox, 2008; Stice, Spoor, Ng, & Zald, 2009; Van den Berg et al., 2011; Verbeken et al., 2012), the relation between reward sensitivity and body weight seems more complex. Various studies demonstrated a significant positive relation between reward sensitivity and body weight in both normal and overweight adults, as well as in elementary school children; highly reward-sensitive individuals reported higher body weight compared to low reward sensitive individuals (Davis & Fox, 2008; De Decker et al., 2016; Verbeken et al., 2012). For individuals with obesity, this correlation sometimes proved to be positive (Van den Berg et al., 2011), and was sometimes found to be negative (Davis & Fox, 2008; Verbeken et al., 2012). As study 2 contained only one child with obesity, we expected a significant positive relation between reward sensitivity and body weight. However, no such relation could be found in study 2. A first possible explanation is the limited range of BMI scores in the sample; more than 80% of the children showed normal weight, and only 2.8% of the children were classified as overweight. A second possible explanation is related to the age of the participants. An observable influence of reward sensitivity on body weight might be harder to detect with decreasing age. It seems plausible that it takes some time before a heightened reward sensitivity manifests in weight gain. Furthermore, body weight is determined by a variety of factors such as physical activity (Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003), eating behaviors (Sleddens et al., 2008) and, for children in particular, parental feeding practices (Moens, Braet, & Soetens, 2007; Rhee, 2008) such as parental feeding restriction (Faith, Scanlon, Birch, Francis, & Sherry, 2004). For example, it is possible that the temperamental characteristic reward sensitivity was not directly related to weight in preschool children, because the food environment is mainly controlled by parents. Future research should incorporate measures of parental feeding practices to confirm this speculation.

Another aim of study 2 was to examine whether a relation existed between reward sensitivity and body weight through food approach behaviors. The selection of food approach behaviors in study 2 was based on the results of study 1. Food responsive behavior and external eating were chosen as food approach behaviors as these were more closely related (i.e. statistically as well as theoretically) to reward sensitivity, compared to other food approach behaviors such as emotional eating. Although previous studies investigated a similar relation (Davis et al., 2007; Van den Berg et al., 2011), no such studies included preschool children. Moreover, one of these studies selected “overeating” as food approach behavior, which was measured using a combination of some of the items of the original food responsiveness and emotional overeating scales of the Child Eating Behavior Questionnaire (Van den Berg et al., 2011). This raises some concerns given the questionability of emotional overeating as food approach behavior driven by reward sensitivity. Despite the absence of a direct relation between reward sensitivity and body weight, both were indirectly related through food responsive behavior and external eating. The indirect effect suggests that reward sensitivity is primarily associated with certain food approach behaviors, such as external eating and food responsive behavior, rather than with the development of overweight per se. This finding is line with the Reinforcement Sensitivity Theory, positing that the

Behavioral Activation System (BAS), which reflects an individual's reward sensitivity, is activated when confronted with rewarding stimuli (Depue & Collins, 1999; Gray, 1981, 1987a), thereby eliciting approach behavior toward the rewarding stimuli (Kane, Loxton, Staiger, & Dawe, 2004). High-energy products, which are highly rewarding stimuli (Epstein, Leddy, Temple, & Faith, 2007), elicit a stronger BAS activation in individuals high in reward sensitivity. Consequently, study 2 suggests that even in young children, reward sensitivity is associated with a heightened sensitivity to palatable foods, and thus with a higher tendency to approach and consume them, which is in turn related to weight status.

The absence of a direct effect is intriguing because it suggests that a high sensitivity to rewards in general might not necessarily lead to overweight. This finding is in contrast with results demonstrating that individuals at risk for obesity showed increased responsivity of the reward circuitry in general (Stice, Yokum, Burger, Epstein, & Small, 2011). However, a recent longitudinal study demonstrated that neural responses on cues signaling food receipt predicted body fat gain, but not the receipt and anticipated receipt of monetary reward (Stice, Burger, & Yokum, 2015). The latter may suggest that, only when children are highly sensitive to the rewarding aspects of palatable foods, they will exhibit more food approach behavior, which affects weight gain. In the current study, highly reward-sensitive children might be profoundly sensitive to different types of reward such as palatable foods, non-food rewards, or both. The use of a broad measure might have reduced the relation between reward sensitivity and food approach behavior, and might have eliminated the direct relation between reward sensitivity and body weight.

The relation between punishment sensitivity and eating behaviors

Besides examining the relation between reward sensitivity and food approach, the first study (i.e. chapter 2) also investigated and provided evidence for the link between punishment sensitivity and food avoidance in preschool children. At least one index of punishment sensitivity was significantly positively correlated with the combined subscales of the Child Eating Behavior Questionnaire measuring food avoidance, food neophobia, satiety responsiveness and food fussiness. High punishment sensitive children seem to display more adaptive (e.g. satiety responsiveness) and maladaptive (e.g. food neophobia) types of food avoidance, compared to low punishment sensitive children.

The hypotheses that punishment sensitivity and reward sensitivity are associated with food avoidance and approach, respectively, are based on Gray's Reinforcement Sensitivity Theory, linking punishment sensitivity with avoidance and reward sensitivity with approach (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003). As BAS and BIS are assumed to be orthogonal systems (Gray, 1987a, 1987b; Pickering, 1997), we did not formulate hypotheses concerning punishment sensitivity and food approach. However, exploratively, we found that punishment sensitivity might also be a determinant of approach behavior, as suggested by the significant correlation between punishment sensitivity and food approach in the regression analyses.

This finding may have been caused by specific types of food approach, including (over)eating as reaction to emotional situations, given the significant positive correlation between punishment sensitivity indices and emotional (over)eating. In such emotional situations, food can be seen as a way of coping with negative emotions (e.g. Heatherton & Baumeister, 1991; Herman & Polivy, 1988). The link between punishment sensitivity and emotional eating in response to negative events is consistent with evidence that punishment sensitivity is strongly associated with negative affect (Watson, Wiese, Vaidya, & Tellegen, 1999).

The significant positive correlation between the BIS scale and the composite score of the Power of Food Scale (PFS) might also have contributed to the significant correlation between punishment sensitivity and food approach in the regression analyses. The former may suggest that the appetitive responsiveness to today's food-abundant environment is also determined by punishment sensitivity. By looking more closely at the relation between the different PFS scales and the BIS scale, we observe that the subscale measuring appetitive responsiveness when food is available but not present (i.e. AnP) is significantly positively correlated with the BIS scale, which might have contributed to the significant positive correlation between the composite score of the PFS and the BIS scale. The former might be explained by the semantics of the items; while items of PnT (i.e. PFS subscale measuring appetitive responsiveness when food is present but not tasted) and TnE (i.e. PFS subscale measuring appetitive responsiveness when food is tasted but not eaten) clearly indicate that food is seen as a reward, items of the AnP are mainly about how preoccupied the child is with food (e.g. "My child thinks about food, even when (s)he is not physically hungry"). These items refer to the general motivational salience of food, irrespective of its rewarding or punishing character. Unlike the unambiguous PnT and TnE items, the items of AnP can be understood in two ways: the child can think about food because (s)he wants it and (s)he sees food as a reward, or the child can think about food in a negative way. We assume that children having a negative relation with food, such as food neophobics or food restrictive children, might also be preoccupied or controlled by food (e.g. “It seems like food controls my child rather than the other way around”), but in a negative way.

Second Research Line

As the vegetable consumption of preschool children is below recommendations (Huybrechts et al., 2008), research is needed to enhance insights in how to increase the consumption of healthy food. The present doctoral dissertation aimed to investigate different strategies to improve the consumption of disliked vegetables in a community sample of preschool children (i.e. 2.5 to 6 years old). Since the first research line underscored the relevance of child characteristics in displaying eating behavior, the role of child characteristics in the effectiveness of these strategies was examined as well. The role of parental characteristics and how the strategy was communicated to parents was additionally examined when parents conducted the strategy.

Strategies to improve the consumption of healthy food

The present doctoral dissertation first examined the general effectiveness of strategies to improve the consumption of vegetables in preschool children. Study 3 focused on increasing children’s *willingness to taste*, while study 4 and 5 additionally investigated the effect of strategies on children’s *liking and consumption*. Several methodologies were used; study 3 was conducted in the laboratory, study 4 at school and study 5 in the home environment. Furthermore, the strategies in study 3 and 4 were researcher-led, while the strategy in study 5 was conducted by the parent.

Willingness to taste

Although past research has taken considerable interest in how to improve overall liking and consumption of vegetables (e.g. Ahern, Caton, Blundell, & Hetherington, 2014; Lowe, Horne, Tapper, Bowdery, & Egerton, 2004), relatively little information is available concerning the strategies that can help children to enhance their *willingness to taste*. It is however crucial to investigate willingness to taste, as it is needed to obtain exposure, and thus, a prerequisite to establish liking. In study 3, it was found that, compared to neutral instructions, children were more willing to taste ("tasting immediately" and "tasting after hesitation" vs. "not tasting") when they were rewarded for tasting with a non-food token (i.e. reward) and tasted more after hesitation (compared to not tasting) when the tasting behavior was modeled by a stranger (i.e. modelling). A trend approaching significance in the same direction was further found in the modelling condition when we compared "tasting immediately" with "not tasting". The findings thus confirm that non-food rewards can be useful in convincing children to engage in the rewarded behavior (Cooke, Chambers, Anez, & Wardle, 2011). The effectiveness of modelling supports the Social Cognitive Theory (Bandura, 1977) stating that a role model motivates children to imitate behavior. On the whole, the results imply that the modelling and the reward strategies are more effective than giving neutral instructions in encouraging children to taste. We could not demonstrate that, in comparison to neutral instructions, children were more willing to taste ("tasting immediately" and "tasting after hesitation" vs. "not tasting") when verbally encouraged by a stranger. As a result, we were unable to confirm the idea that verbal encouragement convinces individuals to make an effort (Andreacci et al., 2002). The absence of significant effects might suggest that the motivational aspect in the verbal encouragement strategy is not strong enough to make children taste more than when neutral instructions are given. An alternative explanation of the null findings is that the children were verbally encouraged by a stranger instead of a familiar adult which might have less impact.

In contrast to study 3, study 4 could not confirm differential effects of strategies on willingness to taste. More specifically, there were no significant differences between the three conditions (i.e. Repeated Neutral Exposure, RE+token reward and RE+social reward) on willingness to taste. A possible explanation for the discrepancy between study 3 (i.e. conducted in the laboratory) and study 4 (i.e. conducted at school) relates to the method of recruitment. While parents of children in study 3 had to actively subscribe on the study, all children of eight classes participated in study 4. The former may have attracted parents of children with higher levels of food neophobia or eating difficulties (i.e. children who may get extra benefit from an additional motivation), which results in a sample different from that of study 4 (i.e. a more representative sample of preschool children who may not need an extra motivation to taste).

It needs to be noted that *willingness to taste* contained 3 categories in study 3 (i.e. tasted immediately, tasted after hesitation and did not taste), while it contained only 2 categories in study 4 (i.e. tasted and did not taste). In contrast to study 4, in which different outcome variables were examined, the main focus of study 3 was willingness to taste. More specifically, study 3 aimed at gaining more insight in the influence of the different strategies on children's willingness to taste by which the 'taste process' was explored: if children taste, how hard is it for them? The latter was determined as the time till the child was willing to taste. The reason for subdividing actual tasting in two categories was to lose as little information as possible. For one child, it takes 5 seconds to taste, for another child it takes 50 seconds to taste etc. Due to a wide inter-individual variation, it was not possible to treat this variable as a continuous one. As a compromise between both extremes (i.e. 2 categories "taste" and "did not taste" versus a continuous variable), we made a distinction between children who had no problems tasting (i.e.

tasting immediately), and children who had difficulties tasting (i.e. tasting after hesitation).

Liking and consumption

Although willingness to taste is a crucial first step in the process of learning to like a disliked food item, it is not enough to establish liking. Instead, several tasting trials are needed, which inevitably creates a learning process. Study 4 and 5 also investigated the effects of repeatedly offering a vegetable on children's liking and consumption of the initially disliked vegetable. Similar effects were found in both studies; in study 4 the results demonstrated that children's liking and consumption of a disliked vegetable significantly increased when repeatedly exposed to the vegetable, either through neutral instructions, or by promised a social or tangible reward for tasting, compared to no exposures. Similarly, in study 5, the reward-based repeated exposure intervention resulted in a significantly higher liking and consumption (i.e. both at post-test and follow-up-test), compared to the control condition. In line with previous research (Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Birch & Marlin, 1982; Wardle, Herrera, Cooke, & Gibson, 2003), these results *first* indicate that liking and consumption of a disliked vegetable can be enhanced through repeated taste exposures. Although the present thesis does not explore the underlying mechanisms behind learning to like the vegetables, it is interesting to make the following speculations. The learning process behind Repeated Neutral Exposure is called non-contingent stimulus presentation, conceptualized as the repeated presentation of the stimulus on its own (i.e. the presentation is not contingent on the presence of other events, such as stimuli or behavior) (De Houwer, 2007). Non-contingent stimulus presentation may cause different types of effects (Domjan, 2014). More specifically, the intensity of the original reaction elicited by the stimulus may either increase (i.e.

sensitization) or decrease (i.e. habitation) (Harris, 1943; Thompson & Spencer, 1966). For example, the first time a loud noise is heard, it will elicit an intense reaction of fear. The intensity of the fear reaction will decrease (i.e. habituation) when hearing the same noise 10 seconds later. In contrast, repeated bullying may cause an increased fear reaction (i.e. sensitization). Besides alterations in intensity, the reaction might become more positive (i.e. mere exposure) (Bornstein, 1989). Indeed, the "mere exposure hypothesis" states that repeatedly making a stimulus available enhances liking for that stimulus (Zajonc, 1968). These three reactions may occur in the present situation in which children are repeatedly exposed to vegetables. Some children might not like vegetables because they are highly food neophobic. The first time a vegetable is presented might induce, an intense fear reaction. Repeated exposure might lower the intensity of their fear reaction (i.e. habituation), which might in turn enhance willingness to taste (i.e. sensitization). At the same time, increased liking might occur as a consequence of the mere exposure hypothesis; the more the child tastes the vegetable, the more the taste buds familiarize with the vegetable, which equals increased liking. Increased liking might enhance the intensity of the reaction "willingness to consume the vegetable" (i.e. sensitisation), which leads to increased consumption.

Besides examining Repeated Neutral Exposure, RE+reward strategies were investigated as well. The addition of a reward to every exposure session leads to a learning process different from non-contingent stimulus presentation. It was assumed that a child given a tangible or non-tangible reward after tasting should be motivated to taste again. This reasoning follows the principle of operant or instrumental conditioning which states that behavior is modified by its consequences (Skinner, 1938). When a specific behavior has unpleasant consequences, the frequency of that behavior will decrease. Conversely, if a behavior is followed by a rewarding stimulus, the behavior will be repeated in the future to re-obtain the rewarding stimulus. With regard to the current doctoral thesis, the first taste causes a positive consequence (i.e. the material or social reward) as well as a negative consequence (i.e. a bad tasting vegetable). As the RE+reward strategies were effective, we assume that the positive consequences were more important than the negative consequences. Indeed, the positive consequence might have been a motivation for children to repeat the tasting behavior, which allowed them to benefit from the positive consequences of repeated exposure (i.e. increased liking and consumption). An important caveat is that a reward is broad concept that should be handled with care, especially in the feeding domain. It has been postulated that a reward serves as an extrinsic motivator that can undermine the intrinsic motivation (Deci, Koestner, & Ryan, 1999). Indeed, no rewards should be used when the food item is liked prior to administration of the reward. Furthermore, offering sweets as a reward seems to provoke negative effects: it enhances the preference for the sweets (Newman & Taylor, 1992). As hypothesized, the current doctoral thesis demonstrated that the appropriate use of rewards (i.e. non-tangible or non-food tangible reward for tasting behavior) can be helpful and effective in increasing preschool children's liking and consumption of an initially disliked vegetable.

Based on the phenomenon of extinction observed in instrumental learning experiments (Domjan, 2014; Neuringer, Kornell, & Olufs, 2001), one may doubt whether the positive effects of the RE+reward strategies (i.e. enhanced liking and consumption) endure once children are no longer rewarded for tasting. Extinction is a phenomenon in which a previously acquired association between a behavior and a reward is unlearned after the reward is no longer offered. As a consequence, the actor will be less likely to display the behavior in the future (Skinner, 1938). In contrast to these findings, no extinction was observed in the present doctoral thesis. Indeed, enhanced liking and consumption at post-test remained stable at follow-up test. This might be explained by an acquired familiarization with the vegetable as a consequence of having repeatedly tasted the vegetable (i.e. mere exposure hypothesis). Indeed, a reward is no longer needed after sufficient taste exposures, as liking is established. We assume that intrinsic motivation to consume the vegetable has been acquired through the initial use of an extrinsic motivator.

In sum, the results from the current doctoral thesis confirm that rewards can become helpful tools in the process of developing the liking for healthy food provided they are used appropriately (Cooke, Chambers, Anez, Croker, et al., 2011; Cooke, Chambers, Anez, & Wardle, 2011; Horne et al., 2004). However, it needs to be noted that, in study 4, no additional advantages of the RE+reward strategies on the outcome variables were found over Repeated Neutral Exposure. From these results, we assume that for many children in the general population, Repeated Neutral Exposure is sufficient to reach enhanced liking and consumption of an initially disliked vegetable. However, in study 3, we *did* find an enhanced willingness to taste in a reward strategy compared to a neutral instructions strategy. As children in study 3 are assumed to display more problematic eating behaviors due to the recruitment procedure, it is possible that a difference between Repeated Neutral Exposure and RE+reward would have been noticed when participants were children with previously known eating problems. This assumption underscores the importance of taking into account differences between children in learning to like and consume vegetables, which was also investigated in the current doctoral thesis.

The role of child characteristics

Previous research mainly focused on the general effectiveness of strategies to improve healthy food consumption, without taking into account child characteristics. However, children may react differently to different strategies, depending on their personal characteristics (Blissett, Bennett, Fogel, Harris, & Higgs, 2016). Study 3, 4, and 5 (i.e. chapter 4, 5 and 6) investigated the moderating role of children's reward sensitivity. Study 5 additionally investigated the moderating role of food neophobia.

Reward sensitivity

It was expected that a reward strategy would be most effective for high reward sensitive children. In general, we found some evidence for the moderating role of reward sensitivity. In study 3, children higher in reward sensitivity were more likely to taste immediately when given a tangible non-food reward compared to the control condition (i.e. neutral instructions). This significant interaction effect is consistent with Gray's Reinforcement Sensitivity Theory (Gray, 1981, 1987a), which posits that individuals with a more active BAS tend to react more heavily to rewards and they are more likely to activate behavior in order to obtain rewards. However, we could not find the interaction effect when comparing "tasting after hesitation" with "did not taste". This unexpected finding might be explained by impulsivity, as this personality factor is positively correlated with reward sensitivity (Torrubia et al., 2001). Put another way, children high in reward sensitivity are more likely to be impulsive: if their BAS is activated, they will not hesitate to obtain their reward, which means they taste immediately. Future research should incorporate impulsivity to confirm this speculation. The results suggest that a tangible non-food reward can convince children to taste immediately, but only if they are highly sensitive to reward. In this sense, it is not impulsivity, but indeed reward sensitivity that drives their willingness to taste, because if impulsivity were the main determinant, children high in reward sensitivity would be more likely to taste immediately in all conditions, not only when a reward is presented.

A similar interaction effect was observed in study 4; children high in reward sensitivity had higher odds of obtaining liking during the tasting trials in the RE+token reward condition compared to children low in reward sensitivity. The theoretical underpinning of this finding is that the BAS is triggered by the presence of the rewarding stimulus. The arousal and emotional changes elicited by the activation of the BAS strengthens the relation between the reward and the initially disliked vegetable in the working memory (Corr, 2001). Since children high in reward sensitivity are expected to respond more strongly to rewarding environmental stimuli, they should obtain liking more quickly in a learning strategy with a rewarding aspect compared to children low in reward sensitivity. However, this interaction-effect could neither be found for the liking variable when comparing pre-test to post-test or follow-up-test (when no rewards were provided), nor be found for the consumption or willingness to taste variable. As this interaction-effect was only present during the tasting trials in the RE+token reward strategy, it suggests that children high in reward sensitivity were more eager to indicate that they liked the chicory when a token reward was promised for tasting.

Besides these hypothesized effects on reward sensitivity, some surprising effects emerged as well. In study 3, children lower in reward sensitivity were more willing to taste after hesitation when verbally encouraged compared to the control condition. The direction of this effect is surprising since verbal encouragement announces a social reward. A similar interaction effect was found in study 4; low compared to high reward sensitive children showed a stronger increase in liking the chicory in the RE+social reward condition at post-test. These results suggest that a verbal encouragement or social reward strategy is more beneficial for low reward sensitive children than for high reward sensitive children. A possible explanation is emotional involvement of the research assistant, which is less present in the other conditions being studied. This social component could be more beneficial for low reward sensitive children, as these are less extravert and less impulsive (Muris et al., 2005; Torrubia et al., 2001); they may need this social support to facilitate the process. However, the interaction effect in study 3 was only present when "tasting after hesitation" was compared with "not tasting". In study 4, this interaction-effect could neither be found in the follow-up-test, nor for the consumption variable at each of the three tests, or during the tasting trials. Furthermore, in study 5, the effectiveness of the reward strategy was not dependent on children's reward sensitivity. Taken together, limited evidence was found for the moderating role of reward sensitivity in strategies to enhance willingness to taste, liking and consumption of a disliked vegetable. Therefore, the assumptions regarding reward sensitivity should be treated with caution.

There are a few possible explanations for the partly inconsistent results regarding reward sensitivity in study 3, 4 and 5. In contrast to study 3, willingness to taste in study 4 was not dependent on children's reward sensitivity. A possible explanation relates to differences in how the dependent variable is constructed in both studies; in study 3, willingness to taste is subdivided in 3 categories (i.e. tasted immediately, tasted after hesitation and did not taste), while it contains only 2 categories in study 4 (i.e. tasted and did not taste). Furthermore, in study 3, there was only one taste session, while study 4 included 8 taste sessions. Therefore, a percentage was calculated to provide an index for willingness to taste. In sum, the influence of reward sensitivity on willingness to taste was visible, but only when taking time of tasting into account.

Next, in study 4, we found some evidence for the moderating role of reward sensitivity on liking, while such effects were not observed in study 5. A possible explanation relates to reliability of the liking assessment. Results in study 4 might be more reliable, as liking was measured in a consistent manner by trained research assistants, while liking in study 5 was measured by the parents. However, it is also possible that liking, either measured by a research assistant or a parent, provides less reliable and less consistent results compared to consumption, as the former is child reported. Indeed, a general observation that emerges from the study results of study 5 is that most of the hypothesized effects could not be found on liking. These results are in line with previous studies showing that positive effects were consistently found on consumption but not on liking (Cooke, Chambers, Anez, & Wardle, 2011; Hendy, Williams, & Camise, 2005).

Furthermore, in contrast to study 5, study 3 and 4 showed to some degree that high reward sensitive children benefited from a tangible reward strategy while low reward sensitive children benefited from a social reward strategy. Although the Taste Kit consists primarily of tangible rewards, it seems plausible that parents additionally provided a social reward after the child tasted (i.e. praise). Combining both strategies might have cancelled out the influence of reward sensitivity in study 5.

The absence of firm effects of reward sensitivity overall may be related to the efforts needed to obtain the reward and the reward itself. The efforts needed to obtain the reward may be perceived by the children as minimal, and the reward itself may be perceived as highly rewarding. Both aspects might have reduced the differentiation between low and high reward sensitive children, and thus eliminated the effect of reward sensitivity.

Food neophobia

In study 5 (i.e. chapter 6), we additionally investigated the effect of the child's food neopbobia on the success of the Taste Kit. The results on consumption were largely in line with the expectations. As expected, the higher the food neopbobia, the smaller the positive effect of the Taste Kit on consumption at the post-test. Children's reluctance to taste might have hampered the tasting process during the intervention. A surprising effect emerged as well; high food neophobic children had higher odds of liking the vegetable in the home visit condition on follow-up-test. A possible explanation is that these high neophobic children gave socially desirable answers (i.e. "I like the vegetable!") in their attempt to avoid another part of the Taste Kit. The results on consumption are in line with this speculation, as we could not find that highly neophobic children had a higher consumption at follow-up test compared to low neophobic children. These results indicate that food neophobia is worth taking into account when constructing an intervention to promote healthy food.

The role of parental characteristics

In contrast to study 3 and 4, the strategy in study 5 (i.e. chapter 6) was conducted by the parent. As a consequence, it enabled us to additionally investigate the moderating role of parental characteristics. More specifically, the influence of two major dimensions reflecting how parents interact with their children during feeding situations on the effectiveness of the strategy was investigated. In line with our hypotheses, significant moderating effects of responsiveness showed that the intervention was most effective for high compared to low responsive parents. This suggests that high responsive parents are able to create a warm, supportive climate which ameliorate the effect of the intervention. Regarding demandingness, the results on consumption showed that the intervention was less effective for high demanding parents, compared to low demanding parents. A possible explanation relates to the amount of control offered by the Taste Kit, which might have been more useful for parents who lack rules about the quality or quantity of diet (i.e. low demanding parents) compared to parents who already have (too) strict rules (i.e. high demanding parents). As the Taste Kit does not remove maladaptive levels of control, it was probably less effective for high demanding parents. Another possible explanation for the finding that the intervention was less effective when applied by high demanding parents, compared to low demanding parents, is because of the positive association between demandingness during feeding situations and negative feeding practices and negative general parenting behaviors such as scolding, pressure to eat and inconsistency (Hennessy, Hughes, Goldberg, Hyatt, & Economos, 2010). These behaviors may create a negative atmosphere which might have reduced the effectiveness of the intervention. The results on parental characteristics suggest that parental characteristics play a significant role in the effectiveness of an intervention.

The role of communication

Knowledge about effective strategies in an artificial situation is one thing, knowing how to transmit it to stakeholders (e.g. the ones that need to carry out the strategy) to produce similar positive effects in daily life is another. Therefore, study 5 also aimed to examine whether the delivery method influenced the effectiveness of the intervention. As expected, the consumption and liking of children in the home visit condition (i.e. visual and verbal instructions) was higher at post-test and follow-up-test as compared to the phone condition (i.e. verbal instructions only). Although these differences were not significant for the liking variable, they were found to be significant and marginally significant for the consumption-variable at post-test and follow-up-test respectively. In accordance with the modality principle, positing that people learn better when different modalities are addressed (Mayer, 2009), parents might have better knowledge and skills on how to conduct the Taste Kit, when it has been explained and demonstrated at home compared to an explanation on the phone. Enhanced knowledge and skills might in turn have resulted in better intervention outcomes. The findings are further in line with the Social Cognitive Theory, stating that people learn from observing others (Bandura, 1977). According to this theory, the adequate reproducibility of the model's behavior (i.e. the experimenter) by the observer (i.e. the parent) is further dependent upon determinants such as outcome expectancies (i.e. does the behavior produce the desired effect?) or self-efficacy (i.e. does the person feel competent to correctly complete the behavior). It seems plausible that parents in the home visit condition had more self-efficacy and better outcome expectancies after it was successfully conducted with their own child. However, from the current study, we could not infer the underlying processes that may have contributed to a higher consumption in the home visit condition compared to the phone condition. Future research should include measures of outcome expectancies, self-efficacy, skills and knowledge to determine the underlying mechanisms.

Furthermore, as expected, the role of individual and parental characteristics in the effectiveness of the Taste Kit altered depending on the delivery method. While the effect of *food neophobia* was significant in the phone condition, it was only trend-significant in the home visit condition. Indeed, we *did* expect the differential influence of high and low food neophobic children on the outcome variables to be less apparent in the home visit condition, as these parents are probably more aware of how to correctly conduct the Taste Kit. At follow-up-test, no moderating effects of food neopbobia were found, which suggests that the difference in consumption between high and low food neophobic children disappears after some time, in both conditions. In sum, although both intervention conditions eventually produce favorable effects, the home visit condition is able to create the positive effects more quickly than the phone condition. In contrast to our expectations, influences of *responsiveness* only emerged in the home visit condition on consumption and not in the phone condition. Thus, parents who are used to act in a responsive way benefit more from the explanation and demonstration of the Taste Kit at home. In other words, both are needed to produce most favorable effects. Furthermore, children of high *demanding* parents, compared to low demanding parents, ate significantly less in the phone condition, and trend significantly less in the home visit condition at post-test. From these results, it might be assumed that the way in which the intervention was delivered could affect the influence of how controlling parents are used to be. However, this assumption does not hold for the follow-up-test, in which children of high demanding parents, compared to children of low demanding parents, ate significantly less in the home visit condition, and trend significantly less in the phone condition. Future research should examine the period in between post-test and follow-up-test to provide an adequate explanation.

Implications

The results of the current doctoral thesis provide insights that can be helpful in developing prevention and intervention programs for eating problems and problematic body weight in young children. These prevention and intervention programs are urgently needed as several alarming trends and statistics have been observed: (a) the overall diet of preschool Flemish children does not meet the recommended food-based dietary guidelines (e.g. not enough vegetables, too much snacks) (Huybrechts et al., 2008), (b) an increase in childhood overweight and obesity prevalence has been observed in the last three decades (Hedley et al., 2004; Ng et al., 2014) and (c) eating problems, such as food neophobia and pickiness, are frequently documented in young children (Jacobi, Agras, Bryson, & Hammer, 2003; Marchi & Cohen, 1990; McDermott et al., 2008; Stice, Agras, & Hammer, 1999).

A first insight is related to improving the consumption of healthy food in young children. The results of study 3, 4 and 5 demonstrate that several strategies are effective and helpful to stimulate healthy eating. Moreover, study 5 presented how a strategy can be successfully transformed into a home-based parent-led intervention (i.e. the Taste Kit). The results of the present doctoral dissertation may further be helpful in deciding which strategy to select for the child. Study 4 showed that Repeated Neutral Exposure seem to be sufficient to increase liking and consumption of an initially disliked vegetable. Indeed, in a *general sample* of preschool children (i.e. study 4), no differences were found between the effectiveness of RE+reward and Repeated Neutral Exposure. However, in contrast to study 4, study 3 showed an enhanced willingness to taste when a motivational component was added (i.e. providing a reward or modeling the behavior) compared to neutral exposure. As we assume that the sample in study 3 and 4 differed in terms of problematic eating behavior, we hypothesize that only children with problematic eating behaviors get extra benefit from a strategy with a motivational component. This assumption points to the importance of taking into account *differences between children* when developing prevention and intervention programs, an insight that has implications for the Taste Kit. For example, since we assume that some children do not need a tangible reward to enhance their willingness to taste, an adapted version of the Taste Kit should be created for these children, in which tasting has no rewarding consequences. Even though similar positive effects were found for rewarding and neutral instructions (i.e. study 4), it cannot be denied that the use of rewards in shaping children's behavior is controversial (Deci et al., 1999); rewarding should therefore not be used unless specifically necessary. The importance of taking into account differences between children was further supported by the results of study 1 and 2. In these studies, a relation was shown between individual differences in the sensitivity of two basic brain systems (i.e. reward and punishment sensitivity) and two eating-related concepts (i.e. food approach and food avoidance) determining body weight.

Results on *food avoidance behaviors* (i.e. study 1) are a first step in understanding how individual differences in the basic temperamental trait punishment sensitivity are related to a certain type of eating behaviors (i.e. food avoidance behavior) determining lower body weight. Although the current cross-sectional research cannot make conclusions on the direction of the relation, it seems plausible to assume that punishment sensitivity influences and contributes to the development of food avoidance behaviors. As a consequence, more attention should be paid to at-risk children (i.e. high in punishment sensitivity) in order to *prevent* the development of problematic food avoidance behaviors (e.g. restrictive or selective eating disorders). Besides information for prevention programs, the results may provide valuable insights for *intervention* programs for children displaying such behaviors. Consistent with a biopsychosocial framework, interventions programs should not focus on the problematic behavior alone, but instead combine multiple perspectives on risk factors (i.e. food avoidance behaviors as well as the temperamental characteristic punishment sensitivity) to address the problem. Indeed, if food avoidance behaviors originate from basal automatic reactions on punishing stimuli, the latter need to be addressed as well. To our knowledge, trainings aimed at altering anxiety-related automatic processes (e.g. Cognitive Bias Modification) (e.g. Koster, Fox, & MacLeod, 2009) have not yet been used in the eating domain.

Besides trying to alter the automatic reactions on punishing stimuli elicited by the Behavioral Inhibition System, prevention programs could also take these avoidance reactions into account when developing and applying strategies to increase the consumption of healthy food. Since the main focus of the current doctoral thesis was reward sensitivity, we did not elaborate on this aspect (i.e. punishment sensitivity) in the other studies. However, as a starting point for taking into account individual differences in (food) avoidance behavior, the influence of food neophobia on the effectiveness of the Taste Kit was investigated. The results showed that the Taste Kit was most effective for low neophobic children. For highly neophobic children who experience considerable difficulties with tasting new and disliked food items, the promise of a reward for tasting may not suffice, which might impede the learning process. Smaller steps (e.g. touch or smell the vegetable), and providing material or social rewards for these steps, might first be needed to reach the point at which the highly neophobic child is ready to taste. More research is needed to further investigate the moderating role of (food) avoidance behavior in strategies to improve liking and consumption of vegetables.

In contrast, results on *food approach behaviors* (i.e. study 1 and 2) provide information that can be used when developing prevention programs for *overweight* in young children. Overweight and obesity prevention programs primarily focus on changing dietary or physical activity behaviors (e.g. Baranowski et al., 2000; Reilly & McDowell, 2003). However, our results suggest that eating behaviors as well as individual characteristics play a significant role. More specifically, food approach behaviors vary in accordance with the child's reward sensitivity. As long as both aspects are not addressed, the child may relapse into previous eating habits, and long-term weight control might remain a challenge. In line with this assumption, a meta-analytic review of obesity prevention programs for children and adolescents demonstrated that, of 21% of the effective prevention programs, only 5% produced effects that persisted over a substantial follow-up period (Stice, Shaw, & Marti, 2006). Therefore, prevention programs should not only focus on proximal factors influencing weight, such as food intake, but also incorporate more distal factors, such as food approach behaviors and reward sensitivity. To our knowledge, training programs for young children to control their automatic urge to approach rewarding stimuli are scarce. However, there is a growing research interest in cognitive retraining of automatic processes in the food domain. For example, the Approach Avoidance Task (Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011) aims at modifying automatic response tendencies toward unhealthy food (Becker, Jostmann, Wiers, & Holland, 2015). Furthermore, studies conducted in an adult population showed that Attentional Bias Modification training was effective in directing attention away from unhealthy foods, directing attention towards healthy food, promoting healthy snack intake and discouraging unhealthy snack intake (Kakoschke, Kemps, & Tiggemann, 2014; Kemps, Tiggemann, Orr, & Grear, 2014; Werthmann, Field, Roefs, Nederkoorn, & Jansen, 2014). It should also be investigated whether these training programs are successful in controlling high reward sensitive children's automatic responses to palatable foods.

Besides focusing on how to handle the automatic reactions on rewarding stimuli elicited by reward sensitivity, prevention programs could also use the strength of these reactions to reach a desired behavior. Study 3, 4 and 5 provide to some extent evidence that these individual differences in reward sensitivity are also worth considering when selecting a strategy to improve healthy food consumption. In study 4, we found that a low reward sensitive child may benefit from a verbal encouragement strategy, while a high reward sensitive child may benefit more from a token reward strategy. We found some similar evidence in study 4, children high in reward sensitivity had higher odds of obtaining liking during the tasting trials in the RE+token reward condition, compared to children low in reward sensitivity and, the lower the reward sensitivity, the stronger the increase in liking the vegetable in the RE+social reward condition at post-test. However, as these effects could not be replicated in study 5, or with other outcome variables in study 4, nor with all categories of willingness to taste in study 3, the assumptions regarding reward sensitivity should be treated with caution. More research is needed to further investigate the moderating role of reward sensitivity in strategies to improve liking and consumption of vegetables, before firm conclusions can be drawn.

Besides demonstrating the importance of taking into account child characteristics, the present doctoral dissertation additionally points to the importance of considering contextual characteristics (i.e. parent characteristics, method of delivery) when constructing interventions to improve children’s consumption of healthy food. In other words, the intervention also needs to be adapted to the ones who will conduct the intervention (e.g. parents, teachers, grandparents). For example, the Taste Kit was most effective for high responsive parents who were visited at home, and for low demanding parents in both intervention conditions, which might imply that the Taste Kit in its current form is less adequate for low responsive parents and high demanding parents. A Taste Kit for low responsive parents should probably include more information on how to encourage eating behavior in a responsive way while highly controlling parents should be made aware of the negative effects of maladaptive control. It was further demonstrated that the method of delivery affects the effectiveness of the Taste Kit. Demonstrating and explaining the Taste Kit at home produced better scores on outcome measures. However, an important disadvantage of this method is its time- and money-consuming nature. Therefore, a trade-off should be made between benefits and costs, based on the needs of the families. For example, as the differential influence of high and low neophobic children on consumption was less apparent in the home visit condition than in the phone condition, it might be assumed that a home visit during which the Taste Kit is explained and demonstrated is more important for high compared to low neophobic children. Furthermore, a considerable amount of parents dropped out for practical reasons. The Taste Kit in its current form may have been too demanding (i.e. offering the vegetable 12 times in two weeks) for some parents. Further studies on feasibility are required to confirm this speculation. In sum, future research should create and investigate other versions of the Taste Kit, tailored to the possibilities and needs of parents and children. Additionally, a suitable cost-effective delivery method should be chosen in order to produce optimal effects.

Strengths and Limitations

A few limitations and strengths of the present doctoral dissertation merit some attention. A limitation of study 1 and 2 is their cross-sectional nature. Based on the theoretical background of reward sensitivity and punishment sensitivity (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003), we might assume that reward and punishment sensitivity determine the extent to which someone approaches or avoids food and not the other way around. However, due to the cross-sectional nature of our design, no conclusions can be drawn regarding causal inferences or directions of the associations. Furthermore, since the variables were assessed concurrently, a longitudinal design might be interesting to get more insight in the developmental course of food approach or avoidance and the link with temperament, and related body weight. In contrast, study 3, 4 and 5 used experimental designs, thereby maximizing the likelihood that the effects have been produced by our manipulations. Despite our cautiousness to ensure the rigor of such an experimental procedure, the external validity of the findings might be challenged in study 3 because the children were not in their natural eating environment in which a familiar adult asks them to taste. Compared to study 3, study 4 has enhanced ecological validity as it is conducted in the school-context. However, similar to study 3, an unfamiliar adult asks them to taste. In contrast to study 3 and 4, study 5 provides a relatively high level of internal validity as well as external validity, as the study was conducted in an ecologically valid setting (i.e. parent-led at home).

A major strength of the current doctoral thesis is the inclusion of individual factors, and more specifically, their role in strategies to improve healthy food consumption (i.e. study 3, 4 and 5). The current doctoral thesis mainly focused on reward sensitivity. However, finding effective strategies for high punishment sensitive children would also be interesting as these children are more likely to display food avoidance behaviors. Moreover, we mainly focused on a basal temperamental characteristic (i.e. reward sensitivity). An exception is study 5 in which we explored the moderating role of food neophobia. The moderating role of other specific food approach and food avoidance behaviors or traits in strategies to improve healthy food consumption should also be investigated.

Next, all studies were conducted in a community sample of young children. Although some differences might have emerged as a consequence of the method of recruitment (e.g. study 3 versus study 4), we did not investigate a group of children with severe eating or weight problems. It might be interesting to investigate the relation between temperamental traits, eating behaviors and related body weight in children with severe eating problems or children with overweight or underweight. As, for example, the correlation between reward sensitivity and body weight in individuals with obesity was sometimes found to be negative (Davis & Fox, 2008; Verbeken et al., 2012), different relations might be observed depending on the weight category. Similarly, strategies to improve healthy eating should also be investigated in children with previously known eating problems. These children might be more in need of an extra motivation to taste, and preferably a motivational strategy that fits well with the child's individual characteristics, traits or behaviors.

In the present doctoral thesis, we mainly used parent-report questionnaires to assess child characteristics or behaviors (e.g. reward sensitivity, punishment sensitivity, food approach, food avoidance). Although previous studies have shown that parent-report is generally a valid and reliable way to obtain information about young children (Copeland, Landry, Stanger, & Hudziak, 2004; Vervoort et al., 2015), other studies found that parent-reported height and weight may not be completely accurate (Huybrechts, De Bacquer, Van Trimpont, De Backer, & De Henauw, 2006; Huybrechts et al., 2011). Furthermore, questionnaires in study 1, 2, 3 and 4 were filled out by the mother, while the questionnaires in study 5 were filled out by the person that is most actively involved in the child's feeding, which is also the person who conducted the Taste Kit. In the first four studies, we asked mothers to fill out the questionnaires for reasons of consistency and standardization. Mothers were chosen instead of fathers as they are, from an evolutionary perspective (e.g. breastfeeding), more involved in feeding young children. However, in the current society, same-sex parents or house-husbands are no exception. Therefore, we adopted the informant assessment in the last study. In sum, multi-informant assessment, the use of behavioral measures or objective measures (e.g. height and weight measured by a trained experimenter) would certainly strengthen the conclusions of the results and are recommended for future research.

We further acknowledge that the studies are constrained by the included variables. For example, in spite of finding evidence for a positive relation between reward sensitivity and food approach, and punishment sensitivity and food avoidance (i.e. study 1), the explained variance was at best moderate (Cohen, 1977). These results suggest that, in addition to reward sensitivity and punishment sensitivity, other factors may determine whether certain appetite related behaviors or thoughts will be present. This is consistent with biopsychosocial models describing multiple determinants of eating behavior (e.g. Davison & Birch, 2001), such as learning processes, parental feeding styles and the obesogenic environment (Eertmans, Baeyens, & Van Den Bergh, 2001; Savage, Fisher, & Birch, 2007; Scaglioni, Arrizza, Vecchi, & Tedeschi, 2011). Similarly, it is possible that the temperamental characteristic reward sensitivity was not directly related to weight in preschool children (i.e. study 2), because the food environment is mainly controlled by parents. In sum, more variables should be included to provide a complete overview.

Conclusions

In the first research line of the current doctoral dissertation, differences in the sensitivity of two basic brain systems (i.e. punishment and reward sensitivity) are found to have relevance for eating behaviors and thoughts in young children. The results further suggest that reward sensitivity may indirectly play a role in weight gain via food approach behaviors including food responsive behavior and external eating. These insights substantially enhance our understandings of eating behavior in children. The current study is one step in understanding how basic temperamental traits, such as reward sensitivity and punishment sensitivity, are related to more proximal eating behaviors (i.e. specific food approach and avoidance behavior or thoughts) determining body weight. We are convinced that, consistent with a biopsychosocial framework, studies and interventions related to eating behavior and body weight should not focus on proximal factors alone, but instead combine multiple perspectives to examine how the interactions between these proximal behaviors and distal factors (such as basal child characteristics) contribute to adaptive and maladaptive eating behaviors, and related body weight.

The second research line confirms the conclusions of previous research that liking and consumption of an initially disliked vegetable can be improved through repeated taste exposures. Furthermore, rewarding provides neither detrimental effects, nor additional advantages over Repeated Neutral Exposure in a general sample of preschool children. Stated differently, Repeated Neutral Exposure is often enough to increase healthy food consumption. In instances where it does not produce desired effects, we summarize and recommend the strategies as follows: (1) modelling and a token reward generally increase the likelihood that a child tastes, and (2) if the child still refuses to taste, a strategy in accordance with the reward sensitivity of the child is proposed: a low reward sensitive child may benefit from a verbal encouragement or social reward strategy, while a high reward sensitive child may benefit more from a token reward strategy. However, as these effects could not be firmly replicated, more research is needed to further investigate the moderating role of child characteristics in strategies to improve liking and consumption of vegetables.

Lastly, the Taste Kit is found to be an effective tool for parents to help their children in enhancing children's liking and consumption of an initially disliked vegetable. However, the results also demonstrated that the effectiveness of the Taste Kit depends on various factors such as the delivery method as well as parent and child characteristics, which supports the need for interventions tailored to the needs of children and parents.

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Nederlandstalige Samenvatting

Eetgedrag van Jonge Kinderen: de Rol van Individuele en Contextuele Kenmerken

Het doctoraatsproefschrift bestaat uit zeven hoofdstukken. In het eerste hoofdstuk wordt een overzicht gegeven van de bestaande literatuur rond eetgedrag en gewichtsstatus bij jonge kinderen. De vijf daaropvolgende hoofdstukken geven de vijf empirische studies weer. Terwijl de eerste twee studies correlaten van eetgedrag en gewichtsstatus nagaan, onderzoeken de laatste drie studies hoe de consumptie van groenten verhoogd kan worden bij jonge kinderen. In het laatste hoofdstuk worden de onderzoeksresultaten van het proefschrift bediscussieerd alsook de implicaties die hieruit resulteren.

Hoofdstuk 1: Algemene inleiding

Gezonde eetgewoonten zijn voor jonge kinderen essentieel voor een adequate groei en ontwikkeling (du Plessis, Naude, & Swart, 2016). Ondanks het belang van gezonde voeding, voldoet de inname van jonge kinderen niet aan de dagelijkse aanbevolen hoeveelheid groenten en fruit (Huybrechts et al., 2008). Parallel aan deze bevinding wordt een stijging in overgewicht en obesitas waargenomen, zowel bij volwassenen als bij kinderen (Hedley et al., 2004; Ng et al., 2014). Eetgedragingen, en het daaraan gerelateerde gewicht, worden volgens biopsychosociale modellen beïnvloed door een variëteit aan factoren op verschillende niveaus, o.a. het contextueel en individueel niveau en interacties tussen beide niveaus (Davison & Birch, 2001; Story, Neumark-Sztainer, & French, 2002).

Binnen het *contextuele* niveau kan er een onderscheid gemaakt worden tussen gezinskarakteristieken, en maatschappelijke karakteristieken. Het spreekt voor zich dat de gezinscontext, en meer specifiek de ouders, een primaire rol spelen in de opvoeding van kinderen. In de literatuur worden twee grote dimensies beschreven die weerspiegelen hoe ouders interageren met hun kinderen, namelijk responsiviteit en controle (Hughes, Power, Fisher, Mueller, & Nicklas, 2005; Maccoby & Martin, 1983). In het voedingsdomein wordt responsiviteit geconceptualiseerd als de mate waarin ouders positief en op een warme ondersteunende manier betrokken zijn bij het eetgedrag van hun kind. Controle verwijst naar de mate waarin ouders het eetgedrag van hun kind monitoren en controleren d.m.v. regels. Naast deze *proximale* omgeving, worden kinderen ook beïnvloed door een meer *distale* omgeving, namelijk de maatschappelijke evoluties. We leven momenteel in een obesogene omgeving waarin sedentair gedrag en de consumptie van ongezonde voeding enorm gepromoot worden (M. Lowe & Butryn, 2007; Young &

Nestle, 2002). Dit hangt ontegensprekelijk samen met de stijgende obesitastrend (Rolls, 2011). Daartegenover promoot de huidige samenleving ook het slanke lichaamsideaal (Brownell, 1992), wat restrictieve eetproblemen, eetstoornissen en ondergewicht in de hand kan werken (Gerner & Wilson, 2005; Smolak & Thompson, 2009).

Echter, niet alle individuen worden in dezelfde mate beïnvloed door deze omgevingsinvloeden, aangezien niet iedereen eetproblemen of overgewicht ontwikkelt. Deze bevinding doet vermoeden dat er naast omgevingsfactoren ook *individuele* factoren betrokken zijn in de ontwikkeling van eetgewoonten en gewichtscontrole. Vooraleer in te gaan op deze individuele factoren dient eerst wat meer uitleg verschaft te worden over het bestaan van verschillende types eetgedragingen. Aangezien voedsel een primaire bekrachtiger is (Berridge, 1996), zal dit in vele gevallen gepercipieerd worden als een beloning die prettige gedachten opwekt en toenaderingsgedrag in de hand werkt (Berridge, 1996; Saper, Chou, & Elmquist, 2002). Echter, voedsel kan ook soms een negatieve, aversieve stimulus zijn, die walging en vermijdingsgedrag veroorzaakt (Batsell, Brown, Ansfield, & Paschall, 2002; Rozin & Fallon, 1980). In het domein van de eetgedragingen werden reeds verschillende concepten gebruikt om adaptieve en maladaptieve bewegingen *naar* en *weg van* voedsel te beschrijven. In de huidige doctoraatsthesis werden eetgedragingen die wijzen op een beweging naar voedsel of gedachten die wijzen op een verlangen naar voedsel, zelfs in de afwezigheid van honger, onder de gemeenschappelijke noemer “voedseltoenadering” geplaatst. Voorbeelden van voedseltoenadering zijn overeten, extern eten (i.e. eten als reactie op voedsel-gerelateerde stimuli) (Van Strien, Frijters, Bergers, & Defares, 1986), en emotioneel eten (i.e. eten als reactie op negatief affect) (Van Strien et al., 1986). Eetgedragingen die wijzen op een beweging weg van voedsel of gedachten die wijzen op een aversie voor voedsel werden onder de gemeenschappelijke noemer “voedselvermijding” geplaatst. Voorbeelden van voedselvermijding zijn kieskeurig eten en voedselneofobie (i.e. de verwerping van nieuw of onbekend voedsel) (Birch & Fisher, 1998). Uit onderzoek bleek dat voedseltoenaderings- en voedselvermijdingsgedragingen respectievelijk gerelateerd waren aan gewichtstoename en gewichtsafname (French, Epstein, Jeffery, Blundell, & Wardle, 2012; Sleddens, Kremers, & Thijs, 2008).

De huidige doctoraatsthesis onderzoekt individuele verschillen in basale neuropsychologische mechanismen die mogelijks verklaren waarom individuen verschillend op voedsel reageren. Deze mechanismen werden beschreven in Gray’s Reinforcement Sensitivity Theory (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003) en betreffen twee biologische motivationele systemen die het gedrag sturen: het gedragsactivatiesysteem (i.e. BAS) en het gedragsinhibitiesysteem (i.e. BIS). Beide systemen resulteren in twee dimensionele karakteristieken die variëren tussen mensen, respectievelijk beloningsgevoeligheid en strafgevoeligheid. BAS reageert op belonende omgevingsstimuli met toenaderingsgedrag, met als doel de beloning te verkrijgen (Gray, 1981, 1987a). BIS reageert op aversieve gebeurtenissen en aangeboren angststimuli met vermijdingsgedrag (Gray, 1987b; Gray & McNaughton, 2003). De invloed van beloningsgevoeligheid vond men reeds terug in eetgedrag, eetmoeilijkheden en gewichtsstatus (Bijttebier, Beck, Claes, & Vandereycken, 2009; Davis, Strachan, & Berkson, 2004; Van den Berg et al., 2011; Verbeken, Braet, Lammertyn, Goossens, & Moens, 2012). Zo werd een hoge mate van beloningsgevoeligheid bij volwassenen en lagere schoolkinderen gelinkt met een hoger gewicht (Davis et al., 2007; Van den Berg et al., 2011). Deze relatie werd gemedieerd door voedseltoenaderingsgedragingen, zoals overeten. Terwijl de rol van beloningsgevoeligheid in eetgedragingen en gerelateerd lichaamsgewicht vrij goed beschreven is in adolescenten en volwassenen, werd de rol van strafgevoeligheid enkel onderzocht in het domein van de eetstoornissen. Zo werd gevonden dat personen met een eetstoornis gekenmerkt door purgeren of uithongering (i.e. voedselvermijdingsgedragingen) meer strafgevoelig zijn dan personen zonder eetstoornis (Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006; Harrison, O'Brien, Lopez, & Treasure, 2010; Matton, Goossens, Vervaet, & Braet, 2015).

Onderzoek naar de link tussen strafgevoeligheid, beloningsgevoeligheid en eetgedrag en lichaamsgewicht focust zich voornamelijk op adolescenten en volwassenen. Dit is verassend aangezien beide temperamentskenmerken (i.e. straf- en beloningsgevoeligheid) en eetgedragingen vroeg ontwikkelen en gewoonlijk verdergezet worden in de adolescentie en volwassenheid (Nicklaus & Remy, 2013). Verder komen eetproblemen in de jonge kindertijd heel vaak voor (Jacobi, Agras, Bryson, & Hammer, 2003; Marchi & Cohen, 1990; McDermott et al., 2008; Stice, Agras, & Hammer, 1999) en zijn zij een risicofactor voor het ontwikkelen van parallelle pathologische problemen in de latere kindertijd en de adolescentie (Marchi & Cohen, 1990). Op basis van voorgaand onderzoek (Bijttebier et al., 2009; Davis et al., 2004; Van den Berg et al., 2011; Verbeken et al., 2012) en theorie (Gray, 1981, 1987a, 1987b; Gray & McNaughton, 2003) wordt verondersteld dat kinderen met een hoge mate van strafgevoeligheid, in vergelijking met kinderen met een lage mate van strafgevoeligheid, meer voedselvermijding stellen. Verder wordt verwacht dat hoog beloningsgevoelige kinderen, in vergelijking met laag beloningsgevoelige kinderen meer voedseltoenadering zullen stellen, wat op zijn beurt de kans op overgewicht en obesitas vergroot.

Gezien de ontwikkeling van eetproblemen en de stijgende prevalentie van overgewicht en obesitas in de vroege kinderjaren (Ng et al., 2014), is deze periode uitermate belangrijk om gezonde eetgewoonten te bewerkstelligen, en zo ook de ontwikkeling van overgewicht en obesitas te voorkomen. Terwijl de eerste onderzoekslijn van het doctoraat focust op correlaten van ongezonde eetgedragingen en gerelateerd lichaamsgewicht, focust de tweede onderzoekslijn op het stimuleren van de consumptie van groenten. Aangezien de voorkeur, of het lusten van voedsel een belangrijke en sterke determinant is van wat kinderen eten (Baxter & Thompson, 2002; Cullen et al., 2003), worden in de huidige thesis verschillende technieken onderzocht om het lusten te bevorderden. Er werd reeds aangetoond dat herhaalde blootstelling, wat inhoudt dat kinderen een aantal keer proeven van het voedingsmiddel, een effectieve leerstrategie is om het lusten van dit voedingsmiddel te bewerkstelligen (Anzman-Frasca, Savage, Marini, Fisher, & Birch, 2012; Birch & Marlin, 1982; Wardle, Herrera, Cooke, & Gibson, 2003). Het probleem is echter vaak dat een kind niet wil proeven van iets dat hij of zij niet kent of niet lust (Lakkakula, Geaghan, Zanovec, Pierce, & Tuuri, 2010). Hoewel voorgaand onderzoek zich focuste op het leren lusten van groenten teneinde de consumptie ervan te verhogen, is er weinig informatie beschikbaar over de eerste stap van dit proces, namelijk het stimuleren van de bereidheid tot proeven. Daarom onderzoekt de huidige doctoraatsthesis naast strategieën om het lusten en de consumptie van groenten te bevorderen, verschillende strategieën om de bereidheid tot proeven te verhogen.

Voorgaand onderzoek toonde reeds aan dat o.a. modelling (Addessi, Galloway, Visalberghi, & Birch, 2005; Hendy, 2002), verbaal aanmoedigen en belonen (Cooke, Chambers, Anez, Croker, et al., 2011) een motivatie kan zijn voor het kind om gewenst gedrag te stellen. Het gebruik van beloningen in de voedingscontext dient echter voorzichtig en op de juiste manier aangewend te worden, aangezien een verkeerd gebruik averechtse effecten in de hand kan werken (voor review zie Cooke, Chambers, Anez, & Wardle, 2011). Het *type gedrag* dat beloond wordt speelt bijvoorbeeld een belangrijk rol. Kinderen belonen omdat ze hun bord leegeten kan het intern regulatiesysteem ondermijnen en verhoogt de voorkeur voor grotere porties (Colapinto, Fitzgerald, Taper, & Veugelers, 2007), wat uiteindelijk tot overgewicht kan leiden (Fisher & Kral, 2008). Het belonen van proefgedrag kan wél positieve effecten opleveren (Cooke, Chambers, Anez, Croker, et al., 2011). Ook het *type beloning* bepaalt het succes van beloningen. Belonen met een dessert of met andere zoetigheid wordt sterk afgeraden aangezien het net de voorkeur voor die zoetigheid verhoogt (Newman & Taylor, 1992). Daartegenover hebben verschillende studies aangetoond dat zowel tastbare, niet-voedsel beloningen (e.g. stickers) als niet-tastbare beloningen (e.g. prijzen) effectief zijn om het lusten en de consumptie van niet-geluste voedingsmiddelen te bevorderen (Lowe, Horne, Tapper, Bowdery, & Egerton, 2004; Nicklas et al., 2001; Vereecken, Keukelier, & Maes, 2004).

Ondanks de bestaande wetenschappelijke onderbouwde kennis over effectieve strategieën om de consumptie van gezonde voeding te stimuleren, en de vele pogingen van verschillende organisaties om voedingsadvies te verspreiden onder ouders, vertaalt dit zich nog steeds niet in een verhoogde consumptie van groenten bij jonge kinderen (Huybrechts et al., 2008; Kim et al., 2014; Storey & Anderson, 2016). Dit doet vermoeden dat de effectiviteit van een strategie niet enkel afhangt van de hierboven beschreven strategie-gerelateerde karakteristieken. De effectiviteit zou ook afhankelijk kunnen zijn van kind-karakteristieken (e.g. beloningsgevoeligheid en voedselneofobie), ouder-karakteristieken (e.g.

responsiviteit en controle) en de manier waarop de strategie gecommuniceerd wordt naar de ouders.

Hoewel *beloningsgevoeligheid* geconceptualiseerd wordt als de sensitiviteit van een belangrijk neuropsychologisch motivationeel systeem dat gedrag stuurt (Beaver et al., 2006; Gray, 1981, 1987a), is er weinig geweten over de specifieke rol van beloningsgevoeligheid in het leren lusten van groenten. Volgens de conceptualisering van beloningsgevoeligheid (Gray, 1981, 1987a) zouden hoog beloningsgevoelige kinderen, vergeleken met laag beloningsgevoelige kinderen, sterker reageren op belonende omgevingsstimuli. Bijgevolg zou een strategie met een beloningsaspect meest effectief zijn voor kinderen met een hoge mate van beloningsgevoeligheid. Naast beloningsgevoeligheid werd ook de rol van *voedselneofobie* onderzocht. Aangezien kinderen met een hoge mate van voedselneofobie meer moeilijkheden ervaren met het proeven van nieuwe en ongekende voedingswaren (Dovey, Staples, Gibson, & Halford, 2008), zou deze karakteristiek (i.e. hoge voedselneofobie in vergelijking met lage voedselneofobie) de effectiviteit van een strategie kunnen reduceren.

Naast kind-karakteristieken werd onderzocht of de effectiviteit van strategieën afhankelijk is van *ouderlijke responsiviteit en controle* in voedingssituaties. Voorgaand onderzoek toonde aan dat responsiviteit in voedingssituaties positief gerelateerd was met positieve ouderlijke opvoedingsvaardigheden in het algemeen (Hennessy, Hughes, Goldberg, Hyatt, & Economos, 2010). Bijgevolg wordt er verwacht dat hoog responsieve ouders, vergeleken met laag responsieve ouders, beter in staat zijn om een warm ondersteunend klimaat te creëren, wat de effectiviteit van de strategie ten goede zou komen. Verder toonde voorgaand onderzoek negatieve effecten van zowel te veel ouderlijke controle (Birch, Fisher, & Davison, 2003; Farrow & Blissett, 2006; Wardle, Carnell, & Cooke, 2005) als van te weinig ouderlijke controle (Robinson, Kiernan, Matheson, & Haydel, 2001). Bijgevolg werd de invloed van ouderlijke controle op de effectiviteit van de strategie onderzocht zonder a priori hypothesen te formuleren.

Verder onderzocht de huidige doctoraatsthesis of de effectiviteit van strategieën afhankelijk is van hoe de strategie gecommuniceerd wordt naar de ouders. Aangezien uit onderzoek blijkt dat ouders vaak niet de juiste kennis hebben omtrent strategieën om hun kind voedingsmiddelen te leren lusten (Vandeweghe et al., 2016), lijkt het cruciaal dat ouders gedetailleerde informatie krijgen over hoe ze de strategie dienen uit te voeren. Op basis van voorgaand onderzoek (Wardle, Cooke, et al., 2003) en theorie (Mayer, 2002, 2009) werd verondersteld dat meer uitgebreide en gedetailleerde informatie (i.e. huisbezoek waarin de strategie uitgelegd en getoond wordt), vergeleken met minder uitgebreide en gedetailleerde informatie (i.e. strategie wordt telefonisch uitgelegd), betere effecten zou opleveren.

Het proefschrift bestaat uit twee grote onderzoekslijnen. De *eerste onderzoekslijn* bevat twee studies waarin de relatie tussen de basale individuele karakteristieken belonings- en strafgevoeligheid en eetgedragingen en lichaamsgewicht nader onderzocht wordt bij jonge kinderen (2.5 – 9 jaar) uit de algemene populatie. De *tweede onderzoekslijn* bevat drie studies en focust op strategieën om de consumptie van groenten bij kleuters (i.e. 2.5 – 6 jaar) uit de algemene populatie te stimuleren, en op factoren die een rol spelen in de werkzaamheid van deze strategieën.

Hoofdstuk 2: Voedseltoenadering en voedselvermijding bij jonge kinderen: de relatie met belonings- en strafgevoeligheid

In deze explorative cross-sectionele vragenlijststudie werd onderzocht of kinderen met een hogere mate van beloningsgevoeligheid meer voedseltoenadering (i.e. gedragingen of gedachten die gekarakteriseerd worden door een beweging naar of een sterk verlangen naar voedsel) stellen, terwijl kinderen met een hogere mate van strafgevoeligheid meer voedselvermijding (i.e. gedragingen of gedachten die gekarakteriseerd worden door een beweging “weg van” of een aversie voor voedsel) stellen.

Participanten waren 98 moeders (leeftijd: *M*=35.03; *SD*=4.89) van Vlaamse kleuters (56,1% jongens; leeftijd: *M*=4.87; *SD*=1.13) uit de algemene populatie. Zoals verwacht vertoonden kinderen met een hogere mate van beloningsgevoeligheid meer voedseltoenadering. Meer specifiek stelden ze meer extern eetgedrag, vertoonden ze een hogere responsiviteit ten opzichte van voedsel en hadden ze meer voedselgerelateerde gedachten en motivaties om ongezond te eten. Hoog strafgevoelige kinderen vertoonden meer voedselvermijding. Meer specifiek hadden deze kinderen een hogere mate van voedselneofobie, vertoonden ze meer kieskeurig en traag eetgedrag, en waren ze responsiever ten opzichte van verzadiging.

Deze resultaten tonen aan dat individuele verschillen in belonings- en strafgevoeligheid reeds op jonge leeftijd tot uiting komen en relevant zijn voor eetgedragingen en gedachten bij kleuters. Mede omdat deze twee basale karakteristieken ook in de adolescentie en volwassenheid voorspellers zijn van maladaptieve eetgedragingen en eetstoornissen, is het van belang deze op jonge leeftijd in kaart te brengen.

Hoofdstuk 3: Beloningsgevoeligheid en lichaamsgewicht: de interveniërende rol van voedselresponsief gedrag en extern eten

In deze cross-sectionele vragenlijststudie werd de relatie onderzocht tussen beloningsgevoeligheid en lichaamsgewicht bij jonge kinderen. Verder werd nagegaan of 2 voedseltoenaderingsgedragingen (i.e. voedselresponsief gedrag en extern eten) intervenieerden in de relatie tussen beloningsgevoeligheid en lichaamsgewicht.

Participanten waren moeders van 211 kinderen tussen 2.5 en 9 jaar (55.5% jongens; leeftijd: M=6.27; SD=1.60) uit de algemene populatie. Data van 98 van deze participanten werd ook gebruikt in hoofdstuk 2. In de huidige sample had 13.3% van de kinderen ondergewicht, 83.4% normaal gewicht, 2.8% overgewicht en 0.5% obesitas.

In tegenstelling tot de verwachtingen toonden de analyses geen directe relatie aan tussen beloningsgevoeligheid en gewichtsstatus. Ondanks het uitblijven van een direct effect, werd een significante indirecte associatie gevonden tussen beloningsgevoeligheid en lichaamsgewicht via beide interveniërende voedseltoenaderingsgedragingen. Een hogere mate van beloningsgevoeligheid was gerelateerd aan een hogere mate van extern eten en voedselresponsief gedrag, wat op hun beurt gelinkt was met een hoger gewicht. Het indirect effect suggereert dat beloningsgevoeligheid eerder geassocieerd is met specifieke voedseltoenaderingsgedragingen zoals extern eten en voedselresponsief gedrag dan met de ontwikkeling van overgewicht op zich.

Deze resultaten impliceren dat programma's ter preventie van overgewicht en obesitas niet enkel mogen focussen op proximale factoren die gewicht beïnvloeden, zoals bijvoorbeeld specifieke types voedseltoenaderingsgedragingen, maar ook op meer distale factoren die indirect gelinkt zijn met gewicht, zoals beloningsgevoeligheid.

Hoofdstuk 4: Strategieën om de bereidheid tot proeven te verhogen: de modererende rol van beloningsgevoeligheid

In deze experimentele lab-studie werd de werkzaamheid van verschillende proef-strategieën onderzocht; hoe kan een kleuter gemotiveerd worden om te proeven van een groente die hij of zij niet lust? Verder wilden we nagaan of er individuele verschillen zijn in hoe goed een strategie werkt; is de effectiviteit van bepaalde strategieën afhankelijk van de mate van beloningsgevoeligheid?

Participanten waren 204 kleuters (51% jongens; leeftijd: *M*=4.48; *SD*=1.01) uit de algemene populatie. Terwijl de moeder de vragenlijsten invulde (o.a. over beloningsgevoeligheid), werd het kind meegenomen naar een aangrenzend lokaal op de faculteit waar het experiment plaatsvond. Elk kind kreeg een groente voorgeschoteld die hij of zij niet lust. De instructies die de proefleider gaf verschilden afhankelijk van de strategie waaraan het kind random was toegewezen. In de beloningsconditie werd het kind een kleine tastbare beloning beloofd wanneer hij of zij proefde. In de modelling conditie toonde de proefleider het proefgedrag voor. In de verbale aanmoedigingsconditie werd het kind verbaal aangemoedigd om te proeven. In de neutrale instructies conditie werd er neutraal gevraagd aan het kind om te proeven.

Aan de hand van multinomiale logistische regressie werd gevonden dat kinderen meer geneigd waren om te proeven wanneer ze een tastbare beloning kregen of wanneer iemand anders het goede voorbeeld toonde, dan wanneer enkel neutrale instructies werden gegeven. Verder toonden de resultaten geen verschil aan tussen de strategieën ‘verbale aanmoediging’ en ‘neutrale instructies’. Dat wil zeggen dat kinderen niet meer geneigd waren om te proeven wanneer ze verbaal aangemoedigd werden, dan wanneer neutrale instructies gegeven werden. Verder toonden de resultaten aan dat hoog beloningsgevoelige kleuters, in vergelijking met laag beloningsgevoelige kleuters, meer geneigd waren om direct te proeven van een groente die ze niet lusten wanneer ze hiervoor beloond werden. Opmerkelijk werd gevonden dat laag beloningsgevoelige kleuters, in vergelijking met hoog beloningsgevoelige kleuters, meer geneigd waren om na twijfel te proeven van een groente die ze niet lusten wanneer ze verbaal aangemoedigd werden.

Op basis van deze resultaten werd geconcludeerd dat modelling en een tastbare beloning over het algemeen de kans verhogen dat een kleuter proeft van een groente die hij of zij niet lust. Als de kleuter nog steeds weigert te proeven, is een strategie in overeenstemming met de mate van beloningsgevoeligheid aan te raden; een laag beloningsgevoelig kind is eerder gebaat met verbale aanmoediging, terwijl een hoog beloningsgevoelig kind eerder gebaat is met een tastbare beloning.

Hoofdstuk 5: Strategieën om de bereidheid tot proeven, het lusten en de consumptie van een niet-geluste groente te bevorderen bij kleuters: de modererende rol van beloningsgevoeligheid

In tegenstelling tot hoofdstuk 4, werden kleuters in deze experimentele studie *herhaaldelijk* gevraagd om te proeven van een groente die ze niet lusten. In deze studie werd de werkzaamheid van drie strategieën onderzocht (i.e. herhaalde neutrale blootstelling, herhaalde blootstelling + tastbare beloning, herhaalde blootstelling + sociale beloning). Verder werd ook nagegaan of de effectiviteit van de strategieën afhankelijk was van de mate van beloningsgevoeligheid.

In totaal namen acht klassen (i.e. tweede en derde kleuterklassen) van twee Vlaamse scholen deel aan deze studie (*N*=154 kleuters: 46,8% jongens; leeftijd: *M*=5.08; *SD*=.61). De studie ging door op school tijdens de schooluren. De vier klassen van elke graad werden random toegewezen aan één van de vier verschillende condities: Herhaalde Blootstelling (HB)+tastbare beloningsconditie, HB+sociale beloningsconditie, herhaalde neutrale blootstellingsconditie (HNB) en controleconditie. In elke conditie (behalve in de controleconditie) werd er gedurende een interventieperiode van 4 weken herhaaldelijk (i.e. 8 proefsessies; 2 keer per week) individueel aan de kinderen gevraagd om te proeven van een groente die de meerderheid van de kinderen niet lustte (i.e. witloof). De instructies die de proefleider gaf verschilden afhankelijk van de conditie waarin het kind zat. In de *HB+tastbare beloningsconditie* werd het kind beloond met een sticker wanneer hij of zij proefde. In de *HB+sociale beloningsconditie* kreeg het kind sociale goedkeuring wanneer hij of zij proefde, dewelke aangekondigd werd aan de hand van verbale aanmoediging. In de *HNB* werd er neutraal gevraagd aan het kind om te proeven. Tijdens de interventieperiode werd na elke proefsessie gevraagd aan het kind hoe lekker hij of zij het vond ("lekker", "gewoon OK" of "niet lekker") en werd de bereidheid tot proeven geregistreerd (i.e. wel of niet proeven). Vóór (i.e. pre-test) en twee keer na de interventieperiode (i.e. post-test en follow-up-test) kregen alle kinderen 60 gram witloof voorgeschoteld. Ze mochten zelf kiezen hoeveel ze ervan aten, en werden niet aangemoedigd. Na acht minuten werd gewogen hoeveel de kinderen van de witloof gegeten hadden, en werd hen gevraagd hoe lekker ze het vonden ("lekker", "gewoon OK" of "niet lekker").

Uit de resultaten blijkt dat de kleuters in elk van de drie strategieën (i.e. HNB, HB+tastbare beloning, HB+sociale beloning), na de proefsessies (i.e. op post-test en follow-up-test) meer witloof aten en de witloof ook lekkerder vonden in vergelijking met de groep die geen proefsessies kreeg. Verder werd er op geen enkele uitkomstvariabele verschil gevonden tussen de drie strategieën, wat suggereert dat beloningen niet noodzakelijk zijn om kinderen uit de algemene populatie een groente graag te leren eten. Verder werd ook de modererende rol van beloningsgevoeligheid onderzocht. Er werd gevonden dat kinderen met een hoge mate van beloningsgevoeligheid, in vergelijking met kinderen met een lage mate van beloningsgevoeligheid, meer aangaven de groente te lusten tijdens de interventieperiode in de tastbare beloningsconditie. Verder toonden kinderen met een lage mate van beloningsgevoeligheid, vergeleken met kinderen met een hoge mate van beloningsgevoeligheid, een grotere stijging in ‘lusten’ direct na de interventie (i.e. post-test) in de sociale beloningsconditie. Gelijkaardig aan hoofdstuk 4 zou hieruit besloten kunnen worden dat kinderen met een hoge mate van beloningsgevoeligheid eerder gebaat zijn met een tastbare beloning, terwijl kinderen met een lage mate van beloningsgevoeligheid eerder gebaat zijn met verbale aanmoediging of sociale beloning (i.e. verbale aanmoediging kondigt een sociale beloning aan). Echter, deze conclusies dienen met enige voorzichtigheid geïnterpreteerd te worden, aangezien deze effecten niet gerepliceerd werden met de andere uitkomstvariabelen.

Hoofdstuk 6: Een beloningsinterventie in de thuisomgeving ter bevordering van de groenteconsumptie bij kleuters (het Proefpakket): werkzaamheid en beïnvloedende factoren

In deze experimentele veldstudie werd de algemene werkzaamheid van het Proefpakket onderzocht. Ten tweede werd nagegaan of de werkzaamheid van het Proefpakket afhankelijk is van bepaalde kind-karakteristieken (i.e. beloningsgevoeligheid en voedselneofobie), ouder-karakteristieken (i.e. responsiviteit en controle), en van de manier waarop het Proefpakket gecommuniceerd wordt naar de ouders.

Het Proefpakket is een zelf-geconstrueerd belonings-gebaseerd instrument dat ouders helpt om hun kind een groente te leren lusten en meer te consumeren. Het Proefpakket bestaat uit een handleiding, een spaarkaart, stickers en 3 pluimen. De handleiding voorziet de nodig informatie om het Proefpakket op een correcte manier uit te voeren. Ten eerste beschrijft deze handleiding het belang van gezonde voeding voor jonge kinderen. Ook de moeilijkheid om aan deze aanbevelingen te voldoen wordt aangekaart. Om ouders gerust te stellen wordt vermeld dat kieskeurig eetgedrag een normale fase is in de ontwikkeling van het kind waarbij het nieuwe smaken moet leren kennen en waarderen. Ondanks het feit dat het een normale fase is, moet het wel op een goede manier aangepakt worden. In de handleiding staat beschreven dat het Proefpakket een leuke, niet-dwingende, wetenschappelijk ondersteunde methode voorziet om kinderen groenten te leren lusten. Het doel van dit pakket is dat het kind zonder tegenpruttelen de groente eet, zodat tafelen een gezond en gezellig gezinsmoment kan zijn. Ook de wetenschappelijke theorie die schuilt achter het Proefpakket wordt uitgelegd: hoe meer kinderen proeven, hoe meer hun smaakpapillen wennen aan de smaak. Deze gewenning staat gelijk aan het leren eten van de groente. Met andere woorden, het kritieke aspect van proeven in het proces van groenten leren eten is het voedsel in contact brengen met de smaakpapillen. Kinderen mogen niet verplicht worden om het voedsel in te slikken, aangezien dit meestal de moeilijkste stap is. Kleine beloningen (i.e. stickers) zijn bedoeld om kinderen te motiveren om te proeven. In de handleiding staat verder uitgelegd hoe het Proefpakket uitgevoerd moet worden. Een kleine portie van een niet-geluste groente dient twaalf keer aangeboden te worden gedurende twee weken. Ouders worden gevraagd om niet boos of gefrustreerd te reageren wanneer het kind niet proeft, maar de volgende keer gewoon opnieuw te proberen.

Participanten waren 147 ouders en hun kleuters (46,3% jongens; leeftijd: *M*=4.58; *SD*=.93), uit de algemene populatie. Het Proefpakket werd op twee verschillende manieren bij de ouders gebracht. Bij een deel van de ouders werd het Proefpakket tijdens een huisbezoek gedetailleerd uitgelegd en werd een proefsessie gedemonstreerd bij het kind (i.e. huisbezoekconditie), terwijl een ander deel van de ouders het Proefpakket via de post ontving en uitleg kreeg via telefoon (i.e. telefoonconditie). Een derde conditie, de controleconditie, kreeg het Proefpakket niet. Vóór (i.e. pre-test) en twee keer na de interventieperiode (i.e. post-test en follow-up-test) kregen alle kinderen 60 gram van de groente voorgeschoteld. Ze mochten zelf kiezen hoeveel ze ervan aten, en werden niet aangemoedigd. Na acht minuten werd gewogen hoeveel het kind van de groente gegeten had, en werd gevraagd hoe lekker hij of zij het vond (“lekker”, “gewoon OK” of “niet lekker”).

Uit de resultaten bleek dat de kleuters in de huisbezoek- en telefoonconditie significant meer van de groente aten en de groente ook lekkerder vonden na de interventieperiode (i.e. op post-test en follow-up-test) in vergelijking met kinderen in de controleconditie. Hoewel beide methoden effectief bleken, toonden de resultaten ook dat kinderen in de huisbezoekconditie een grotere stijging in consumptie vertoonden dan kinderen in de telefoonconditie (i.e. significant op post-test; trend-significant op follow-up-test). Verder vertoonden kinderen van responsievere ouders een grotere stijging in consumptie (i.e. significant op post-test; trend-significant op follow-up-test). Echter, deze effecten werden enkel gevonden in de huisbezoekconditie. Verder vertoonden kinderen van minder controlerende ouders een grotere stijging in consumptie, zowel in de telefoonconditie (i.e. significant op post-test; trend-significant op follow-up-test) als in de huisbezoekconditie (i.e. trend-significant op post-test; significant op follow-up-test). In tegenstelling tot de verwachtingen werd geen effect gevonden van beloningsgevoeligheid: het Proefpakket was in beide condities even werkzaam voor hoog als voor laag beloningsgevoelige kinderen. Verder vertoonden laag neofobische kinderen een grotere stijging in consumptie op post-test in vergelijking met hoog neofobische kinderen. Echter, hierbij dient vermeld te worden dat dit effect duidelijker aanwezig was wanneer ouders instructies kregen via telefoon dan wanneer het Proefpakket thuis uitgelegd en gedemonstreerd werd. Met andere woorden, als ouders meer uitgebreide instructies kregen, leek de mate van neofobie een minder grote rol te spelen.

Uit de resultaten werd besloten dat het Proefpakket een werkzaam middel is om ouders te helpen wanneer hun kind een groente niet lust. Echter, de resultaten tonen ook aan dat de werkzaamheid van het Proefpakket afhangt van verschillende factoren zoals de manier waarop het overgebracht wordt, kind-karakteristieken en ouder-karakteristieken. Deze resultaten wijzen op het belang van interventies die aangepast zijn aan de noden en behoeftes van kinderen en ouders, teneinde groentebevordering optimaal te bewerkstelligen.

Hoofdstuk 7: Algemene discussie

Het afsluitende hoofdstuk begon met een overzicht van de belangrijkste onderzoeksresultaten per studie. De resultaten werden vervolgens besproken per onderzoekslijn, waarna de daarbij horende implicaties over de verschillende studies heen werden bediscussieerd. De algemene discussie eindigde met sterktes en limitaties van de uitgevoerde empirische studies, richtlijnen voor toekomstig onderzoek en een algemene conclusie. Hieronder gaan we voornamelijk in op de belangrijkste onderzoeksresultaten van het proefschrift en de implicaties die hieruit resulteren.

In de *eerste onderzoekslijn* werd de relatie onderzocht tussen individuele verschillen in basale karakteristieken (i.e. beloningsgevoeligheid en strafgevoeligheid) en voedseltoenadering en voedselvermijding. Zoals verwacht bleek uit de resultaten van zowel hoofdstuk 2 als 3 dat kinderen met een hogere mate van beloningsgevoeligheid meer voedseltoenadering vertoonden. Bovendien bleek uit hoofdstuk 3 dat een hogere mate van beloningsgevoeligheid indirect gelinkt was met een hoger gewicht via voedseltoenadering (i.e. extern eten en voedselresponsief gedrag). Zoals verwacht toonde hoofdstuk 2 verder aan dat hoog strafgevoelige kinderen meer voedselvermijdingsgedrag stelden. Uit de resultaten van de eerste onderzoekslijn kan besloten worden dat individuele verschillen in de sensitiviteit van twee basale neuropsychologische systemen (i.e. strafgevoeligheid en beloningsgevoeligheid) relevant zijn voor het stellen van eetgedragingen, en gerelateerd lichaamsgewicht, in de jonge kindertijd. In lijn met biopsychosociale modellen, zijn we ervan overtuigd dat studies, preventie- en interventieprogramma's gerelateerd aan eetgedrag en lichaamsgewicht niet enkel mogen focussen op proximale determinanten van lichaamsgewicht (e.g. extern eten). In plaats daarvan dienen zij verschillende perspectieven te combineren, om op die manier rekening te houden met het aandeel van zowel proximale gedragingen (e.g. voedseltoenadering en voedselvermijding) als distale factoren (e.g. belonings- en strafgevoeligheid) in de ontwikkeling van adaptieve en maladaptieve eetgedragingen en gerelateerd lichaamsgewicht.

De studies in de *tweede onderzoekslijn* (i.e. hoofdstuk 4, 5 en 6) werden ontwikkeld om meer inzicht te verkrijgen in het stimuleren van gezonde voeding bij jonge kinderen. Over de studies heen toonden de resultaten dat verschillende strategieën effectief zijn om de consumptie van een niet-geluste groente te bevorderen. In hoofdstuk 5 werd geen verschil gevonden in werkzaamheid tussen herhaalde neutrale blootstelling en herhaalde blootstellingsstrategieën die een tastbare of sociale beloning voorzagen telkens wanneer er geproefd werd. In tegenstelling tot deze resultaten, toonden de resultaten van hoofdstuk 4 wél een verhoogde bereidheid tot proeven wanneer een extra motivatie (i.e. modelling of tastbare beloning) toegevoegd werd. Mogelijks ligt een verschillende sample als gevolg van een verschillende rekruteringsmethode aan de oorzaak van deze discrepantie; ouders in hoofdstuk 4 schreven actief in voor de studie terwijl alle kinderen van 8 klassen deelnamen aan de studie beschreven in hoofdstuk 5. Ouders die actief inschreven ervoeren mogelijks reeds problemen om hun kind groenten te laten eten. Als gevolg daarvan hadden de deelnemende kinderen in hoofdstuk 4 mogelijks meer eet-gerelateerde problemen dan de kinderen in hoofdstuk 5, waardoor zij wel extra voordeel haalden uit een strategie met een motivationele component. In hoofdstuk 6 werd een beloningsstrategie vertaald in een concreet instrument (i.e. het Proefpakket). De algemene resultaten toonden aan dat het Proefpakket, aangebracht via een huisbezoek of uitgelegd via de telefoon, een effectief werkmiddel is voor ouders om hun kleuter een groente te leren lusten en consumeren.

Verder leveren hoofdstuk 4, 5 en 6 enige evidentie dat het belangrijk is om kind-karakteristieken in rekening te brengen bij het selecteren van een strategie om de consumptie van gezonde voeding te bevorderen. Zo suggereerden sommige resultaten in hoofdstuk 4 en 5 dat kinderen met een hoge mate van beloningsgevoeligheid eerder gebaat zijn met een tastbare beloningsstrategie, terwijl kinderen met een lage mate van beloningsgevoeligheid eerder gebaat zijn met een verbale aanmoedigingsstrategie of een sociale beloningsstrategie. Echter, hierbij dient vermeld te worden dat deze effecten (a) niet consistent teruggevonden werden bij alle categorieën van de uitkomstvariabele "bereidheid tot proeven" in hoofdstuk 4, (b) slechts gevonden werden bij twee uitkomstvariabelen in hoofdstuk 5, (c) niet gerepliceerd werden in hoofdstuk 6. Daarom dienen de resultaten omtrent de modererende rol van beloningsgevoeligheid met enige voorzichtigheid geïnterpreteerd te worden en is verder onderzoek nodig voordat sluitende conclusies getrokken kunnen worden.

Hoewel de modererende rol van beloningsgevoeligheid niet teruggevonden werd in het Proefpakket, bleek de effectiviteit van het Proefpakket wel afhankelijk te zijn van andere factoren, namelijk de manier waarop het Proefpakket gecommuniceerd werd naar de ouders, de ouder-karakteristieken controle en responsiviteit en de kind-karakteristiek voedselneofobie. Dit impliceert dat verschillende versies van het Proefpakket gemaakt dienen te worden; versies die aangepast zijn aan de eigenschappen en noden van gezinnen. Het Proefpakket was bijvoorbeeld het meest effectief (a) bij kinderen van hoog responsieve ouders in de huisbezoekconditie, (b) bij kinderen van laag controlerende ouders in beide interventiecondities en (c) voor kinderen met een lage mate van voedselneofobie. Deze resultaten suggereren dat het Proefpakket in zijn huidige vorm minder aangepast is aan laag responsieve ouders, hoog controlerende ouders en kinderen met een hoge mate van voedselneofobie. Een Proefpakket voor laag responsieve ouders moet misschien meer informatie bevatten over hoe eetgedrag op een responsieve manier aangemoedigd kan worden terwijl de bewustmaking van de negatieve effecten van maladaptieve controle mogelijks een meerwaarde zou zijn voor hoog controlerende ouders. Een versie van het Proefpakket die mogelijks meer aangepast is aan hoog neofobe kinderen zou kunnen starten met gemakkelijke opdrachtjes (e.g. de groente aanraken, ruiken aan de groente) vooraleer aan het kind gevraagd wordt om te proeven.

Concluderend kunnen we stellen dat het huidige proefschrift een waardevolle bijdrage levert aan de kennis op het gebied van eetgedrag bij jonge kinderen, en hoe dit eetgedrag in de gewenste "gezonde" richting te sturen.

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Wardle, J., Cooke, L. J., Gibson, E. L., Sapochnik, M., Sheiham, A., & Lawson, M. (2003). Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. *Appetite, 40*(2), 155-162. doi:10.1016/S0195-6663(02)00135-6

Wardle, J., Herrera, M. L., Cooke, L., & Gibson, E. L. (2003). Modifying children's food preferences: the effects of exposure and reward on acceptance of an unfamiliar vegetable. *European Journal of Clinical Nutrition, 57*(2), 341-348. doi:10.1038/sj.ejcn.1601541

Young, L. R., & Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *American journal of public health, 92*(2), 246-249.

Data Storage Fact Sheets

Data Storage Fact Sheet

Name/identifier study: Chapter 2 PhD Laura Vandeweghe
Author: Laura Vandeweghe
Date: 18/03/2017

1. Contact details
===

1a. Main researcher

- name: Laura Vandeweghe
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Laura.Vandeweghe@UGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof dr. Caroline Braet
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be

If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies
==

* Reference of the publication in which the datasets are reported: Vandeweghe, L., Vervoort, L., Verbeken, S., Moens, E., & Braet, C. (2016). Food Approach and Food Avoidance in Young Children: Relation with Reward Sensitivity and Punishment Sensitivity. *Frontiers in Psychology*, *7*.

* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
==

3a. Raw data
----

* Have the raw data been stored by the main researcher? [x] YES / [ ] NO
If NO, please justify:

* On which platform are the raw data stored?
- [x] researcher PC
- [x] research group file server
- [ ] other (specify): ...

* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP

- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

3b. Other files

----

* Which other files have been stored?

-[ ] file(s) describing the transition from raw data to reported results. Specify: ...

-[x] file(s) containing processed data. Specify: scale scores (SPSS)

-[x] file(s) containing analyses. Specify: syntaxes and output files (SPSS)

-[x] files(s) containing information about informed consent (blank copy of the informed consent form)

-[x] a file specifying legal and ethical provisions (The study procedure was conducted in accordance with the ethical guidelines of the Ethical Committee. Furthermore, data from this study were part of a larger project for which approval was granted from the Ethical Committee)

-[ ] file(s) that describe the content of the stored files and how this content should be interpreted. Specify: …

-[x] other files. Specify: SPSS syntaxes describing the transition from the raw data to the processed data

* On which platform are these other files stored?

- [x] individual PC
- [x] research group file server
- [ ] other: ...

* Who has direct access to these other files (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

4. Reproduction
==

* Have the results been reproduced independently?: [ ] YES / [x] NO

* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 3 PhD Laura Vandeweghe
Author: Laura Vandeweghe
Date: 18/03/2017

1. Contact details
==
1a. Main researcher

- name: Laura Vandeweghe
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Laura.Vandeweghe@UGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof dr. Caroline Braet
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be

If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies
===

* Reference of the publication in which the datasets are reported: Vandeweghe, L., Verbeken, S., Vervoort, L., Moens, E., & Braet, C. (2017). Reward sensitivity and body weight: the intervening role of food responsive behavior and external eating. *Appetite*, *112*, 150-156.

* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
===

3a. Raw data
----

* Have the raw data been stored by the main researcher? [x] YES / [ ] NO
If NO, please justify:

* On which platform are the raw data stored?
- [x] researcher PC
- [x] research group file server
- [ ] other (specify): ...

* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher

- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

3b. Other files

----

* Which other files have been stored?
-[ ]file(s) describing the transition from raw data to reported results. Specify: ...
-[x] file(s) containing processed data. Specify: scale scores (SPSS)
-[x] file(s) containing analyses. Specify: syntaxes and output files (SPSS)
-[x] files(s) containing information about informed consent (Both the recruitment letter and the homepage of the website of the online questionnaire included informed consent information)
-[ ] a file specifying legal and ethical provisions (the study procedure was conducted in accordance with the ethical guidelines of the Ethical Committee)
-[ ] file(s) that describe the content of the stored files and how this content should be interpreted. Specify: ...
-[x] other files. Specify: word-file and SPSS syntaxes describing the transition from the raw data to the processed data

* On which platform are these other files stored?
- [x] individual PC
- [x] research group file server
- [ ] other: ...

* Who has direct access to these other files (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

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* Have the results been reproduced independently?: [ ] YES / [x] NO

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- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 4 PhD Laura Vandeweghe
Author: Laura Vandeweghe
Date: 18/03/2017

1. Contact details
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1a. Main researcher

- name: Laura Vandeweghe
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Laura.Vandeweghe@UGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof dr. Caroline Braet
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be

If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies
===

* Reference of the publication in which the datasets are reported: Vandeweghe, L., Verbeken, S., Moens, E., Vervoort, L., & Braet, C. (2016). Strategies to improve the Willingness to Taste: The moderating role of children's Reward Sensitivity. *Appetite*, *103*, 344-352.

* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
===

3a. Raw data
----

* Have the raw data been stored by the main researcher? [x] YES / [ ] NO
If NO, please justify:

* On which platform are the raw data stored?
- [x] researcher PC
- [x] research group file server
- [ ] other (specify): ...

* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP

- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

3b. Other files

----

* Which other files have been stored?

-[ ]file(s) describing the transition from raw data to reported results. Specify: ...

-[x] file(s) containing processed data. Specify: scale scores (SPSS)

-[x] file(s) containing analyses. Specify: syntaxes and output files (SPSS)

-[x] files(s) containing information about informed consent (blank copy of the informed consent form)

-[x] a file specifying legal and ethical provisions (The documents that were submitted to the Ethical Commission are on my PC and I have a paper letter with the approval of the Ethical Commission)

-[ ] file(s) that describe the content of the stored files and how this content should be interpreted. Specify: ...

-[x] other files. Specify: video-files on which the scoring was based and SPSS syntaxes and word-file describing the transition from the raw data to the processed data

* On which platform are these other files stored?
- [x] individual PC
- [x] research group file server
- [ ] other: ...

* Who has direct access to these other files (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

4. Reproduction
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* Have the results been reproduced independently?: [ ] YES / [x] NO

* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 5 PhD Laura Vandeweghe
Author: Laura Vandeweghe
Date: 18/03/2017

1. Contact details
===

1a. Main researcher

- name: Laura Vandeweghe
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Laura.Vandeweghe@UGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof dr. Caroline Braet
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be

If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies
===

* Reference of the publication in which the datasets are reported: Vandeweghe, L., Verbeken, S., Braet, C., Loeys, T., De Henauw, S. & Moens, E. (submitted). Strategies to increase preschool children's willingness to taste, liking and consumption of a disliked vegetable: the role of Reward Sensitivity. Manuscript submitted for publication.

* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
===

3a. Raw data
----

* Have the raw data been stored by the main researcher? [x] YES / [ ] NO
If NO, please justify:

* On which platform are the raw data stored?
- [x] researcher PC
- [x] research group file server
- [ ] other (specify): ...

* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP

- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

3b. Other files

----

* Which other files have been stored?
-[ ]file(s) describing the transition from raw data to reported results. Specify: ...
-[x] file(s) containing processed data. Specify: scale scores
-[x] file(s) containing analyses. Specify: syntaxes and output files (SAS).
-[x] files(s) containing information about informed consent (blank copy of the passive informed consent document)
-[x] a file specifying legal and ethical provisions. (The documents that were submitted to the Ethical Commission are on my PC and I have a paper letter with the approval of the Ethical Commission)
-[ ] file(s) that describe the content of the stored files and how this content should be interpreted. Specify: ...
-[x] other files. Specify: SPSS syntaxes and word-file describing the transition from the raw data to the processed data

* On which platform are these other files stored?
- [x] individual PC
- [x] research group file server
- [ ] other: ...

* Who has direct access to these other files (i.e., without intervention of another person)?

- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

4. Reproduction
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* Have the results been reproduced independently?: [ ] YES / [x] NO

* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail:

Data Storage Fact Sheet

Name/identifier study: Chapter 6 PhD Laura Vandeweghe
Author: Laura Vandeweghe
Date: 18/03/2017

1. Contact details
===

1a. Main researcher

- name: Laura Vandeweghe
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Laura.Vandeweghe@UGent.be

1b. Responsible Staff Member (ZAP)

- name: Prof dr. Caroline Braet
- address: Henri Dunantlaan 2, 9000 Gent
- e-mail: Caroline.Braet@UGent.be

If a response is not received when using the above contact details, please send an email to data.pp@ugent.be or contact Data Management, Faculty of Psychology and Educational Sciences, Henri Dunantlaan 2, 9000 Ghent, Belgium.

2. Information about the datasets to which this sheet applies
===

* Reference of the publication in which the datasets are reported:

Vandeweghe, L., Verbeken, S., Moens, E., & Braet, C. (submitted). Home based parent-led reward intervention to increase preschoolers' liking and consumption of a disliked vegetable (Taste Kit): effectiveness and influencing factors. Manuscript submitted for publication.

* Which datasets in that publication does this sheet apply to?: The sheet applies to all the data used in the publication.

3. Information about the files that have been stored
===

3a. Raw data
----

* Have the raw data been stored by the main researcher? [x] YES / [ ] NO
If NO, please justify:

* On which platform are the raw data stored?
- [x] researcher PC
- [x] research group file server
- [ ] other (specify): ...

* Who has direct access to the raw data (i.e., without intervention of another person)?
- [x] main researcher

- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

3b. Other files

----

* Which other files have been stored?

-[ ]file(s) describing the transition from raw data to reported results. Specify: ...

-[x] file(s) containing processed data. Specify: scale scores.

-[x] file(s) containing analyses. Specify: syntaxes and output files (SAS).

-[x] files(s) containing information about informed consent (blank copy of the informed consent form)

-[x] a file specifying legal and ethical provisions (The documents that were submitted to the Ethical Commission are on my PC and I have a paper letter with the approval of the Ethical Commission)

-[ ] file(s) that describe the content of the stored files and how this content should be interpreted. Specify: ...

-[x] other files. Specify: SPSS syntaxes and word-file describing the transition from the raw data to the processed data

* On which platform are these other files stored?

- [x] individual PC
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- [ ] other: ...

* Who has direct access to these other files (i.e., without intervention of another person)?
- [x] main researcher
- [ ] responsible ZAP
- [ ] all members of the research group
- [ ] all members of UGent
- [x] other (specify): IT worker Steven Vandenhole

4. Reproduction
==
* Have the results been reproduced independently?: [ ] YES / [x] NO

* If yes, by whom (add if multiple):
- name:
- address:
- affiliation:
- e-mail: