



Research report

Associations of parenting styles, parental feeding practices and child characteristics with young children's fruit and vegetable consumption[☆]Carine Vereecken^{a,b,*}, Alisha Rovner^c, Lea Maes^b^aFWO Flanders, Belgium^bDepartment of Public Health, Faculty of Medicine and Health Sciences, Ghent University, UH – Bloc A, 2nd Floor, De Pintelaan 185, B-9000 Ghent, Belgium^cPrevention Research Branch, Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, 6100 Executive Blvd, Room 7B13A, MSC 7510, Rockville, MD 20852, USA

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ABSTRACT

The purpose of this study was to investigate the role of parent and child characteristics in explaining children's fruit and vegetable intakes. In 2008, parents of preschoolers (mean age 3.5 years) from 56 schools in Belgium-Flanders completed questionnaires including a parent and child fruit and vegetable food frequency questionnaire, general parenting styles (laxness, overreactivity and positive interactions), specific food parenting practices (child-centered and parent-centered feeding practices) and children's characteristics (children's shyness, emotionality, stubbornness, activity, sociability, and negative reactions to food). Multiple linear regression analyses ($n = 755$) indicated a significant positive association between children's fruit and vegetable intake and parent's intake and a negative association with children's negative reactions to food. No general parenting style dimension or child personality characteristic explained differences in children's fruit and vegetable intakes. Child-centered feeding practices were positively related to children's fruit and vegetable intakes, while parent-centered feeding practices were negatively related to children's vegetable intakes. In order to try to increase children's fruit and vegetable consumption, parents should be guided to improve their own diet and to use child-centered parenting practices and strategies known to decrease negative reactions to food.

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Introduction

Fruit and vegetable intake may reduce the risk of chronic diseases such as obesity, cardiovascular disease, diabetes and some cancers (World Health Organization, 2003). However, many children in Belgium Flanders, consume less than the recommended amounts of fruit and vegetables (Huybrechts et al., 2008; Vereecken & Maes, 2010). Given that dietary patterns mainly develop within the context of the family, examining parent factors and their potential relationship with children's dietary intake is important. Parents influence their children's eating behaviours in several ways including controlling availability and accessibility of foods in the home and modelling food-related behaviours (Cullen

et al., 2001; Hanson, Neumark-Sztainer, Eisenberg, Story, & Wall, 2005). Also, general parenting styles (Kremers, Brug, de Vries, & Engels, 2003; Rhee, Lumeng, Appugliese, Kaciroti, & Bradley, 2006) and specific food-related parenting practices (Birch & Fisher, 2000; Birch, Fisher, & Davison, 2003; De Bourdeaudhuij, 1997; Fisher & Birch, 1999a, 1999b; Fisher, Mitchell, Smiciklas-Wright, & Birch, 2002; Vereecken, Keukelier, & Maes, 2004; Wardle, Carnell, & Cooke, 2005) may play an important role. Moreover, parenting does not occur in isolation, but rather in the context of other social-environmental factors as well as in response to child characteristics (Rhee, 2008).

General parenting style refers to the broad pattern of attitudes and practices that provide the emotional background in which parent behaviours are expressed and interpreted by the child (Rhee, 2008). On the other hand, food-related parenting practices refer to specific food-related interactions between parents and their children. For example, 'restriction', refers to limiting access to foods, usually sweets and snacks, and 'pressure to eat' refers to attempts to increase consumption usually of healthy foods (Birch et al., 2001). Although it has been suggested that parenting practices are domain specific (Darling & Steinberg, 1993), most investigations have supported associations between specific food parenting practices and parental styles (Blissett & Haycraft, 2008;

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Hubbs-Tait, Kennedy, Page, Topham, & Harrist, 2008; Hughes, Power, Orlet, Mueller, & Nicklas, 2005) with the exception of one study (Brann & Skinner, 2005).

Evidence suggests that a general authoritative parenting style is favourable for supporting positive food-related behaviours in adolescents (Kremers et al., 2003). However, other studies suggest that the association between general parenting style (authoritative, authoritarian, indulgent or neglectful) and children's dietary intake does not exist (De Bourdeaudhuij et al., 2009; Vereecken, Legiest, De Bourdeaudhuij, & Maes, 2009). Still others suggest that parenting style modifies or impacts the relationship between parent practices and child outcomes (Kremers et al., 2003; van der Horst et al., 2007). For example, in a study of 383 adolescents the association of parenting practices and sugar-sweetened beverage consumption was more pronounced among those who perceived their parents as moderately strict and highly involved (van der Horst et al., 2007).

Inconsistent results have also been reported for specific food related parenting practices and children's eating behaviour. One study found a positive association between pressuring and children's fruit/vegetable consumption (Bourcier, Bowen, Meischke, & Moinpour, 2003), while several others have found a negative association (Fisher et al., 2002; Galloway, Fiorito, Lee, & Birch, 2005) or no association (Vereecken et al., 2004). Differences in samples and methodologies may explain the inconsistent results among studies of parenting practices and children's dietary behaviours (Carnell & Wardle, 2007). In addition, it is fairly common for different researchers in this area to use different questions to measure the same construct. The questions used may vary in areas such as: level of control, level of parental demandingness and responsiveness to children's wishes so that some encouragement measures may refer to more authoritarian pressure to eat, while others may refer more to positive reinforcement to increase consumption of healthful foods. In addition, studies have used different methodologies to estimate dietary intake including three 24-h recalls (Fisher et al., 2002) or a single four point-likert scale (Bourcier et al., 2003). Additional confounding factors, such as parental intake or child characteristics, may contribute to these mixed results (van der Horst et al., 2007; Vereecken, Legiest, et al., 2009). For example, in one study the effect of parental control (including aspects of restriction and pressure) on children's intake was no longer present after controlling for food neophobia (Wardle et al., 2005).

Personality dimensions are also regarded as potentially important determinants of health related behaviours (de Bruijn, Kremers, van Mechelen, & Brug, 2005). A child's personality or temperament refers to the way in which he or she typically experiences the internal and external environments and responds to them (Carey, Hegvik, & McDevitt, 1988). Infants who are prone to negative emotional expression, low adaptability, high activity, and low emotional regulation may be described as having a "difficult" temperament style (Chess & Thomas, 1989). Over time, these children are more likely to develop behaviour problems (Chess & Thomas, 1989), including aggressive behaviour (Bates, Maslin, & Frankel, 1985) and social inhibition (Kagan, 1994). However, few studies have investigated whether there is an association between dietary intake and broad personality characteristics. Studies of adolescents that investigated associations between the 'Big Five' characteristics (extraversion, agreeableness, conscientiousness, emotional stability and openness to experience) and dietary intake demonstrated significant positive associations between agreeableness and vegetable consumption as well as between openness to experiences and fruit and vegetable consumption (de Bruijn et al., 2005). Additionally, the effect of parenting practices on soft drink

consumption was most pronounced in adolescents with moderate levels of agreeableness (de Bruijn, Kremers, de Vries, van Mechelen, & Brug, 2007). In another study of 2-year old children, child's behavioural characteristics also moderated the influence of parenting practices (Gubbels et al., 2009). A stronger association of parenting with dietary intake was found in non-depressed, low anxious, low overactive children as well as children with a favourable eating style (not slow, likes many foods, and not reluctant).

More research is needed to investigate the specific role of parent and child characteristics, in explaining young children's food intake. Most previous studies have included associations with only one of these domains or components; therefore, examining different components of each will help clarify the independent relationship between different parental components (i.e. their own eating behaviour, their general parenting styles and specific parental feeding practices) and children's dietary intake. We hypothesized that higher fruit and vegetable consumption in parents, and more adaptive parenting styles (less lax, and overreactive and more supporting) and more adaptive feeding practices (less parent-centered and more child-centered) would be associated with higher intakes of fruit and vegetables. Because of the importance of children's food neophobia in children's fruit and vegetable intake, the negative reactions to food scale (a measure of food neophobia) was also included in the analyses. Finally, we explored the role of child temperament characteristics with fruit and vegetable intake.

Methods

Design and procedure

The data were collected as part of the Familial Influences on Food Intake study (FIFI) (Vereecken, Covents, Haynie & Maes, 2009). The FIFI-study, a biennial longitudinal study that started in 2008, follows Belgian-Flemish children from the age of three until adolescence. The goal of FIFI is to identify familial influences on dietary intake during the transition from childhood to adolescence. The results presented in this paper are cross-sectional from the baseline data collection which occurred between January and April 2008. Ethical approval for the study was obtained from the ethical board of the Ghent University Hospital.

Eighty schools from East and West Flanders randomly selected from the list of schools provided by the Ministry Department of Education were invited to participate. Forty-six schools, with a total of 56 campuses, agreed to participate. Parents from children of the first grade of the nursery schools were invited by letter to participate in the study. In Belgium children begin nursery school between the ages of 2.5 and 3 years, and are there for three full years. Parents were asked to return the completed questionnaires and the signed informed consent in a sealed envelope to the school within one week. Parents were provided phone numbers and e-mail addresses of the project staff in case they had questions.

Measures

The child's primary caregiver completed self-administered questionnaires on parent and child demographic characteristics, parent's and child's diets, and several aspects of general parenting styles, specific parental feeding practices and child's temperament, using mainly pre-existing scales and subscales. The measures are described below; psychometric properties (number of items, Chronbach's alphas, means and standard deviations), example items and response options are presented in Table 1.

Table 1
Overview of measures included in the study.

	# Items	Example item	Response ranges	Alpha	Mean (SD)
<i>Children's consumption</i>					
	6	For the following questions: think about the last three months. How often does your child eat... legumes	"Never or less than 1 day per month", "1–3 days per month", "1 day per week", "2 days per week", "3–4 days per week", "5–6 days per week" and "every day"		
	6	And how much on average on such a day... (1 spoon = 30 g)	"30 g", "60 g", "90 g" up to "210 g" and "... gram"		
<i>Parents' consumption</i>					
	3	How often does the mother/father of the child eats prepared vegetables	"Never or less than 1 day per month", "1–3 days per month", "1 day per week", "2 days per week", "3–4 days per week", "5–6 days per week" and "every day"		
	3	And how much on average on such a day... (1 spoon = 30 g)	"... gram"		
<i>General parenting styles</i>					
Laxness	6	When my child does something I don't like...	1 = "I do something every time it happens" to 7 = "I often let it go"	0.76	2.37 (0.94)
Overreactivity	6	When my child misbehaves...	1 = "I handle it without getting upset" to 7 = "I get so frustrated or angry that my child can see I'm upset"	0.58	2.92 (0.81)
Support/positive interactions	5	Praise your child by saying "Well done"	1 = "never" to 5 = "always"	0.77	4.41 (0.41)
<i>Parental feeding practices</i>					
Parent-centered	12	Tells child to eat something on plate	1 = "never" to 5 = "always"	0.84	2.58 (0.58)
Child-centered	7	Says something positive about the food the child eats	1 = "never" to 5 = "always"	0.59	3.17 (0.51)
<i>Child characteristics</i>					
Shyness	5	Takes a long time to warm up to strangers	1 = "completely disagree" to 5 = "completely agree"	0.78	2.27 (0.74)
Emotionality	5	Gets upset easily	1 = "completely disagree" to 5 = "completely agree"	0.79	2.91 (0.88)
Stubbornness	4	Often protests, talks back	1 = "completely disagree" to 5 = "completely agree"	0.82	2.86 (0.92)
Active	5	Is very energetic	1 = "completely disagree" to 5 = "completely agree"	0.69	4.17 (0.59)
Sociable	4	Prefers playing with others rather than alone	1 = "completely disagree" to 5 = "completely agree"	0.69	3.94 (0.64)
Neg. reactions to food	5	Child rarely takes a new food without fussing.	1 = "not at all typically my child" to 5 = "typically my child"	0.86	2.65 (1.02)

Children's and parents' fruit and vegetable intakes

Children's general fruit and vegetable intakes were estimated with a food frequency questionnaire consisting of six items (fresh fruit, canned fruit & fruit sauce, dried fruit, raw vegetables, legumes, other prepared vegetables). For each item, a question asked about the frequency of their child's consumption during the last three months (Table 1). The time frame of three months was selected, as dietary habits of young children are not very stable yet and hence a year (which would have covered seasonal variations) seemed to be a too long period to be able to accurately estimate the diet of these children. They also only recently (about 4–5 months earlier) started with school, which for many children may considerably have changed their daily routines. Response options ranged from "never or less than 1 day per month" to "every day". A second question asked parents about the average consumption on a day that the food item was consumed: for each of the items, 5–7 portion sizes were defined, as well as an open category (e.g. for legumes: "30 g", "60 g", "90 g" up to "210 g" and "... gram"). To facilitate the estimation of consumed amounts written descriptions of examples were provided (e.g. 1 spoon of legumes = 30 g). The portion sizes and examples are based on the Belgian Manual of Household measures (Health Council Belgium, 2005). The food frequency questionnaire has been compared with a 3-day online dietary record in a subsample of participants ($n = 216$) (Vereecken, Covents, & Maes, 2010). After completing the food frequency questionnaire, parents were requested to record everything their child consumed for three non-consecutive days, announced one day in advance. Spearman's correlations of children's overall

consumption of fruit and overall consumption of raw and prepared vegetables between both methods were 0.53 and 0.39, respectively. Comparison of the median intake of fruits and vegetables did not result in a significant difference for fruit, but did result in an overestimation for vegetables using the food frequency questionnaire. More details about the food frequency questionnaire, the reference method and the comparison between both instruments have been published (Vereecken, Covents, et al., 2009; Vereecken et al., 2010).

Parents' fruit and vegetable consumption was assessed by asking how often the mother/father of the child consumed fresh fruit, raw vegetables and prepared vegetables and how much they consumed on average on such a day; however, no time frame was specified. The same food frequency response options and examples were used as in the children's questions; however, to assess the average consumption only an open response format was provided ("... gram"). For the present paper, only data of the parent completing the questionnaire were included.

The average daily consumption of each food item was estimated by multiplying the consumption frequency of each food (group) by the specified portion size. In cases where the frequency of consumption was reported but the portion size was missing (on average 3%, 26% and 29% of children's, mothers' and fathers' portion sizes, respectively), the missing value was replaced with the average reported portion size of the subjects in this study (data imputation for children used children's intakes; for mothers and fathers, respectively mothers' and fathers' intakes were used). Next, the average daily consumption of fresh fruit, canned fruit &

fruit sauce and dried fruit were summed as well as the average consumption of raw vegetables, legumes and other prepared vegetables.

General parenting styles

Parental style has several dimensions including parental support, structure, positive discipline, psychological control and physical punishment (Verhoeven, Junger, Van Aken, Dekovic, & Van Aken, 2007). In the present study, existing scales of laxness (six items), overreactivity (six items) and support/positive interactions (four items) were used (Arnold, O'Leary, Wolff, & Acker, 1993; Strayhorn & Weidman, 1988). Laxness, describes a parent who is permissive and inconsistent when providing discipline. Overreactivity describes the parental tendency to react on children's misbehaviour in an unstructured exaggerated manner. The support/positive interactions scale measures the degree to which a parent is involved in positive interactions with the child (Strayhorn & Weidman, 1988).

Parental feeding practices

Parental feeding practices were assessed with the 19-item caregiver's feeding styles questionnaire (Hughes et al., 2005). This measure describes verbal and physical feeding strategies used by parents to get their preschool children to eat. Based on factor analysis, the strategies have been categorized into more parent-centered (e.g. warning and physically struggling) or more child-centered (e.g. reasoning and praising) dimensions.

Child's characteristics

Parents completed temperament questionnaires, including the EAS Temperament Survey for Children (Parental Ratings) (Rowe & Plomin, 1977) and the Reactions to Food Scale of the Colorado Childhood Temperament Inventory (Pliner & Loewen, 1997; Rowe & Plomin, 1977), to which a measure of stubbornness was added. The EAS Temperament survey includes five items for each of the four temperament dimensions (emotionality, shyness, activity and sociability). One item from the sociability scale ("when alone, child feels isolated") was forgotten in the questionnaire. The Reactions to Food Scale (Rowe & Plomin, 1977) is a five item scale assessing children's dislikes of food (the higher the score, the lower the level of acceptance). The measure of stubbornness was a newly developed four item scale asking about stubbornness, temper, disobedience and protest since difficult children may be less flexible in adapting to new foods.

Statistical analyses

To improve normality of children's fruit and vegetable consumption the squared root was computed. Relationships between the transformed consumption variables, and parent and child characteristics were first examined using bivariate Pearson correlation coefficients. Next linear regression analyses were performed. An internal linear regression analysis was conducted for each set of variables (general parenting styles, parental feeding practices and child's characteristics) (Table 3, Models 2–4), using a significance level of $p < 0.1$, to select variables to be included in the final full model (Table 3, Model 5). This intra-set analysis consisted of linear regressions between the outcome variables (children's fruit or vegetable consumption) and all the variables in one specific domain as predictors (e.g. the three parenting styles). After this preliminary analysis, the linear regression analyses were carried out including all significant ($p < 0.1$) parameters from previous models but now adopting a significance level of $p < 0.05$ (Model 5). Finally, we tested a potential moderating effect for each of the parenting styles and

child characteristics with the parental feeding practices by adding a two-way interaction between the respective child characteristics and parenting styles and the parental feeding practices in separate general linear models including all parameters from the full model (Table 3, Model 5). Interactions were considered significant at $p < 0.01$. Data were analyzed using the Statistical Package for the Social Sciences SPSS 15.0.1.1 (SPSS Inc., Chicago, IL, 2007).

Results

Of the 1611 parents invited to participate in the study, 862 (54%) completed the questionnaires. Those with missing data on any of the scales were excluded, resulting in a final sample of 755 (88%). Ninety-one percent of the questionnaires were completed by mothers. On average, children were 3.5 (SD = 0.4) years of age; 50% were girls and mothers were 33.4 (SD = 4.5) years of age. Children of mothers with less education were more likely to drop out of the study. The drop out rates by mothers' level of education were 6.4%, 7.2% and 16.4% for master's, bachelor's and less than bachelors' degree, respectively ($p < 0.001$). No significant differences were found for fathers' degree or any other variables examined. Children consumed on average 119 g of fruit (SD = 75) (fresh fruit: 108 g; canned fruit and fruit sauce: 9 g; dried fruit: 2 g) and 65 g of vegetables daily (SD = 47) (raw vegetables: 16 g; legumes: 2.5 g; other prepared vegetables: 47 g) while for children in this age group it is advised to consume 1–2 pieces (1 piece = 125 g) of fruit and 100–150 g of vegetables (Nutrition Information Center, Flemish Association of Child Medicine, Child & Family, & Flemish Institute for Health Promotion, 2006). No significant association was found for both variables with age or gender. Parents reported an average consumption of 126 g of fruit and 196 g of vegetables.

Significant associations were found between the parenting styles with more supportive parents being less overreactive and less lax and more lax parents being more overreactive (Table 2). A supportive/positive interactions parenting style was positively associated with child-centered parenting practices, while overreactive parenting was positively associated with parent-centered feeding practices and negatively with child-centered feeding practices. A strong positive association ($r = 0.5$) was found between child-centered and parent-centered feeding practices. Notable were also the positive associations found between the negative reactions to food scale and both the parenting practices scales ($r = 0.30$ – 0.44). Of the child temperament characteristics mainly stubbornness and emotionality were associated with parental styles and parenting practices, with more stubborn and emotional children having more lax, overreactive parents, using more parent-centered feeding practices. For most child and parent characteristics significant univariate associations were found with one or both outcome variables.

Linear regression analyses (Table 3) demonstrated that for fruit most of the variance was explained by parents' fruit consumption, followed by children's negative reactions to foods. For vegetables, most of the variation was explained by the negative reactions to food scale, followed by parents' vegetable consumption (Table 3). Including all parenting variables (parental food consumption, parenting practices and styles) and child characteristics in the same model, indicated no significant association of parenting style or child temperament dimensions with children's fruit or vegetable intake (Table 3, Model 5). A significant higher consumption of fruit and vegetables was found in children with less negative reactions to foods, with parents with a higher consumption of fruit and vegetables, and more child-centered practices. A significant lower consumption of vegetables was found in children with more parent-centered practices. None of the two-way interactions between the parent and child characteristics and the parenting practices were significant at $p < 0.01$.

Table 2
Pearson correlations between the dependent and independent variables.

	General parenting styles			Parental feeding practices		Child characteristics (temperament + negative reactions to food)						Parent's consumption of		Child's consumption	
	Laxness	Overreactivity	Positive interactions	Parent-centered	Child-centered	Shyness	Emotional	Stubborn	Active	Sociable	Negative reactions to food	Fruit	Vegetables	Fruit (squared root)	Vegetable
<i>General parenting styles</i>															
Laxness															
Overreactivity	0.23***														
Support/positive interactions	-0.19***	-0.27***													
<i>Parental feeding practices</i>															
Parent-centered	0.05	0.13***	0.03												
Child-centered	-0.04	-0.11**	0.27***	0.50***											
<i>Child characteristics</i>															
Shyness	0.03	0.09*	-0.08*	0.14***	0.01										
Emotionality	0.12***	0.20***	0.02	0.13**	0.08*	0.23***									
Stubbornness	0.15***	0.26***	-0.05	0.20***	0.02	0.07	0.46***								
Active	-0.06	-0.07	0.10**	-0.10**	-0.05	-0.32***	-0.05	0.08*							
Sociable	-0.09*	-0.12***	0.08	-0.02	0.00	-0.38	-0.14***	-0.03	0.27***						
Neg. reactions to food	0.13***	0.12***	0.01	0.44***	0.30***	0.12**	0.20***	0.26***	-0.06	-0.07*					
<i>Parents consumption of</i>															
Fruit	-0.09	-0.06	0.01	0.02	0.08*	-0.02	-0.04	-0.06	0.05	0.05	-0.04				
Vegetables	-0.07	-0.06	0.05	-0.01	0.09*	-0.03	-0.01	-0.04	0.07*	0.00	-0.07	0.27***			
<i>Squared root of child's consumption of</i>															
Fruit	-0.04	-0.08*	0.08*	-0.07	0.06	0.00	-0.04	-0.07*	0.08*	0.03	-0.23***	0.28***	0.17***		
Vegetable	-0.10**	-0.11**	0.05	-0.22***	-0.05	-0.12**	-0.10**	-0.08*	0.10**	0.04	-0.39***	0.13***	0.28***	0.32***	

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Table 3
Coefficients of the independent variables of the multiple regression analyses predicting fruit and vegetable consumption.

	Fruit ^a				Vegetables ^a			
	β	SE	Standardized β	<i>p</i>	β	SE	Standardized β	<i>p</i>
Model 1: parents' consumption	$R=0.281$;	$R^2=0.079$;	adj $R^2=0.078$;	$p<0.001$	$R=0.284$;	$R^2=0.081$;	adj $R^2=0.080$;	$p<0.001$
Parents' consumption	0.010	0.001	0.281	<0.001	0.008	0.001	0.285	<0.001
Model 2: parenting styles	$R=0.102$;	$R^2=0.010$;	adj $R^2=0.007$;	$p=0.047$	$R=0.128$;	$R^2=0.016$;	adj $R^2=0.012$;	$p=0.006$
Laxness	-0.048	0.140	-0.013	0.735	-0.221	0.117	-0.072	0.063
Overreactivity	-0.238	0.167	-0.056	0.155	-0.273	0.140	-0.077	0.051
Support/positive interactions	0.538	0.319	0.064	0.091	0.118	0.266	0.017	0.658
Model 3: parental feeding practices	$R=0.133$;	$R^2=0.018$;	adj $R^2=0.015$;	$p=0.001$	$R=0.232$;	$R^2=0.054$;	adj $R^2=0.051$;	$p<0.001$
Parent-centered practices	-0.794	0.245	-0.135	0.001	-1.289	0.201	-0.261	<0.001
Child-centered practices	0.884	0.281	0.131	0.002	0.462	0.231	0.082	0.046
Model 4: child characteristics	$R=0.247$;	$R^2=0.061$;	adj $R^2=0.054$;	$p<0.001$	$R=0.403$;	$R^2=0.162$;	adj $R^2=0.156$;	$p<0.001$
Shyness	0.244	0.187	0.053	0.192	-0.250	0.148	-0.064	0.091
Emotional	0.044	0.162	0.011	0.785	-0.072	0.128	-0.022	0.575
Sociable	0.076	0.207	0.014	0.714	-0.147	0.164	-0.033	0.370
Stubbornness	-0.100	0.152	-0.027	0.509	0.084	0.120	0.027	0.483
Active	0.464	0.223	0.080	0.036	0.303	0.176	0.062	0.084
Negative reactions to food	-0.766	0.124	-0.228	<0.001	-1.072	0.098	-10.929	<0.001
Model 5 (1+2+3+4)	$R=0.383$;	$R^2=0.147$;	adj $R^2=0.140$;	$p<0.001$	$R=0.484$;	$R^2=0.234$;	adj $R^2=0.226$;	$p<0.001$
Parents' consumption	0.009	0.001	0.260	<0.001	0.007	0.001	0.246	<0.001
Laxness					-0.064	0.104	-0.021	0.540
Overreactivity					-0.060	0.123	-0.017	0.626
Support/positive interactions	0.396	0.298	0.047	0.184				
Parent-centered practices	-0.135	0.246	-0.023	0.584	-0.462	0.199	-0.094	0.020
Child-centered practices	0.782	0.278	0.116	0.005	0.443	0.217	0.078	0.041
Shyness					-0.171	0.133	-0.044	0.198
Active	0.280	0.198	0.048	0.158	0.195	0.165	0.040	0.239
Negative reactions to food	-0.823	0.127	-0.245	<0.001	-0.965	0.102	-0.343	<0.001

Model 1–4: linear regression for each set of variables; Model 5: linear regression starting from those variables with $p<0.1$ in Models 1–4.

^a To improve normality, the squared root was used as dependent variable.

Discussion

This study investigated the influence of parental behaviour (parent's consumption, general parenting styles, and food related parenting practices) and child characteristics (temperament and negative reactions to food), on young children's fruit and vegetable intake. The results indicated that parent's consumption was the most important predictor of children's fruit consumption. In addition, children's negative reactions to foods were also a strong contributor to children's fruit intake, but in a negative direction. The same predictors of fruit consumption were also important predictors of children's vegetables consumption; however, in the opposite order. The importance of parents' consumption (De Bourdeaudhuij et al., 2008; Fisher et al., 2002; Galloway et al., 2005; Gibson, Wardle, & Watts, 1998; Hannon, Bowen, Moinpour, & McLerran, 2003; Vereecken, Van Damme, & Maes, 2005) and food neophobia or pickiness (children's "negative reactions to food" in our study) (Cooke, Carnell, & Wardle, 2006; Cooke, Wardle, & Gibson, 2003; Galloway, Lee, & Birch, 2003; Wardle et al., 2005) in predicting children's dietary intake is well documented in the literature. We speculate that the more pronounced association of the "negative reactions to food scale" with children's vegetable consumption may be related to bitter sensitivity (Bell & Tepper, 2006; Drewnowski & Gomez-Carneros, 2000). Fruit is more often sweeter (Gibson et al., 1998) and therefore, in general, more liked than vegetables (Domel et al., 1993; Skinner, Carruth, Wendy, & Ziegler, 2002; Worobey, Ostapkovich, Yudin, & Worobey, 2010).

Similar to studies in older children (De Bourdeaudhuij et al., 2009; Vereecken, Legiest et al., 2009), our study indicated that more specific nutrition related parental feeding practices are of greater importance in promoting fruit and vegetable intake than the general parental style (positive interactions, laxness and overreactivity). None of the univariate significant associations between general parenting styles and children's consumption remained significant in the final models. In other studies,

the general parenting style was a significant predictor of adolescents' fruit consumption (Kremers et al., 2003; Pearson, Atkin, Biddle, Gorely, & Edwardson, 2009). However, those populations were older, they used other scales and they did not control for parental feeding practices. Additionally, in Pearson's study no significant association was found for vegetables (Pearson et al., 2009).

In our final models, controlling for parental behaviour and negative reactions to food, we found a negative association of parent-centered feeding practices with children's vegetable consumption and a positive association of child-centered feeding practices with both outcome variables. In a study by Wardle et al, parental control was also found to be a predictor of children's fruit and vegetable consumption however in their study the effect of control was no longer significant after taking into account food neophobia (Wardle et al., 2005). According to the authors of that study, this suggests that it is not parents' feeding practices that influence their child's intake but rather that parental control is a response of concerned parents to the lower consumption in more neophobic children. Our results, on the other hand, provide some evidence for benefits of child-centered feeding practices and adverse consequences of the parent-centered practices. However, to adequately address causality longitudinal and experimental study designs are necessary. Most studies on parental influences are cross sectional so it is not clear whether a child's dietary intake is the cause or consequence of certain parenting behaviour. It is possible that more "pressured" children may always have been difficult to feed thus eliciting more pressure from their parents now and in the past (low intake as a cause). Alternatively, it is also possible that more "pressured" children learn to ignore or oppose to requests to eat from their parents (decreased intake as a consequence) (Galloway, Fiorito, Francis, & Birch, 2006). Two studies that indicated that the use of pressure can foster negative affective responses to foods and a decreased liking of individual foods support that latter (Batsell Jr., Brown, Anfield, & Paschall,

2002; Galloway et al., 2006). In addition, evidence suggests that pressuring children to eat may diminish their ability to self-regulate intake (Birch, McPhee, Shoba, Steinberg, & Krehbiel, 1987; Carper, Orlet, & Birch, 2000). However, a bi-directional relationship is likely (Faith & Kerns, 2005; Galloway et al., 2005; Ventura & Birch, 2008).

Although other studies have found associations (de Bruijn et al., 2007, 2005) or a moderating role (Gubbels et al., 2009) of adolescent and child personality characteristics with parenting practices none of the temperament characteristics included in our study remained significant in the final model or played a moderating role.

Strengths of our study include the relatively large sample size and the use of validated questionnaires. However, some limitations should also be noted. First, the results are based on self-report measures, and hence social desirability and recall bias are possible. Second, parents reported both their own and their child's dietary intake, by which common reporting bias/error might increase the correlation between the parent and the child's intake. Third, a brief FFQ was used to estimate fruit and vegetable intake. FFQs seem to be valid as a means of ranking subjects by level of fruit and vegetable intake but they may be affected by scaling biases and random error when estimating absolute intake (Agudo, 2005). In general fruit and vegetable FFQs tend to overestimate mainly vegetable intake (Agudo, 2005). Comparison of this FFQ (Vereecken et al., 2010) against a three day online assessment (Vereecken, Covents et al., 2009) resulted also in an overestimation for vegetables but not for fruit so some caution is necessary when interpreting the consumed amounts. Correlations between both methods were, however, acceptable and the FFQ can therefore be used as an effective method in correlation analyses. Fourth, because young children have a limited ability to cooperate (Livingstone & Robson, 2000), assessment of children's dietary intake depends primarily on the ability of their parents/caregivers to accurately report their child's intake. Evidence suggests that parents can be reliable reporters in the home setting (Baranowski, Sprague, Baranowski, & Harrison, 1991), however, in away-from-home situations, parents might be unaware of their child's intake (Livingstone & Robson, 2000). Nonetheless, in a study of Parrish, Marshall, Krebs, Rewers, and Norris (2003) meal providers in addition to the parents did not seem to compromise the validity of the parental reported FFQ in preschool children. Fifth, because of space limitation, an open response format (... gram) was used to assess parents' portion sizes, while a closed format (5–7 predefined categories + an open category) was used to assess children's portion sizes. This open format resulted in a larger number of missing responses and should be avoided in future studies. Sixth, our results might not be generalizable to the general population. The response rate was 54% and questionnaires with missing information on one or more of the scales were excluded from the analyses. Moreover, comparison of mother's education level (58% higher education or university) with that of the general Flemish population (43.3% in 25–34 years old in 2006), indicated that our sample was highly educated (Research Department of the Flemish Authority, 2009). Finally, given the cross-sectional nature of the data, conclusions about causality cannot be made.

In conclusion, the present findings support that encouraging parents to recognize the importance of their own eating behaviour has the potential to improve their children's diets (Brown & Ogden, 2004). Additionally, the relatively strong association of fruit and vegetable intake with "the negative reactions to food scale" suggest that attempts to increase children's fruit and vegetable intake could benefit from strategies known to increase liking (Cooke et al., 2006) such as modelling (Birch, 1980) and taste exposure (Wardle, Cooke et al., 2003; Wardle, Herrera, Cooke, & Gibson, 2003). Finally, we also found positive associations with the

child-centered feeding practices, however, to further investigate the immediate and long term consequences of parental feeding practices longitudinal and experimental data are needed.

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