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A cross-sectional study of children's temperament, food consumption and the role of food-related parenting practices

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ABSTRACT

Although evidence exists of the association between children's temperament and weight, only few studies have examined how temperament is associated with actual food consumption among preschoolers. We examined concurrent associations between children's temperament and the consumption of different foods, and investigated whether the association between children's temperament and vegetable consumption is mediated by vegetable-related parenting practices. We utilized the data from the cross-sectional DAGIS study of 864 preschool children aged between three to six and their families, conducted between 2015 and 2016 in Finland. The parents reported their children's temperament, food consumption, and their vegetable-related parenting practices. Adjusted logistic regression analyses found positive associations between surgency and vegetable consumption as well as between effortful control and vegetable consumption. Both associations were mediated by one examined vegetable-related parenting practice: enhanced availability and autonomy support. No associations were found between children's negative affectivity and food consumption or vegetable-related parenting practices. In conclusion, children's temperament may be an important factor behind food-related parenting practices and children's diet. However, further longitudinal research and research covering different food-related parenting practices and home environment factors is necessary to better understand the complex associations between temperament and food consumption among young children.

1. Introduction

The foundations of eating habits are formed in childhood (Natale et al., 2013) and early learned eating patterns tend to continue into later life (Emmett, Jones, & Northstone, 2015). As an unhealthy diet is a notable behavioral risk factor for overweight and obesity (Swinburn, Caterson, Seidell, & James, 2004), as well as for non-communicable diseases such as cancers, diabetes and cardiovascular diseases (World Health Organization [WHO] 2013), it is important to start on a healthy path already at an early age. According to social ecological models, physical home environment and social interactions with parents are some of the most proximate factors that influence the formation and adoption of healthy eating habits among children (Davison & Birch, 2001; Sallis, Owen & Fischer, 2008). Thus, a substantial number of studies have focused on parent behavior and parenting style and practices, and their association with children's food consumption (Blissett, 2011; Kiefner-Burmeister, Hoffmann, Meers, Koball, & Musher-Eizenman, 2014; Larsen et al., 2015; Yee, Lwin, & Ho, 2017). Parenting style refers to the general way in which parents interact with their children in various situations, and parenting practices are defined as the behavior-specific strategies that parents apply to guide their children in certain situations (Baranowski et al., 2013a; Darling & Steinberg, 1993). In the feeding context, rules, meal time routines, control and restriction of the consumption of certain foods, for example, are considered parenting practices (Kremers et al., 2013).

Although the environmental influences on children's food

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consumption are increasingly better understood, a need has been recognized to also better understand the role of children's individual characteristics and the bidirectional influences of the parent-child relationship in the context of eating and weight trajectories (Bergmeier, Skouteris, Horwood, Hooley, & Richardson, 2014; Faith & Hittner, 2016; Skouteris et al., 2011). Individual differences in behavior are partly due to individual temperament, that is, biologically-based, early developing and relatively stable ways in which to react to environmental stimuli (Rothbart, 2007). Rothbart, Ahadi, Hershey, and Fisher (2001) have defined three broad dimensions of temperament among three-to seven-year-old children that mirror the individual's reactivity, affectivity and impulse control: negative affectivity is a temperament dimension that includes, for example, high negative emotionality, frustration, sadness, discomfort and low soothability. Surgency comprises characteristics such as high activity level, extraversion and enjoyment of high intensity activities. Effortful control is characterized by high attention capacity and inhibitory control, as well as enjoyment of low intensity activities, and reflects a child's self-regulatory abilities.

Based on their temperament, children may be differentially sensitive to the effects of environment, including parenting (Boyce & Ellis, 2005). Especially, children high in negative emotionality seem to be vulnerable to negative experiences but they may also have extra benefit from positive experiences (Belsky & Pluess, 2009; Boyce & Ellis, 2005). Children are not, however, merely passive recipients in their environment; they also shape the environment with their reactions and behavior (Klahr & Burt, 2014). Thus, children develop in an environment which is a product of reciprocal effects of their characteristics and environmental factors (Kiff, Lengua, & Zalewski, 2011). Also in the context of children's developing food consumption patterns and eating behaviors, relationship between children's characteristics, behavior and parenting is complex. To some degree food-related parenting practices seem to be driven by the children's temperamental characteristics. For example, children's high negative affectivity has been linked to the use of emotional and instrumental feeding practices both concurrently (McMeekin et al., 2013; Stifter, Anzman-Frasca, Birch, & Voegtline, 2011) and longitudinally (Kidwell, Kozikowski, Roth, Lundahl, & Nelson, 2018). Furthermore, low self-regulation has been associated with restrictive (Horn, Galloway, Webb, & Gagnon, 2011) and controlling feeding practices (Tan & Holub, 2011). However, at the same time for instance restrictive feeding practices are shown to predict children's appetite persistence (Godefroy, Champel, Trinchera, & Rigal, 2018), heightened desire to eat the restricted food and increased consumption of the restricted food (Jansen, Mulkens, & Jansen, 2007), pointing out that also in the feeding context the associations are bidirectional.

The majority of studies concerning children's temperament and food-related parenting practices have focused on controlling, restrictive, instrumental or emotional feeding practices. These practices have been linked with adverse effects on children's eating behaviors (Hughes & Papaioannou, 2018; Rodgers et al., 2013) and can be thus considered counterproductive or negative. In contrast, studies on children's temperament and positive food-related parenting practices, i.e. practices that seem to support the adoption of healthy eating habits, is scarce. Such practices are, for example, child involvement, modeling and enhanced availability of healthful foods (DeCosta, Møller, Frøst, & Olsen, 2017). To our knowledge, only one study has examined the association between children's temperamental characteristics and positive feeding strategies among preschoolers, and it found that children's effortful control and surgency were associated with parents' positive emotions and their effectiveness rating of different feeding strategies (Hughes & Shewchuk, 2012).

Adults' personality traits, developed as a result of interplay between temperamental characteristics and the environment (Rothbart, Ahadi, & Evans, 2000), are associated with people's food consumption (Conner et al., 2017; Keller & Siegrist, 2015; Lunn, Nowson, Worsley, & Torres, 2014; Tiainen et al., 2013). Only a few studies, however, have examined the associations between temperament and food consumption among children, despite the fact that infants' and children's temperaments have been associated with their weight outcomes (Anzman-Frasca, Stifter, & Birch, 2012; Bergmeier et al., 2014), suggesting that diet could be one factor influencing this association. In one recent study by van den Heuvel et al. (2017), high negative affectivity and low effortful control among three-year-old children were associated with unhealthy food consumption. In a study by Vollrath, Stene-Larsen, Tonstad, Rothbart, and Hampson (2012), negative emotionality measured at the age of 1.5 predicted unhealthy food consumption, whereas surgency/positive emotionality predicted daily fruit and vegetables consumption at the age of three and seven.

The literature suggests that temperament and personality may affect food consumption and weight in multiple ways. Children's high negative affectivity and low effortful control have been linked with greater physiological stress responses (Mackrell et al., 2014; Mayer, Abelson, & Lopez-Duran, 2014) as well as less adaptive coping strategies in stressful situations (Compas, Connor-Smith, & Jaser, 2004; Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001), which may increase preference for highly palatable foods (Wilson & Sato, 2014). Further, negative affectivity has been linked with avoidant eating behavior (Haycraft, Farrow, Meyer, Powell, & Blissett, 2011) and selective eating (e.g. Blissett, 2011; Brown et al., 2018; Hafstad, Abebe, Torgersen, & von Soest, 2013), which in turn has been associated with reduced consumption of, for example, fruit and vegetables, whole grain products and fish or seafood, and increased consumption of confectionary (Taylor, Wernimont, Northstone, & Emmett, 2015). Effortful control, in turn, seems to predict self-regulation in eating (Godefroy, Trinchera, Romo, & Rigal, 2016) which could have further beneficial links to diet and weight. In addition, individual differences in temperamental approach to novelty, trait included in surgency dimension of temperament, may affect food consumption by facilitating acceptance of new fruits and vegetables (Vollrath et al., 2012). At the same time, however, surgency has been associated with obesogenic eating behaviors such as enjoyment of food and eating in general, frequent desire to eat and external eating, which in turn have been linked to higher BMI z-score (Leung et al., 2016) indicating that high surgency could also predispose to obesogenic diet.

The purpose of this study was twofold: firstly, we examined the concurrent associations between children's temperament and their consumption of foods recommended for a balanced diet, i.e. vegetables, fruit and berries, whole grain products, fish and unflavored yoghurt and quark, as well as their consumption of sweets, treats and sweet drinks. We hypothesized that children's negative affectivity would be negatively associated with the consumption of the recommended foods and positively associated with the consumption of sweets, treats and sweet drinks, and that effortful control would be positively associated with the consumption of the recommended foods and inversely associated with the consumption of sweets, treats and sweet drinks. Further, we hypothesized that surgency would be positively associated with the consumption of the recommended foods as well as the consumption of sweets, treats and sweet drinks. Secondly, we investigated whether the association between temperamental characteristics and vegetable consumption is mediated through vegetable-related parenting practices at meal times, i.e. encouragement, modeling and enhanced availability. We expected that 1) children's negative affectivity would be associated with low vegetable consumption and that this association would be mediated through parents using less positive feeding practices at meal times, 2) children's effortful control would be positively associated with vegetable consumption and that this association would be mediated through parents' use of positive feeding practices, and 3) children's surgency would be positively associated with the consumption of vegetables and the association would be mediated through parents' use of positive feeding practices.

2. Methods

2.1. Study design and participants

A cross-sectional survey was conducted between fall 2015 and spring 2016 as part of the ongoing DAGIS (Increased Health and Wellbeing in Preschools) research project (www.dagis.fi/in-english/). The study protocol for the project has been published previously (Lehto et al., 2018; Määttä et al., 2015). The overall aim of the project was to decrease socioeconomic differences in preschool children's energy balance-related behaviors, such as food consumption, physical activity, sedentary behavior, and long-term stress.

For the cross-sectional survey, we recruited families with three-to six-year-old children, through preschools. The recruitment process is described in more detail elsewhere (Lehto et al., 2018). Altogether 864 children (25% of the invited children) and their families, from 66 preschools (43% of the invited preschools) in eight municipalities consented to participate in the survey. The families were recruited in preschools that were public, had at least one group with children aged between three and six, and provided child care in either Finnish or Swedish and were only open during the daytime. The families were eligible for the survey if they had children aged between three and six and they had sufficient skills in Finnish, Swedish or English. Families willing to participate in the study gave the researchers their written informed consent. The study was conducted in accordance with the Declaration of Helsinki. The study was approved by the University of Helsinki Ethical Review Board in the Humanities and Social and Behavioral Sciences in February 2015 (#6/2015).

2.2. Measures

Table 1 presents the independent, dependent and potential mediating variables, as well as the questions and items included in each of these variables. All information used in the analyses are reported by one parent in each family, however, the parent is not necessarily the same for all of the measures.

2.3. Temperament

Children's temperament was measured using the very short form of the Children's Behavior Questionnaire (CBQ-VSF), developed for children aged three to eight (Putnam & Rothbart, 2006). One parent in each family indicated their opinion on the thirty six items included in the CBQ-VSF, using a seven-point Likert scale ranging from 1 (= extremely untrue) to 7 (= extremely true). Three broad temperament dimensions established by instrument developers were constructed from the CBQ-VSF: surgency, negative affectivity and effortful control. Each dimension was measured using 12 items. Table 1 presents the examples of the items in each dimension. The questionnaire has shown to demonstrate acceptable internal consistency and criterion validity (Putnam & Rothbart, 2006). In this study, the Cronbach's alpha values for surgency, negative affectivity and effortful control were 0.80, 0.76 and 0.74, respectively.

2.4. Food consumption

To measure children's food consumption, we asked one parent to fill in a food frequency questionnaire (FFQ) developed for the DAGIS project (Määttä et al., 2018). In this questionnaire, the parents reported how often their child had consumed forty seven different foods and beverages at home/when not at preschool during the past week. The parents indicated consumption frequency by reporting the exact number of times (either in times per day or times per week) the child had consumed each food or beverage included in the FFQ. There was also a "not at all" response option for each item, to be chosen if the child had not consumed that food or beverage during the past week.

For the present study we calculated weekly consumption frequencies for 1) vegetables, 2) fruit and berries, 3) wholegrain bread, 4) brown rice and pasta, 5) wholegrain porridge and cereal with no added sugar, 5) unflavored yoghurt and quark, 6) fish, 7) sweets and treats and 8) sugary juice and soft drinks. Table 1 shows the items constituting the abovementioned food groups. Temperament's associations with the consumption of vegetables and fruit and berries were examined separately, as they are often eaten in different kinds of situations, and fruit and berries are usually more easily accepted than vegetables (Appleton et al., 2016). Wholegrain products were also examined in separate groups, partly because of differential consumption patterns (e.g. rice and pasta as part of a main meal vs. bread or porridge as breakfast or a snack) and partly because of differences in their texture: the sensory properties of food, such as texture, may be important factors for its acceptance (Nederkoorn, Jansen, & Havermans, 2015; Ray, Määttä, Lehto, Roos & Roos, 2016; Taylor et al., 2015), and thus we did not examine bread together with, for example, porridge and cereals.

Because of the non-normality of the food consumption variables they were dichotomized for the analyses. For recommended foods, the group of children consuming the least amount of these foods was of interest. Consumption of brown rice and pasta, wholegrain porridge and cereal, unflavored yoghurt and quark, and fish where dichotomized into "consumers" and "non-consumers" as a substantial portion of children did not consume these foods at all during the past week. Because proportion of non-consumers of wholegrain bread was non-existent, the variable was dichotomized at the 20th percentile. For wholegrain bread the cutoff point at 20th percentile divided children into " $<$ 5 times a week" vs. " $\geq$ 5 times a week" categories. In order to compare the results with previous studies, vegetable consumption and fruit and berry consumption were dichotomized into "less than daily" vs. "daily" categories. Finally, as our interest regarding sugary foods and drinks was in the group of children consuming these foods most frequently, the consumption of these foods and drinks were dichotomized at 80th percentile. For sugary juices and soft drinks the cutoff point divided children as "less than daily" vs. "daily" consumers, and for sweets and treats into " $\leq$ 1 time a week" and " $>$ 1 time a week" categories.

2.5. Vegetable-related parenting practices

To measure vegetable-related parenting practices, we asked the parents to report their use of twelve different practices by choosing a response option on a five-point Likert scale ranging from totally disagree to totally agree. The items were adapted from previously validated measure by Baranowski et al. (2013b) and were related to positive parenting practices such as verbal encouragement and modeling of vegetable consumption, involving children in vegetable preparation and making vegetables available at meal times. In our study we used only a part of the items included in the original measure, as we wanted to control the length of our questionnaires. We selected items that were considered most relevant in the light of results from our previously conducted focus groups with Finnish parents of preschool aged children (Ray, Määttä, Roos, & Roos, 2016). Further, we excluded controlling practices as our focus was on the positive practices.

2.6. Confounding variables

The child-related variables adjusted for in the analyses were age (continuous) and gender. The parent-related variables adjusted for were the age (continuous), highest education level and parental status (mother/father/other) of the FFQ respondent. The respondents indicated their highest education level as one of the following: 1) Comprehensive/elementary school, 2) vocational school, 3) high school, 4) bachelor's degree/college level training, 5) master's degree or 6) licentiate/doctor. Education was categorized into three categories: low (= high school or vocational school graduate or lower), middle (=

Table 1
Measures used to assess children's temperament, food consumption and vegetable-related parenting practices.

Variable name	Survey questions and items	Variable descriptives
Independent variables		
Dimensions of temperament[a]	Please read each statement and decide whether it is a "true" or "untrue" description of your child's reactions within the past six months. Use the following scale to indicate how well a statement describes your child.[b]	
Effortful control	Altogether 12 statements. E.g. “Is good at following instructions”, “Prepares for trips and outings by planning things s/he will need”	Construct, mean 5.2 range 2.4–6.9 Cronbach's α = 0.74 n = 751
Surgency	Altogether 12 statements. E.g. “Often rushes into a new situation”, “Seems to be at ease with almost anyone”	Construct, mean 4.7 range 2.0–7.0 Cronbach's α = 0.80 n = 751
Negative affectivity	Altogether 12 statements. E.g. “Gets quite frustrated when prevented from doing something s/he wants to”, “Is very difficult to soothe when upset”	Construct, mean 3.7 range 1.3–6.5 Cronbach's α = 0.76 n = 751
Potential mediators		
Vegetable-related parenting practices[c]	To what extent do you agree with the following statements?[d]	
Encouragement and modeling	I show my child that I really like eating vegetables. I praise my child when I see him/her eat vegetables. I encourage my child to eat vegetables so that s/he will become strong and stay healthy. I tell my child that vegetables taste good. I encourage my child to taste the same vegetable a couple of times.	Construct, mean 4.3 range 1.2–5.0 Cronbach's α = 0.80 n = 796
Child involvement	I ask my child to help select vegetables at the grocery store. I involve my child in preparing (peeling, cutting and serving) vegetables. I ask my child to choose vegetables for meals and snacks.	Construct, mean 3.3 range 1.0–5.0 Cronbach's α = 0.76 n = 797
Enhanced availability and autonomy support	At meals, my child usually serves him/herself vegetables. At meals, I usually serve several vegetables and let my child decide which one s/he will eat. At meals, I place a bowl with vegetables within my child’s reach so that s/he can easily serve them her/himself. I include vegetables with most meals.	Construct, mean 3.4 range 1.3–5.0 Cronbach's α = 0.64 n = 795
Dependent variables		
Food consumption	How many times has your child eaten the following foods at home or in places other than preschool during the past week?[e]	
Vegetables	Fresh vegetables Cooked or canned vegetables	Construct, dichotomized into: 1 = daily (79%) 0 = less than daily (21%) n = 807
Fruit and berries	Fresh fruit Berries (fresh or frozen)	Construct, dichotomized into: 1 = daily (63%) 0 = less than daily (37%) n = 809
Wholegrain bread	Rye bread, crispbread, thin rye crackers White wholemeal bread (e.g. multigrain bread, wholemeal rolls, fiber-rich oatbread)	Construct, dichotomized into: 1 = at least five times a week (80%) 0 = four times a week or less (20%) n = 807
Brown rice or pasta	Brown rice or pasta	Dichotomized into: 1 = consumers (60%) 0 = non-consumers (40%) n = 811
Wholegrain porridge and cereals	Wholegrain porridge and cereals (no added sugar, e.g. oatmeal porridge, Weetabix)	Dichotomized into: 1 = consumers (69%) 0 = non-consumers (31%) n = 811
Unflavored yoghurt and quark	Natural yoghurt and quark (also plant-based products)	Dichotomized into: 1 = consumers (37%) 0 = non-consumers (63%) n = 812
Fish	Fish dishes and fish products (e.g. fish soup, fried fish, tuna)	Dichotomized into: 1 = consumers (80%) 0 = non-consumers (20%) n = 810
Sugary juice and soft drinks	Sugar-sweetened fruit drinks Fruit juice Soft drinks (with added sugar) Reduced sugar juices and soft drinks	Construct, dichotomized into: 1 = daily (21%) 0 = less than daily (79%) n = 805
Sweets and treats	Chocolate (e.g. chocolate covered raisins, pralines, milk chocolate) Sweets (e.g. licorice or fruit drops, pick'n'mix sweets, lollipops) Sweet biscuits and cereal bars Cakes, cupcakes, sweet rolls, Danish pastries, pies and other sweet pastries Ice cream	Construct, dichotomized into: 1 = > 1.14 times a day (20%) 0 = ≤ 1.14 times a day (80%)

(*continued on next page*)

Table 1 (*continued*)

Variable name	Survey questions and items	Variable descriptives
		n = 806

[a] Measured using Children's Behavior Questionnaire, very short form by Putnam & Rothbart (2006).
[b] Response categories: 1 = completely untrue, 2 = quite untrue, 3 = slightly untrue, 4 = neither true nor false, 5 = slightly true, 6 = quite true, 7 = completely true.
[c] Measured using items adapted from the research by Baranowski et al. (2013b).
[d] Response categories: 1 = totally disagree, 2 = somewhat disagree, 3 = neither disagree nor agree, 4 = somewhat agree, 5 = totally agree.
[e] Response categories: open-ended columns "times per day" and "times per week" and a response option "not at all".

bachelor's degree or equivalent) and high (= master's degree or higher). Other confounding variables adjusted for were the number of the children's preschool days/week (≤3, 4 or 5) and whether they had siblings in the study. The parents reported all confounding factors.

2.7. Statistical analysis

To reduce the number of variables of vegetable-related parenting practices, we conducted a principal component analysis. The original constructs by Baranowski et al. (2013b) were not used, as only a part of the original items were adapted for our study. Using Varimax rotation and based on an eigenvalue of ≥1, we formed three constructs: 1) encouragement and modeling, 2) child involvement and 3) enhanced availability and autonomy support. Cronbach's alpha values (Table 1) were calculated to examine the internal consistency of the created constructs. To examine inter-correlations among the three temperament dimensions, we calculated Pearson correlation coefficients. We also studied differences in food consumption and background characteristics between children included in the final mediation analyses and those who were excluded from the analyses due to missing data in one or more variables. For categorical variables we used chi-square statistics and for continuous variables independent samples *t*-test to compare the groups.

We examined the associations between temperament dimensions and food consumption using logistic regression analysis in crude and adjusted models. In the crude models, we included only the three temperament dimensions that were entered to the model simultaneously. In the adjusted models, we first entered all background variables into the model in Step 1. In Step 2, the three temperament dimensions were added to examine whether they predict food consumption above and beyond the background variables. We studied the mediating role of vegetable-related parenting practices in the association between children's temperament and vegetable consumption using Hayes's macro (Hayes, 2017) for SPSS with 10 000 bootstraps to generate a sampling distribution and obtain 95 percent confidence intervals for the indirect effects. As it can be assumed that no single factor can explain the association between temperament and vegetable consumption, and because it was hypothesized that all potential mediators examined in this study would act in parallel, we conducted one parallel multiple mediation analysis to estimate the indirect effects, as suggested by Hayes and Rockwood (2017). All statistical analyses were performed using the SPSS statistical software package for Windows (IBM SPSS version 22.0 Statistics: Chicago, Illinois). For all associations, a p-value of 0.05 or less was taken to indicate a statistically significant finding.

3. Results

Table 2 presents the characteristics of the participating children and their parents. In the final adjusted models we included children with complete data in all the measures (complete case analysis). For the logistic regression analyses 676–681 children (78–79% of the children with any data) had the required data. For the mediation analysis 672 children (78% of the children with any data) had complete data in all measures. About half of the children were girls, and the mean age was 4.7 years. Roughly one fifth of the children had one or more siblings also participating in the study. The majority, nearly two thirds of the children, went to preschool five days a week. Of the parents responding to the FFQ, 93% were mothers and the mean age was 36 years. Among the children excluded from the current analyses because of some missing data, the proportion of fish consumers and daily vegetable consumers was significantly smaller than among the children included in the final analyses (71% v. 82%, X^2 test P = 0.007 and 70% v. 81% X^2 test P = 0.006 respectively). We found no other differences between the two groups in terms of the other food groups, children's age, gender, parent's educational level, temperament dimensions or vegetable-related parenting practices.

Table 2
Characteristics of participating children and their parents (n 672).

	%
Children	
Age, mean (SD)	4.7 (0.89)
Gender, female	49
Number of preschool days/week	
≤ 3	19
4	17
5	64
Siblings in the study, yes	22
Respondents of food frequency questionnaire	
Mothers	93
Age, mean (SD)	35.9 (4.8)
Education	
low	29
middle	40
high	31

Table 1 presents the descriptive statistics of the independent and dependent variables as well as the potential mediators. The majority, approximately four out of five children, consumed vegetables daily, and two out of three children consumed fruit and berries daily. The means for children's effortful control, surgency and negative affectivity scores were similar to those of other studies using CBQ-VSF (Hughes & Shewchuk, 2012; van den Heuvel et al., 2017). Pearson correlation coefficients for bivariate associations between surgency and effortful control, and surgency and negative affectivity were −0.27 and −0.19 (P < 0.01), respectively. Negative affectivity and effortful control were not significantly correlated (r = −0.02, P = 0.53).

3.1. Associations between temperament dimensions and food consumption

Table 3 presents the associations between the three temperament dimensions and children's food consumption. In the crude models, effortful control was positively associated with vegetable consumption and fruit and berry consumption. After adjustments, the positive association with vegetable consumption remained. However, the association with fruit and berry consumption was attenuated to non-significant. Children's effortful control was also associated with the consumption of unflavored yoghurt and quark in both the crude and adjusted models. After adjustments, every unit increase in children's

Table 3
Logistic regression analyses of crude (n 723–728) and adjusted (n 676–681) associations between children's temperament and food consumption.

	Effortful control				Surgency				Negative affectivity			
	Crude[a]		Adjusted[b]		Crude[a]		Adjusted[b]		Crude[a]		Adjusted[b]	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Vegetables	**1.42 (1.09–1.84)**	**0.01**	**1.45 (1.09–1.94)**	**0.01**	1.22 (0.98–1.53)	0.08	**1.37 (1.07–1.74)**	**0.01**	0.91 (0.73–1.13)	0.40	1.06 (0.83–1.35)	0.65
Fruit and berries	**1.26 (1.01–1.56)**	**0.04**	1.20 (0.95–1.52)	0.13	1.00 (0.83–1.21)	0.99	1.01 (0.83–1.24)	0.90	1.07 (0.89–1.28)	0.45	1.20 (0.98–1.46)	0.08
Wholegrain bread	1.15 (0.89–1.48)	0.30	1.27 (0.96–1.68)	0.10	0.88 (0.70–1.11)	0.29	0.92 (0.73–1.17)	0.51	0.99 (0.80–1.23)	0.95	1.03 (0.81–1.31)	0.79
Wholegrain cereals and porridge	1.09 (0.87–1.37)	0.45	1.07 (0.83–1.38)	0.59	0.82 (0.67–1.00)	0.05	0.82 (0.66–1.02)	0.07	0.83 (0.69–1.00)	0.05	0.87 (0.70–1.07)	0.18
Brown rice or pasta	1.01 (0.82–1.25)	0.92	0.94 (0.74–1.19)	0.60	1.05 (0.87–1.26)	0.60	1.05 (0.86–1.28)	0.65	0.97 (0.81–1.16)	0.72	1.01 (0.83–1.23)	0.91
Unflavored yoghurt and quark	**1.28 (1.03–1.60)**	**0.03**	**1.31 (1.02–1.67)**	**0.04**	0.99 (0.82–1.19)	0.89	0.98 (0.80–1.20)	0.87	1.04 (0.87–1.24)	0.71	1.12 (0.91–1.36)	0.28
Fish and fish dishes	1.15 (0.88–1.51)	0.29	1.06 (0.79–1.43)	0.69	0.98 (0.78–1.24)	0.90	0.95 (0.74–1.22)	0.70	0.90 (0.72–1.13)	0.36	0.98 (0.77–1.25)	0.87
Sugary juice and soft drinks	0.90 (0.70–1.17)	0.45	0.85 (0.64–1.12)	0.24	1.00 (0.80–1.25)	0.99	0.98 (0.78–1.25)	0.88	1.03 (0.83–1.27)	0.82	1.01 (0.80–1.28)	0.92
Sweets and treats	0.97 (0.74–1.26)	0.82	0.82 (0.61–1.09	0.18	1.01 (0.80–1.27)	0.93	1.02 (0.80–1.30)	0.88	0.96 (0.77–1.20)	0.71	1.00 (0.78–1.26)	0.97

Abbreviations: CI, confidence interval; OR, odds ratio.
Statistically significant results in bold.
[a] Adjusted for other two temperament dimensions.
[b] Adjusted for child's age, gender, and other two temperament dimensions, parental highest education, age and parental status of FFQ respondent, number of child's preschool days/week and whether multiple children participating from the same family.

effortful control increased the odds for consuming unflavored yoghurt and quark by 31%. In the crude models, children's surgency was positively associated with the consumption of whole grain cereals and porridge. After adjustments however, this association was attenuated to non-significant and we found only a positive association between surgency and daily vegetable consumption. In the adjusted model, the odds of daily vegetable consumption increased by 37% with every unit increase in children's surgency. We found no associations between children's negative affectivity and food consumption.

3.2. *Temperament, vegetable consumption and the mediating role of vegetable-related parenting practices*

Table 4 presents the results of the mediation model examining the associations between children's temperament dimensions, daily vegetable consumption and vegetable-related parenting practices. The coefficients for Path a represent the association between temperament dimension and each of the vegetable-related parenting practices. Children's effortful control was positively associated with all three vegetable-related parenting practices: 1) encouragement and modeling, 2) child involvement and 3) enhanced availability and autonomy support. Children's surgency was positively associated with two out of three practices, namely encouragement and modeling, as well as with enhanced availability and autonomy support. Negative affectivity was not associated with any of the three parenting practices. The coefficients for Path b represent the association between each parenting practice and children's daily vegetable consumption controlled for children's temperament dimensions, the other two mediators and the confounding variables. Of the studied parenting practices, enhanced availability and autonomy support was positively associated with children's daily vegetable consumption. Of the studied indirect effects (Path a x b), two were statistically significant: the association between children's effortful control and daily vegetable consumption was mediated through enhanced availability and autonomy support. Furthermore, children's surgency was positively associated with daily vegetable consumption through enhanced availability and autonomy support.

4. Discussion

The purpose of the present study was to investigate the associations between children's temperament and food consumption. We also aimed to examine the mediating role of vegetable-related parenting practices in the association between children's temperament and daily vegetable consumption frequency. Children's effortful control was found to be positively associated with daily vegetable consumption and the consumption of unflavored yoghurt and quark. We also found a positive association between children's surgency and daily vegetable consumption. Negative affectivity was not associated with either food consumption or the vegetable-related parenting practices examined in the present study. Of the three examined vegetable-related parenting practices only one, enhanced availability and autonomy support, mediated the association between effortful control and daily vegetable consumption as well as the association between surgency and daily vegetable consumption.

In line with our hypothesis and the existing literature (van den Heuvel et al., 2017), children's effortful control was associated with some features of healthy food consumption in the present study. We also found a positive link between effortful control and all the vegetable-related parenting practices examined. This finding is consistent with the results of Hughes and Shewchuk (2012), which showed an association between children's effortful control and parents' higher effectiveness ratings of different feeding strategies. The association between effortful control and vegetable consumption was mediated through only one of the parenting practices we examined: making vegetables more available at meal times and supporting children's autonomy in choosing and portioning out vegetables. Even though no

Table 4
Unstandardized regression coefficients *(B)* and 95% confidence intervals (CI) for associations between child's temperament dimensions, vegetable-related parenting practices and children's daily vegetable consumption (n 672).[a]

	Direct effect, Path c[b]	Path a[c]	Path b[d]	Mediated effect, a x b[e]	
	B	*B*	*B*	*B*	95% CI
Effortful control → Daily vegetable consumption	0.25				−0.05–0.54
Encouragement and modeling		**0.17*****	0.29	0.05	0.00–0.11
Child involvement		**0.17****	0.22	0.04	−0.00–0.11
Enhanced availability and autonomy support		**0.15****	**0.65*****	**0.10***	**0.03–0.19**
Total				**0.18**	**0.08–0.31**
Surgency → Daily vegetable consumption	0.21				
Encouragement and modeling		**0.07***	0.29	0.02	0.00–0.06
Child involvement		0.06	0.22	0.01	−0.00–0.06
Enhanced availability and autonomy support		**0.10***	**0.65*****	**0.06***	**0.01–0.13**
Total				**0.10**	**0.02–0.18**
Negative affectivity→ Daily vegetable consumption	0.04				
Encouragement and modeling		−0.02	0.29	−0.00	−0.03–0.01
Child involvement		−0.02	0.22	−0.00	−0.04–0.01
Enhanced availability and autonomy support		−0.00	**0.65*****	0.00	−0.06–0.05
Total				−0.01	−0.08–0.07

Statistically significant results in bold. Statistical significance of associations *P < 0.05,**P < 0.01,***P < 0.001.

[a] Adjusted for the following confounding variables: child's age, gender, and other two temperament dimensions, parental highest education, age and parental status of FFQ respondent, number of child's preschool days/week and whether multiple children participating from the same family.

[b] The coefficients for Path c' represent the association between the temperament dimension and daily vegetable consumption adjusted for potential mediators in addition to the confounding variables.

[c] The coefficients for Path a represent the association between the temperament dimension and each of the individual mediators with no other adjustments except for the confounding variables.

[d] The coefficients for Path b represent the association between each mediator and children's daily vegetable consumption adjusted for the temperament dimension and the other two mediators in addition to the confounding variables.

[e] The coefficients for Path a x b represent the specific and total indirect effects. Specific indirect effects represent the mediated effect when controlled for all other mediators in the model in addition to the confounding variables.

conclusions about causality can be made on the basis of these cross-sectional results, the abovementioned findings imply that children's general self-regulatory abilities; high capacity for consideration, focusing attention and following rules, may shape the feeding practices that parents adopt, which in turn could lead the way to healthy food consumption patterns and preferences. In terms of weight outcomes, it has been suggested that children's self-regulatory abilities first become important later in childhood, when higher expectations of children's own capacity to self-regulate eating emerge (Francis & Susman, 2009; Leung et al., 2016). However, our results suggest that effortful control may be an important factor for healthy eating environment already at a young age.

Children's surgency was connected to higher odds of daily vegetable consumption which is in line with the results reported by Vollrath et al. (2012). As described in the introduction, highly surgent children may more quickly learn to accept and like new tastes than less surgent children because of their positive approach to novelty (Vollrath et al., 2012). Further, children's sociability, a characteristic included in the surgency dimension of temperament, has been found to predict the effectiveness of an intervention aiming to increase the consumption of a disliked vegetable, which implies that children high in sociability may be more receptive to social influences such as positive food parenting practices than less sociable children (Holley, Farrow, & Haycraft, 2016). As we found children's surgency to be positively associated with two of the three examined vegetable-related parenting practices, it may be that in addition to being more receptive to social influences, highly surgent children may reinforce parents' use of positive practices by showing interest in available vegetables and accepting them with ease. On the other hand, children with high surgency could also be at risk of adopting less healthy eating habits if a variety of less healthy foods is available and parental guidance is low. The results of Leung et al.'s (2014) study indicate this direction, showing a positive link between preschooler's surgency and BMI z-score through food enjoyment and higher responsiveness to environmental food cues (Leung et al., 2014). In our study, however, we found no associations between surgency and the consumption of sugary fruit juice, soft drinks, sweets and treats.

Contrary to our hypothesis, we failed to find any associations between children's negative affectivity and food consumption or vegetable-related parenting practices. These results differ from other results: two previous studies found that children's negative emotionality was inversely related to the consumption of fruit and vegetables and positively related to the consumption of sweet foods and drinks (Vollrath et al., 2012) and an unhealthy overall diet (van den Heuvel et al., 2017). Furthermore, negative affectivity has previously been linked to harmful food parenting practices such as instrumental and emotional feeding (Kidwell et al., 2018), negative parental emotions and feeding problems (Hughes & Shewchuk, 2012). Based on the current literature findings, it seems that children's negative affectivity may increase parents' use of harmful practices rather than be inversely associated with the use of beneficial ones. However, research on the topic is scant and mostly concurrent so causality cannot be concluded.

The fact that the results of the present study partly differ from previous results may be due to differences in the measurement of food consumption or temperament. In the study by Vollrath et al. (2012), temperament was measured by combining questions from two different sources. Thus the possible differences in the dimensions of children's negative emotionality might explain the differing results. Moreover, van den Heuvel et al. (2017) measured food consumption as a composite score, reflecting the overall healthiness of children's food consumption, whereas we studied single food groups separately using dichotomized variables. This is a limitation in our study, as it may have led to the loss of information and power to detect associations (Altman & Royston, 2006). However, we still chose to use binary outcomes because of the non-normality of the food consumption variables. Furthermore, our FFQ measured only the time outside preschool hours. The reason for this was that in Finland, children do not eat home-packed

lunches at preschool; the municipality offers three free meals during the preschool day to all children. Thus, the greatest variation in the diet of preschool children presumably derives from foods eaten outside preschool hours. Furthermore, assessing children's food consumption during the preschool day would not have been possible for the parents.

Further limitations of this study include the fact that all the measures we used were parent-reported, and thus the results are subject to response bias. The mother nearly always filled in the FFQ and the parent's questionnaires, which may have biased the results, as children's food consumption seems to more closely resemble the diet of the parent who has reported their child's food consumption (Vepsäläinen et al., 2018b). Regarding children's temperament, in previous studies, mothers' and fathers' reports have only moderately agreed (Clark et al., 2016; Rothbart et al., 2001), showing that, for example, mothers tend to rate children's effortful control and surgency higher than fathers (Clark et al., 2016). In addition, respondents' feelings of stress and their own temperament have shown to influence their reports on their children's temperament (Bayly & Gartstein, 2013). However, we were unable to account for these factors, as we had no information on who reported the children's temperament and we did not collect information on the parents' temperaments. Furthermore, we did not include the children's nor the parents' BMI as covariates in the analyses, since these factors did not fulfil the criteria for confounders, as suggested in the literature (McNamee, 2003): parent's BMI was not associated with children's temperament, which is in conflict with the criteria of confounders being associated with exposure. However, children's temperament has been causally linked with children's BMI (Anzman-Frasca et al., 2012; Bergmeier et al., 2014), which in turn contradicts the criteria of confounders not being affected by exposure.

The fact that we investigated only unidirectional associations is also a limitation, as in reality food-related parenting practices and children's food consumption probably influence each other in a reciprocal way. The same is likely to hold true also for children's temperament and vegetable-related parenting practices. Further, we were unable to take into account the role of children's eating behaviors e.g. picky eating and appetitive traits as we did not measure the constructs. Future longitudinal studies investigating the potential bidirectional associations would provide deeper understanding on the relationship between children's characteristics, parenting practices and children's diet. Including measures of children's eating behaviors would be important as it could provide further insight into processes and mechanisms behind the associations of temperament and food consumption patterns of young children.

Overall, the strength of the associations between temperament and diet were modest, which was expected, as children's food consumption is affected by many other, more proximal factors such as parents' behaviors (Pearson, Biddle, & Gorely, 2009) and the physical food environment at home (Vepsäläinen et al., 2018a). As we examined the role of all the three temperament dimensions simultaneously in our models and the dimensions correlate moderately, the investigated associations may have attenuated to some degree. Furthermore, the low response rate of the study (25%) and participants lost due to missing data may have biased the sample: proportions of fish and daily vegetable consumers were higher among the participants who had complete data for analyses compared to those who had not, which indicates a somewhat selected sample with participants interested in healthy eating. It may also be that due to the selected sample there was less variation in food consumption in our data than in the general population. Thus, it is possible that we were not able to detect the associations that actually exist in the general population. As the participants in the study were mainly Finnish-speaking, highly-educated mothers and their children, the generalizability of the results is limited. We were also unable to draw conclusions about the causality of the associations because of the cross-sectional design. In light of these limitations to this work, our results must be interpreted with caution.

The strengths of our study include a valid, widely used measure of temperament, which enables comparison between the results and those of other studies. Furthermore, we examined associations between preschool children's temperament and food consumption and positive food-related parenting practices, which have not been extensively studied in the current literature. A better understanding of the bidirectional associations of individual characteristics and the environment during childhood is essential for efforts to support lifelong health, as many health behaviors are adopted in childhood. Future research on children's temperament, food consumption and parenting should further study the three temperament dimensions and food consumption in relation to a variety of food-related parenting practices, as well as in relation to the physical food environment. Examination of the interaction effects of different temperament dimensions and food-related parenting on diet could also be a fruitful approach. Some examples of this already exist, such as the study by Rollins, Loken, Savage, and Birch (2014), which found that the effect of restriction on food consumption was dependent on children's inhibitory control and approach tendencies. Furthermore, Larsen et al. (2015) suggested that the interaction effects of children's characteristics and the availability and accessibility of foods on diet should be further studied. Studies that measure food consumption by food records could also be informative in the future, as FFQ only captures consumption frequency, whereas food records reveal information about the amount eaten.

5. Conclusions

In conclusion, children's temperament dimensions and effortful control and surgency were associated with features of healthy food consumption. Parents' practices to make vegetables more available at meals and to support children's autonomy in choosing and portioning out vegetables mediated the association of effortful control and surgency with daily vegetable consumption. These results suggest that temperament may be an important factor behind parent's feeding practices, children's food consumption and the bidirectional associations of these factors. Further longitudinal studies are necessary in order to draw conclusions about the causality of the associations.

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