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Smell differential reactivity, but not taste differential reactivity, is related to food neophobia in toddlers

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ABSTRACT

Previous research has identified relationships between chemosensory reactivity and food neophobia in children. However, most studies have investigated this relationship using declarative data and without separately analysing smell and taste reactivity. Our first objective was to assess the relationships between smell and taste differential reactivity in toddlers (i.e. reactivity towards several stimuli), using experimental behavioural measurements. The second objective was to determine the relationships between smell (or taste) differential reactivity and food neophobia in toddlers, with the hypothesis that the more responsive a toddler was across food odours or tastes, the more neophobic s/he would be. An additional objective was to determine whether the potential relationships between smell (or taste) differential reactivity and food neophobia differ according to gender.

One hundred and twenty-three toddlers aged from 20 to 22 months from the Opaline birth cohort (Observatory of Food Preferences in Infants and Children) were involved. A questionnaire was used to assess child's food neophobia. Toddlers' differential reactivity for smell (and for taste) was defined as the variability of behavioural responses over 8 odorants, and over the five basic tastes.

Smell and taste differential reactivities were not correlated. Food neophobia scores were modestly but significantly positively correlated with smell differential reactivity but not with taste differential reactivity. When gender was considered, smell reactivity and neophobia were correlated only among boys.

This indicates the need to study smell and taste reactivity separately to determine their associations with eating behaviours. This suggests that the rejection of novel foods in neophobic boys could be partly due to food odour. This finding is new and clearly requires further investigation.

1. Introduction

Food neophobia, which is common in children between the ages of 2 and 6, is the reluctance to taste or consume new foods (Blissett & Fogel, 2013; Dovey, Staples, Gibson, & Halford, 2008; Pelchat & Pliner, 1995; Pliner & Hobden, 1992). Food neophobia is considered an efficient behavioural strategy that prevents young children from ingesting poisonous substances as their autonomy and freedom from parental supervision increases (Carruth, Ziegler, Gordon, & Barr, 2004; Cashdan, 1994). Despite this potential advantage, food neophobia has negative consequences for diet quality. It is well documented that food neophobia lowers dietary variety (Falciglia, Couch, Gribble, Pabst, & Frank, 2000; Nicklaus, Chabanet, Boggio, & Issanchou, 2005; Skinner, Carruth, Bounds, & Ziegler, 2002) and fruit and vegetable consumption (Cooke, Wardle, & Gibson, 2003; Galloway, Lee, & Birch, 2003). Because fruits and vegetables are known to be nutrient-rich low-calorie foods (Darmon, Darmon, Maillot, & Drewnowski, 2005) that can contribute to the prevention of many chronic diseases, including cardiovascular diseases and some cancers (WHO, 2003), determining the factors associated with children's food neophobia is a challenging priority for both public health and education. Children's food neophobia is a source of concern for parents who are

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worried about their child's low dietary diversity and who encounter difficulties with meal management (Pelchat & Pliner, 1986).

It has been recently reported that food neophobia may be more intense in children with higher chemosensory "sensitivity", defined by the authors as the reactions to chemosensory stimuli (Coulthard & Blissett, 2009). They found a significant correlation between child food neophobia and child taste/smell sensitivity using parental report data (e.g. my child 'avoids tastes or food smells that are typically part of a children's diet'). These authors also showed that 2- to 5-year-old children who were rated as more taste/smell sensitive were less likely to model their parents' consumption of fruits and vegetables than less sensitive children. In a study conducted by Farrow and Coulthard (2012), both anxiety and parent's perceptions of child taste/smell sensitivity (defined above) were associated with selective/neophobic eating in children between the ages of 5 and 10. Moreover, the results demonstrated that children's "sensory sensitivity" mediated the relationship between anxiety and selective/neophobic eating in children, suggesting that sensitivity to sensory cues may explain why more anxious children are more likely to be selective/neophobic eaters.

Because foods differ in their sensory properties, it is not surprising that children's food intake/preferences may be influenced by "sensory sensitivity" or more generally by the level of reactions to sensory cues (Beauchamp & Moran, 1982; Bell & Tepper, 2006; Blossfeld, Collins, Boland, Baixauli, Kiely, & Delahunty, 2007; Coulthard & Blissett, 2009; Cooke et al., 2003; 2004; Cooke, Carnell, & Wardle, 2006; Drewnowski, 1997; Liem, Bogers, Dagnelie, & de Graaf, 2006; Monneuse, Rigal, Frelut, Hladik, Simmen & Pasquet, 2008; Schwartz, Chabanet, Lange, Issanchou, & Nicklaus, 2011), but this result is not systematically reported (see Keller, Steinmann, Nurse, & Tepper, 2002; Lumeng, Cardinal, Sitto, & Kannan, 2008; Solbu, Jellestad, & Strætkvern, 1990). To date, only one study has assessed the relationship between food intake, sensory sensitivity to a bitter compound and food neophobia in preschool children (Tsuji et al., 2012). In this study, vegetable, fruit and soy food intake were estimated from dietary records of Japanese preschoolers classified as either tasters or non-tasters of 6-n-propylthiouracil (PROP), a bitter compound. The children's food neophobia was assessed using a parent-administered questionnaire. The results revealed that a high intake of vegetables was significantly associated with low neophobia levels, but only in boys. Interestingly, soy food intake was significantly higher for both boys with low neophobia levels and PROP tasters, but no effect of neophobia was found among non-tasters. These data suggest that sensitivity to bitterness and food neophobia may interact to influence the consumption of vegetables and soy foods among preschool boys.

The first objective of the present study was to assess the relationship between smell and taste differential reactivity in toddlers. Contrary to previous studies, most of which were based on questionnaires, smell and taste reactivity are considered separately in this study and are experimentally measured using a set of sensory stimuli. Smell (or taste) differential reactivity was defined as within-subject variability of behavioural responses across odours (or tastes). We hypothesised that children's smell and taste differential reactivity were independent behaviours. For smell, children's exploratory responses to successive similar objects differing in odour were recorded as done in previous studies (e.g., Delaunay-El Allam, Soussignan, Marlier, & Schaal, 2010; Mennella & Beauchamp, 1998; Wagner, Issanchou, Chabanet, Marlier, Schaal, & Monnery-Patris, 2013; Wagner, Issanchou, Chabanet, Lange, Schaal & Monnery-Patris, 2014). For taste, children's intake of aqueous solutions differing in taste was recorded (Beauchamp & Moran, 1982; Schwartz, Issanchou, & Nicklaus, 2009).

The second objective was to understand the associations between food neophobia and sensory reactivity in young children. Because neophobic behaviours emerge between 18 and 24 months (Addessi, Galloway, Visalberghi, & Birch, 2005; Carruth et al., 2004; Cashdan, 1994; Cooke et al., 2003; Dovey et al., 2008; Rigal, Chabanet, Issanchou, & Monnery-Patris, 2012), children aged approximately 20–22 months were included in the study. We expected that children with higher smell/taste differential reactivity would be more food neophobic. An additional goal was to determine whether the relationship between smell (or taste) differential reactivity and food neophobia differed by gender.

2. Methods

2.1. Context and ethics

The data were collected in the context of a larger programme, OPALINE (Observatory of the food preferences of infants and children), which seeks to understand the formation of food preferences from birth up to two years of age. Participating mothers were recruited before the last trimester of pregnancy through leaflets placed with health professionals and in day care centres. To be included in the cohort, both parents were required to be at least 18 years old and the children had to be in good health. The study procedures were explained to both parents. Written and informed consent was obtained from both parents for all children.

The study was conducted in accordance with the Declaration of Helsinki and was approved by local ethical committees (*Comité Consultatif de Protection des Personnes dans la Recherche Biomédicale de Bourgogne and Comité pour la Protection des Personnes EST-1 Burgundy*). We certify that all applicable institutional and governmental regulations concerning the ethical use of human volunteers were complied with during this research study.

2.2. Participants

The present study involved 123 toddlers who participated in two sensory tests in our laboratory: a taste test, which was performed when the child was 20 months old (mean ± SD: 616 ± 15 days), and a smell test, which was performed when the child was 22 months old (mean ± SD: 671 ± 11 days). None of the children were suffering from oro-nasal infection at the time of each sensory test. The children's characteristics are described in Table 1.

2.3. Procedure & materials

2.3.1. Food neophobia measurement

In children, the food neophobia construct is generally measured by questionnaires, and it is commonly admitted that this is a valid approach (e.g., Mennella, Pepino, & Reed, 2005; Pliner, 1994; Wardle, Guthrie, Sanderson, & Rapoport, 2001). The questionnaire developed by Rigal et al. (2012), which measures four

Table 1
Children's characteristics at the time of the smell and taste tests.

Children's characteristics	
Gender (girl:boy, N)	63:60
Milk feeding mode at birth (N)[a]	
Exclusively breastfed	91
Breast and formula fed	16
Exclusively bottle fed	13
Duration of exclusive breastfeeding (mean ± SD, days)	91 ± 61
Duration of total breastfeeding (mean ± SD, days)	165 ± 148

[a] The data for three of the children are missing.