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Food rejection and the development of food categorization in young children

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ABSTRACT

Food rejection and food categorization are the hallmarks of the omnivore's dilemma, but little is known about the former's development or its relationship with the latter in children. We recruited 79 children aged 2–6 years and 30 adults to test the hypotheses that (i) children's food categorization starts to improve at 2 years, (ii) their food rejection is intrinsically linked to development of the food categorization system, and (iii) food categorization relies mainly on color, which conveys information about food typicality. In a categorization task, participants were shown color photographs of fruit and vegetables, and asked to put items belonging to the same category in the same box. Results on accuracy indicated an age-related increase in food categorization performances, and provided the first empirical evidence speaking in favor of i) a relationship between children's food rejection and food categorization, and ii) the central role of color typicality in food categorization.

1. Introduction

Food is of central biological importance to humans, but while "trying new foods is at the core of omnivorousness (. . .) so is being wary of them" (Rozin, 1976). As insightfully stated by Rozin, humans, along with other omnivorous species, are caught on the horns of this omnivore's dilemma. Humans need to have a diverse diet to ensure their nutritional health, survival, and reproduction. To satisfy this dietary diversity, they must therefore continually sample new food resources, as they move away from a mono diet, namely their mother's milk, to a diverse food repertoire. However, this search for variety can prove hazardous, as new substances may be toxic, and a single mistake in this search could potentially lead to death, and thus hinder reproduction (generally associated with evolutionary success; Dakwins, 1976).

Two design features appear to have emerged through natural selection to solve this adaptive problem.[1] Grasping the first horn of the dilemma, a categorization system allowing for a food/nonfood distinction and discrimination between different food items enables efficient sampling of new food resources and enrichment of the food repertoire. Categorization is a fundamental cognitive process that allows us to organize objects into groups (Vauclair, 2004). Without such abilities, each item would be perceived as new, and it would be impossible to generalize its properties (such as assuming that because a carrot is edible, other carrots will be too; Murphy, 2002).

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[1] An adaptive problem is a problem, like this omnivore's dilemma, whose solution can affect reproduction, and hence evolutionary success (Cosmides, Tooby, & Barkow, 1992).

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Grasping the second horn of the dilemma, *food neophobia* (defined as the reluctance to eat novel food items; Pliner & Hobden, 1992) and *food pickiness* (defined as the rejection of a substantial amount of familiar foods, the consumption of an inadequate amount of food, and the rejection of certain food textures; Rydell, Dahl, & Sundelin, 1995; Smith, Roux, Naidoo, & Venter, 2005; Taylor, Wernimont, Northstone, & Emett, 2015) prevent individuals from ingesting substances that are potentially poisonous (Cashdan, 1994; Pliner, Pelchat, & Grasbski, 1993; Rozin, 1977). It has been reported that these rejection behaviors are mainly targeting plants, fruits and vegetables (Dovey, Staples, Gibson, & Halford, 2008). This is in line with recent evidence showing that infants as young as eight months old exhibit greater reluctance to touch basil and parsley plants, compared to plastic artefacts in the absence of social information (Wertz & Wynn, 2014a).

However, while these food rejection behaviors had an adaptive value in Pleistocene hunter-gatherers' hostile food environment, in our modern societies, where food safety is controlled in food supply chains, they are less useful. Indeed, as food rejection behaviors lead to a low consumption of fruit and vegetables by young children (Dovey et al., 2008), they are responsible for a reduction in dietary variety (Birch & Fisher, 1998; Falciglia, Couch, Gribble, Pabst, & Frank, 2000) needed for normal and healthy child development (Carruth et al., 1998; Cashdan, 1998).

The assumption that food rejection and food categorization processes are natural selection's solutions to the omnivore's dilemma led us to compare the scientific literature on food rejection and on children's cognitive development, in particular the development of a food categorization system (Lafraire, Rioux, Giboreau, & Picard, 2016). This comparison, which we expected to shed light on the mechanisms underlying food rejection behaviors from the perspective of overcoming them, uncovered several interesting outcomes or hypotheses.

First, an increasing number of research studies have related eating disorders to abnormal cognitive development, such as in autism spectrum disorder (Postorino et al., 2015; Rochedy & Poulain, 2015; Stough, Gillette Roberts, Jorgensen, & Patton, 2015). Children with autism are known to have cognitive deficits (Frith & Happé, 1994; Ozonoff, Pennington, & Rogers, 2015), and interestingly eating problems are common in this clinical population (Ahearn, Castine, Nault, & Green, 2001). Approximately 80% of young children on the autism spectrum are described as picky eaters, and 95% of them are reported by parents to be resistant to trying new foods (Lockner, Crowe, & Skipper, 2008) while prevalence of picky eating in young neurologically typical children usually ranges from 25% to 50% (Taylor et al., 2015). Moreover, Bandini et al. (2010) found that children with autism had more limited food repertoires than typically developing children.

Second, the sensitive period for food rejection starts at around 2 years, when children become mobile and begin to reason about food items other than through their caregivers[2] (Cashdan, 1994; Dovey et al., 2008; Lafraire et al., 2016). It is precisely at this point that a food categorization system is assumed to take its place within the child's cognitive system. Before the age of 2 years, infants exhibit very limited food categorization abilities. For instance, using a sequential touching procedure, Brown (2010) found that 20-month infants did not systematically distinguish between food and animal categories. In the same vein, using a looking time procedure, Shutts, Condry, Santos, and Spelke (2009) showed that 9-month-old infants direct their attention equally to domain-relevant properties (e.g., color and texture) and to domain-irrelevant properties (e.g., shape of the food's container) when reasoning about food. However, a rapid change occurs between 2 and 3 years of age. Using a sorting task procedure, Bovet, Vauclair, and Blaye (2005) found that 3-year-olds systematically distinguished between toy items and food items, demonstrating that these toddlers had developed a conceptual food category. Moreover, Brown (2010) established that, at this age, children also differentiate between categories within the food domain, such as biscuit and fruit. These results are in line with Nguyen and Murphy's claim that taxonomic categories[3] are available to children quite early in development (Nguyen & Murphy, 2003).

Third, rejection usually occurs at the mere sight of the food (Carruth et al., 1998), leading some authors to hypothesize that as children wish to recognize the foods they are given (to be sure of the consequences of ingestion), there is a perceptual mismatch between the meal that is presented and the prototypical food representations in their mind, possibly leading to food rejection (Brown, 2010; Dovey et al., 2008). For instance, Dovey et al. (2008, p. 183) hypothesized that "children build up schemata of how an acceptable food should look, and perhaps smell, and so foods not sufficiently close to this stimulus set will be rejected".

Fourth and last, one important finding in the domain of food categorization is that children from the age of 2–3 years attend to information about color or texture, rather than shape (Landau, Smith, & Jones, 1988; Yoshida & Smith, 2003) when discriminating between edible and inedible substances or between different kinds of foods (Lavin & Hall, 2001; Macario, 1991; Ross & Murphy, 1999; Shutts, Kinzler, McKee, & Spelke, 2009). For example, in a conflicting picture triad procedure,[4] Macario (1991, Exp. 4) showed 3- to 4-year-old children a novel object, described as either a thing to eat (*food* condition) or a thing to play with (*toy* condition). The children were then introduced to two other novel objects: a *color match* with the target object; and a *shape match* with the target object. When asked which one was like the target object, children were more likely to choose the color-match object in the *food* condition, whereas they were more likely to choose the shape-match object

[2] Before this age, food reasoning and selection seem to be mainly driven by social information (Wertz & Wynn, 2014b). For example infants preferentially reach for food that had been endorsed by native speaker of their native language (Shutts, Kinzler et al., 2009). See Lafraire et al. (2016), Lumeng (2013) and Shutts, Kinzler & DeJesus (2013) for reviews of the social influences on food selection.

[3] Taxonomic categories are based on common properties and are organized into hierarchies, such as apple-fruit-food (Nguyen & Murphy, 2003).

[4] In a conflicting triad procedure, a target and two test items are pitted against each other. Children are required to match one of the test items with the target.