



Visual exposure and categorization performance positively influence 3- to 6-year-old children's willingness to taste unfamiliar vegetables



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ABSTRACT

The present research focuses on the effectiveness of visual exposure to vegetables in reducing food neophobia and pickiness among young children. We tested the hypotheses that (1) simple visual exposure to vegetables leads to an increase in the consumption of this food category, (2) diverse visual exposure to vegetables (i.e., vegetables varying in color are shown to children) leads to a greater increase in the consumption of this food category than classical exposure paradigms (i.e. the same mode of presentation of a given food across exposure sessions) and (3) visual exposure to vegetables leads to an increase in the consumption of this food category through a mediating effect of an increase in ease of categorization. We recruited 70 children aged 3–6 years who performed a 4-week study consisting of three phases: a 2-week visual exposure phase where place mats with pictures of vegetables were set on tables in school cafeterias, and pre and post intervention phases where willingness to try vegetables as well as cognitive performances were assessed for each child. Results indicated that visual exposure led to an increased consumption of exposed and non-exposed vegetables after the intervention period. Nevertheless, the exposure intervention where vegetables varying in color were shown to children was no more effective. Finally, results showed that an ease of categorization led to a larger impact after the exposure manipulation. The findings suggest that vegetable pictures might help parents to deal with some of the difficulties associated with the introduction of novel vegetables and furthermore that focusing on conceptual development could be an efficient way to tackle food neophobia and pickiness.

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1. Introduction

Over the past years concern has arisen over the lack of children's dietary diversity, which is necessary for healthy development (Falciglia, Couch, Gribble, Pabst, & Frank, 2000). This lack of variety is directly associated with poor intake of fresh products such as fruits and vegetables, far below the recommended intake of five portions a day (Coulthard & Blissett, 2009). Arguably, *food neophobia* (defined as the reluctance to eat new foods; Pliner & Hobden, 1992) and *food pickiness* (defined as the rejection of new foods and certain familiar foods; Taylor, Wernimont, Northstone, & Emmett, 2015) are two strong barriers to children's higher

consumption of fruits and vegetables (Birch & Fisher, 1998; Dovey, Staples, Gibson, & Halford, 2008; Galloway, Lee, & Birch, 2003; Lafraire, Rioux, Giboreau, & Picard, 2016). Because the impact of these two kind of food rejections extends well beyond childhood, as dietary habits acquired during this period partly determine dietary patterns in adulthood (Nicklaus, Boggio, Chabanet, & Issanchou, 2005), it is essential to design effective interventions that aim to overcome children's food neophobia and pickiness.

1.1. The impact of mere exposure on children's food acceptance: a role for visual exposure

According to the "mere exposure" theory, the exposure to one instance of a given stimulus is sufficient to trigger a more positive attitude toward a subsequent instance of that particular stimulus (Zajonc, 1968). A considerable body of research has therefore investigated whether repeated taste exposure to fruits and vegetables might be employed to enhance children's acceptance and

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reduce rejections (for a review on food exposure see [Cooke, 2007](#); [Keller, 2014](#)). There is considerable support for the success of such repeated taste exposure in controlled experimental settings ([Birch & Marlin, 1982](#); [Birch, McPhee, Shoba, Pirok, & Steinberg, 1987](#)) as well as in more ecological settings like home or school environments ([Mustonen & Tuorila, 2010](#); [Park & Cho, 2015](#)). However these intervention programs often lead to a significant increase for children's fruit intake, but only minor changes for vegetable intake ([Appleton et al., 2016](#); [Evans, Christian, Cleghorn, Greenwood, & Cade, 2012](#)). Additionally these strategies may have limited efficacy in reducing neophobia or pickiness since several studies revealed that 10 to 15 taste exposures to a new food item may be needed for its successful acceptance in preschool-aged children ([Birch et al., 1987](#); [Wardle, Carnell, & Cooke, 2005](#)). This is a number greater than most parents are willing or able to provide ([Carruth, Ziegler, Gordon, & Barr, 2004](#)).

Because a neophobic reaction results in foods being rejected on mere sight ([Cashdan, 1998](#); [Dovey et al., 2008](#)), it is reasonable to assume that *visual* exposure could actually be more effective to reduce food rejections than *taste* exposure. In addition, it could be more effortless for caregivers to provide visual exposure to food (e.g. through picture books), especially if it occurs outside mealtimes. There is in fact an encouraging body of evidence to support research into the impact of visual exposure on children's food rejections ([Heath, Houston-Price, & Kennedy, 2011, 2014](#); [De Droog, Buijzen, & Valkenburg, 2014](#); [Houston-Price, Butler, & Shiba, 2009](#); [Osborne & Forestell, 2012](#)). For example, providing 2- to 6-year-old children with picture books about leeks and carrots, [Heath et al. \(2011\)](#) and [De Droog et al. \(2014\)](#) showed that toddlers consumed more of the vegetable they had seen in their picture book, compared to a matched control vegetable.

1.2. *The impact of mere exposure on children's food acceptance: a role for diverse visual exposure*

In the large majority of studies that investigate the effect of mere food exposure, children were exposed to the same mode of presentation of a given food across exposure sessions ([Caton et al., 2013](#); [Olsen, Ritz, Kraaij, & Moller, 2012](#)). For instance, in [Caton and colleagues' study \(2013\)](#), infants received the same preparation of artichoke puree for ten days, prepared with commercialized baby food. However, a recent study conducted by [Houston-Price, Burton, et al. \(2009\)](#) revealed that offering children different modes of presentation of a food could lead to greater interest in this food. They exposed toddlers for two weeks, either to picture books containing five *identical* pictures of a given fruit (e.g. apple), or to picture books containing five *different* pictures of the same fruit (e.g. an apple on a tree, an apple cut up on a plate etc.). They found that toddlers' looking interest in the exposed fruit was greater in the latter condition. They hypothesized that toddlers' more positive attitude toward the fruit after the "diverse" exposure intervention was driven by experiences that had allowed them to furnish an elaborate representation in mind of the exposed food.

This kind of "diverse" exposure could be greatly beneficial for children with high food neophobia and pickiness. In a recent study [Rioux, Lafraire, and Picard \(under revision\)](#) showed that 2- to 6-year-old neophobic and picky children tended to generalize knowledge to novel foods based on color similarity instead of category membership (see [Murphy, 2002](#), pp. 371–375 for a summary of the development of induction in childhood). For instance when taught a new fact about a red tomato, they tended to generalize it to a red apple rather than to a green tomato. Food rejections exhibited by certain children may discourage caregivers from presenting fruit and vegetables to their children. This would lead to fewer learning opportunities and to poor representation of

fruit and vegetable categories tied to perceptual properties, such as color, explaining poor category-based induction abilities (see [Lavin & Hall, 2001](#) and [Macario, 1991](#), for the importance of color over shape in the food domain). In this instance "diverse" exposure that allows children to furnish an elaborate mental representation of the food, as in [Houston-Price, Burton and colleagues' study \(2009\)](#), should greatly benefit neophobic and picky children. These children, who relied heavily on color similarity for induction in [Rioux and colleagues' experiment](#), should benefit from exposure intervention and learning opportunities that expose them to diverse colors for given food items. They could learn that color similarity should be disregarded, in favor of labels, when making predictions and consumption choices about food items. It is therefore worth exploring further the potential for visual exposure, with various presentations of the same food across exposure sessions.

1.3. *The mechanisms behind mere exposure*

Surprisingly, while a large body of research has investigated the potential effect of exposure, the accepted mechanistic explanation remains elusive. One of the mechanisms by which exposure is assumed to engender a positive attitude toward a stimulus is thought to be "learned safety" ([Kalat & Rozin, 1973](#); [Zajonc, 2001](#)). Exposure removes our natural fear of new stimuli through a process of conditioning. Indeed repeated ingestion of an unfamiliar food without negative consequences will lead to increased acceptance of this food ([Cooke, 2007](#)). Nevertheless, the recent evidence that mere visual exposure could also enhance the acceptance of unfamiliar food items ([De Droog et al., 2014](#); [Osborne & Forestell, 2012](#)) casts doubt on whether the "learned safety" hypothesis entirely explains the positive effect of exposure. Additionally, since rejections usually occur at the mere sight of the food ([Dovey et al., 2008](#)), there are valid grounds for assuming that food appearances might play a more central role than the absence of post-ingestion consequences, in a child's decision to consume a novel food item ([Heath et al., 2011](#)).

An alternative explanation, which embodies a cognitive approach to the mere exposure effect, was offered by [Bornstein and D'Agostino \(1994\)](#). By increasing the amount of experience an individual has with any stimulus, repeated exposure increases the ease and speed with which the stimulus is categorized, leading to a positive attitude toward the stimulus ([Bornstein & D'Agostino, 1994](#); [Seamon, Williams, Crowley, Langer, Orne, & Wishengrad, 1995](#)). Categorization is a fundamental cognitive process that allows us to organize objects into groups ([Vauclair, 2004](#)). When a food item is first presented to a child it is organized into categories relating to its characteristics ([Murphy, 2002](#); [Vauclair, 2004](#); see also [Lafraire et al., 2016](#)). Knowledge gained through this first encounter allows for easier and faster categorization, when subsequently presented with the same or a similar food item ([Aldridge, Dovey, & Halford, 2009](#)).

According to this cognitive approach, this ease in categorization of a given food item should lead to a reduction of food neophobia and pickiness. A recent study supports this hypothesis. [Rioux, Picard, and Lafraire \(2016\)](#) showed that categorization performance predicted food neophobia and pickiness. The authors asked children to sort pictures of fruits and vegetables into two different boxes according to their categories, and found that children with poor categorization performance were likely to be highly neophobic and picky. Hence, they proposed that food acceptance depends upon categorization ([Rioux et al., 2016](#); see also; [Brown, 2010](#); [Dovey et al., 2008](#)).

Nevertheless it is important to note that within this cognitive approach it remains to be seen if positive effects are restricted to the exposed stimulus (e.g. a carrot) or are generalizable to other

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