Food Quality and Preference 49 (2016) 87–91

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Short Communication

Rapid categorization of food and nonfood items by 3- to 4-year-old children

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ARTICLE INFO

Article history:
Received 27 October 2015
Received in revised form 3 December 2015
Accepted 7 December 2015
Available online 8 December 2015

Keywords:
Children
Food
Categorization

ABSTRACT

We assessed young children's ability to discriminate visually between food and nonfood items, and the possible relationship between this ability and their level of food neophobia. A sample of 42 children, aged 36–53 months, performed a rapid categorization task in which they were shown a series of color photographs of food and nonfood items, each displayed for 80 ms. Their task was to say as quickly as possible whether or not each item was edible. We measured both accuracy (hits, false alarms, discriminability) and response times. The children's food neophobia score was assessed on a standardized scale. Results indicated that children had a high rate of hits (81%), but also a high rate of false alarms (50%). Discriminability and neophobia both increased with chronological age, and response times decreased. There were no significant correlations between categorization performances and food neophobia scores after controlling for age effects. We conclude that children aged 3–4 years have a *liberal* food categorization system, accepting large numbers of nonfood items as edible.

1. Introduction

Categorization is a basic means of organizing the world around us, and is critical for the structure and stability of our cognition (Mareschal & Quinn, 2001). Categorization abilities mainly develop during early childhood, when children encounter many new stimuli. Without these abilities, children would have to learn to respond anew to each novel stimulus they encountered (Bornstein & Arterberry, 2010). Categorization abilities therefore play a major role in children's cognitive development. In the present study, we focused on children's ability to categorize objects as edible or not. So far, there has been little research on food categorization in children, even though the ability to distinguish between food and nonfood items is crucial for adaptation and survival.

Deciding whether or not an object is edible is far from easy, as this type of categorization is carried out not on a perceptual basis (where items are classified according to their physical resemblance), but on a functional one (where items are classified solely according to function, without any perceptual resemblance between members of a given class; see, for example, Rosch & Mervis, 1975; Tomikawa & Dodd, 1980). Studies of functional categorization involving food have shown that a variety of nonhuman animals are able to categorize objects as edible or nonedible. This ability has been observed, for instance, in pigeons (Watanabe, 1997), chimpanzees (Savage-Rumbaugh, Rumbaugh, Smith, & Lawson, 1980), baboons (Bovet & Vauclair, 2001), and rhesus monkeys (Fabre-Thorpe, Richard, & Thorpe, 1998). Studies suggest that children have only a limited ability to differentiate between food and nonfood items below the age of 2 years. For instance, using a looking-time procedure, Shutts, Condry, Santos, and Spelke (2009) showed that 9-month-old infants divide their attention equally between domain-relevant properties (e.g., color and texture) and domain-irrelevant ones (e.g., shape of the food's container). By contrast, at around 3 years, children start to generalize learning about novel foods according to color, texture, and odor, whereas they generalize learning about novel artifacts according to shape (Lavin & Hall, 2002; Macario, 1991; Santos, Hauser, & Spelke, 2002). Using a sorting procedure, Bovet, Vauclair, and Blaye (2005) observed that at age 3, the majority of children successfully sorted pictures of food and toys into different boxes, thus showing a basic ability for conceptual categorization in the food domain.

Children's ability to perform categorization in the food domain therefore appears to improve rapidly from the age of 3 years (Nguyen & Murphy, 2003). However, only few studies have investigated the nature of the underlying categorization system, and its

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http://dx.doi.org/10.1016/j.foodqual.2015.12.003
0950-3293/

developmental characteristics remain unclear. We designed the present study to fill this gap. We tested 3- to 4-year-old children's ability to classify color photographs of objects as edible or nonedible. Unlike previous studies featuring lengthy exposure to stimuli, we set up a rapid categorization procedure, following the example of Fabre-Thorpe et al. (1998) in their study with rhesus monkeys. The advantage of using a rapid categorization task is that brief presentations of stimuli rule out the use of exploratory eye movements. According to Fabre-Thorpe et al. (1998, p. 307), this demanding task "encourages subjects to make rapid intrinsic decisions on the basis of the first rapid pass through the system". In addition, the food and nonfood items used in our study were individually matched on color and shape, thus making the rapid categorization task even more complex.

The present study was driven by two main research questions. First, how do 3- to 4-year-old children perform a rapid categorization task involving food items, and what does this reveal about their underlying categorization system? We considered the following two alternative hypotheses: children produce many hits and false alarms, pointing to a liberal system (Hypothesis 1); children produce many correct rejections and many omissions, pointing to a conservative system (Hypothesis 2). Second, is there any relationship between children's performance on a rapid categorization task and their level of food neophobia (i.e., reluctance to eat novel food)? This question is worth exploring because food neophobia (Dovey, Staples, Gibson, & Halford, 2008; Lafraire, Rioux, Giboreau, & Picard, 2016) peaks between 2 and 6 years of age (Cashdan, 1994), that is to say precisely at the point when a food categorization system is thought to emerge within the child's cognitive system. Is this mere coincidence or are the two somehow related?

2. Method

2.1. Participants

Forty-two French children (23 boys, 19 girls; mean age = 3 years 8 months, *SD* = 5 months, age range = 36–53 months) took part in the study, with written parental consent. Prior to the study, parents rated their children's food neophobia on the Food Neophobia Scale (Pliner, 1994). The children's scores on this scale ranged from 14 to 68 ($M = 39$, $SD = 14$), and were distributed normally (Shapiro–Wilk test, W = .98075, $p = .69$). Food neophobia scores correlated with age in months (Pearson's correlation, $r = .403$, $p = .008$), with scores increasing with age. A one-way analysis of variance (ANOVA) showed that these scores did not vary according to sex, $F(1,40) = .74$, $p = .39$.

2.2. Stimuli and apparatus

The test stimuli were 40 color photographs, half featuring food items, half nonfood items. The food items were fruit or vegetables (lemon, blackcurrant, kiwi, blueberry, apple, orange, raspberry, green bean, cauliflower, red beetroot, carrot, broccoli, potato, pea, mushroom, tomato, eggplant, cucumber, bell pepper, corn). Each food item was paired with a nonfood item of a generally similar shape and color (e.g., the lemon was paired with an oval bar of yellow soap). Six additional stimuli, which were neither fruit nor vegetables, were used for practice (half food, half nonfood items). Fig. 1 provides examples of the test stimuli.

The visual stimuli were displayed on a PC computer screen. The E-Prime® 2.0 program controlled all the experimental events and the data recording. The *S* and *L* keys of the computer keyboard were used to provide the responses. Because we were testing young children who might have difficulty pressing the keys with their index finger, we adapted the keyboard so that the *S* and *L* keys were each connected to a large button. To differentiate between these buttons, one had a black cross on the top and the other a black circle. Children put their whole hand on the button and pushed it down to provide their responses.

2.3. Procedure

Children were observed individually in a quiet room at their kindergarten. They sat at a table in front of a computer screen, with the experimenter on their left. The computer screen was 50 cm from them. The keyboard was 30 cm away, and each button was within easy reaching distance. The experimenter explained to the children that they were going to play a game with pictures showing things that could be eaten and things that could not be eaten. The rule of the game was to indicate as quickly as possible whether the picture showed a thing that could be eaten or could not be eaten. If the picture showed a thing that could be eaten, the children had to press the button with a circle (*yes* response). If the picture showed a thing that could not be eaten, the children had to press the button with a cross (*no* response). The spatial location (right/left) of the yes (circle) and no (cross) buttons was counterbalanced across participants (i.e., for half the children, the yes button was on the right, and for the other half, it was on the left).

The session started with a familiarization phase, followed by a test phase. For both phases, the temporal events were as follows. A fixation point (star) was first displayed in the center of the screen for 500 ms, in order to capture the children's attention. The first picture was then flashed for 80 ms. This very rapid presentation had already been successfully used with rhesus monkeys (Fabre-Thorpe et al., 1998), and pilot tests had indicated that an 80-ms duration was also adequate for rapid visualization of the stimulus by children aged 3–4 years. Once the children had provided an answer, the experimenter asked them to prepare for the next trial, and to pay attention to the screen again. A fixation point appeared (500 ms), followed by a second picture (80 ms), and so on. During the familiarization phase (six practice pictures), the experimenter showed the children how to respond to the first two pictures. For the remaining four practice pictures, they had to do so on their own. Whenever necessary, the experimenter repeated the explanation of how to play the game. The order of presentation of the practice pictures was randomized for each child. During the test phase, four series of 10 pictures were successively presented to the children, with a 30-s break between two successive series. During these breaks, a cartoon was displayed on the computer screen. The order in which the pictures appeared in a series was randomized for each participant, with the constraint that each series had to include five pairs of food/nonfood items. In both the familiarization and test phases, verbal encouragements were given to the children, but there was no feedback indicating whether the responses were correct or not.

2.4. Data recording and offline analysis

Individual response times (ms), and type of response for each food item (hit or miss) and nonfood item (correct rejection or false alarm) were recorded online with E-Prime® 2.0. Offline analyses assigned each participant a score for hits (i.e., *yes* answers when the stimuli were food items), and a score for false alarms (i.e., *yes* answers when the stimuli were nonfood items). Both scores could vary between 0 and 20. Based on signal detection theory, we measured an index of discriminability (A′) and an index of the child's decision criterion (B″; see Grier, 1971; Stanislaw & Todorov, 1999). The A′ index ranges from 0 to 1, with .50 indicating responses at chance level, and 1 indicating maximum discrim-