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Effects of allocation of attention on habituation to olfactory and visual food stimuli in children

Leonard H. Epstein*, Frances G. Saad, April M. Giacomelli, James N. Roemmich

Department of Pediatrics, School of Medicine and Biomedical Sciences, State University of New York, Farber Hall; Room G56, 3435 Main Street, Buffalo, NY 14214, United States

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Abstract

Responding to food cues may be disrupted by allocating attention to other tasks. We report two experiments examining the effects of allocation of attention on salivary habituation to olfactory plus visual food cues in 8–12-year-old children. In Experiment 1, 42 children were presented with a series of 8 hamburger food stimulus presentations. During each intertrial interval, participants completed a controlled (hard), or automatic (easy) visual memory task, or no task (control). In Experiment 2, 22 children were presented with 10 presentations of a pizza food stimulus and either listened to audiobook or no audiobook control. Results of Experiment 1 showed group differences in rate of change in salivation (p=0.014). Children in the controlled task did not habituate to repeated food cues, while children in the automatic (p<0.005) or no task (p<0.001) groups decreased responding over time. In Experiment 2, groups differed in the rate of change in salivation (p=0.004). Children in the no audiobook group habituated (p<0.001), while children in the audiobook group did not habituate. Changes in the rate of habituation when attending to non-food stimuli while eating may be a mechanism for increasing energy intake.

Keywords: Habituation; Salivation; Attention; Olfaction

A large and consistent body of research has shown that rats [1–5], non-human primates [6,7] and humans [8–13] habituate to repeated food cues, and dishabitutate or recover responding when a new food cue is presented. Research has also shown that habituation to food cues is associated with the termination of eating in non-human primates [6,7] and humans [8], and the rate of change for salivary habituation and motivated responding for food is very similar in children [14]. Presenting a new food after habituation can result in dishabituation of salivary responding and a recovery of eating [8]. Similarly, presenting a new food in a motivated behavior paradigm will result in a resumption in responding for the new food in children [14]. Dishabituation of responding to new food cues may in part mediate the influence of food variety on increases in food intake [15].

In addition to the influence of novel food cues on dishabituation or recovery of responding, non-food stimuli can serve to dishabituate responding to food cues. For example, playing a video game in between food presentations can slow the rate of habituation [16]. Playing video games can dishabituate responding, and the more arousal generated by a video game the greater the degree of dishabituation [10]. One model that may help understand how food or environmental stimuli can act to influence responding to repeated food cues is the information processing model developed by Wagner [17–19]. Wagner argues that habituation is mediated in part by the matching of new information to information that is stored in short-term memory, and allocation of attention to new information removes information from short-term memory and disrupts habituation. The information processing model was tested by having participants engage in either a controlled search task (demanding attentional resources), an automatic search task (needing fewer attentional resources), or no task in

* Corresponding author. Tel.: +1 716 829 3400; fax: +1 716 829 3993.
E-mail address: LHENET@buffalo.edu (L.H. Epstein).

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between presentations of repeated food cues in two experiments [12]. Research has suggested that there is a distinction between automatic and controlled modes of information processing [20–22]. Automatic processes require fewer attentional resources and are possible when stimuli are consistently and reliably mapped to their appropriate responses. On the other hand, controlled responses demand more attentional resources when the stimulus-response mappings are inconsistent and unreliable. Consistent with the allocation of attention hypothesis, the automatic and no task groups habituated to the repeated presentation of food cues in both experiments, but the controlled search group did not.

The purpose of this study is to extend our research on the influence of allocation of attention on habituation to food cues to children. Research suggests that children consume a substantial amount of energy while engaged in other activities, such as watching television [23,24], and reducing access to behaviors such as television watching may reduce energy intake [25]. Consistently engaging in alternative activities while eating may alter the rate of habituation to repeated food cues, and thus, increase energy intake. We have completed an initial study in children demonstrating habituation to repeated food cues and showed that the habituation model fit both salivation as well as motivated responding to obtain food [14]. The two studies in this report are designed to replicate the influence of tasks that vary in their attentional demands on habituation to repeated food cues, and to examine the influence of common auditory distractors on the rate of habituation. Experiment 1 compares the influence of memory tasks that require different degrees of attention, while Experiment 2 evaluates the influence of attending to interesting audiobooks.

1. Experiment 1

1.1. Method

1.1.1. Participants

Participants were 21 male and 21 female non-obese (<95 BMI percentile) [26] children between the ages of 8 and 12 years old recruited from a newspaper advertisement and provided US$20.00 compensation for participation. Potential participants were excluded if they met any of the following criteria: medications or conditions that could influence olfactory sensory responsiveness or appetite (e.g., upper respiratory illness, diabetes, ADHD, methylphenidate); dietary restraint that would alter responding to food cues; current psychological disorder or developmental disability; or not rating test foods at least moderately liked. Participants were randomly assigned to one of the three groups: controlled search task, automatic search task and no task. The sample included 98% non-Hispanic white children and 2% African American children.

1.1.2. Procedures

Parents of the participants were screened by telephone to determine whether they met the above inclusion criteria, with the exception of liking of the test foods, which was assessed during the session. Eligible participants were scheduled for a 90-min appointment and the parents were instructed to not have the children consume the test food for 24 h and not to eat for at least 3 h prior to coming to the laboratory. Upon arrival to the laboratory, participants and parents read and signed informed consent and assent forms. Parents then completed a socioeconomic form [27], while children completed 5-point Likert scales, which assessed liking of the study foods and hunger, the Dutch Eating Behavior Questionnaire adapted for children [28] and a same-day food recall. Participants' heights and weights were then measured.

1.1.2.1. Experimental tasks. To adapt participants to the experimental methods, participants received four 1-min practice sessions of the search task, followed by a 1-min habituation trial using water as a neutral stimulus. They were then provided with eight 1-min habituation trials to half of a fresh Burger King® hamburger sandwich served on a 7 in. plate and heated in a microwave oven for 25 s. After each habituation trial, food stimuli were promptly removed from the experimental room. During salivation collection, participants wore headphones and listened to 62 dB of white noise to control for auditory stimulation. After completion of the habituation trials, food liking was reassessed. The search tasks took place in the 1-min period between habituation trials 1 and 8, presented on a color video monitor controlled by a BASIC computer program. The tasks consisted of a four consonant memory-set presented for 10 s followed by 20 presentations of 2 character search frames shown for 2 s. Each search frame remained on the screen for the same duration to equate total task duration across groups. Participants responded *yes* by pressing the left mouse button if a search frame matched the memory-set or *no* by pressing the right button if the search frame did not match a memory-set.

The controlled search task had target and distractor consonants that varied from trial to trial [20,21]. The controlled task provided participants with memory-set that included four consonants, and search frames that either included at least one consonant that matched the consonants in the memory-set (correct response) or two incorrect consonants (incorrect response). The automatic search task required less allocation of attention than the controlled search task since the search frames included either a correct consonant and a numeric character (correct response) or two numeric characters (incorrect response). The no task condition did not involve attending to a task, and participants in the no task condition continued to listen to white noise during the intertrial interval. The number of errors in each memory-set trial were recorded as a