Appetite 105 (2016) 575–581

Contents lists available at ScienceDirect

Appetite

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

Healthy eating decisions require efficient dietary self-control in children: A mouse-tracking food decision study

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ARTICLE INFO

Article history:
Received 5 February 2016
Received in revised form
8 June 2016
Accepted 22 June 2016
Available online 25 June 2016

Keywords:
Decision-making
Food choices
Dietary self-control
Youth
Obesity
Mouse-tracking

ABSTRACT

Learning how to make healthy eating decisions, (i.e., resisting unhealthy foods and consuming healthy foods), enhances physical development and reduces health risks in children. Although healthy eating decisions are known to be challenging for children, the mechanisms of children's food choice processes are not fully understood. The present study recorded mouse movement trajectories while eighteen children aged 8–13 years were choosing between eating and rejecting foods. Children were inclined to choose to eat rather than to reject foods, and preferred unhealthy foods over healthy foods, implying that rejecting unhealthy foods could be a demanding choice. When children rejected unhealthy foods, mouse trajectories were characterized by large curvature toward an eating choice in the beginning, late decision shifting time toward a rejecting choice, and slowed response times. These results suggested that children exercised greater cognitive efforts with longer decision times to resist unhealthy foods, providing evidence that children require dietary self-control to make healthy eating-decisions by resisting the temptation of unhealthy foods. Developmentally, older children attempted to exercise greater cognitive efforts for consuming healthy foods than younger children, suggesting that development of dietary self-control contributes to healthy eating-decisions. The study also documents that healthy weight children with higher BMIs were more likely to choose to reject healthy foods. Overall, findings have important implications for how children make healthy eating choices and the role of dietary self-control in eating decisions.

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1. Introduction

Healthy food choices require a person to resist tasteful but unhealthy foods while actively choosing nutritious foods that may have less flavor (Hare, Malmaud, & Rangel, 2011). Finding ways to help children choose nutritious foods has significant implications for obesity and lifelong health. Regardless of age, knowledge of nutrition and food healthiness is necessary, though not sufficient for making healthy food choices. Interestingly, the majority of adults who know which foods are healthy consistently make choices to the contrary (Epstein, Salvy, Carr, Dearing, & Bickel, 2010; Lim & Bruce, 2015a). To a certain extent, children's unhealthy food choices may be attributed to a limited knowledge about food nutritional quality and healthiness (Bruce et al., 2015; Croll, Neumark-Sztainer, & Story, 2001; Gibbs & Chapman-Novakofski, 2012; Gibson, Wardle, & Watts, 1998; Variyam, Blaylock, Lin, Ralston, & Smallwood, 1999; Vereecken & Maes, 2010; Wellman & Johnson, 1982). However, some studies have indicated that the level of nutritional knowledge is similar in obese and non-obese children (Peniche et al., 2015; Reinehr, Brylak, Alexy, Kersting, & Andler, 2003). Thus, other key factors must be at play when children make food choices.

Dietary self-control is the ability to choose a healthier food option rather than a less healthy food option (Hare, Camerer, & Rangel, 2009; Jasinska et al., 2012; Lim & Bruce, 2015b; Sullivan, Hutcherson, Harris, & Rangel, 2015). Whereas adults with successful dietary self-control make food choices based on both taste

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http://dx.doi.org/10.1016/j.appet.2016.06.027
0195-6663/Published by Elsevier Ltd.

and healthiness, those with poor dietary self-control make food choices based predominantly on taste rather than healthiness (Hare et al., 2011; Harris, Hare, & Rangel, 2013; Jasinska et al., 2012; Sullivan et al., 2015). Thus, successful dietary self-control can lead to healthy food choices, which is associated with maintaining the long-term health goals such as healthy body weight (Jasinska et al., 2012; Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010). In children, little is known about how dietary self-control is involved in food choices. Basic inhibitory control, a component to self-control, is the ability to override or resist a dominant response or behavior (MacLeod, 2007; Morasch & Bell, 2011). Inhibitory control matures throughout adolescence along with the development of working memory and processing speed (Luna, Garver, Urban, Lazar, & Sweeney, 2004; Morasch & Bell, 2011; Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999; Raffaelli, Crockett, & Shen, 2005). Thus, dietary self-control would be constrained developmentally in children, considering that inhibitory control has not yet reached sufficient efficiency (Luna et al., 2004), children's food choices are not internalized, yet need external modulation by parents' food choices (Bernier, Carlson, & Whipple, 2010; Klesges, Stein, Eck, Isbell, & Klesges, 1991; Lim et al., 2016), and food taste and preferences mostly determine food choices in children (Birch & Fisher, 1998; Domel et al., 1996). Nevertheless, several lines of evidence suggest that self-control is involved in healthy food choices and obesity. For example, the ability to execute self-control is less efficient in overweight and obese children compared to healthy weight children, and neuroimaging findings also suggest that obese children who view food cues have less brain activation in regions known to be associated with self-control (Bruce et al., 2013, 2015; Nederkoorn et al., 2010; Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006; Reyes, Peirano, Peigneux, Lozoff, & Algarin, 2015). Further, poor self-control predicts unsuccessful weight loss among obese children (Bruce, Black, Bruce, Daldalian, Martin, & Davis, 2011; Bruce, Martin, & Savage, 2011; Nederkoorn et al., 2006; Nederkoorn, Jansen, Mulkens, & Jansen, 2007). Even healthy weight children with poor self-control demonstrate greater unhealthy food consumption and more weight gain during the transition from preadolescence to adolescence (Duckworth, Tsukayama, & Geier, 2010; Riggs, Spruijt-Metz, Sakuma, Chou, & Pentz, 2010).

Despite this evidence indicating that basic self-control is associated with healthy food choices and obesity in children, how dietary self-control is executed during children's food decision-making is not yet fully understood. Also, how dietary self-control develops during middle childhood to early adolescence needs to be examined. To better understand the dynamics of food choice processes and the role of dietary self-control in children, we applied the recently developed mouse-tracking paradigm to a food choice task (Freeman & Ambady, 2010). While questionnaires report decisions that have already been made, and response times provide estimates of decision-making difficulty between two alternatives (Bogacz, Brown, Moehlis, Holmes, & Cohen, 2006; Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Steptoe, Pollard, & Wardle, 1995), these typical methods do not specifically delineate what occurs *during* the decision-making process. The mouse-tracking paradigm enables us to explore how children make decisions while they are making choices. It records the real-time decision-making process by tracking the actual mouse movement *trajectory* from the initiation to the completion of decision-making. Comparison between the ideal trajectory (i.e., straight line from the initiation to completion points) and the actual trajectory yields insights into the dynamics of the ongoing decision-making process.

The current study is the first investigation of food decision-making in children using the mouse-tracking paradigm. In particular, to investigate the role of dietary self-control in resisting unhealthy foods, we examined the dynamics of the food decision process by comparing conditions as a function of food healthiness (unhealthy vs. healthy foods) and food choices (no vs. yes). It was hypothesized that the decision process of resisting unhealthy foods would require greater dietary self-control represented by greater cognitive efforts and time than the decision process of rejecting healthy foods.

2. Methods

2.1. Participants

Eighteen healthy children (8 girls, 10 boys) aged 8–13 years (Mean = 11.07, *SD* = 1.36, range = 8.39–12.89 years) with normal or corrected-to-normal vision participated in this study. All participants were recruited from the Kansas City metropolitan area and spoke English as their first language. The racial background of the participants was: 13 Caucasian (72%), 2 African American (11%), 2 Multiracial (11%), and 1 Asian (6%). The mean body mass index was 18.45 kg/m^2 (BMI; *SD* = 3.81, range 13.4–28.4), and the mean BMI-for-age percentile was 46.14 (*SD* = 28.74, range = 5.8–91.0). Based on the CDC BMI percentiles, 16 children were categorized as healthy weight (89%), and two children were categorized as overweight (11%). Participants reported their puberty stages using Pubertal Development Scale (PDS) (Petersen, Crockett, Richards, & Boxer, 1988), and they were at mid-pubertal stage on average (*M* = 8.83, *SD* = 1.95, *range* = 6–12). Two additional participants were excluded from subsequent data analyses due to their failure to follow experiment instructions provided to perform the mouse-tracking food choice task ($n = 1$), or an experiment error ($n = 1$). This study was approved by the Institutional Review Boards at University of Missouri – Kansas City and the University of Kansas Medical Center.

2.2. Materials and stimuli

2.2.1. Food stimuli

Sixty food images representing foods that are often consumed by children were used for the food rating and mouse-tracking food choice tasks. The healthy and unhealthy foods consisted of 30 food items in each category. The healthy food stimuli included foods of high nutrient density, such as vegetables, fruits, and beans. The unhealthy food stimuli included foods of low nutrient density, such as fast foods, sweet desserts, processed meats, and fried foods. Food images were presented without any logos or brand names. All color images were matched for resolutions and sizes (300 × 300 pixels; 72 dpi; RGB color), and were presented on a white background.

2.2.2. Food rating tasks

Participants rated each food item using a 4-point rating scale on the basis of subjective food healthiness ("very unhealthy" to "very healthy"), taste ("very bad" to "very good"), and liking (i.e., preference, "strongly dislike" to "strongly like"). Each rating task was performed separately. Food items rated "very healthy" or "healthy" were categorized as healthy foods and those rated "very unhealthy" or "unhealthy" were categorized as unhealthy foods.

2.2.3. Food choice task

The mouse-tracking paradigm has been used in studies examining social decision making (Freeman, Ma, Han, & Ambady, 2013), language skills (Barca & Pezzulo, 2012), affective choice tasks (Leitner, Hehman, Deegan, & Jones, 2014; van der Wel, Sebanz, & Knoblich, 2014), and adults' attitudes toward healthy and unhealthy foods (Gillebaart, Schneider, & De Ridder, 2015; Schneider et al., 2015). In the present study, we developed a mouse-tracking