Appetite 91 (2015) 226–232

Contents lists available at ScienceDirect

Appetite

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

Research report

Taste and food reinforcement in non-overweight youth ☆

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ARTICLE INFO

Article history:
Received 17 September 2014
Received in revised form 6 April 2015
Accepted 10 April 2015
Available online 16 April 2015

Keywords:
Reinforcing value
Energy intake
Children
Liking
Taste

ABSTRACT

Food reinforcement is related to increased energy intake, cross-sectionally related to obesity and prospectively related to weight gain in children, adolescents and adults. There is very limited research on how different characteristics of food are related to food reinforcement, and none on how foods from different taste categories (sweet, savory, salty) are related to food reinforcement. We tested differences in food reinforcement for favorite foods in these categories and used a reinforcing value questionnaire to assess how food reinforcement was related to energy intake in 198 non-overweight 8- to 12-year-old children. Results showed stronger food reinforcement for sweet foods in comparison to savory or salty foods. In multiple regression models, controlling for child sex, minority status and age, average reinforcing value was related to total energy and fat intake, and reinforcing value of savory foods was related to total energy and fat intake. Factor analysis showed one factor, the motivation to eat, rather than separate factors based on different taste categories. Liking ratings were unrelated to total energy intake. These results suggest that while there are differences in the reinforcing value of food by taste groups, there are no strong differences in the relationship between reinforcing value of food by taste groups and energy or macronutrient intake.

Introduction

Food reinforcement provides an index of the motivation to eat (Epstein, Leddy, Temple, & Faith, 2007). The reinforcing value of food has been cross-sectionally related to energy intake and obesity (Giesen, Havermans, Douven, Tekelenburg, & Jansen, 2010; Saelens & Epstein, 1996; Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008), and prospectively related to body fat and weight gain in children (Hill, Saxton, Webber, Blundell, & Wardle, 2009), adolescents (Epstein, Yokum, Feda, & Stice, 2014), and adults (Carr, Lin, Fletcher, & Epstein, 2014). Reinforcing value of food paradigms usually assess a person's favorite food, and there has been very little research on characteristics of food that may drive the motivation to eat. In a previous study with humans, reinforcing value of food was most strongly related to sugar intake (Epstein, Carr, Lin, & Fletcher, 2011), but this study did not assess reinforcing value for different types of food. Previous studies have examined differential effects of repeated consumption of high and low energy dense foods on food reinforcement of high and low energy dense foods (Clark, Dewey, & Temple, 2010). Women with higher, but not lower BMI showed an increase in food reinforcement after repeatedly consuming higher energy dense foods. Repeated consumption of lower energy density foods reduced food reinforcement for all women. Another approach to categorizing food is by basic types of taste: salty, sweet, umami (savory), bitter and sour. To date, no studies have determined if the reinforcing value of food varies as a function of taste properties.

While reinforcing value of a favorite food has been related to energy intake in the laboratory and natural environment (Epstein et al., 2011), there is no research on how reinforcing value driven by different tastes would relate to total energy intake, or energy intake of specific macronutrients. It is possible that reinforcing value of a specific taste would relate to total energy intake, or only to intake of specific macronutrients. Reinforcing value of sweet foods may be related to sugar intake, or reinforcing value of savory foods to fat intake.

Another commonly studied determinant of eating is food liking or hedonic ratings of food (Drewnowski & Hann, 1999; Finlayson, King, & Blundell, 2007). Although foods that are highly liked are often found to be highly reinforcing as well, the incentive salience theory of addiction argues that liking and wanting are separate processes

☆ *Acknowledgements:* This research was registered at http://www.clinicaltrials.gov as NCT02229552. This research was funded in part by a grant from the National Institute of Diabetes and Digestive Diseases R01 DK 090106 awarded to Dr. Epstein. Appreciation is expressed to Matt Murry, Christina Stanton, Corey Chase, Ken Wojnowski, and Yi Ching Tan for assistance in running the study. Dr. Epstein is a consultant to and has equity in Kurbo. The other authors have no conflict of interest.

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http://dx.doi.org/10.1016/j.appet.2015.04.050
0195-6663/

that may differentially relate to consumption (Robinson & Berridge, 2004). This theory was originally developed to understand drug addiction, but it has been extended to natural rewards, such as food (Kelley & Berridge, 2002). Liking and wanting have been shown to differentially influence factors that regulate eating in animal studies (Berridge, 1996; Kelley & Berridge, 2002), and human studies suggest that factors that influence the motivation to eat differentially influence liking (Epstein, Truesdale, Wojcik, Paluch, & Raynor, 2003). Previous studies have shown that food reinforcement is a stronger predictor of energy intake than is liking (Epstein et al., 2011; Temple et al., 2008), but these studies have only studied one favorite food.

The goal of this study is to assess reinforcing value and liking of sweet, salty and savory (umami) foods and relate reinforcing value and liking to total energy and macronutrient intake in a large sample of non-overweight 8- to 12-year-old children. While sour and bitter are two additional basic tastes, children do not often choose to consume bitter or sour foods (Birch, 1999), and so we limited this study to basic tastes that more commonly drive food intake. This research will provide the first examination of how foods that vary in taste may differentially relate to food reinforcement, and how measures of food reinforcement relate to energy and macronutrient consumption. Studying foods from multiple taste categories provides the opportunity to assess whether the reinforcing value of salty, savory and sweet foods are uniquely related to energy and macronutrient intake, or whether there are one or two factors that describe the relationship between food reinforcement and intake. Based on previous research (Epstein et al., 2011) we hypothesize that food reinforcement will be greatest for sweet foods, reinforcing value will be related to energy and macronutrient intake, and that reinforcing value will be a stronger predictor of intake than liking (Epstein et al., 2011; Temple et al., 2008).

Methods

Participants and design

The participants were 198 (100 female and 98 male) non-overweight children 8–12 years old. The current study uses baseline data from a prospective study designed to examine individual differences in habituation of behavioral responding for food as risk factors for zBMI (standardized Body Mass Index) changes over a two year period in 231 healthy 8- to 12-year-old non-overweight children. Children were not included if they did not respond for the food in at least one of the taste groups, suggesting they did not find any of the foods in that category to be reinforcing (N = 33). The average characteristics of participants were 10.5 ± 1.4 years of age, zBMI of –0.08 ± 0.73, and 31.0% minority. Percentage of children identified by their parents in different minority groups included 6.6% Hispanic, 2% as Asian, 13.1% as African American, and 10.1% as multiracial. The average parental education was 15.8 ± 2.0 years.

Children who were not overweight, but at risk for becoming overweight were recruited if they were between the 50th BMI percentile and the 85th BMI percentile or if they were below the 50th BMI percentile, but had at least one parent with a current BMI ≥ 25 kg/m^2 (Magarey, Daniels, Boulton, & Cockington, 2003; Nader et al., 2006). Children also had to report at least a moderate liking (6 or greater on a 10-point Likert-type scale) for the study foods, and be at a second grade reading level based on the Wide Range Achievement Test (WRAT) (Wilkinson, 1993). Exclusionary criteria included 1) dietary restrictions that could interfere with the experiments, including food allergies or religious or ethnic practices that limit food choice or medical conditions which alter nutritional status or intestinal absorption, 2) activity restrictions due to medical or physical problems, such as uncontrolled exercise induced asthma or a disability requiring wheelchair; 3) psychopathology (e.g. childhood schizophrenia) or developmental disabilities; or 4) medications that could affect their level of activity or appetite (e.g. methylphenidate).

Procedures

Families were screened by phone and, if eligible, children were scheduled for four visits to the laboratory lasting approximately 120 minutes. Participants were instructed to refrain from eating and drinking anything except for water in the 3 hours prior to the test sessions and they were also instructed not to eat any of the study foods 24 hours before the test sessions. During the first visit to the laboratory the parents and children signed consent and assent forms, the child (with the help of the parent) completed a same-day food recall, the child and parent had their height and weight measured and the parents filled out demographic and medical questionnaires. The children picked their favorite salty food [Wheat Thins (Wheat thins snacks, original, Mondelez Global LLC., East Hanover, NJ), pretzels (Wegmans Party Pretzels, Wegmans Food Markets Inc., Rochester, NY), tortilla chips (Tostitos Tortilla chips, crispy rounds, Frito-Lay Inc., Plano, TX), Fritos (Fritos Corn Chips, original, Frito-Lay Inc)], savory (umami) food [cheddar cheese (Wegmans cheese sticks, cheddar, Wegmans Food Markets Inc.), Goldfish (Goldfish crackers, baked snack, cheddar, Pepperidge Farm Inc., Norwalk, CT), pepperoni (Wegmans Sliced Pepperoni, Italian Style, Wegmans Food Markets Inc.), bologna (Oscar Meyer Bologna, Beef, Kraft Foods Group Inc., Northfield, IL)], and sweet food [chocolate chip cookies (Mini chips ahoy! Chocolate chip cookies, Mondelez Global LLC), Oreos (Mini Oreo cookie sandwiches, Mondelez Global LLC.), Honey Buns (Little Debbie Honey Buns, McKee Foods, Collegedale, TN), Twizzlers (Twizzlers twists, strawberry, Hershey Company, Hershey, PA)] and they needed to report at least a moderate liking (6 or greater on a 10-point Likert-type scale) of their favorite foods. Foods were placed in these categories if 1) 25% or more of the kilocalories from the snack was from sugar (sweet), 2) the presence of an umami flavor (e.g. Meats, tomato, and cheeses) (savory), or 3) the presence of sodium (>120 mg a serving) (salty) with less than 15% of the snack from sugar and no presence of umami flavor.

During the first laboratory session the reinforcing value of food (salty, savory, and sweet foods) was measured using a validated questionnaire (Goldfield, Epstein, Davidson, & Saad, 2005), with foods presented in random order. Dietary awareness was also measured in the first session. Energy and macronutrient intake was measured during sessions 2–4. Behavioral habituation, executive function, physical activity, and food neophobia were measured but not reported here. At the end of the sessions, participants were compensated $80.00 US dollar gift cards for completing the four sessions. All procedures were conducted in accordance with guidelines for the ethical conduct of human research and with the approval of the University at Buffalo Social and Behavioral Sciences Institutional Review Board.

Measures

Demographics

A general demographics questionnaire was used to assess education, annual income, and race. Years of education were coded separately for fathers and mothers, and the highest level of education was used as the family education. Children were coded as minority or non-minority (Caucasian).

Anthropometrics

Weight was assessed by a digital scale (TANITA Corporation of America Inc, Arlington Heights, IL) and height using a digital stadiometer (Measurement Concepts & Quick Medical, North Bend, WA). Body mass index (BMI) was calculated according to the formula: BMI = kg/m^2. BMI percentile values were standardized for the child's