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Research report

Validating a behavioral economic approach to assess food demand: Effects of body mass index, dietary restraint, and impulsivity ☆

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ABSTRACT

Behavioral economic theory is a useful framework for analyzing factors influencing choice, but the majority of human behavioral economic research has focused on drug choice. The behavioral economic choice paradigm may also be valuable for understanding food-maintained behavior. Our primary objective was two-fold: (1) Validate a human laboratory model of food-appetitive behavior, and (2) Assess the contribution of individual level factors that may differentially impact food choice behavior. Two studies were conducted. In Study 1, female subjects ($N = 17$) participated in two *consecutive* food choice experimental sessions, whereas in Study 2, female subjects ($N = 21$) participated in one *concurrent* food choice experimental session. During *consecutive* choice sessions (Study 1), demand for the more palatable food (i.e., high-sugar/high-fat) was more inelastic than the less palatable (i.e., low-sugar/low-fat) option. During concurrent choice sessions, demand for the more palatable food (i.e., high-sugar/high-fat) was more inelastic for restrained vs. unrestrained eaters, and for those who were overweight vs. normal weight. Demand for both palatable and less palatable choices was more elastic for high-impulsive vs. low-impulsive subjects. These findings suggest that the behavioral economic framework can be used successfully to develop a human laboratory model of food-appetitive behavior.

Introduction

Behavioral economic theory provides a framework for conceptualizing and analyzing factors that influence choice. Behavioral economic choice paradigms, rooted in classic behavior analytic theory (Hursh, 1984), provide participants access to reinforcers varying in accessibility, amount, or extent of work necessary to obtain them. By comparing response patterns, the relative reinforcing value of commodities can be gleaned and the influence of alternatives assessed. Behavioral economic studies of drug choice emphasize two fundamental principles that influence drug seeking behavior (Bickel, Madden, & Petry, 1998; Vuchinich & Tucker, 1988). First, consumption of a reinforcer (i.e., drug) tends to decrease when constraints on access (e.g., price) are increased, and second, consumption is affected by the availability of concurrent alternative reinforcers. The same model may be applicable to the study of food choice behavior.

When given a choice between preferred snack foods or fruits and vegetables, research suggests that individuals initially choose the snack foods. However, as response cost to obtain the preferred food (i.e., snacks) increases, choices shift to the less preferred but less costly alternative (Epstein & Leddy, 2006; Epstein, Salvy, Carr, Dearing, & Bickel, 2010; Goldfield & Epstein, 2002). In behavioral economic terms, this shift in food choice reflects an increase in the elasticity (price-sensitivity) of demand for the preferred food at higher response costs. Thus, in the present study, it was hypothesized that the reinforcing value of a food option will depend on its unit price (UP [Hursh, 1984]; cost per unit amount), concurrent alternatives (e.g., sweet vs. less palatable food), and constraints on availability of these options. Increases in UP decrease consumption in a positive decelerating fashion. This relationship between UP and food consumption has been validated in laboratory animals (e.g., Collier, Johnson, Hill, & Kaufman, 1986; Madden, Dake, Mauel, & Rowe, 2005; Mathis, Johnson, & Collier, 1996).

Despite the value of behavioral economics in defining the relationship between food UP and behavioral response, few studies have been conducted with humans. Several studies have found that increases in response cost reduced food reinforcing value, yet most studies did not use a classical demand curve approach; rather, analyses of variance (ANOVAs) were used to block on fixed ratio (FR) or variable ratio (VR) requirements (e.g., Giesen, Havermans, Nederkoon, Strafaci, & Jansen, 2008; Raynor & Epstein, 2003; Temple, Chappel, Shalik, Volcy, & Epstein, 2008). In one recent study, Yang and Chiou (2010) used this model with more

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sensitive regression analysis (to estimate elasticity coefficients) to evaluate influences on beverage choice behavior. They noted that lowering the cost of healthful alternatives and heightening concerns about less healthy alternatives shifted choice toward more healthful beverage options (e.g., sugar-free green tea vs. sweet tea).

In the present investigation, a classical demand curve approach was utilized to analyze food choice responding. Typically, a demand function describes the relationship between the quantity of a commodity consumed and its UP. This approach involves plotting consumption of the reinforcer (e.g., food) against its UP, which yields a positively decelerating demand function (Hursh, 1980). The behavioral economic approach offers conceptual and analytic advantages over conventional procedures. First, the influences of several cost and benefit parameters can be parsimoniously integrated within a single UP metric (Bickel, DeGrandpre, Hughes, & Higgins, 1990). Second, choice/demand is predicted to be independent of the specific cost (numerator) and benefit (denominator) values that comprise the UP (principle of functional equivalence), which enables cross-study comparisons. Third, demand curves provide analytic and graphical results that are not intuitively obvious from other response data such as breakpoints; furthermore, breakpoints depend on the specific values of the progressive ratio schedule (i.e., number of trials and relative steepness of response requirements) and unit doses/amounts, resulting in findings that cannot readily be compared across studies. Demand curves can be adapted to study group choice behavior (instead of consumption amounts) when the participant only has one opportunity to choose a commodity at each UP (e.g., Greenwald & Hursh, 2006). Under these conditions, one analyzes the percent of the group (i.e., consumer market) that chooses the commodity at each UP (known as "participation rate"). The present study aimed to validate this approach to study food choice, and to examine microeconomic factors that may advance our understanding of palatable food demand, analogous to prior findings with respect to human subjects' psychoactive drug demand (e.g., Greenwald, 2010; MacKillop & Murphy, 2007; Madden & Bickel, 1999).

Several factors may differentially impact food choice behavior and the reinforcing value of food including body mass index (BMI; Clark, Dewey, & Temple, 2010; Epstein et al., 2010; Epstein, Temple et al., 2007; Giesen, Havermans, Douven, Tekelenburg, & Jansen, 2010; Saelens & Epstein, 1996; Smith & Epstein, 1991; Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008; Temple et al., 2009), level of dietary restraint (e.g., Giesen, Havermans, & Jansen, 2010; Giesen et al., 2008; Goldfield & Legg, 2006; Goldfield & Lumb, 2008; Houben, Roefs, & Jansen, 2010), and delay discounting (e.g., Christakou, Brammer, & Rubia, 2011; Rollins, Dearing, & Epstein, 2010). More specifically, the reinforcing efficacy of high-fat, high-carbohydrate, low-protein snack food is generally found to be higher among obese relative to non-obese individuals (e.g., Epstein, Temple et al., 2007; Saelens & Epstein, 1996; Temple et al., 2009), and, compared to unrestrained eaters, individuals high in dietary restraint tend to prefer unhealthful food over healthful alternatives (i.e., high calorie snack vs. fruit; Houben et al., 2010). Delay discounting is a construct often used as a proxy measure of impulsivity (Perry, Larson, German, Madden, & Carroll, 2005), and greater discounting occurs when small immediate rewards are chosen over larger delayed rewards (Bickel et al., 1998). As impulsivity is associated with binge eating (Dawe & Loxton, 2004), it is not surprising that this variable differentially impacts food reinforcement (Epstein, Dearing, Temple, & Cavanaugh, 2008). The prevalence of overweight and obesity have increased dramatically in recent decades (e.g., Flegal, Carroll, Ogden, & Curtin, 2010; Hedley et al., 2004), with recent estimates classifying 66.3% of American adults as overweight or obese (Ogden et al., 2006). Using behavioral economic analysis to examine these individual difference factors contributing to food preferences and reinforcement, and by extension, weight, may thus yield data related to factors motivating food-related decision making, appetitive behavior, and weight gain.

The purpose of this investigation is two-fold. First, we aimed to validate a human laboratory model of food-appetitive behavior using a classical demand curve approach. To our knowledge, this is the first investigation to use a human laboratory choice task to assess demand curves for two different *food* options. The secondary aim was to assess the association between individual difference factors that may alter food choice behavior. Two studies were conducted to accomplish these aims. The goal of Study 1 was to demonstrate that *consecutive* session demand curves could be generated to significantly differentiate the reinforcing efficacy of two food options varying in palatability. It was hypothesized that a high-sugar/high-fat option (Dove Milk Chocolate™) would maintain a greater reinforcing efficacy and inelastic behavior compared to a low-sugar/low-fat option (Teddy Grahams™). Study 2 was conducted to demonstrate that *concurrent* session demand curves could be generated to significantly differentiate the reinforcing value of two food options, equated on mass, calories, and fat, and differing on only one major nutrient dimension (i.e., high-sugar/high-fat vs. low-sugar/high-fat options). Study 2 also assessed individual difference variables (BMI, dietary restraint, impulsivity) to evaluate whether they impact food choice responding in this paradigm. These relationships were assessed to provide additional evidence of validity for this model. Validity for this procedure would be supported if food choice responding relates to BMI, restraint, and impulsivity in ways that have been supported in the extant literature. While it was once again hypothesized that the high-sugar/high-fat option (Hershey Milk Chocolate Kiss™) would maintain greater reinforcing efficacy and inelastic behavior compared to the high-fat/low-sugar option (Kraft Cheddar Cheese Cubes™), BMI, dietary restraint, and impulsivity were expected to moderate this relationship. In particular, both higher BMI and greater dietary restraint were expected to be associated with greater food-inelastic demand during experimental sessions for the hypothesized more palatable (high-fat/high-sugar) food option. Additionally, more extreme discounting (higher impulsivity) was expected to be associated with greater food-elastic demand, as individuals high in impulsivity are likely to desire smaller, more immediate outcomes. Individuals who choose more immediate food rewards, however, may discount future problems associated with obesity (Epstein, Leddy, Temple & Faith, 2007).

Methods

Overview

In the two experiments reported here, candidates were screened using online survey methodology, and those who met eligibility criteria were invited to the laboratory to complete either a consecutive (Study 1) or concurrent (Study 2) food choice study in which they were asked to complete a computerized task to earn access to food varying in amount and type. The details of the two choice procedures are described below, under Study 1 and Study 2, respectively, but we first provide the general framework. Both the screening and experimental phases of the project were reviewed and approved by the Eastern Michigan University Human Subjects Review Committee (IRB).

Recruitment

Email invitations were sent to undergraduate psychology instructors requesting that they distribute a 20–30 min screening survey to students. A link to this screening survey was also posted