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Daily consumption of individual snack foods decreases their reinforcing value

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Abstract

The reinforcing value of food is one factor that influences energy intake. The purpose of this study was to determine if the reinforcing value of highly liked snack foods could be modified by restriction or daily intake of individual preferred foods in the absence of changes in total energy intake. Food reinforcement was tested at baseline and after each of two, two-week phases. During the restriction phase, participants did not eat a target food or closely related foods while during the daily intake phase, participants consumed a 200–300 kcal portion of the target food daily. The reinforcing value of the target food significantly decreased after two weeks of daily intake. Restriction did not change food reinforcement. These data suggest that eating a portion of a highly palatable food every day decreases its reinforcing value. Implications for weight control are discussed.

Keywords: Food reinforcement; Restriction; Satiation; Satiety; Energy intake; Dieting

1. Introduction

The prevalence of overweight and obesity is increasing in all developed countries. Weight gain and obesity are due to positive energy balance in which energy intake exceeds energy expenditure. Energy intake in humans is a complex process that is driven by both homeostatic and hedonic motivations (Blundell & Finlayson, 2004; Lowe & Levine, 2005; Saper, Chou, & Elmquist, 2002). These separate, but overlapping, processes have evolved to ensure proper nutrient and energy intake (homeostatic) as well as to reinforce eating behavior by increasing the reward value of foods with desirable sensory properties (hedonic) (Kringelbach, 2004).

One factor that influences energy intake is the reinforcing value of food (Epstein, Leddy, Temple, & Faith, 2007). Reinforcing value is defined as the amount of work an individual is willing to perform to gain access to food, measured using progressive ratio schedules of reinforcement in which the schedule of reinforcement increases after each food reinforcer is earned (Epstein, Leddy et al., 2007; Epstein, Temple, Neaderhiser, Salis, & Leddy, 2007). High levels of food reinforcement are related to greater energy intake, and food reinforcement is a better predictor of energy intake than

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self-reported food liking (Epstein, Temple et al., 2007; Epstein et al., 2004). In addition, obese adults, who would be expected to have elevated energy intake, find food more reinforcing than non-obese adults (Epstein, Temple et al., 2007; Saelens & Epstein, 1996). Because the regulation of energy intake is influenced by factors that also regulate food reinforcement, identification of mechanisms by which the reinforcing value of food can be altered may be a valuable tool that can potentially be used to modify ingestive behavior.

The most widely-used weight loss strategies encourage reducing energy intake, primarily by limiting or eliminating intake of high energy density foods (Brownell, 1999). Thus, in addition to restriction of energy intake in general, intake of preferred foods is simultaneously restricted. It is common for overweight people to lose weight and then to relapse over time, which may be due in part to restriction of energy intake or to restriction of highly liked, highly reinforcing foods, which may increase their reinforcing value and motivation to eat. Research has shown the reinforcing value of food is increased after acute food deprivation or restriction (Epstein, Truesdale, Wojcik, Paluch, & Raynor, 2003; Raynor & Epstein, 2003). Restriction of highly palatable foods can increase craving for them relative to foods that are not restricted (Gendall, Joyce, Sullivan, & Bulik, 1998; Pelchat, 1997; Polivy, Coleman, & Herman, 2005), which may be enhanced for foods that are not easily replaced, or substituted, with other foods (Polivy et al., 2005).

In contrast to the effects of restriction, repeated reinforcer presentation leads to a reduction in reinforcer efficacy (Murphy, McSweeney, Smith, & McComas, 2003), and reduced motivation to obtain the reinforcer. The effect of repeated presentation of a reinforcer on within-session changes in responding for food has been observed in animals (McSweeney, Hinson, & Cannon, 1996; McSweeney & Swindell, 1999a) and in humans (Epstein, Saad et al., 2003; Temple et al., 2006). When larger reinforcers are used or exposure to reinforcers is prolonged, loss of reinforcer efficacy occurs at a faster rate (Bizo, Bogdanov, & Killeen, 1998). One extension of this research is that repeated forced consumption of palatable foods over days may lead to reduced motivation to consume those foods.

The purpose of this study was to examine the effects of manipulating intake of specific, highly liked foods on reinforcing value. Food reinforcement was measured at baseline and after two, two-week phases: restriction, where a target food was restricted, and daily intake, where the same target food was consumed daily. We hypothesized that restriction and daily intake would have opposing effects, with restriction of a preferred target food resulting in an increase in reinforcing value and daily intake of that food resulting in a decrease in reinforcing value.

2. Methods

2.1. Participants

Participants were male ($n=10$) and female ($n=14$) adults recruited from flyers posted on the University at Buffalo campus. In order to first establish an effect in non-obese adults and to minimize potential variability related to age, we excluded participants who were <18 years old or >40 years old or had BMI ≥ 30. Additional exclusionary criteria included: smoking, self-reported current dieting, scores of >27 on the Binge Eating Scale (Spitzer et al., 1993) and a Binge Eating Disorder indication on the Questionnaire of Eating and Weight Patterns (Gormally, Black, Daston, & Rardin, 1982), any medications that might affect appetite (ex. methylphenidate), and any digestive, endocrine or nervous system disorder that may limit eating.

2.2. Screening procedures

Potential participants were first screened by phone to collect demographic and basic medical information (height/weight, current medications or illnesses, etc). After this, several questions were asked to get a general indication of dietary restraint, including: "Do you count calories when you eat?", "Do you avoid stocking up on tempting foods in order not to gain weight?", "Do you often diet in a conscious manner to loose weight?". In order to reduce the variability that may be introduced by participants with extreme levels of dietary restraint, participants were not eligible of they answered yes to >5 of the 14 questions about dietary habits. Once determined to be eligible, they were given a basic description of the study. If interested, potential participants were given a list of 22 foods and rated each one on a 7-point scale for liking (1="Do not like at all" and 7="Like very much"), number of times consumed each week, perceived difficulty restricting for two weeks and difficulty consuming daily for two weeks (1="Extremely easy" and 7="Extremely difficult"). The list of foods included potato chips, Doritos™, tortilla chips, pretzels, popcorn, ice cream, M&Ms™, Twix™, Butterfinger™, other candy bars, Oreos™, Chips Ahoy™, other cookies, carrots, muffins, donuts, cupcakes, cake, brownies, grapes, yogurt, and french fries. In addition, participants were asked if there were additional foods that they enjoy eating for snacks that were not mentioned on this list. The target food to be used for testing was selected based on the liking score and the number of times consumed per week. All target foods were liked at least a 5 on the 7-point scale and were consumed 3–5 times per week. We chose foods that were highly liked and consumed frequently, but target foods were not consumed every day so our manipulations would be