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Research Report

Smoking, dietary restraint, gender, and the relative reinforcing value of snack food in a large university sample

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Abstract

The present study examined the independent and interactive association between smoking, gender, dietary restraint and the relative reinforcing value of snack food in a university sample. Four hundred and three introductory psychology students completed questionnaires assessing age, gender, BMI, hunger, smoking status, nicotine dependence, dietary restraint, hedonic ratings and the relative reinforcing value of snack food and fruits and vegetables. The relative reinforcing value of snack food was determined by the number of button presses subjects would be willing to do to obtain (100 g) of snack food versus 100 g of fruits and vegetables. Multiple regression analyses yielded a significant three-way interaction of gender, restraint, and smoking in predicting the relative reinforcing value of snack food indicating that in female smokers, dietary restraint was inversely associated with the relative reinforcing value of snack food, whereas in male smokers, restraint was not significantly related with the reinforcing value of snacks. These findings remained significant after controlling for BMI, hunger, and hedonics, suggesting that there are gender differences in relationship between smoking, dietary restraint, and snack food reinforcement. Among female university students, smoking moderates the relationship between dietary restraint and food reinforcement whereby high-restraint female smokers appear to be at lower risk of over-consuming energy dense snack food compared to low-restraint female smokers, while high-restraint male smokers may not be at higher risk than low-restraint male smokers.

Keywords: Food reinforcement; Relative reinforcing value of food; Eating; Smoking; Dietary restraint; Gender

Food is very reinforcing (Berridge, 1996; Salamone, 1994) and in some cases, can be as reinforcing as drugs of abuse such as heroin (Carroll & Carmona, 1991; Elsmore, Fletcher, Conrad, & Sodetz, 1980; Hursh & Bauman, 1987). Although food is a primary reinforcer (Berridge, 1996; Salamone, 1994), by repeated association of pleasure and hedonic feelings derived from the anticipation and ingestion of palatable food, food adopts secondary reinforcing effects (Del Parigi, Chen, Salbe, Reiman, & Tataranni, 2003). The reinforcing value of food or any reward can be defined as how hard an organism is willing to work to gain access to food (Nader & Woolverton, 1991), and is usually defined in terms of how many responses will be made on a particular schedule of reinforcement to obtain food (Epstein & Leddy, 2006). Much advancement in the neurobiology and genetics of food reward research has been made. Dopamine is a neurotransmitter that mediates the rewarding value of a wide range of appetitive behaviours (i.e., drug abuse, eating, sex). Recent data show reduced brain dopamine, invoked either by impaired physiology or genetic polymorphisms regulating the production, release, uptake and/or receptor signalling, has been associated with increased reinforcing value of food, greater food intake (Epstein et al., 2004) and obesity (Epstein, Truesdale, Wojcik, Paluch, & Raynor, 2003; Epstein et al., 2004; Wang, Volkow, & Fowler, 2002; Wang et al., 2001). This body of

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research indicates that the reinforcing value of food is a strong determinant of food intake, is influenced by synaptic dopamine availability, and high food reinforcement may contribute to excessive energy intake, increasing the risk of becoming overweight or obese. Therefore, obtaining a better understanding of the independent and interactive determinants of food reinforcement may help identify risk and preventive factors, as well as targets for intervention designed to treat or prevent obesity or eating disorders.

Moderate to severe caloric deprivation reliably increases the motivation to eat and the reinforcing value of food (Epstein & Leddy, 2006), including snack foods (Raynor & Epstein, 2003). Given many obese people diet in attempt to lose weight, it may be theoretically hypothesized that the positive association between dieting and weight gain may be mediated by increases in the reinforcing value of food caused by the psychological and physiological effects of deprivation (Epstein & Leddy, 2006), which may, in turn, precipitate overeating (Polivy & Herman, 1985). Many studies have investigated a type of disordered eating behaviour known as dietary restraint, defined as those who have concerns about weight and who try to restrict food intake to control body weight. Most of these studies were conducted in the context of stress or other potential "disinhibitors" in restrained eaters, with a general trend showing that stress increases food intake in restrained compared to non-restrained eaters, while intake stays the same or decreases in non-restrainers (Greeno & Wing, 1994). However, most of the laboratory studies investigating factors that influence the reinforcing value of food have excluded smokers, restrained eaters and males (Epstein & Leddy, 2006), thus, it is uncertain how chronic dietary restraint is related to food reinforcement, and whether smoking and/or gender moderate this relationship. Gaining a further understanding of how restraint and smoking interact to influences food reinforcement as a proxy for ingestive behaviour is important for identifying which subpopulations are at risk and the processes (i.e. the reinforcing value of food) involved that may confer the risk or protection of overeating.

Dietary restraint is believed to be an important cognitive and behavioural component of the maintenance and perhaps development of anorexia nervosa, over eating, and binge eating (Brewerton, Dansky, Kilpatrick, & O'Neil, 2000; Howard & Porzelius, 1999; Polivy & Herman, 1993). The literature on dietary restraint and food intake in human laboratory research shows mixed findings. Restricting foods for brief periods of time has been shown to increase preference and consumption of the restricted food in animals (Corwin, Wojnicki, Dimitriou, Rice, & Young, 1998) and children (Fisher & Birch, 1999a, 1999b). However, food restriction did not increase consumption (Mann & Ward, 2001) or the relative reinforcing value of food in an experiment designed to simulate real world conditions of dietary restraint (Raynor & Epstein, 2003). Less work has been done in the natural environment on the relationship between dietary restraint and ingestive behaviour. Some research has found dietary restraint predicted positive energy balance leading to weight gain (Field, Austin, Taylor, & Malspeis, 2003), but other research found no relationship between restraint and weight change over time (van Strien et al., 2007). Recent laboratory studies found that restraint (RS, TFEQ, DEBQ) was not related to food intake, and that tendency to overeat was a better predictor of food intake than restraint (Ouwens, van Strien, & van der Staak, 2003b; van Strien, Cleven, & Schippers, 2000). Not surprisingly, the relationship between restraint and indices of ingestive behaviour, both in the laboratory and natural environment, appears to be influenced by the presence or absence of a pre-load or other disinhibiting stimuli, sample characteristics, as well as the scale used to measure restraint (Gorman & Allison, 1995; Williamson et al., 2007). New research by Del Parigi et al. (2007) found that in response to meal consumption, successful dieters had a greater activation in the dorsal prefrontal cortex (DPFC), dorsal striatum and anterior cerebellar lobe as compared to non-dieters, raising the possibility that cognitive control over food intake is achieved by modulating neural circuits controlling food reward.

Smoking is another appetitive behaviour that has been widely studied in relation to eating behaviour and body weight. Smoking is inversely related to body weight, and smoking cessation usually results in weight gain (Klesges, Meyers, Klesges, & LaVasque, 1989). Although smoking increases metabolism (Perkins, 1992b), most of the weight suppressing effects of smoking are likely due to its influence on caloric intake (Perkins, 1992a; Perkins et al., 1991). There is evidence that smoking may reduce food intake more in females compared to males (Grunberg, Winders, & Popp, 1987), and post-cessation weight gain may be greater in females (Williamson et al., 1991). Subsequent research, however, found that the anorectic effects of smoking were more pronounced in a subset of women who were high in dietary restraint (Ogden, 1994), consistent with findings indicating that restrained eaters are more likely to report weight control as their motivation for smoking compared to non-restrained eaters (Ogden & Fox, 1994). Relatedly, Duffy and Hall (1988) found in a study of male and female smokers that 24-h abstinence from smoking was associated greater intake of ice cream compared with no-abstinence, but only for those high in dietary restraint. Unfortunately, gender differences were not directly examined. Despite this literature, very little research has examined how smoking influences the reinforcing value of food, which may shed light on the mechanisms by which smoking influences energy intake. Perkins, Epstein, Fonte, and Mitchell (1995) observed that the relationship between dietary restraint and reinforcing value of food was complex as it may be moderated by smoking and gender. For example, the reinforcing value of food was significantly less during smoking versus abstinence conditions for high-restrained females only and not for low-restraint females or for males (Perkins et al., 1995). This finding supports the notion that