



Research report

Food cravings and food cue responding across the menstrual cycle in a non-eating disordered sample

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ABSTRACT

The study aim was to examine changes in food cue-elicited cravings and the macronutrient content of craved foods across menstrual cycle phases in a non-eating disordered sample. Thirty-five college females attended laboratory sessions in the late follicular and late luteal phases. In each session they completed a measure of state food craving before and after exposure to preferred, high fat/high sugar chocolate candy. Candy consumption following cue exposure was measured during an *ad libitum* "taste test." Additionally, participants rated their desire to eat foods differing systematically and significantly in macronutrient content. Ovulation was confirmed with luteinizing hormone detection kits. Results show that whereas the food cue increased cravings, this effect did not differ between cycle phases examined. The macronutrient content of foods desired also did not differ significantly between cycle phases, however, a non-significant trend suggested that high fat/high complex carbohydrate and low fat/high protein foods were more strongly desired in the late luteal phase. Amount of chocolate candy eaten did not differ between cycle phases. These results suggest that cravings for high fat/high sugar foods do not differ between menstrual cycle phases examined, whereas cravings for other foods may fluctuate across cycle phases in non-eating disordered women.

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Introduction

Food cravings, defined as "intense desire[s] to eat a specific food or food type," (Hill, 2007; Weingarten & Elston, 1990) are associated with higher Body Mass Index (BMI; Delahanty, Meigs, Hayden, Williamson, & Nathan, 2002; White, Whisenhunt, Williamson, Greenway, & Netemeyer, 2002) as well as eating disorders (Cepeda-Benito, Fernandez, & Moreno, 2003; Mussell et al., 1996). Women consistently endorsed greater food cravings than men (Lafay et al., 2001; Weingarten & Elston, 1990; Zellner, Garriga-Trillo, Rohm, Centeno, & Parker, 1999). Notably, women also have higher rates of obesity and eating disorders than men (Flegal, Carroll, Ogden, & Curtin, 2010; Geary & Lovejoy, 2008; Hudson, Hiripi, Pope, & Kessler, 2007). These sex differences, considered together with evidence showing that food cravings are associated with eating and weight pathology, suggest that women's food craving experiences may be relevant in the etiology, maintenance, and treatment of obesity and eating disorders.

There is evidence that the frequency and intensity of food cravings may fluctuate across the menstrual cycle in women. In retrospective studies, women have commonly endorsed an increase in

food cravings during the days prior to menses (i.e., the late luteal phase), with some studies also finding elevations in food cravings during menses (Dye, Warner, & Bancroft, 1995; McVay, Copeland, & Geiselman, 2011; Rozin, Levine, & Stoess, 1991). However, retrospective ratings of menstrual cycle symptoms may result in greater symptom reporting than prospective or daily ratings (Marván & Cortés-Iniestra, 2001; Parlee, 1982). Fortunately, a few studies have utilized data collection approaches that reduce reliance on retrospective accounts. These studies have also typically found an increase in food cravings in the late luteal phase (Gallant, Hamilton, Popiel, Morokoff, & Chakraborty, 1991; Hill & Heaton-Brown, 1994) or mid-to-late luteal phase of the menstrual cycle (Cohen, Sherwin, & Fleming, 1987). However, the strength of these findings is reduced due to common methodological limitations, including imprecise definitions of menstrual cycle phases; inattention to individual variability in menstrual cycle length; the use of measures that have not been tested for reliability or validity; and lack of verification of ovulation in study participants (Cohen et al., 1987; Hill & Heaton-Brown, 1994; Yen et al., 2010). This latter problem is important, as anovulation is common among young women (Metcalf & Mackenzie, 1980) and may attenuate luteal phase appetite changes (Barr, Janelle, & Prior, 1995). Additionally, past studies that have attempted to measure food cravings using daily diary or ecological momentary assessment methods have been limited in that participants' recordings have not been verified to

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have occurred on the reported date of recording (Hill & Heaton-Brown, 1994).

Past studies have also been limited by a lack of attention to participants' level of eating disorder symptomatology, resulting in the inclusion of a heterogeneous sample with regards to eating disorder pathology. This is important, as some recent research suggests that eating disorder pathology may impact menstrual cycle fluctuations in eating-related variables. Specifically, some studies utilizing retrospective self-reports have found that menstrual cycle-related fluctuations in food cravings are associated with greater eating and weight pathology (Hormes & Timko, 2011; McVay et al., 2011). Additionally, women with bulimia nervosa have been shown to have increased binge eating symptoms during the luteal phase (Gladis & Walsh, 1987; Lester, Keel, & Lipson, 2003). Whereas this research suggests that non-eating disordered women may have lesser fluctuations in food cravings across the menstrual cycle than eating disordered women, it is also relevant to note that other researchers have detected menstrual cycle-related variations in emotional eating in a non-eating disordered sample (Klump, Keel, Culbert, & Edler, 2008). Given that past studies examining food cravings have combined women with and without eating disorder pathology, it is of interest to study menstrual cycle variations in food cravings in a sample of non-eating disordered women.

Although previous studies have focused on frequency and intensity of food cravings across the menstrual cycle, no known study has examined the effects of the menstrual cycle on cravings specifically in response to environmental food cues. Food cravings are commonly reported following food cue exposure in the laboratory (Cornell, Rodin, & Weingarten, 1989; Nederkoorn, Smulders, & Jansen, 2000; Tetley, Brunstrom, & Griffiths, 2009) and outside the laboratory, food cravings appear to be frequently precipitated by exposure to food cues (Hill & Heaton-Brown, 1994). Importantly, food cue-elicited cravings have been found to be associated with binge eating (Sobik, Hutchison, & Craighead, 2005) and overweight (Ferriday & Brunstrom, 2011).

Though further research is needed to determine the effects of the menstrual cycle on food cravings, there is a substantial body of well-designed research demonstrating cyclical variations in the amount of food women eat. Specifically, women consume fewer kilocalories during the late follicular and periovulatory phases of the menstrual cycle compared to the luteal phase (Bryant, Truesdale, & Dye, 2006; Geiselman et al., 2006; Johnson, Corrigan, Lemmon, Bergeron, & Crusco, 1994; Pelkman, Chow, Heinbach, & Rolls, 2001). Fluctuations in the female sex hormones estrogen and progesterone appear to account for these cyclical variations in food intake. In women, estrogen levels are elevated and progesterone levels are low during the late follicular and periovulatory phases of the menstrual cycle, phases in which food intake is at its nadir. Similarly, food intake is lower during days when estrogen levels are high and progesterone levels are attenuated across a variety of vertebrate animal species, including rats, guinea pigs, and monkeys (Czaja & Goy, 1975; Drewett, 1974; Eckel, Houpt, & Geary, 2000; Geiselman & Smith, 2006). Experimental studies in animals have supported the role of estrogen and progesterone in food intake (Asarian & Geary, 2002; Bartness & Waldbillig, 1984; Wade, 1975). Potentially, the lower levels of estrogen and higher levels of progesterone during the luteal phase may contribute to increased food cravings and food cue responding. Supporting this hypothesis, a relationship has been found between binge eating and elevated progesterone and lower estrogen during the luteal phase of the menstrual cycle (Edler, Lipson, & Keel, 2007; Klump et al., 2008).

Macronutrient content of food cravings

Limited attention has been given to the macronutrient content of craved foods as it relates to the menstrual cycle. This is unfortu-

nate, as the macronutrient content of foods has a significant impact on appetite motivation and food intake, and thereby has important implications for weight control. Numerous studies have shown that individuals consume more total energy when provided with foods high in fat than when given lower fat foods (Blundell & Macdiarmid, 1997; Lissner, Levitsky, Strupp, Kalkwarf, & Roe, 1987; Stubbs, Harbron, Murgatroyd, & Prentice, 1995). Whereas foods high in fat tend to promote hyperphagia, foods high in protein are associated with greater satiation and satiety (Green, Burley, & Blundell, 1994; Rolls, Hetherington, & Burley, 1988). Studies have also suggested that foods high in simple sugars may contribute to hyperphagia (Raben, Macdonald, & Astrup, 1997; Rolls et al., 1988). The combination of fat and sugar may be particularly conducive to increased food intake (Drewnowski & Greenwood, 1983; Rolls et al., 1988) and the intake of high fat/high sugar foods is associated with obesity in women (Drewnowski, Kurth, Holden-Wiltse, & Saari, 1992; Macdiarmid, Vail, Cade, & Blundell, 1998).

Though the effects of the menstrual cycle on the macronutrient content of food cravings have not been well-studied, a specific increase in high fat/high sugar foods during the late luteal phase can be hypothesized for several reasons. Women have reported an increase in cravings for chocolate foods, which are typically high in fat and sugar, during this menstrual cycle phase (Rozin et al., 1991; Zellner, Garriga-Trillo, Centeno, & Wadsworth, 2004). Additionally, past research has shown a specific increase in the consumption of dietary fats during the late luteal phase of the menstrual cycle (Johnson et al., 1994; Tarasuk & Beaton, 1991) and data indicate that people tend to consume the foods they crave (Hill & Heaton-Brown, 1994).

In one of the few studies to examine the differences in types of foods that women crave across the menstrual cycle, Hill and Heaton-Brown (1994) reported that cravings for "chocolate-containing foods," "sweet-tasting foods" and "savory foods" increased similarly during the days prior to menses. Unfortunately, it is unclear what criteria guided the classification of foods as sweet or savory in this study, making it difficult to interpret these findings with respect to the macronutrient content of craved foods. In a recent study by Yen et al. (2010), 60 women without Premenstrual Dysphoric Disorder were tested during the luteal phase and the follicular phase of their menstrual cycle. During each testing, participants completed an adapted version of the Food Craving Inventory (FCI), a measure that evaluates cravings for many different types of foods over the past month and includes the subscales of High Fat Foods, Sweets, Carbohydrates/Starches, and Fast Food Fats (White et al., 2002). The authors reported a luteal phase increase in ratings for foods in the Carbohydrate/Starches and Fast Food Fats. However, a few limitations present in this study suggest the need for further research. First, though the FCI provides useful information on empirically derived categories of food cravings, it does not allow for a systematic examination of the macronutrient content of craved foods. Second, the researchers also did not verify ovulatory status, nor did they appear to verify that luteal phase data collection was accurately scheduled during the luteal phase. Third, it is unclear if the researchers controlled for the participant's nutritional status (i.e., what they ate and how recently they had eaten) prior to the study.

Summary and specific aims

In the current study, a laboratory-based food cue exposure paradigm was utilized to measure food craving in response to a preferred high fat/high sugar chocolate candy cue among non-eating disordered women during two menstrual cycle phases: the late follicular phase and the late luteal phase. Chocolate was utilized because it is the most commonly craved food by women (Rozin et al., 1991), and women frequently report craving chocolate pre-

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