Symposium: Sugar and Fat—From Genes to Culture

Sugar and Fat: Cravings and Aversions

Susan Yanovski

National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD 20892

ABSTRACT Food cravings are extremely common, particularly among women. Cravings are frequently reported for specific types of foods, including chocolate and foods high in both sugar and fat. Cravings for specific macronutrients, such as carbohydrate, have been postulated to result from a physiological need to alter neurotransmitters in such states as eating disorders, affective disorders or obesity. However, studies of such cravings are often confounded by differing sensory properties of high and low carbohydrate foods. There is some evidence that sweet, high fat foods are preferred by women with binge-eating disorders and that those preferences are mediated by the endogenous opioid system. Aversion to fat is seen primarily in women with anorexia nervosa. However, it is possible that changes in fat preference may be achieved through behavioral or pharmacological approaches. An understanding of food cravings and aversions may lead to improved methods for the prevention and treatment of obesity and eating disorders. J. Nutr. 133: 835S–837S, 2003.

KEY WORDS: • obesity • eating disorders • binge eating • macronutrient craving

Craving is defined as “a consuming desire or yearning” (1). Cravings for foods are extremely common, with 97% of women and 68% of men reporting episodes of food cravings (2). Much of the literature on food cravings has been devoted to carbohydrate cravings and to the connection between food and mood. A frequently proposed theory is that many individuals ingest carbohydrates in an effort to elevate mood (3). This postulate states that, in essence, food is being used as a form of self-medication to ameliorate unpleasant affective states. This occurs through increases in the brain neurotransmitter serotonin, which is known to have a positive impact on mood.

Animal studies have found that diets that increase the ratio of tryptophan relative to other amino acids lead to higher levels of brain tryptophan and increased serotonin synthesis (4,5). This is said to occur via reduction in plasma levels of large neutral amino acids that compete with tryptophan for transport across the blood-brain barrier (6). Tryptophan is a precursor for the neurotransmitter serotonin, which is believed to be important in both affect and appetite regulation (7).

Carbohydrate craving has been reported in bulimia nervosa, premenstrual syndrome and seasonal affective disorder (3,8,9). Many eating-disordered individuals report “carbohydrate craving” during binge episodes (7). However, studies evaluating macronutrient composition of binge episodes in laboratory feeding studies (10,11) and in recorded information from food diaries (12,13) do not support a preferential consumption of carbohydrate during binge versus nonbinge episodes, in either normal-weight women with bulimia nervosa or obese women with binge-eating disorder. Although the absolute amounts of protein, carbohydrate and fat increase during a binge episode, the macronutrient content of binge and nonbinge episodes, expressed as a percentage of energy, generally remains constant (11). In a laboratory study, binge-eating episodes were associated with an increased percent energy from fat, reduced percent energy from protein and unchanged percentage of energy from carbohydrate (10).

Another study of self-identified frequent cravers examined the impact of macronutrients, carbohydrate, protein or fat on subsequent craving and binge eating (14). Subjects were randomly preloaded on three separate occasions with a high protein, high carbohydrate and mixed meal of similar energy content, fat content and weight. The high protein meal condition increased susceptibility to cravings for sweet-tasting, palatable food and increased ad libitum consumption of these foods, relative to the high carbohydrate or mixed-meal conditions. However, the study had several limitations. The nine subjections included women who were taking antidepressant medications on a chronic basis (44%) and women who had a diagnosis of bulimia nervosa (11%), major depression (56%) and/or substance abuse (22%). The different meal conditions, although isocaloric, had different sensory properties, and subjects were easily aware that some meals were high in protein, whereas others were high in carbohydrate. Expectations could play a role, as could sensory-specific satiety.

One study of 24 women with premenstrual syndrome attempted to control for such factors. Based on a double-blind crossover design, the study found that a carbohydrate-rich beverage decreased negative mood symptoms at 180 min and carbohydrate "craving" at 90 min relative to isocaloric beverages with similar sensory properties (15). The carbohydrate-
rich beverage was designed to increase the ratio of tryptophan to large neutral amino acids, whereas the control beverage was not (15).

**Chocolate: craving versus “addiction”**

One cannot discuss cravings, sugar and fat without discussing the role of chocolate. Chocolate is the most frequently craved food in North America (16). Chocolate cravings are endorsed by 40% of women and 15% of men (17), and although many chocolate cravers report an overall preference for sweet foods, most report that other foods will not suffice to satisfy a craving for chocolate (18).

Whether chocolate can be defined as an addiction, which requires compulsion to use a substance, uncontrolled consumption and existence of withdrawal symptoms, is a matter of some debate (16). Numerous studies describe psychoactive substances in chocolate, including theobromine (a weak central nervous system stimulant), ergotamine (a potent hallucinogen), phenylethylamine (an amphetamine-like compound) and caffeine. However, the amounts of these psychoactive substances are so small as to be unlikely to play a major role in chocolate consumption (19,20). Because chocolate is high in magnesium, it has been suggested that a deficiency of magnesium may play a role in chocolate craving; however, other foods much higher in magnesium (such as nuts) are rarely the object of craving (16). In a study attempting to differentiate orosensory from pharmacological effects of chocolate, Michener and Rozin (20) randomly presented “chocolate cravers” with sealed boxes containing a milk chocolate bar, a white chocolate bar or capsules containing cocoa (which theoretically would contain the “psychoactive” substances in chocolate), capsules containing white chocolate and cocoa or placebo capsules. Only consumption of the white or milk chocolate bars reduced chocolate craving, suggesting that orosensory, rather than pharmacological, effects were primarily involved in chocolate craving.

A subset of chocolate cravers may show elevated levels of eating disordered and general psychopathology. One study found that self-described “chocolate addicts” scored higher in disinhibition and hunger on the Three-factor Eating Questionnaire (21), as well as other measures of disordered eating and depression, than did controls (22). In response to chocolate exposure (visual and smell), they reported greater cravings; however, no consistent difference was found in physiological responses, such as salivation or heart rate. When presented with a large amount of chocolate (200 g), the “chocolate addicts” ate more than twice the amount of controls (112 versus 45 g). However, the “chocolate addicts” were both older (mean age, 39.8 versus 30 years) and heavier (mean body mass index, 28.8 versus 24.4 kg/m²), and although these differences were not statistically significant, due to the small group size, an effect of age or body mass index cannot be ruled out.

**Sweet and high fat foods**

Women in particular report extreme liking of or craving for foods that are both sweet and high in fat (e.g., candies, cakes or pastries, ice cream) (23). One proposed model for binge eating of palatable foods (particularly those rich in both sugar and fat) is that intake of these foods is influenced by the opioid peptide system. Drewnowski et al. (24,25) found that the opiate antagonist drug naloxone reduced hedonic preferences for sugar/fat mixtures in both binge eaters and controls. Naloxone also preferentially reduced intake of sweet high fat foods in binge eaters compared with low fat carbohydrates, such as pretzels, jelly beans or popcorn (Fig. 1). Although there may be a modest role of opioid involvement in the consumption of sweet high fat foods, particularly among binge eaters, it does not appear that the use of opioid antagonists is clinically useful in achieving or sustaining reductions in body weight (19,23).

**Fat aversion**

Aversion to fat has been described in eating disordered individuals, such as those with anorexia nervosa (26) Among the majority of those in westernized societies, fat consumption is regarded as pleasurable. Fats increase the palatability of foods, helping to enhance food flavors, odors and textures. The hedonic value of fat may decrease when sensory exposure to fat is absent over an extended period of time, although this may not translate into a longer-term reduction in fat consumption (27,28). Because a high fat diet is considered to be an important factor in the establishment or maintenance of overweight, reduction in fat consumption is desirable from a public health perspective.

Orlistat is a gastrointestinal lipase inhibitor that results in the excretion of about one third of ingested dietary fat into the stool. It is currently approved for weight loss and the maintenance of weight loss in obese adults (29). One question has been whether the averse gastrointestinal side effects (bloating, loose stools) seen after a high fat meal while taking Orlistat might lead to aversion for high fat foods, an “Ant-abuse effect.” Alternatively, because Orlistat is prescribed during a moderate fat (30% kcal from fat) diet and higher fat levels produce side effects and may improve adherence to the prescribed diet, the consumption of a lower fat diet over time might decrease liking for high fat foods. In a preliminary study, McDuffie et al. (30) tested whether the hedonic value of high fat foods changed in overweight adolescents taking Orlistat in the context of a 30% fat diet over a 3-mo period. Seventeen adolescents (nine females and eight males) completed hedonic value ratings, at baseline and after 3 mo of Orlistat treatment, for vanilla pudding (0%–16% fat) and tomato soup (0%–16% fat). Subjects were blinded to fat content, sample order was randomized and each sample was tasted twice, in fixed volumes. The average weight loss at 3 mo was 3.7 kg. Although there was no change in the hedonic value ratings for the soup (which showed little variability), hedonic ratings for the va-
nilla pudding increased for the 4% and 8% fat levels and decreased for the 16% fat level. This change in fat preference was independent of weight change. Although the study was limited by small sample size and the absence of a control group, this study suggests that treatment with Orlistat may play a role in decreasing liking of high fat foods.

In summary, although food cravings are very common, evidence for specific macronutrient craving as a form of self-medication appears to be inconsistent at best. Many human studies are confounded by the differing orosensory properties of isocaloric “carbohydrate” and “protein” foods. There is some evidence that sweet, high fat foods are strongly preferred by women and that there may be involvement of the opioid system in such preferences. The potential impact of macronutrient composition on craving for carbohydrates or sweet/fat combinations remains an interesting topic for further investigation. The possibility of decreasing preference for high fat foods, through either pharmacological or behavioral intervention, is another potentially fruitful area for study. Understanding the mechanisms underlying food cravings and aversions may lead to improved methods for the prevention and treatment of obesity and eating disorders.

LITERATURE CITED