



Original Article

Mood and carbohydrate cravings

L. Christensen and L. Pettijohn

University of South Alabama

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The relationship between mood and carbohydrate cravings, and the possible role of gender in these associations, was investigated in a sample of 113 males and 138 female college students. Participants completed a Cravings Questionnaire and several mood inventories (profile of mood states, Beck Depression Inventory, and the Vitality Inventory) in groups of 25. Individuals classifying themselves as "carbohydrate cravers" reported foods rich in carbohydrates, and "protein cravers" reported protein-rich foods as being the ones they most strongly craved. Carbohydrate cravers reported feeling distressed prior to their cravings and satisfied, happy/good and relaxed following carbohydrate consumption. Protein cravers reported feeling anxious or hungry prior to their cravings and happy, normal, bored, and energetic following protein-rich food consumption. A non-significant correlation existed between "protein" cravers' ratings of craving intensity and mood, but a significant positive correlation existed between "carbohydrate" cravers' ratings of craving intensity and almost all mood scales assessed for both male and female "carbohydrate" cravers. The correlation between craving intensity and mood existed predominately with individuals who craved sweet carbohydrate-rich foods.

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Introduction

The hypothetical construct of cravings, an intense desire or longing for a particular substance (Weingarten & Elston, 1990), has a rather lengthy history as a key explanatory concept in models of both addiction and alcoholism (Tiffany, 1990). More recently, the term has been used to refer to the urge to seek out and consume particular foods. Up to 97% of women and 68% of men report food cravings (e.g. Weingarten & Elston, 1991). The significance of investigating food cravings is seen in studies (e.g. Bjorvell, Ronnberg & Rossner, 1985) reporting that overweight women indicate that carbohydrate cravings are a precipitant of unwanted eating and an impediment to weight loss.

Of the different types of food that have been investigated, carbohydrate cravings seem to have attracted

the most attention. This may be because carbohydrate cravings, originally defined as "a ravenous appetite for a variety of sweet substances including chocolates, cake, pastry, and ice cream" (Paykel, Mueller & de la Vergne, 1793, p.503), have frequently been reported in women experiencing premenstrual syndrome (e.g. Bancroft, Cook & Williamson, 1988; Bowen & Grunberg, 1990; Cohen, Sherwin & Fleming, 1987; Smith & Sauder, 1969), individuals with seasonal affective disorder (e.g. Lingjaerde & Reichborn-Kjennerud, 1993; Rosenthal *et al.*, 1984), and overweight individuals (Wurtman & Wurtman, 1986; Wurtman, 1988). While it has been demonstrated (e.g. Drewnowski *et al.*, 1992) that foods which have been labeled carbohydrate-rich and associated with carbohydrate cravings are generally sweet carbohydrate/fat-rich foods, it is the sweet component that is salient and the component that seems to lead individuals to label the food as a carbohydrate (e.g. Drewnowski *et al.*, 1992).

Weingarten and Elston (1990) have pointed out that explanations for cravings have revolved around an abstinence model and an expectancy model. The abstinence model suggests that cravings arise from the

Address correspondence to: Larry Christensen, PhD, Department of Psychology, University of South Alabama, Mobile, AL36688, U.S.A.

dysphoric state created from abstaining from a desired or needed substance. The expectancy model suggests that cravings are triggered by exposure to either internal or external cues associated with the desired substance. Most of the literature on carbohydrate cravings and consumption has focused on the relationship with dysphoric mood. The most common assumption is that a dysphoric mood elicits carbohydrate cravings because of a serotonin deficit. This deficit promotes the consumption of carbohydrates because pure carbohydrate elevates central serotonin synthesis (Wurtman, 1987), and the increased synthesis of serotonin is assumed to ameliorate the dysphoric mood which strengthens the connection between dysphoric mood and carbohydrate consumption.

The evidence supporting a connection between a dysphoric mood and carbohydrate consumption comes from a variety of sources. Hill, Weaver and Blundell (1991) found a significant correlation between food cravings and emotional eating. Krauchi, Wirz-Justice and Graw (1990) revealed that individuals with seasonal affective disorder experienced an increase in carbohydrate cravings during winter depression. Fernstrom, Krowinski & Kupfer (1987), Kazes *et al.* (1993), and Christensen & Somers (1994) have revealed that individuals not only report increasing their preference for sweet tasting foods as they become depressed, but that depressed individuals consume more carbohydrates, especially simple carbohydrates, than their non-depressed counterparts. Other studies have revealed that consumption of carbohydrate-rich foods leads to an amelioration of the dysphoric mood state in individuals with seasonal affective disorder (Rosenthal *et al.*, 1989), individuals with severe premenstrual syndrome (Wurtman *et al.*, 1989), and overweight individuals (Wurtman, 1988). This connection has led some (e.g. Leibenluft *et al.*, 1993) to suggest that dysphoric individuals may be engaged in a type of self-medication with carbohydrates.

The data supporting the connection between dysphoric mood, carbohydrate cravings, and consumption of carbohydrate/fat rich foods is confined primarily to individuals with specific disorders, primarily psychiatric disorders. However, Weingarten and Elston (1991) have revealed that food cravings exist among a very large portion of the population, and that much of this craving is for sweets (Pelchat, 1997). Given that a dysphoric mood stimulates carbohydrate cravings in several psychiatric groups, it seems logical that such a relationship would also exist among the general population. The present study investigated the relationship between trait mood states and general carbohydrate cravings in a sample of college students.

Method

Research participants

The research participants consisted of 113 males (M age = 21.44; SD = 3.95) and 138 females (M age = 21.49; SD = 5.26) of approximately equal educational background (males M = 13.59 years; SD = 1.22 and females M = 13.20 years; SD = 1.11). The mean weight of the males was 170.85 lbs (SD = 36.98) and the mean weight of the females was 140.42 lbs (SD = 34.49). Table 1, which depicts the mean Beck Depression Inventory (BDI; Beck *et al.*, 1979), and Profile of Mood States (POMS; McNair, Lorr & Droppleman, 1992) scale scores for the subject sample, reveals that the sample represents, based on the BDI, a non-depressed group of individuals and exhibits about the same mood level as the average college student in the normative sample (McNair *et al.*, 1992).

Assessment instruments

A "craving questionnaire", patterned after one used by Weingarten and Elston (1991), was used to identify the type of cravings a person experienced, measure the intensity of participants' cravings, identify the foods that were craved, and the relationship of the craved foods to the affective state of the participants. This questionnaire asked participants for demographic information regarding their age, weight, education, if they had any physical or psychological illnesses for which they were currently being treated or psychological illnesses for which they had been treated in the past, to identify any medications currently taking, and whether females were pregnant. Participants were then asked if they "generally experienced intense desires or urges (cravings) to eat specific foods"? This question was used as the participants self identification as a food craver.

The craving questionnaire next asked participants to describe their food cravings as either carbohydrate, protein, or fat cravings. Examples were given of each

Table 1. Mean BDI and POMS scale scores. BDI, Beck Depression Inventory; POMS, Profile of Mood States. POMS SD is for the raw scores. POMS T-score is based on the norms for college students

Instrument	Scale	Mean raw score	T-Score	SD
BDI		8.09	—	6.99
POMS	Tension	11.57	48	6.66
POMS	Depression	11.30	48	10.88
POMS	Anger	16.57	60	8.92
POMS	Vigor	16.41	51	6.64
POMS	Fatigue	9.34	48	6.55
POMS	Confusion	8.57	48	5.43

type of craving to maximize the probability that the participants would associate the appropriate food (e.g. candy) with the appropriate type of craving (e.g. carbohydrate). After specifying the type of food craving experienced, participants rated the "general intensity" of these cravings on a 6-point scale from "very weak" to "very strong". A rating of "intensity" was used as the measure of craving rather than a measure such as frequency because self-report measures using rating scales (i) are common indices of the degree of craving or desire for some object (Weingarten & Elston, 1990); (ii) have been demonstrated to be useful for quantifying and measuring subjective states such as attitudes and personality (Robinson, Shaver & Wrightsman, 1991); and (iii) would seem to capture the "intensity" or "longing" component included in the general definition of craving, "an intense desire or longing for a substance" (Weingarten & Elston, 1990, p.231), more effectively than a frequency measure would. Participants next specified the food they craved the most or "strongest" as well as their mood, and how they felt just before craving this food and after consuming the food.

Mood state was assessed with the POMS and BDI. The POMS is a factor analytically derived self-report inventory consisting of 65 adjectives responded to on a 5-point rating scale and providing a measure of six mood states: tension-anxiety, depression-dejection; anger-hostility; vigor-activity; fatigue-inertia; and confusion-bewilderment. Participants are instructed to respond to each adjective in terms of how they have been feeling "during the past week including today". The BDI is a 21-item self-report inventory responded to on a 3-point scale and designed to measure the severity of depression. The Vitality Inventory (VI; Christensen & Ouellette, 1995) is a 22-item factor analytically derived scale designed to measure the degree of vigor and exhaustion experienced by the participants. Participants respond to each question in terms of how they have been feeling during the past month including today.

Procedure

The research participants read and signed a "consent to participate" form after all questions asked had been answered. They then completed the assessment battery, consisting of the Craving Questionnaire and the psychological inventories, in groups of 25. The inventories and the craving questionnaire comprising the assessment battery were counterbalanced to control for an order effect.

Results

Inspection of the Craving Questionnaire revealed that none of the participants reported any physical or

psychological disorders at the time of completion of the assessment instruments. Two females reported being pregnant and their data was excluded from the study to eliminate any confound of pregnancy on crave ratings or mood assessment. Ninety-one percent, 228 of the participants, responded positively to the question asking them if they "generally experienced intense desires or urges (cravings) to eat specific foods". This is consistent with the data obtained by Weingarten and Elston (1991) who revealed that 88% of college students reported food cravings. Participants were then classified as being carbohydrate, protein, or fat cravers based on their response to the question which asked them to identify the type of food (carbohydrate, protein or fat) that they most craved. All participants, including the 9% who indicated that they did not experience "intense desires or urges to eat specific foods", were asked to make such a designation to permit categorization of all individuals into a specific type of craver to maximize the range of intensity of craving from those who stated that they experienced no intense urge or desire to eat a specific food to those who experienced varying degrees of desire. Of the 251 participants, 72% described themselves as carbohydrate cravers, 26% as protein cravers, and 2%, six participants, as fat cravers. Fat cravers were eliminated from further analysis because of their small number. Chi-square analysis revealed that significantly, $\chi^2(1)=78.4$, $p<0.01$, more females identified themselves as carbohydrate cravers than as protein cravers. Males did not differ significantly, $p>0.05$, in terms of the number of self identified carbohydrate and protein cravers. The foods most strongly craved by carbohydrate cravers were chocolate (25%), pasta (13%), desserts (12%), candy (7%), potatoes (7%), ice cream (6%) and bread (6%). The remaining 24% of the participants identified pizza, potato chips, rice, crackers/pretzels, cookies, vegetables and soda as the carbohydrates they craved most.

When carbohydrate cravers were asked how they felt just before they experienced their food craving, the four most frequently stated responses, as revealed in Table 2, were anxiety, fatigued, hunger and depressed. Anxiety, fatigue, and depressed accounted for 67% of the responses and hunger account for 14% of the responses. The remaining 19% of responses consisted of happy/good, angry, bored, and relaxed. After consuming the craved food 79% of the participants stated that they felt satisfied, happy/good, relaxed, or energetic. The other 21% of responses consisted of tired/sleepy, guilty, normal, same or no difference, and wanting more of the craved food.

Protein cravers reported that the food most frequently craved was steak/beef (48% of responders), followed by

chicken (20% of responders) with seafood, cheese, pizza, vegetables, and milk comprising the remaining 32% of responders. Table 2 reveals that the affective state most frequently reported as occurring prior to the craving was anxious (36% of responders), and hungry (34% of responders) with happy, normal, bored, and energetic comprising the remaining 30% of responders. Following consumption of the craved protein, 80% of the responders reported being satisfied, good, or

relaxed, with tired, energetic, and normal comprising the remaining 20% of responses.

To determine if intensity of participants' cravings were related to their mood state, correlations were computed between participants' rating of craving intensity and their mood state as assessed by the BDI, POMS, and VI. These correlations, which were computed separately for carbohydrate cravers and protein cravers in addition to a combined analysis, appear in Table 3. When considering all participants combined, the results reveal that all mood scales were significantly correlated, $p < 0.05$, with craving intensity except the confusion and vigor scales of the POMS, and the vitality scale of the VI. Half of the significant correlations were of small effect size and half were of medium effect size (Cohen, 1988). Similar results were obtained when the cravings ratings were correlated with the mood scales for carbohydrate cravers alone. All mood scales were significantly $p < 0.05$, correlated with ratings of craving intensity with the exception of the vigor scale of the POMS, and the vitality scale of the VI, and 71% of the correlations were of medium effect size. For protein cravers, only one mood scale, the anger scale of the POMS, was significantly, $p < 0.05$, correlated with ratings of craving intensity.

Correlations were then computed separately for female and male ratings to identify a gender difference which may exist in the relationship between type of cravings and mood. Correlations were first computed between female carbohydrate and protein cravers' ratings of craving intensity and the various measures of mood. As revealed in Table 4, mood was significantly

Table 2. Affective states reported by carbohydrate and protein cravers before and after consumption of the food most strongly craved

Before consumption		After consumption	
Affective state	%reporting	Affective state	%reporting
<i>A. Carbohydrate cravers</i>			
Anxious	27	Satisfied	25
Fatigued	26	Happy/Good	21
Hungry	14	Relaxed	20
Depressed	14	Energetic	13
Happy/Good	11	Tired/Sleepy	9
Angry	3	Guilty	5
Bored	3	Normal	3
Relaxed	2	Same	2
		Wanting more	2
<i>B. Protein cravers</i>			
Anxious	36	Satisfied	40
Hungry	34	Good	21
Happy	11	Relaxed	20
Normal	9	Tired	9
Bored	8	Energetic	7
Energetic	2	Normal	3

Table 3. Correlations and their effect size between mood measures and craving intensity in carbohydrate and protein cravers, separately and combined. BDI, Beck Depression Inventory; POMS, Profile of Mood States; VI, Vitality Inventory. d , the effect size index. The d corresponding to a given r was determined by rounding the r in the table down to the nearest r depicted in Table 2-2-1 of Cohen (1988). For example, an r of 0.18 was rounded down to an r of 0.148 and then given the effect size of 0.3 rather than rounding up to the nearest r of 0.196 which would correspond to an effect size of 0.4. ** $p < 0.01$; * $p < 0.05$

Instrument	Scale	Carb cravers <i>N</i> = 175		Protein cravers <i>N</i> = 64		Combined <i>N</i> = 239	
		<i>r</i>	d	<i>r</i>	d	<i>r</i>	d
BDI	Depression	0.28**	0.6 ^b	-0.09	—	0.23**	0.4 ^a
POMS	Depression	0.29**	0.6 ^b	0.15	—	0.26**	0.5 ^b
POMS	Tension/Anxiety	0.28**	0.5 ^b	0.16	—	0.26**	0.5 ^b
POMS	Anger	0.22**	0.4 ^a	0.26*	0.5 ^b	0.22**	0.4 ^a
POMS	Confusion	0.29**	0.6 ^b	0.002	—	0.10	—
POMS	Fatigue	0.28**	0.5 ^b	0.17	—	0.26**	0.5 ^b
POMS	Vigor	-0.13	—	0.02	—	0.10	—
VI	Exhaustion	0.23**	0.4 ^a	0.12	—	0.21**	0.3 ^a
VI	Vitality	-0.05	—	-0.08	—	-0.06	—

^aSmall.

^bMedium.

^cLarge effect size.

Table 4. Correlations and their effect size between mood measures and craving intensity in female carbohydrate and protein cravers. BDI, Beck Depression Inventory; POMS, Profile of Mood States; VI, Vitality Inventory. *d*, the effect size index. The *d* corresponding to a given *r* was determined by rounding the *r* in the table down to the nearest *r* depicted in Table 2.2.1 of Cohen (1988). For example, an *r* of 0.18 was rounded down to an *r* of 0.148 and then given the effect size of 0.3 rather than rounding up to the nearest *r* of 0.196 which would correspond to an effect size of 0.4. ***p* < 0.01; **p* < 0.05

Instrument	Scale	Carb cravers <i>N</i> = 118		Protein cravers <i>N</i> = 14	
		<i>r</i>	<i>d</i>	<i>r</i>	<i>d</i>
BDI	Depression	0.26**	0.5 ^b	-0.02	—
POMS	Depression	0.22*	0.4 ^a	-0.42	—
POMS	Tension/Anxiety	0.21*	0.4 ^a	-0.25	—
POMS	Anger	0.19*	0.4 ^a	-0.52	—
POMS	Confusion	0.27**	0.5 ^b	-0.28	—
POMS	Fatigue	0.24**	0.5 ^b	-0.10	—
POMS	Vigor	-0.17	—	-0.17	—
VI	Exhaustion	0.18**	0.3 ^a	-0.06	—
VI	Vitality	-0.05	—	0.09	—

^aSmall.

^bMedium.

Table 5. Correlations and their effect size between mood measures and craving intensity in male carbohydrate and protein cravers. BDI, Beck Depression Inventory; POMS, Profile of Mood States; VI, Vitality Inventory. *d*, the effect size index. The *d* corresponding to a given *r* was determined by rounding the *r* in the table down to the nearest *r* depicted in Table 2.2.1 of Cohen (1988). For example, an *r* of 0.18 was rounded down to an *r* of 0.148 and then given the effect size of 0.3 rather than rounding up to the nearest *r* of 0.196 which would correspond to an effect size of 0.4. ***p* < 0.01; **p* < 0.05

Instrument	Scale	Carb cravers <i>N</i> = 57		Protein cravers <i>N</i> = 50	
		<i>r</i>	<i>d</i>	<i>r</i>	<i>d</i>
BDI	Depression	0.32*	0.6 ^b	-0.10	—
POMS	Depression	0.42**	0.9 ^c	0.23	—
POMS	Tension/Anxiety	0.44**	0.9 ^c	0.23	—
POMS	Anger	0.31*	0.6 ^b	0.32*	0.6 ^b
POMS	Confusion	0.33*	0.6 ^b	0.01	—
POMS	Fatigue	0.34*	0.6 ^b	0.23	—
POMS	Vigor	-0.04	—	-0.02	—
VI	Exhaustion	0.31*	0.6 ^b	0.16	—
VI	Vitality	-0.05	—	-0.14	—

^aSmall.

^bMedium.

^cLarge effect size.

correlated with carbohydrate cravers' ratings of craving intensity on all scales except POMS vigor and the VI vitality scale. About half of these correlations were of small effect size and half were of medium effect size. However, none of the mood scales correlated significantly with the ratings of craving intensity of the female protein cravers. Correlations between the ratings of craving intensity and mood for male carbohydrate and protein cravers revealed a slightly different pattern of results. For male carbohydrate cravers (see Table 5),

significant correlations were found between ratings of craving intensity and all mood scales except the POMS Vigor and the VI vitality scale. All of these correlations were of either large or medium effect size. For male protein cravers only the POMS anger scale was significantly, *p* < 0.05 correlated with ratings of craving intensity.

When the correlations between mood scales and craving intensity are compared for male and female carbohydrate cravers (see Tables 4 and 5) it is apparent

Table 6. Correlations and their effect size for carbohydrate cravers who crave sweet and non-sweet foods.
* $p < 0.05$

Instrument	Scale	Cravers of sweet carb foods <i>N</i> = 53		Cravers of non-sweet foods <i>N</i> = 42	
		<i>r</i>	<i>d</i>	<i>r</i>	<i>d</i>
BDI	Depression	0.20	—	0.14	—
POMS	Tension	0.27*	0.5 ^b	0.33*	0.7 ^b
POMS	Depression	0.24*	0.5 ^b	0.13	—
POMS	Anger	0.31*	0.6 ^b	0.13	—
POMS	Fatigue	0.25*	0.5 ^b	0.19	—
POMS	Vigor	0.07	—	-0.03	—
POMS	Confusion	0.24*	0.5 ^b	0.30*	0.6 ^b
VI	Exhaustion	0.26*	0.5 ^b	0.10	—
VI	Vitality	0.18	—	-0.03	—

^aSmall.

^bMedium.

^cLarge effect size.

that significant correlations exist on the same mood scales. However, the effect size is greater in males on the POMS depression, anxiety, and anger and VI exhaustion scales. The difference in the size of the correlations is equivalent to a small effect size on all of these scales.

The carbohydrate cravers were then divided into those who stated that the food they craved most was a sweet carbohydrate-rich food (e.g. a dessert) or a non-sweet carbohydrate-rich food (e.g. pasta).¹ Table 6, which depicts the correlation between the ratings of craving intensity and mood for each of these two groups of individuals, reveals that mood was correlated with craving intensity on all scales except the BDI, the POMS vigor scale, and the VI vitality scale in individuals who craved sweet carbohydrate-rich foods. The magnitude of the correlations was of a medium effect size. For individuals who craved non-sweet carbohydrate-rich foods, mood was correlated with craving intensity only on the POMS tension and confusion scales.

Discussion

The purpose of the present study was to determine if a relationship existed between the intensity of general carbohydrate cravings and trait measures of mood among a group of nondistressed individuals. Carbohydrate cravers and protein cravers were self identified based on their self report of being a carbohydrate, or protein craver. Carbohydrate cravers identified carbo-

hydrate rich foods (e.g. chocolate, pasta and desserts) as the foods which they most strongly craved lending validity to their designation as carbohydrate cravers. These foods, however, are not pure carbohydrates or even predominately carbohydrates in some instances. Rather, they are foods that are sweet carbohydrate/fat rich foods. However, the sweetness is the more salient sensory attribute (Drewnowski *et al.*, 1992) and the attribute that lends the food to be considered a carbohydrate. Because many of the foods which carbohydrate cravers identified as the craved food are also fat-rich, there is some speculation (Drewnowski *et al.*, 1992) that the desired macronutrient may be the fat and not the carbohydrate. The bulk of the literature seems to suggest that the carbohydrate cravings are associated with snack foods (e.g. Schlundt *et al.*, 1992). The dominant selection is for sweet snacks (Bowen & Grunberg, 1990; Krauchi *et al.*, 1990) rather than non-sweet foods suggesting that it is the sweet carbohydrate motivating the selection process and not the fat. This conclusion is also supported by the current data indicating that mood is correlated with craving intensity ratings primarily in individuals who crave foods that are sweet. Protein cravers listed foods such as steak and chicken as the foods which they most strongly craved again lending validity to their classification as protein cravers.

The largest percentage of individuals (72%) identified themselves as carbohydrate cravers which is consistent with prior research (Pelchat, 1997; Weingarten Elston, 1991) revealing that most cravings are carbohydrate cravings. These findings also add to the developing literature indicating that food cravings, and particularly carbohydrate cravings, are not confined to psychiatric populations, but are a rather widespread phenomenon. The interesting component is that these cravings are

¹ This comparison was suggested by one of the reviewers. The N for the participants craving sweet and non-sweet carbohydrates does not equal the total N for carbohydrate cravers because the original crave questionnaire had to be consulted to classify these participants and some of these questionnaires had been misplaced or thrown away inadvertently.

especially apparent among females. In the present study 90% of the females classified themselves as carbohydrate cravers whereas only 53% of males did so. This finding is consistent with other studies (see Ganley, 1989) demonstrating a greater incidence of carbohydrate cravings in females. However, these cravings do seem to abate with age (Pelchat, 1997). There is little evidence to suggest why more females would experience carbohydrate cravings other than the fact that females are more likely to have a mood disorder such as depression (Robins *et al.*, 1984).

The primary purpose of the present study was to determine if a relationship existed between trait measures of mood and general carbohydrate cravings. Two sources of data indicate that carbohydrate cravings increase with negative moods. Over two-thirds of the carbohydrate cravers indicated that they experience mood states such as anxiety, fatigue, and depression prior to their cravings. The only negative mood state reported by protein cravers was anxiety and this was reported by only 34% of the responders. The other 66% reported states such as hungry, happy, bored, or energetic as the state preceding their cravings. Carbohydrate cravers, therefore, are much more likely to identify a negative mood state as preceding their craving.

The correlation between craving intensity and mood confirms even further that negative moods are related to carbohydrate cravings. Ratings of carbohydrate cravings were significantly correlated with all negative mood states. The only ones not correlated with the crave ratings were vigor and vitality. These are positive mood states. The only mood state that correlated with protein cravers ratings of craving intensity was anger. Because nine correlations were computed, it is likely that this is a chance correlation. This relationship between craving intensity and negative mood is consistent not only with other studies (e.g. Wurtman *et al.*, 1989; Wurtman & Wurtman, 1986; Willner *et al.*, 1998) of food cravings using both state and trait mood measures, but also with studies demonstrating a relationship between state measures of negative mood and desire to smoke (Tiffany & Drobes, 1990) or use drugs (Childress *et al.*, 1994). It is apparent that a negative mood state contributes to a variety of cravings and it makes no difference whether it is a state or trait mood state.

If negative mood states contribute to cravings, the question is why? The drug, alcohol, and tobacco literature focuses on issues such as cravings being triggered by the dysphoric state associated with abstinence of the desired or needed substance, and on exposure to stimuli associated with the desired substance triggering cravings (Weingarten & Elston, 1990). While such factors are supported in drug, alcohol, and tobacco literature, they have received little attention in the food craving litera-

ture. The food craving literature has focused most attention on a self-medication hypothesis (Leibenluft *et al.*, 1991) which states that cravings for carbohydrate-rich food substances exist because consumption of these foods results in relief of the dysphoric symptoms they are experiencing. The relief in dysphoric symptoms is assumed to occur because carbohydrate-rich foods increase the plasma ratio of tryptophan to the other large neutral amino acid residues. This permits more tryptophan to cross the blood-brain barrier resulting in an increased synthesis of central serotonin (Wurtman, 1987) which in turn is assumed to ameliorate the dysphoric mood.

The self-medication hypothesis makes sense because of the positive effect which consumption of carbohydrate-rich foods has been demonstrated to have on mood (e.g. Rosenthal *et al.*, 1989; Wurtman *et al.*, 1989). Therefore, a dysphoric mood would be associated with a desire to consume carbohydrates because of their negative reinforcing effect of producing a decline in the dysphoric state, and the positive reinforcing effect of mood enhancement. However, it has repeatedly been pointed out (e.g., Christensen, 1997; Young, 1991) that the mood alteration produced by consumption of a carbohydrate-rich snack is probably not due to an increased synthesis of central serotonin because the rise in the plasma tryptophan ratio which results from the carbohydrate consumption may be too small to influence central serotonin significantly (Ashley, Liardon & Leathwood, 1985). Also, as little as 4% protein can block the rise in the plasma tryptophan ratio (Teff, Young & Blundell, 1989) and there are few foods or meals that contain less than 4% protein. In addition, the present data reveals that the relationship between mood and craving intensity existed primarily for individuals who craved sweet carbohydrate-rich foods and the carbohydrate-serotonin connection is not specific to such foods.

An abstinence model does not seem to be useful in explaining the relationship between dysphoric mood and carbohydrate craving because this model requires the withdrawal or abstinence of the target substance which, in this case, would be carbohydrates. Most foods, meals, and snacks include carbohydrates, and even if one snack contains no carbohydrate, the subsequent meal in all probability does. An expectancy model also does not seem to be very useful in explaining the relationship between dysphoric mood and carbohydrate cravings unless the hedonic pleasure derived from eating a sweet carbohydrate/fat-rich food temporarily enhances mood. However, this seems like only a remote possibility. At the present time the self-medication hypothesis seems to be the best explanation to account for the craving-negative mood relationship.

While the self-medication hypothesis is supported by the results of the present study as well as others, the correlation between dysphoric mood and carbohydrate craving is not strong and accounts for only a small portion of the variance in carbohydrate cravings. This means that other factors also contribute to carbohydrate cravings. If the relationship between dysphoric mood and carbohydrate cravings is due to a combined positive and negative reinforcement phenomenon, then a whole host of environmental factors, such as the sight and smell of various food items, as well as thoughts or imagery, should also be related to carbohydrates. These are variables that have been demonstrated (e.g. Weinstein *et al.*, 1998; for a review, see Tiffany, 1990) to contribute to drug and alcohol cravings and probably also contribute to carbohydrate cravings. However, virtually no attention has been given to these variables as possible contributors to carbohydrate cravings. Investigation of such factors deserves the attention of individuals interested in the phenomenon of carbohydrate cravings or food cravings if we are to have a complete understanding of this phenomenon.

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