Researchers have extensively studied the influence of food on mood. Often, people seek out comfort foods when experiencing a low mood (Christensen & Brooks, 2006; Christensen & Pettijohn, 2001; Dubé, LeBel, & Lu, 2005). These comfort foods usually have high carbohydrate and fat content and frequently have a sweet flavor. Notably, chocolate features many of the characteristics associated with comfort foods: a sweet flavor and the macronutrients carbohydrates and fat. Chocolate seems to be a particularly popular food for which many people reach when feeling low. However, some people prefer savory foods (i.e., foods prepared with little or no sugar, thus having no sweet or sugary flavor) when seeking to alleviate a negative mood. Whether sweet or savory, comfort foods tend to contain high levels of carbohydrates, fat, or both nutrients, and people feel soothed and consoled by eating them.

Examining the effect of sweet flavor on mood enhancement, Kampov-Polevoy, Alterman, Khalitov, and Garbutt (2006) investigated the relation between a preference for sweet flavor (sweet liking), cravings for sweet foods, and diminished constraint over eating sweet foods in a sample of healthy college-aged men and women. The researchers developed a questionnaire designed to determine the level of participants’ inhibition regarding eating sweets and their susceptibility to the mood-influencing effects of sweets. At random intervals, the participants tasted five different concentrations of sucrose solution and rated them based on intensity of the sweet flavor and how much they liked the flavor. The researchers found a direct relation between sweet liking and a susceptibility to the mood-influencing effects of sweets. Further, the researchers found that women were more likely than men to eat sweets as well as experience mood-modifying effects of eating sweets.

Sweet flavor also seems to have a calming effect that is present at birth. Barr et al. (1999) conducted an experiment investigating the effect of sweet flavor on crying healthy newborns between 12 and 96 hr old. They compared solutions of sucrose, aspartame, polyose (a readily digestible carbohydrate), and water. The researchers randomized participants into a between-groups design for the solutions, using water as a control. The researchers dropped the solutions on the tongues of the crying infants and recorded their calming response. The infants responded almost identically to the sucrose solution and the aspartame solution by calming faster and staying calm longer compared to the water control. The polyose solution affected crying no differently than water. This finding could indicate that a sweet flavor has more of a calming effect than carbohydrates and that this effect is present at birth.

Similar to the effects of a sweet flavor, carbohydrates also seem to affect mood. Christensen and Pettijohn (2001) hypothesized a relation between mood and carbohydrate cravings in the general population. They surveyed college-aged men and women. Self-identified protein cravers and carbohydrate cravers completed a craving questionnaire and three mood surveys. Carbohydrate cravers showed a significant correlation between craving strength and negative mood scores.

Chocolate and Cheese: Their Effects on Mood

Researchers have related several food factors to an effect on mood, most notably sweet flavor, carbohydrates, fat, and the chemical compounds in chocolate. The purpose of this study was to parse these different characteristics in select foods to determine which has the pivotal effect on mood. Participants (N = 105) consumed chocolate (white, milk, or dark) or cheese and completed a preconsumption and postconsumption Positive and Negative Affect Schedule mood test. Participants showed a general decline in positive affect. Women who ate dark chocolate had a significant rise in negative affect. Women who ate cheese experienced a decrease in negative affect.

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mood on nearly all of the surveys. That correlation appeared primarily in people craving sweet-flavored, carbohydrate-rich foods.

The relation between food and mood is reciprocal; as well as food choices affecting mood, mood can influence food choice and preference. Christensen and Brooks (2006) studied the influence of mood on food choice in 98 college-aged men and women. Participants read vignettes with either a sad or happy theme and projected themselves into the scenario described. The participants reported whether they thought they might want to eat, and if so, what they would want to eat. The authors hypothesized that participants experiencing a sad event would be more inclined to eat carbohydrate- and fat-rich foods and that women would be more inclined than men to eat those foods. Contrary to the first hypothesis, both men and women indicated they would be more inclined to eat after a happy event rather than a sad event, with men showing a greater effect. Further, the type of food men and women thought they would eat varied based on the type of event. Vegetarian and snack foods emerged as the most popular foods after a happy event for all participants, with men presuming they would be more inclined than women to eat after such an event. Consistent with the second part of the hypothesis, women thought they would be more inclined to eat sweet carbohydrate- and fat-rich foods after a sad event.

Dubé et al. (2005) conducted further research supporting the influence of mood on food choice. They administered an Internet survey that assessed the emotional triggers of eating comfort foods and whether the food eaten could be related to positive or negative affect. Male respondents reported a tendency to seek comfort food to enhance a positive mood, whereas women reported seeking comfort food to ameliorate a negative mood. Further, although the consumption of comfort foods relieved negative moods in women, in some it also rendered guilt. The researchers also found that although low-calorie foods helped boost positive mood, foods high in sugar and fat were most effective at relieving a negative mood.

In a review of the literature, Benton (2002) pointed out that many of the foods sought during a dysphoric emotional state are foods that are sweet tasting and high in both carbohydrates and fat. Benton’s assertion raises the question of whether it is the carbohydrate or fat content or a combination of the two that increases mood. Foods high in carbohydrates and fats tend to be highly palatable. Drewnowski (1997) suggested palatability triggers an increase in mood after consumption, because eating palatable foods stimulates the release of endorphins, which would result in a sense of well-being.

It is a common view that carbohydrates alone can enhance a person’s mood. Fernstrom and Wurtman (1971) found that ingesting carbohydrates can trigger the release of serotonin in the brain, thus increasing positive mood. However, Yokogoshi and Wurtman (1986) found that small levels of protein (as low as 5-10%) inhibited release of serotonin, therefore disrupting the mood enhancement. Noting milk chocolate is high in sugar and fat and quite low in protein (3-6%), Gibson (2006) postulated that if eaten on an empty stomach, chocolate could trigger the release of serotonin, thus stimulating elevation or enhancement of positive mood.

Chocolate is an extremely popular and highly palatable food for many people. Macht and Dettmer (2006) examined the effects of eating chocolate, fruit, or nothing on the moods of 37 healthy women. The experiment extended across six days with the women participating in two food conditions each day. The women abstained from eating for 1 hr prior to opening an envelope containing instructions to eat a chocolate bar, an apple, or nothing. The women then completed mood surveys at 5, 30, 60, and 90 min after following the instructions. Both foods decreased hunger and mood, with chocolate affecting the women most. In addition, among some women, positive response to the chocolate was followed by guilt.

Chocolate seems to have an effect on men, too. Macht, Roth, and Ellgring (2002) studied the influences of different emotions on eating chocolate among healthy men. Independent variables were emotion (fear, anger, sadness, or joy induced by presentation of selected film clips) and food deprivation (2 or 8 hr). The participants (a) completed a survey regarding current emotional state and motivation to eat; (b) watched a film clip; (c) ate either a piece of white or milk chocolate, determined by personal preference; and then (d) completed another survey about current emotional state, motivation to eat, and response to the chocolate. Macht and colleagues found that participants’ motivation to eat was increased by joy, the enjoyment of the chocolate, and by the 8 hr deprivation. Conversely, sadness and anger decreased participants’ motivation to eat.

Interestingly, chocolate does not enhance mood for everyone. Macdiarmid and Hetherington (1995) conducted a study of chocolate’s effect on mood in self-identified “chocolate addicts.” The participants were 40 women: 20 controls and 20 chocolate addicts. Participants kept a diary for seven days in which they recorded their hunger levels, mood, chocolate cravings, and quantity of chocolate eaten. Chocolate addicts recounted eating more chocolate than controls. The addicts also reported that eating the chocolate
produced feelings of guilt but did not enhance their moods. Like any addictive substance, chocolate may alleviate withdrawal and forestall a negative state but over time it may potentially lose its power to produce a pleasant effect in addicts.

Chemical components of chocolate may explain its influence on mood. Smit, Gaffan, and Rogers (2004) conducted two studies on the psychopharmacologically active components of chocolate. In the first study, participants consumed capsules containing identical amounts of cocoa powder, a theobromine/caffeine composition (referred to as methylxanthines), or a placebo. The researchers then measured participants’ mood and their performance on tasks. The effects of the cocoa powder and the methylxanthines were the same, with participants showing a significant positive improvement on both mood and performance on a simple reaction time task. In the second study, participants consumed water (as a control), white chocolate (containing no methylxanthines), milk chocolate (containing low methylxanthines), or dark chocolate (containing high methylxanthines) and completed similar tasks and mood questionnaires. White chocolate and water produced no differences in mood or performance. Milk chocolate and dark chocolate produced results comparable to one another and similar to the first study. The results of these two experiments demonstrated that the sugar and fat in prepared chocolate did not appear to hinder or enhance the effects of methylxanthines, nor was there a discernable difference between milk and dark chocolate that could be attributed to differing levels of methylxanthines.

Parker, Parker, and Brotchie (2006) reviewed the literature and argued that chocolate is not unique in producing a mood-altering effect. Rather, they asserted, when an individual experiences a dysphoric mood, any carbohydrate would serve as a comfort food to raise mood. Further, Hetherington and Macdiarmid (1993) found that individuals experience an improvement in mood only while actually eating chocolate, with a dysphoric mood returning immediately after consumption. This finding implies that the mood change is due to the experience of eating chocolate, probably the sweet flavor and texture, not the methylxanthines.

Thus, it appears that sweet flavor, carbohydrates, and methylxanthines in chocolate can enhance mood. Further, people often use foods that are rich in a combination of carbohydrates and fat to alleviate negative moods. It is important to note that carbohydrates, fat, sweet flavor, and even methylxanthines co-occur in popular foods. Ice cream is a sweet, carbohydrate- and fat-dense food that is frequently chocolate flavored. The same is true of cookies and cakes. Which of these elements makes the difference when people reach for a snack to lift mood? Is it the sweet flavor, the carbohydrates, the carbohydrates combined with fat, the fat alone, or is it the methylxanthines in chocolate that enhances mood?

The purpose of this study was to parse these different characteristics to determine which has the pivotal effect on mood. Chocolate is a food that embodies all the characteristics that seem to influence mood in a positive manner. It has a sweet, pleasant flavor and is highly palatable. In addition, it contains high levels of sugar and fat. Chocolate also contains methylxanthines, which research has shown to increase mood. Interestingly, no one has examined the macronutrient fat in isolation as far as it pertains to contributing to an increase in mood after consumption. Therefore, by using white chocolate, milk chocolate, dark chocolate, and cheese, we examined the comparative effects of sweet flavor, methylxanthine content, carbohydrate content, and fat content on mood. Table 1 shows a breakdown of the constituents of each food. We compared these factors to determine which has the strongest effect on mood and if any of the factors interacted to influence mood. We hypothesized that sweet and fat would both enhance a positive mood and that milk chocolate would be the food with the greatest impact on overall mood because of its sweet flavor, high carbohydrate and fat content, and methylxanthine content.

**Method**

**Participants**

We recruited 52 men and 53 women from a small Midwestern university with a population that is 82% Caucasian. We recruited participants from introductory psychology classes and compensated them with course credit. We also recruited participants from other classes as well as from public meeting areas such as the student union. Those participants received no compensation. We excluded data from four participants because they did not complete the experiment.

**Materials**

The foods we used were Lindt Swiss Classic White Chocolate, Lindt Swiss Classic Milk Chocolate, Lindt Excellence 85% Cocoa Dark Chocolate, and Land O Lakes Snack ‘N Cheese To-Go! Co-Jack cheese. We based our portion size on the suggested serving size specified on the food packaging: for chocolate, 40 gm; and for cheese, two prepackaged portions totaling 42 gm. To disguise the purpose of the experiment, we designed two decoy questionnaires comprised of Likert-type statements on flavor and food preferences: a pretaste questionnaire containing 25 items addressing flavor preferences (e.g., “I prefer the flavor of milk chocolate”) and a posttaste questionnaire containing 25 items...
addressing immediate reaction to the food (e.g., “I found the flavor to be sweet”). The essential measure was the PANAS mood scale (Watson, Clark, & Tellegen, 1988), which participants completed in concert with the decoy surveys. The PANAS test measures positive affect (PA) and negative affect (NA). Alpha reliability for “in the present moment” PA and NA are .89 and .85, respectively with a -.15 PA-NA intercorrelation. Test-retest reliabilities for in the moment PA and NA are .54 and .45, respectively. Scale validity for in the moment PA and NA are .95 and .91, respectively. Item validity ranges from .52-.75 (Watson et al., 1988).

Procedure
We tested participants in groups of 30 or fewer. We initially presented participants with the pretaste questionnaire and then the PANAS test. The participants completed the PANAS after the pretaste questionnaire in order to prevent students from thinking about mood in connection with chocolate. Upon completing the survey, participants ate a randomly assigned food: white chocolate, milk chocolate, dark chocolate, or cheese. We provided participants with a cup of water to drink while eating. After eating, the participants immediately completed the posttaste questionnaire and the PANAS test again. We debriefed and thanked participants via e-mail.

Results
Using the PANAS mood test, we measured participants’ levels of positive and negative affect. We administered the PANAS prior to eating an assigned food as a pretest and after eating the assigned food as a posttest. The mean PANAS scores and standard deviations appear in Table 2.

A 2 (sex) x 4 (food) x 2 (time) mixed group ANOVA was performed on both positive and negative affect scores. For PA, there was a main effect for time, $F(1, 92) = 12.00, p = .001$, such that participants showed a general decline in PA from pretest to posttest (Figure 1). There was no main effect for food or sex. There were no interactions between time and sex; sex and food; food and time; or among time, sex, and food.

For NA, we performed a 2 (sex) x 4 (food) x 2 (time) mixed group ANOVA and found an interaction among time, food, and sex, $F(3, 91) = 4.27, p = .007$. Paired $t$ tests ($p \leq .017$), by sex and food categories across time, revealed that women who ate dark chocolate experienced a significant increase in negative affect and women who ate cheese experienced a decrease in negative affect. Figure 2 illustrates the results for the 3-way interaction.

Discussion
By using white chocolate, milk chocolate, dark chocolate, and cheese, we examined the comparative effects of sweet flavor, methylxanthine content, carbohydrate content, and fat content on mood. We hypothesized that both sweet flavor (white and milk chocolate) and isolated fat (cheese) would enhance a positive mood and that milk chocolate would be the food with the greatest impact on mood because of its combination of sweet flavor, high carbohydrate and fat content, and methylxanthine content. Contrary to our expectations and hypotheses, no participants experienced an increase in positive affect. Rather, participants experienced a general decline in positive affect for all foods.

This finding, that positive mood decreased, contradicts the extant literature. The most salient explanation may be the surprising dislike the participants demonstrated for the dark chocolate. Figure 1 shows a marked decrease in positive affect for participants who ate dark chocolate. Several participants complained about the flavor of the dark chocolate, and four participants exited the experiment citing the dark chocolate flavor

| TABLE 1 |
| Food Nutrients and Characteristics |
| --- | --- | --- |
| Food | Nutrient (in grams) | Characteristic |
| | Carbohydrate | Fat | Flavor | Methylxanthine content |
| White chocolate | 22 | 14 | Sweet | None |
| Milk chocolate | 23 | 12 | Sweet | Low |
| Dark chocolate | 8 | 18 | Bitter | High |
| Cheese | 0 | 18 | Savory | None |
as the reason. It is possible that the students did not like the dark chocolate because the chocolate we served was high quality, European chocolate with 85% cocoa. Although there is not an American standard for dark chocolate, sweet chocolate and bittersweet chocolate (which are often considered dark chocolate) must have at least 15% and 35% chocolate liquor, respectively (FDA Food for Human Consumption, 2010). Similarly, Europe legislates that dark chocolate have at least 35% chocolate liquor (European Parliament, 2000). Dark chocolate that is advertised as “Extra Dark” by Hersheys has 60% liquor (“Types of Chocolate,” n.d.). Comparatively, milk chocolate requires only 10% chocolate liquor (“Types of Chocolate,” n.d.). Thus, 85% chocolate is a markedly higher concentration of chocolate than most American chocolate and what many Americans are used to. In addition, the higher the cocoa content, the more bitter and less sweet chocolate is. The dark chocolate may have been so disappointing relative to student expectations of chocolate that the disappointment, more than the taste, influenced mood negatively.

Unexpectedly, we found women who ate dark chocolate experienced a significant increase in negative affect. This finding is inconsistent with the findings on the effects of methylxanthines by Smit et al. (2004). Perhaps the surprise of the unpleasant, bitter flavor had a greater impact on mood than the methylxanthines in the dark chocolate. It is unclear why dark chocolate had a stronger negative impact on women than men. However, Zellner, Garriga-Trillo, Rohm, Centeno, and Parker (1999) found that American women reported twice the chocolate cravings as men. Perhaps because women have a stronger affinity for chocolate than men, their feelings of disappointment were greater.

Two additional characteristics of the study may explain participants’ decrease in positive mood. First, we randomly assigned food categories to participants who knew they were signing up for a food study that included chocolate and cheese. This assignment of the food item may have resulted in disappointment for some participants if they did not get their preferred food choice. Secondly, the serving sizes were large in order to be sure there was enough chocolate or fat to have an effect. However, the serving may have been so large that consuming the whole product became aversive. This possibility may be especially true if the food was considered too bitter or too rich. Anecdotally, many students commented on a desire not to consume the full product.

Although positive affect declined in general, women who ate cheese experienced a decrease in negative affect. To clarify, women felt an improvement in mood after eating fat not because they had an increase in positive affect, but due to a decrease in negative affect. Thus, this finding suggests fat may be a factor with a positive impact on mood. Further, it is important to note that the reaction to cheese was immediate. The macronutrient fat typically can take hours to digest, in contrast to carbohydrate and protein macronutrients.

| Table 2 |

Positive Affect (PA) and Negative Affect (NA) Scores by Food Condition and Testing Times

<table>
<thead>
<tr>
<th>Food Condition</th>
<th>PA</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>White chocolate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>25.58</td>
<td>8.05</td>
</tr>
<tr>
<td>Posttest</td>
<td>22.42</td>
<td>8.91</td>
</tr>
<tr>
<td>Milk chocolate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>25.58</td>
<td>8.05</td>
</tr>
<tr>
<td>Posttest</td>
<td>29.79</td>
<td>9.90</td>
</tr>
<tr>
<td>Dark chocolate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>28.43</td>
<td>6.83</td>
</tr>
<tr>
<td>Posttest</td>
<td>23.68</td>
<td>10.13</td>
</tr>
<tr>
<td>Cheese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>26.57</td>
<td>6.86</td>
</tr>
<tr>
<td>Posttest</td>
<td>25.05</td>
<td>7.41</td>
</tr>
</tbody>
</table>
Thus, the immediate mood-improving response to fat may suggest something about the flavor or the sensory experience of eating fat. Interestingly, fat receptors have been identified in the mouths of rats and mice (Laugerette et al., 2005). It is possible that similar receptors exist for humans and, if so, such receptors could account for participants’ immediate response to fat. However, if these receptors do exist in humans, it would not explain why only women experienced the decrease in negative affect. Further, cheese and dark chocolate contained identical amounts of the macronutrient fat, and women who ate dark chocolate experienced an increase in negative affect. The strong flavor of the dark chocolate may have counteracted any positive influence from other factors, including fat. Our search of databases (PsycINFO and PsycARTICLES) revealed no research addressing fat as an isolated factor and its effect on mood. However, it appears that the macronutrient fat may be a relevant component in comfort food.

Although these findings are interesting, some limitations exist. We did not control for potential confounds such as whether participants had ingested caffeine or other foods prior to the experiment. For instance, Gibson (2006) postulated that, if eaten on an empty stomach, chocolate could trigger the release of serotonin, thus stimulating elevation or enhancement of positive mood. Because we did not monitor or control for other food or beverages ingested by the participants at any time prior to or during the experiment, perhaps other substances ingested by participants prior to the experiment interrupted the effects of the chocolate. Individuals conducting future research should account for such variables.

In this experiment, women who ate dark chocolate experienced a significant increase in negative affect, which appeared to be due to an unpleasant flavor. Further, participants experienced a general decline in positive affect, which we surmise may have been due to food preferences and/or flavor. The influence on mood of the unpleasant flavor appears to be stronger than the influence of methylxanthines. Due to these unexpected findings, future research is warranted to determine the magnitude of the influence of flavor, particularly unpleasant or less preferred flavor, on mood. It would be interesting to further explore how varying intensities of bitter flavor in chocolate, flavor preference, and methylxanthine levels interact to influence mood. Perhaps the results would be different for participants who anticipate and enjoy the pronounced flavor of very dark chocolate.

Future research is also warranted to examine the macronutrient fat and its influence on mood. In this experiment, fat influenced mood in a positive direction by decreasing negative affect in women; however, fat did not increase positive affect for any participants. This finding may be relevant in research exploring the role that fat plays in various comfort foods. Perhaps fat contributes to the soothing element of comfort food not by increasing positive affect but rather simply by reducing negative affect. In other words, perhaps fat does not help a person feel good per se, but feel less uncertain.

### FIGURE 1

Mean level of positive affect at pre- and posttesters for participants eating white, milk, dark chocolate and cheese

![Graph showing mean level of positive affect for different types of chocolate and cheese](image1.png)

### FIGURE 2

Mean level of negative affect at pre- and posttesters for men and women eating white, milk, dark chocolate and cheese.

![Graph showing mean level of negative affect for different types of chocolate and cheese](image2.png)
bad. Future research exploring mood as influenced by the macronutrient fat could prove interesting and relevant to understanding why people eat what they do.

References


FDA Food for Human Consumption, Title 21 § 163.123 (2010).


