Food and emotions: Assessing the effects of food behaviors and prior associations on the emotional response to food consumption

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DEDICATION

To all food lovers:

> Nothing would be more tiresome than eating and drinking if God had not made them a pleasure as well as a necessity.
>
> ~Voltaire

ABSTRACT

Because of the impact diet and food choice have on health, and the role that emotion may play in food choice, a growing research interest in the links between food and emotion has emerged. The research presented in this thesis attempted to further the understanding of the relationships between food and emotion, focusing particularly on the effects of certain food behaviors on mood, and the formation of emotional associations with food. The objective of Part 1 was to determine whether having a choice of meal components (vs. no choice) and/or preparing a meal (vs. someone else preparing) influenced the stress-relieving and mood-boosting effects of food and eating. One hundred eighteen participants completed a laboratory stress task in which they were asked to deliver an impromptu speech and to do complex mental arithmetic. Following the stress task, participants consumed a pasta meal. Participants either chose the components of their pasta meal or not (experimenter chose the components for them), and either prepared it themselves or not (experimenter prepared it for them). Stress (salivary cortisol, heart rate, and blood pressure) and mood (adapted Profile of Mood States) were measured several times throughout the experiment. Not choosing the meal components resulted in greater reductions in anxiety and anger than choosing. Systolic blood pressure was reduced more in the no choice than in the choice condition after the meal. Preparing versus not preparing had little effect on stress and mood measures. Given that people generally have emotional responses to food and eating experiences, the second part of this thesis explored why and how those emotional associations are formed. The main objective of Part 2 was to attempt to induce positive emotional associations with novel foods in the laboratory by conditioning the foods with emotionally positive film clips. The effect of calorie content of foods on formation of emotional associations was also examined, as was the relationship between liking ratings of the novel foods and emotional associations. One hundred participants completed a conditioning procedure in which they ate novel foods (*High-Calorie* foods or *Low-Calorie* foods) while viewing film clips (*Positive* film clips or *Neutral* film clips) for four consecutive days. Prior to conditioning, they made baseline ratings of explicit (Positive and Negative Affect Schedule) and implicit (Implicit

Positive and Negative Affect Test) emotional associations and liking (9-point hedonic scale). On the day after the last conditioning session, and also one week later, participants rated explicit and implicit emotional associations and liking again. Positive emotional associations were not successfully induced with novel foods. No differences in emotional associations between high-calorie and low-calorie foods were observed. A major limitation was that the film clips did not reliably increase participants' positive mood, which may have contributed to the failure of our conditioning procedure. Liking ratings of the novel foods increased throughout the duration of the study, and were positively associated with positive emotional associations. The research presented in this thesis demonstrates the complexity of the relationships between food and emotions, and sheds light on the many methodological issues to consider when studying these relationships.

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CHAPTER 1 LITERATURE REVIEW

1.1 Introduction

An improved understanding of the links between food and emotion will help people leverage their emotional responses to food to improve food choice and ultimately overall health. The relationships between food and emotion are complex and are just beginning to be unraveled. Emotions appear to drive food choice, and, in turn, the foods we eat affect the way we feel (King & Meiselman, 2010). Emotions can also drive people's intentions to engage in certain health behaviors (Keer, van den Putte, & Neijens, 2010), including healthy eating. Food choice and consumption (and thus 'healthiness' of the diet) is entirely dependent on behavior (Bellisle, 2009), which is influenced by emotional state. The study of food and emotion involves the integration of food science with psychology and human physiology. The research presented in Chapters 2 and 3 of this thesis aims to address how certain food behaviors impact the emotional response to foods and how emotional associations with food are formed. This chapter will provide an introduction to terminology and methods used throughout the thesis as well as a discussion of what is currently known about the links between food and emotion.

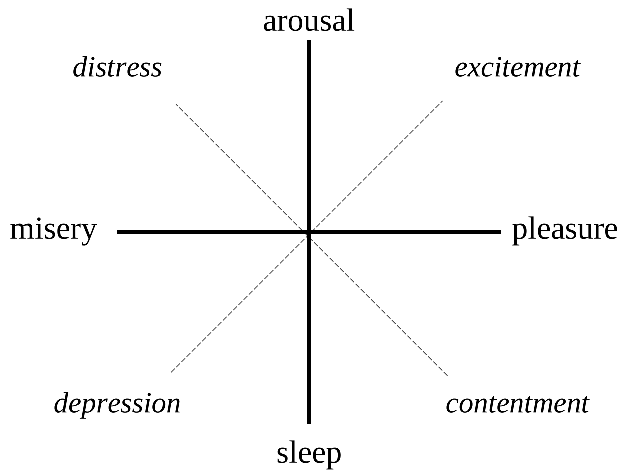
1.2 Definition and usage of 'emotion'

The words 'mood' and 'emotion' are often used synonymously, although there are clear distinctions between the two in terms of psychological constructs. Emotions are briefer, more overt, and more intense than moods, and transpire as a result of an action/occurrence, while moods come on gradually and do not occur because of obvious stimuli (Bagozzi, Gopinath, & Nyer, 1999; Gibson, 2006). Moods only involve subjective feelings, while emotions also involve physiological effects (Cranford et al., 2006; Damasio, 2001). Moods and emotions are both generated by a person's sensory relationships to the environment and memories of prior experiences (Barrett, Mesquita, Ochsner, & Gross, 2007). In line with current usage in the literature (see Desmet & Schifferstein, 2008; Edwards, Hartwell, & Brown, 2013; King & Meiselman, 2010), the words 'mood' and 'emotion' will be used interchangeably for the remainder of this thesis.

The broader term ‘affect’ will also be used in this thesis, which encompasses moods, emotions, and hedonic tone (liking).

Emotions can be differentiated based on a variety of criteria, but generally can be modeled in a two-dimensional space. Russell (1979, 2003) classified emotions in terms of arousal level and valence (**Figure 1.1a**). Arousal level refers to the extent to which a person is physically and psychologically activated by the emotion, and ranges from low arousal (e.g. sleepy) to high arousal (e.g. astonished). Valence refers to whether the emotion is pleasant (e.g. happy) or unpleasant (e.g. sad). Russell arrived at the two factor arousal/valence solution by doing a factor analysis on emotion words. Later, Watson and Tellegen (1985) obtained slightly different factors via factor analysis (**Figure 1.1b**). They classified emotions in terms of Positive Affect and Negative Affect (see *Positive and Negative Affect Schedule*, **section 1.3.1**), which corresponded to a 45-degree rotation of Russell’s model. As shown in **Figure 1.1**, both classifications can be fit into the same two-dimensional space. Watson, Clark, and Tellegen (1988) described the two-dimensional models well: “Although the terms Positive Affect and Negative Affect might suggest that these two mood factors are opposites (that is, strongly negatively correlated), they have in fact emerged as highly distinctive dimensions that can be meaningfully represented as orthogonal dimensions in factor analytic studies of affect.” For example, someone who is experiencing low levels of positive affect (e.g. ‘dull’) is not necessarily experiencing high levels of negative affect (e.g. ‘distressed’), and vice versa.

a) Russell 1979, 1980:



b) Watson & Tellegen 1985:

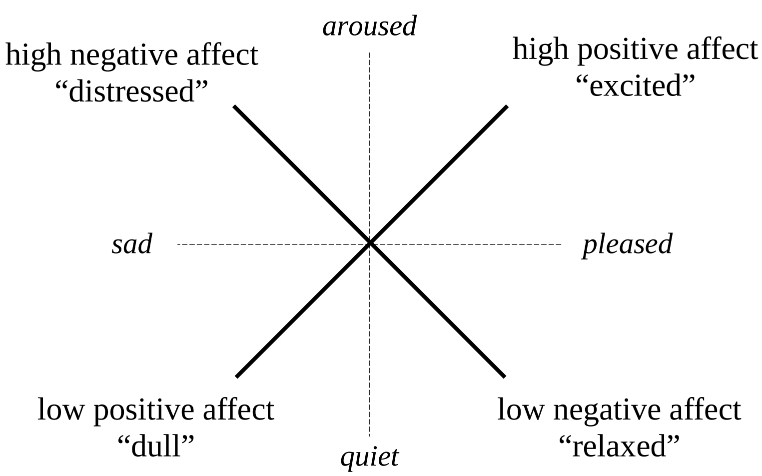


Figure 1.1 Two models of emotion.
A) Russell's (1979, 1980) arousal scale ranges from low (sleep) to high (arousal) and is perpendicular to the valence scale, which ranges from unpleasant (misery) to pleasant (pleasure). The dashed lines include word labels identified as being between the arousal and valence dimensions, but they also correspond similarly to Watson & Tellegen's (1985) model (B).
B) Watson & Tellegen's model is a 45-degree rotation of Russell's model. Their positive affect scale ranges from low (dull) to high (excited) and their negative affect scale ranges from low (relaxed) to high (distressed). The dashed lines include word labels that reflect Russell's arousal and valence dimensions.

1.3 Measuring emotions

In the laboratory, emotions are typically measured by questionnaire. Self-reported mood and emotion scales are commonly used in psychology research, and traditionally consist of a list of words (mainly negatively-valenced) that participants use to rate their current emotional state. This section provides descriptions of the main emotion measurement tools used in this thesis.

1.3.1 Positive and Negative Affect Schedule

The Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) provides a method to assess overall positive and negative emotions based on the two dominant emotion factors identified by Watson and Tellegen (1985). It returns a Positive Affect (PA) score and a Negative Affect (NA) score instead of distinct emotional states such as anger, anxiety, calmness, etc. PA and NA are orthogonal to each other and uncorrelated (**Figure 1.1b**). PA ranges from low (low-pleasant and low-arousal, e.g. dull) to high (high-pleasant and high-arousal, e.g. excited). NA ranges from low (high-pleasant and low-arousal, e.g. calm) to high (low-pleasant and high-arousal, e.g. hostile). The PANAS consists of 20 terms (10 high-PA and 10 high-NA) rated on a 5-point scale from 1 = not at all to 5 = extremely. The PA score is calculated by averaging the ratings of the 10 positive emotion terms, and the NA score is calculated by averaging the ratings of the 10 negative emotion terms.

1.3.2 Implicit Positive and Negative Affect Test

Indirect or implicit measurements of emotion, such as the Implicit Positive and Negative Affect Test (IPANAT; Quirin, Kazen, & Kuhl, 2009), are useful in research because participants may not always be aware of, or may misinterpret, their emotional state. Implicit measures also reduce demand effects, which occur when participants make ratings based on what they think is supposed to happen, or what they think the researchers want (Orne, 1962). In the IPANAT, participants are instructed to evaluate words from an artificial language. They are told that words sometimes ‘sound’ like they have an emotional meaning. They are asked to rate each of six artificial words on how much they seem to express each of six emotion words. The emotion words consist of three positive and three negative terms, and are rated on a 4-point scale from 1 = doesn't fit at all to 4 = fits very well. The scores of all positive terms (18 total, three for each of the six nonsense words) are averaged to give an implicit positive affect (PA) score. The average of all negative terms gives an implicit negative affect (NA) score. The more positively (higher) the participants rate the artificial words for the positive terms (i.e. the higher the PA score) the more positive their emotional state. The more negatively (higher) the artificial words are rated for the negative terms, the more negative the participants' emotional state. During development of the IPANAT, the implicit PA and NA scores were found to correlate with the PA and NA scores of the PANAS, indicating that the two scales measure similar emotional constructs.

1.3.3 Profile of Mood States

The Profile of Mood States (POMs; McNair, Lorr, & Droppleman, 1971) is a commonly used emotion-measurement tool developed for use in clinical psychiatry. It is meant to assess momentary emotional state or changes in emotional state over short periods of time. The full scale consists of 65 emotion terms that break down into six categories: tension/anxiety, depression/dejection, anger/hostility, vigor/activity, fatigue/inertia, and confusion/bewilderment. The scale can be used to assess mood during various time periods (e.g. 'right now', 'in the last week', etc.) Participants are asked to rate their mood during the specified time period by rating each term on a 5-point scale (1 = not at all to 5 = extremely). The scores for all words in each category are averaged, to give an overall score for that category. Since the full scale of 65 terms is very long, short forms have been developed (see Cranford et al., 2006; Smit & Rogers, 2002).

1.3.4 Emotion measurement in sensory science

Recently, emotion measurement has emerged as an additional source of information related to acceptance of food and consumer products (Cardello et al., 2012). New scales, such as the EsSense Profile™ (King & Meiselman, 2010) have been developed for food. The EsSense Profile consists of 39 emotion terms: 25 positive, 3 negative, and 11 unclassified (neither positive nor negative). Participants are asked to rate (from 1 = not at all to 5 = extremely) to what extent they experience each of the emotion words in response to a food. Emotions are generally considered individually, and not collapsed into categories or positive/negative affect, as in the POMS, PANAS, or IPANAT. This allows greater differentiation among foods, which has been the main goal of emotional profiling in sensory science. The emotional scaling needs of sensory scientists in industry are different than the needs of sensory scientists in academia. The EsSense Profile and other food-oriented emotion scales are composed mostly of positively-valenced emotion words, because most emotional responses to foods are positive (Cardello et al., 2012; Desmet & Schifferstein, 2008; King & Meiselman, 2010). For some experimental objectives, negative emotional responses remain important, so the validated psychological scales described in the preceding paragraphs remain useful. For example, researchers often want to know how food consumption impacts negative emotional states such as stress and sadness. A more complete emotional profile of the overall food experience (and changes in emotions from before to after eating a food) can be identified when both positive and negative emotion words are used.

1.3.5 Emotions and liking

Positive emotions are often associated with liking, but comparison of emotions and liking can be a problematic because they are not always defined as clearly distinct concepts. The hedonic scale typically used to assess liking is sometimes anchored with the words unpleasant – pleasant (Herz et al., 2004; Hetherington, Bell, & Rolls, 2000), rather than disliking – liking (Baeyens et al., 1996; Kuenzel, Zandstra, et al., 2011). ‘Pleasant’ is also sometimes considered an emotion, for example in the EsSense Profile (King & Meiselman, 2010). Steiner’s (1974) classic experiments on infants’ facial responses to basic tastes equated pleasant-looking facial movements with liking. Do those facial expressions really indicate liking, or do they indicate positive emotion? The ‘smiley scale’, used to measure children’s food preferences, consists of 3-7 cartoon faces ranging from a frowning face (labeled ‘super bad’) to a smiling face (labeled ‘super good’) (Chen, Resurreccion, & Paguio, 1996). Children are instructed to point to a face corresponding to how much they like a particular food, but again, frowning and smiling faces also indicate emotional valence. The children could presumably point to the smiling face if they were *feeling* happy, versus *liking* the food. Is feeling pleasant (emotion) the same as finding something pleasant (liking)? Does it matter?

Some researchers have experimentally found links between liking and emotional response that strengthen the idea that positive emotions are highly related to liking. During development of the EsSense Profile, King et al. (2010; King & Meiselman, 2010) collected both liking and emotion ratings in response to food consumption. They found liking ratings to be positively correlated with ratings of many positive emotion words and negatively correlated with ratings of many negative emotion words (King et al., 2010). This finding was corroborated by Cardello et al. (2012). They had participants taste foods and rate emotional response (EsSense Profile) and liking. They found that liking ratings positively correlated with positive emotion words and negatively correlated with negative emotion words. For example, liking ratings of dark chocolate were correlated with 'happy' ratings ($r = 0.58$, $p < 0.01$; Cardello et al., 2012). Manzocco et al. (2013) had participants view fruit salads that were 0, 6, or 10 days old and rate liking and emotional response (using a check-all-that-apply method). They found a correlation ($r > 0.99$) between frequency of some of the reported positive emotions (including peaceful, friendly, and eager) and liking of the appearance of fruit salads. Some of the examples in the paragraphs that follow use liking as a proxy measurement for emotional response. We have opted to include them in this literature review because although they do not directly measure emotional response, their methodology and the concepts they illustrate lend support to our experimental objectives.

1.3.6 Research environment

In laboratory studies, mood and emotion may be affected by the research environment. First, bringing participants into the research environment may induce some psychological stress and confound further measures of stress and mood (Baum, Grunberg, & Singer, 1982). Second, emotion ratings are subject to demand effects, which occur when participants change their behavior and ratings to align with what they believe the purpose of the experiment to be (Orne, 1962). Based on what they think is supposed to happen, participants may report a certain emotional response to a food, similar to a placebo drug making people feel better (Hammersley, Reid, & Duffy, 2007). Third, participants may respond based on prior experiences instead of actual feelings at the time of tasting (Cardello et al., 2012). Cardello et al. (2012) had participants rate emotional response to both food names and actual tasted foods. They found that emotional responses (both positive and negative) to the word 'chocolate' were greater than emotional responses to tasted chocolate. They supposed that a food name evokes expectations of the ideal experience with that food, which likely would be an intensely emotional experience. Tasting a food in a laboratory could hardly live up to ideal expectations, so emotional responses to foods in a laboratory setting would be less intense.

Appropriate timing of emotion measurements in food consumption research is critical for accurate assessment of mood and emotion. The best time to measure emotion changes due to eating is during consumption or immediately (no more than a minute) after (Hammersley et al., 2007; King et al., 2010). Since emotions are fleeting, the immediate emotional response induced by ingestion of a food can be quickly overruled by cognitive thoughts and associated changes in emotion (Hammersley et al., 2007), rendering later measurements less accurate. This is not to say that those later feelings are not an important part of the food-mood relationship, but they may not be a good indicator of the initial response to a particular food. Measuring emotion repeatedly throughout the experiment will show how emotion changes over time. Emotional response will also depend on emotional state upon arrival to the laboratory (Hammersley et al., 2007). For example, if a participant is having a bad day, her emotion ratings will reflect her negative mood. Measuring emotion immediately upon arrival will account for daily fluctuations in emotional states.

1.4 Why study food and emotion?

The origin of scientific research in the area of food and emotions was likely the idea of 'comfort food', but the origin (and definition) of 'comfort food' is murkier. Most people can identify a ‘comfort food’ that they believe will improve distressed or depressed mood. Why do we believe that food will affect our emotional state? Proust’s madeleine is a commonly cited anecdotal example of food eliciting a positive emotional response (as discussed in Chu & Downes, 2004; Herz & Schooler, 2002; Jellinek, 2004; Kuenzel, Blanchette, et al., 2011). In his writings, Proust describes how the taste and smell of a madeleine cake take him back to childhood, and he not only recalls the food and environment in which it was eaten, but also experiences intensely positive emotions. The term ‘comfort food’ was added to many dictionaries in the mid-1990s, but definitions vary. Most definitions indicate that comfort foods originate during childhood and include an emotional component. Some include type of food, such as those high in sugar or carbohydrates (Oxford English Dictionary). Many researchers have used the common definitions of comfort foods (Kandiah, Yake, Jones, & Meyer, 2006; Tomiyama, Dallman, & Epel, 2011; Wansink, Cheney, & Chan, 2003; Wansink & Sangerman, 2000), while others have been more skeptical and have struggled to define them (Gibson, 2012; Wagner, Ahlstrom, Redden, Vickers, & Mann, 2014; Wood, 2010). In the following paragraphs, we attempt to elucidate why foods elicit emotional responses and which characteristics of food might be responsible.

1.4.1 Does food elicit an emotional response?

The recently developed food-emotion scales (such as the EsSense Profile; King & Meiselman, 2010) were based on the belief that food *does* elicit an emotional response, but experimental evidence is inconclusive. Bongers, Jansen, Havermans, Roefs, & Nederkoorn (2013) tested the effects of mood state on food intake and subsequent mood improvement. Their participants watched film clips to induce positive, negative, or neutral mood. They rated how frightened, sad, happy, guilty, enthusiastic, nervous, and ashamed they felt (from 0 = not at all to 100 = very much) before and after the film clips, and 5, 10, and 15 minutes after beginning to eat. After viewing the film clips, participants ate as much as they liked from a selection of potato chips and chocolates. Regardless of mood induced (via positive, negative, or neutral film clips), all participants’ mood improved after eating. The researchers found a positive correlation between food intake and mood improvement in the first five minutes of eating, indicating that the more food eaten, the more mood improved. Macht, Gerer, & Ellgring (2003) also found that food elicited an emotional response, but in the opposite direction. They had participants taste small samples of food with low-, medium-, and high-energy contents, and then immediately rate mood. Participants rated the extent to which they felt happy, angry, anxious, sad, and ashamed on a seven-point scale (from 0 = not at all to 6 = very strongly). They found that, for some participants, positive emotion ratings decreased with increasing energy content of foods, and negative emotion ratings increased with increasing energy content of foods (Macht et al., 2003). These two examples illustrate some of the work that has been done to show that food elicits an emotional response, and other examples will be described in the paragraphs that follow.

1.5 Why might food elicit an emotional response?

Several research groups have conducted qualitative studies to find out why we have emotional associations with foods, and three main themes have been identified. Macht, Meininger, and Roth (2005) conducted interviews in which they asked participants about what social aspects and eating behaviors make a meal pleasurable, what feelings and moods are experienced during pleasurable meals (and why), and what makes pleasurable meals different from normal meals. Locher, Yoels, Maurer, and van Ells (2005) had students bring their own personal comfort foods into class for a potluck. For extra credit in the class, the students wrote essays about why their chosen food was comforting to them. Desmet and Schifferstein (2008) asked people to describe instances in which specific foods elicited specific emotions, and why. All of these groups identified sources of food-elicited emotions that could be classified under three main themes: post-ingestive effects of food consumption, sensory properties of the food, and psychological associations with the food. Desmet and Schifferstein (2008) provided an example of post-ingestive effects from one of their participants: “I felt stimulated after drinking coffee”. In this example, ‘stimulated’ was the emotional response to coffee ingestion. One of Macht et al.’s (2005) participants describes the emotional response (enjoyment) to the sensory properties of food: “For me, enjoyment is looking at food beforehand, then smell it, feel it (sometimes I also like to eat with my hands)”. Psychological associations with food are often an expectation that consuming a food will improve one’s emotional state because it has elicited positive emotions in the past, such as this example from Locher et al. (2005): “Whenever I am feeling depressed, sad, or just bored, I can get a big bag of fried pork skins and it will boost my spirits.” **Figure 1.2** shows how these themes related to each other. The following paragraphs discuss each theme in more detail.

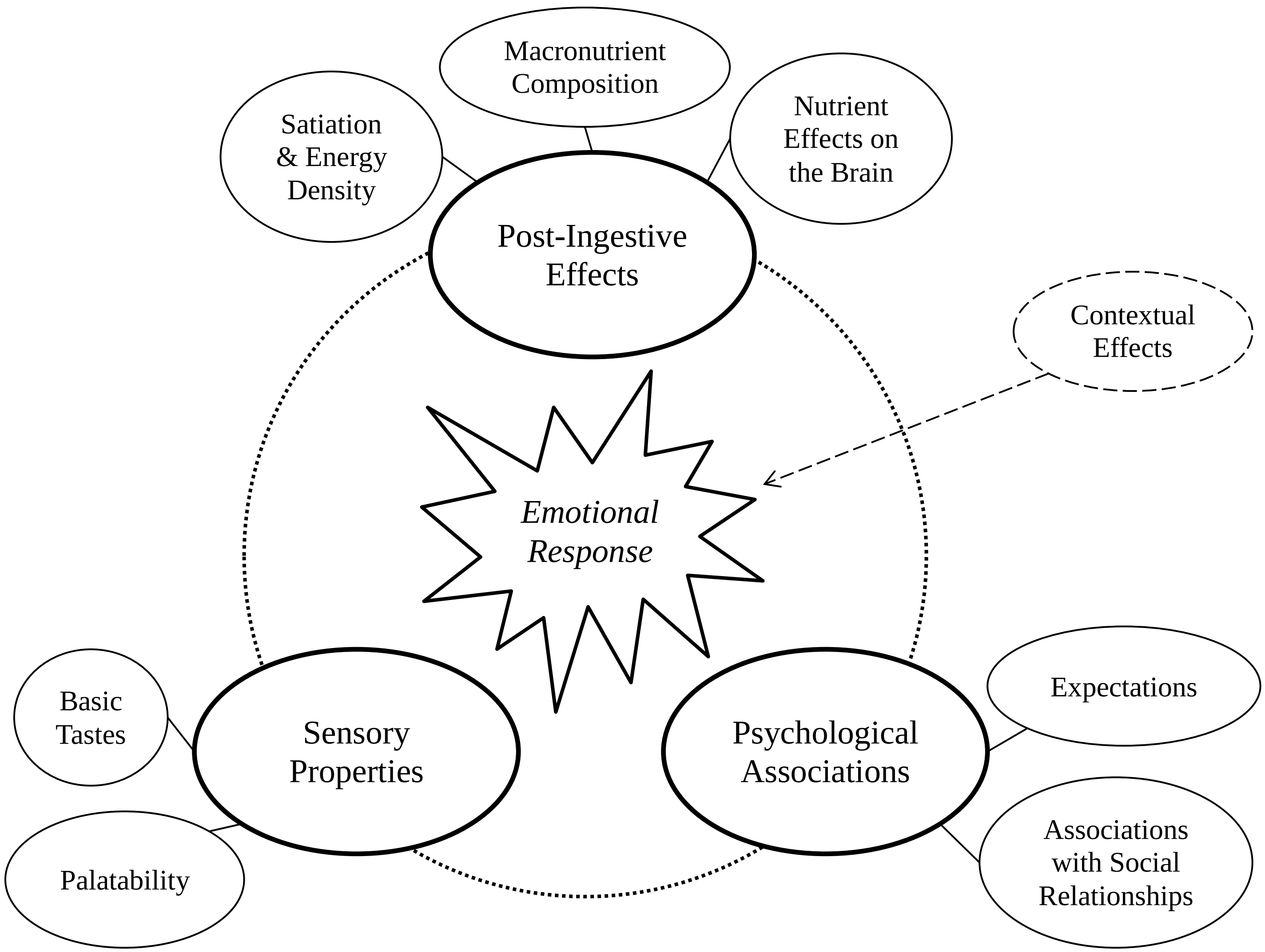


Figure 1.2 Sources of food-elicited emotions.

1.5.1 Post-ingestive effects

Post-ingestive effects of eating contribute to the emotional response to foods. These effects include feelings of satiation (e.g. satisfaction, fullness, or alleviation of hunger), changes in blood glucose, and nutrient effects on the brain.

1.5.1.1 Satiation & energy density

One post-ingestive effect of food consumption that may influence emotional response is satiation, which can be related to energy density of the foods eaten. Generally, people are alert and irritable when hungry, and calm and sleepy when full (Gibson, 2006). Locher et al.'s (2005) participants reported satiating/filling foods to be especially comforting. Energy-dense foods may be more likely to elicit strong emotional associations because they are more satiating. This effect was observed when mood improved more after eating a high-calorie chocolate bar than a low-calorie apple (Macht & Dettmer, 2006). Their participants completed four trials each of consuming a chocolate bar, an apple, or nothing. They rated hunger (from 0 = not at all to 7 = very strongly) and mood (from 0 = extremely bad to 10 = extremely good) before consumption and 5, 30, 60, and 90 minutes after consumption. Eating the chocolate bar alleviated hunger more than the apple, which alleviated hunger more than eating nothing. Mood improved from before to after eating the chocolate bar or the apple, but mood improved more after eating the chocolate bar compared to the apple. Eating nothing did not result in any changes in mood. Dubé, LeBel, and Lu (2005) had 277 participants complete an online survey in which they were asked to name a comfort food and to think about times that food had been eaten. Then they were asked to recall to what extent they had felt each of 10 emotions (4 positive and 6 negative, rated from 1 = not at all to 7 = very intensely) both prior to and after eating their comfort food. Comfort foods named by the participants were categorized into 1) high-calorie sweet foods (including ice cream and chocolate), 2) high-calorie non-sweet foods (including pizza and salty snacks), and 3) low-calorie foods (including fruits and vegetables). Overall, positive emotions increased and negative emotions decreased after consumption of foods from any of the categories. Negative emotions decreased more after consumption of high-calorie sweet foods (as in the chocolate bar from Macht and Dettmer (2006)) compared to high-calorie non-sweet foods or low-calorie foods (as in the apple from Macht and Dettmer (2006)). Cardello et al. (2012) found that when participants rated emotional responses to food names, high-calorie foods (chocolate) elicited stronger emotional responses (both positive and negative) than low-calorie foods (oatmeal and carrots).

On the other hand, we have some evidence that low-calorie foods may improve mood more than high-calorie foods, so direction of mood change may depend on type of food. In addition to finding that high-calorie foods decreased negative mood more than low-calorie foods, Dubé et al. (2005) found that consumption of low-calorie foods increased positive emotions more than high-calorie non-sweet foods. In other words, Dubé et al. (2005) provided evidence that low-calorie foods could improve mood more than high-calorie foods. Macht et al. (2003) found similar evidence of low-calorie foods being associated with greater positive mood compared to high-calorie foods. They asked participants to taste small samples of low-calorie foods (carrot, strawberry, salmon), medium-calorie foods (cheese, quark, ham), and high-calorie foods (hazelnut, chocolate, salami) in random order. The participants rated to what extent they felt each of seven emotions (happy, angry, anxious, sad, ashamed, attentive, sleepy; rated from 0 = not at all to 6 = strongly) immediately after tasting each food. Negative emotion ratings increased, and positive emotion ratings decreased, with increasing energy content of the foods. Clearly, there are differences in emotional responses due to consumption of low-calorie compared to high-calorie foods, but calorie density does not appear to have a direct or predictable relationship with emotion ratings.

1.5.1.2 Macronutrient composition

Carbohydrates have generally been shown to improve emotional state. Low blood glucose is associated with negative mood (Benton, 2002), and carbohydrates may improve mood simply by raising blood glucose (Hammersley et al., 2007). Benton and Owens (1993) measured participants' blood glucose and mood before and after consuming either a beverage containing 50 grams of carbohydrate or a placebo beverage without carbohydrate. Their mood questionnaire consisted of 30 items measuring the extent to which participants felt tired/energetic and relaxed/tense (each item rated from 1 = definitely do not feel to 4 = definitely feel). Those who consumed the glucose-containing beverage exhibited a greater increase in blood glucose than those who consumed the placebo beverage. Blood glucose levels were positively correlated with ‘energetic’ ratings, and negatively correlated with ‘tense’ ratings.

Ingestion of foods high in carbohydrates (and the resulting increase in blood glucose) may also affect emotional state because carbohydrates activate the stress response and correspondingly elevate cortisol (Gibson, 2006; Lemmens, Martens, Born, Martens, & Westerterp-Plantenga, 2011). While this might suggest that carbohydrate consumption causes an increase in negative mood (as a result of stress activation), it could be that the corresponding cortisol release acts to reduce psychological feelings of stress (Schlotz et al., 2008). When carbohydrate intake is chronically high, the stress response is blunted, which results in lower average plasma cortisol levels (Gibson, 2006), causing fatigue and depressed mood (Christensen, 1993). The result is a vicious cycle in which carbohydrates must be repeatedly consumed to counteract the negative emotional state.

Most research on the emotional response to protein has compared it with carbohydrate; and protein does not appear to improve mood to the same extent as carbohydrate. Spring et al. (2008) found that carbohydrate-only beverages improved mood better than carbohydrate + protein beverages, but this was specific to their overweight, carbohydrate-craving participants. Participants completed two 3-day sets of laboratory sessions in which they were subjected to a negative mood induction. On the first day of each set, participants consumed either a carbohydrate-only beverage or a carbohydrate + protein beverage. On the second day, participants consumed the beverage they had not consumed the previous day. On the third day participants were asked to choose, between the two beverages, which one had put them in a better mood. Mood was rated (POMS) before and after negative mood induction and 45, 90, 135, and 180 minutes after beverage consumption. The carbohydrate-only beverage was chosen more often than the carbohydrate + protein beverage as the beverage that participants expected would put them in a better mood. Negative mood decreased (i.e. mood improved) after consuming the carbohydrate-only beverage but not after consuming the carbohydrate + protein beverage. Lemmens et al. (2011) found no difference in mood ratings after a stress task when participants consumed high-carbohydrate compared to high-protein meals. Their participants attended four sessions – to consume a high-carbohydrate meal under stress, a high-carbohydrate meal under rest, a high-protein meal under stress, and a high-protein meal under rest. Mood (POMS) was rated several times throughout each session, and the area under the curve over all time points for each mood word served to indicate the total stress response. Stress-related emotions were greater in the stress sessions compared to the rest sessions, but there were no differences due to consumption of a high-carbohydrate vs. a high-protein meal. Macronutrient content of the meal had no differential effect on self-reported mood response to the stressful task.

Fat has been shown to blunt emotional responses after a sad mood induction more than no food (van Oudenhove et al., 2011). Participants underwent four functional MRI scans after 1) gastric infusion (through a feeding tube) of fatty acids during a sad mood induction, 2) gastric infusion of fatty acids during a neutral mood induction, 3) gastric infusion of saline during a sad mood induction, and 4) gastric infusion of saline during a neutral mood induction. At four points throughout each infusion, participants rated mood (on a 9-point scale ranging from 1 = sad to 5 = neutral to 9 = happy), hunger, fullness, and nausea. The sad mood induction was not as effective when fatty acids were infused into the stomach compared to saline. In other words, fat present in the stomach during a sad emotion induction seemed to have a protective effect on mood changes (both self-reported mood and associated neurological changes) compared to saline. No effect of the fatty acid versus saline infusion was found for ratings of hunger or fullness. The researchers' intent was only to look at nutrient-induced gut-brain signaling (i.e. food vs. no food). Therefore, they did not consider differential effects of fat compared to the other macronutrients, so we were unable to draw comparisons between the emotional effects of fat seen in this study and those of carbohydrate or protein.

De Castro et al. (1987) conducted a survey study in which the emotional associations with all three macronutrients (fat, protein, and carbohydrate) were examined. Participants kept food diaries for nine days. They were instructed to record everything they ate and their mood at the time they ate it. Mood was rated on three 7-point scales: elated/depressed, tired/energetic, and anxious/tranquil. Based on reported intake and statistical modeling, the researchers estimated the macronutrient content of participants' stomachs before and after each meal. With these estimates, they were able to correlate mood with the amount of each macronutrient in the stomach at the moment mood was rated. They found no correlation of macronutrient intake with momentary mood ratings, but over the nine-day period, carbohydrate intake was associated with increased 'energetic' mood and decreased 'depressed' mood. Also over the nine-day period, protein intake was associated with increased 'depressed' mood and fat was associated with decreased 'energetic' mood. In this study, then, it appeared that carbohydrate intake improved mood, while protein and fat intake diminished mood.

1.5.1.3 Nutrient effects on the brain

Information about nutrient digestion and absorption travels from the intestines to the brain via the vagus nerve (Gibson, 2006), and signals the brain to release neurotransmitters, including dopamine, endogenous opioids (endorphins), and serotonin. The ways in which these neurotransmitters affect mood are described in the paragraphs below.

The release of dopamine and endogenous opioids (endorphins) are direct results of food ingestion, and both may affect mood. Dopamine is released both before and during food consumption, in response to expectations attributed to the food (Berridge & Robinson, 1998). After the release of dopamine, positive 'reward' feelings ensue (Arias-Carrión & Pöppel, 2007; Berridge & Robinson, 1998). Certain types of people such as obese and/or emotional eaters may be predisposed to overeating for the purpose of releasing dopamine (Gibson, 2006) and achieving its positive effects. Ingestion of palatable (i.e. highly liked) foods activates the opioid system, which results in the release of endorphins (Gibson, 2006). Elevated endorphin levels in the brain cause pleasant feelings and emotions (Benton, 2002; Gibson, 2006). Over time, the pleasantness of ingesting certain foods becomes associated with the release of endorphins, which may result in increased consumption during times of stress (Weltens, Zhao, & Van Oudenhove, 2014).

Yeomans and Wright (1991) demonstrated the effect of the opioid system on emotional response to foods. Upon arrival to the laboratory, participants rated appetite and mood (including alertness, anxiety, drowsiness, and elation, rated from 0 = not at all to 100 = very). Participants then consumed a dose of either nalmefene or a placebo. Nalmefene is a drug that blocks the action of opioids on the brain. They rated appetite and mood again, and then rated appearance, smell, and taste (including pleasantness and attractiveness, on the same scale as the appetite and mood ratings) of several food items on a buffet. They rated appetite and mood a third time, and then were allowed to eat as much as they liked from the buffet. After eating, the participants rated appetite and mood one last time, and the researchers weighed the uneaten food. Those participants who were treated with nalmefene rated pleasantness of the taste and smell of the foods lower than those in the placebo group. The intake of individual food items was positively correlated with sensory ratings, indicating that the nalmefene group consumed less of certain foods because they found them less palatable. Those in the nalmefene group consumed less fat and protein, but not carbohydrate, than those in the placebo group. Appetite did not differ at any time point between the two groups. Of the mood ratings, those in the nalmefene group were generally more 'alert' while those in the placebo group were generally more 'elated'.

Digestion and absorption of carbohydrate affects the levels of amino acids in the blood, which in turn alter brain chemistry. Carbohydrate digestion and absorption increase blood glucose, which stimulates the release of insulin. Insulin, in turn, increases uptake of certain amino acids from the blood. These include large neutral amino acids (LNAA), but not tryptophan. The result is a high ratio of tryptophan to LNAA in the blood. The high ratio of tryptophan to LNAA after carbohydrate ingestion results in a greater amount of tryptophan entering the brain, where it is converted into serotonin (Wurtman, Hefti, & Melamed, 1981). Serotonin is a neurotransmitter that induces positive emotions (Young, 2007). The problem with this phenomenon is that it only occurs after consumption of pure carbohydrate. As little as 5% of calories from protein in a food is enough to eliminate the effect (Benton, 2002). Protein increases the blood levels of all amino acids, so the ratio of tryptophan to LNAA is smaller, and less tryptophan enters the brain to be converted into serotonin. On very few occasions do people consume pure carbohydrate (except for candy, soda, and other sweetened beverages), so it is unlikely that this phenomenon truly contributes to elevated mood.

1.5.2 Sensory properties

Sensory attributes of a food, individually or collectively, can lead to the establishment of emotional associations. Since sensory attributes are experienced much more quickly than physiological changes, it is likely the former contribute more to emotional effects of the food than the latter (Macht & Dettmer, 2006). Some believe that individual sensory aspects of a food can directly elicit emotions (Jiang, King, & Prinyawiwatkul, 2014). Labbe, Martin, Le Coutre, & Hudry (2011) hypothesized that water ices with 'refreshing' sensory attributes would improve mood more than either a regular water ice or plain water. 'Refreshing', in their definition, referred to a food or beverage that alleviated thirst and relieved mouth dryness. 'Cold' and 'sour' sensory perceptions were also considered components of 'refreshing'. Their participants attended one laboratory session in which they consumed regular water ices, one session in which they consumed 'refreshing' water ices, and one session in which they consumed plain water. Water ices were made from water, sugar, and citrus flavor, and in the 'refreshing' condition, citric acid and a menthol-like cooling agent were added. Participants rated mood (alertness, contentedness, and calmness) before, immediately after, and 15 minutes after consuming each water ice/plain water. Consumption of either the regular or 'refreshing' water ices resulted in higher 'alertness' and 'contentedness' ratings compared to plain water, but lower 'calmness' ratings. No differences in mood ratings between the regular water ice and the 'refreshing' water ice were observed, but the researchers argued that the regular water ices were likely more 'refreshing' than plain water as well. The term 'refreshing' seems to be a sensory-related term that also hints at an emotional state. Thomson and Crocker (2013) attempted to classify over 500 mood and emotion terms into basic categories of emotions. The word ‘refreshed’ was included in their initial word list and ended up lumped into their final ‘excited’ category, which also included the words ‘energetic’ and ‘lively’. Descriptors like ‘refreshing’, then, lend credence to the idea that the sensory experience and emotional response to a food are closely linked.

1.5.2.1 Basic tastes

The basic tastes, when consumed independently, may evoke different emotional responses. Robin, Rousmans, Dittmar, & Vernet-Maury (2003) related emotional responses to the basic tastes using autonomic nervous system (ANS) parameters, such as skin conductance and heart rate. (A ‘signature’ ANS response pattern has been established for each of the emotions happiness, surprise, sadness, fear, anger, and disgust using this method, developed by Ekman, Levenson, & Friesen (1983)). Robin et al. (2003) had participants taste each of the basic tastes (sweet, sour, salty, bitter) while ANS parameters were recorded. The basic tastes produced ANS responses that corresponded with the ANS responses of emotions. Sweet solutions were associated with the positive emotions happiness and surprise, and bitter solutions were associated with the negative emotions anger and disgust, while salty and sour solutions had more variable responses. Several researchers have looked at emotional response to the basic tastes by characterizing facial expressions of infants after consumption (Rosenstein & Oster, 1988; Steiner, Glaser, Hawilo, & Berridge, 2001; Steiner, 1974). They all used a similar protocol: the basic tastes (sweet, sour, salty, bitter) were administered to infants and their facial expressions were recorded. A previously developed coding system was used to classify the facial expressions (including lip/mouth movements, eye crinkling, and nose wrinkling) as positive or negative. All of the researchers identified consistent facial reactions to sweetness characterized as positive or appetitive and consistent facial reactions to bitterness characterized as negative or aversive. Reactions to sour taste were classified as mostly negative but sometimes positive. Rosenstein & Oster (1988) found that salty tastes elicited indistinctive facial expressions (Steiner et al., 2001 did not test a salty stimulus). Based on this and other work, researchers have concluded that sweet taste is innately liked (at least partly because it induces positive facial reactions) and bitter taste is innately disliked (at least partly because it induces negative facial reactions) (Rosenstein & Oster, 1988; Rousmans, Robin, Dittmar, & Vernet-Maury, 2000; Steiner et al., 2001; Steiner, 1974).

1.5.2.2 Palatability

Palatability (albeit a vague term describing sensory pleasantness) may also affect emotional responses to food. Generally, palatable foods are thought to improve mood more than unpalatable foods (Benton, 2002; Macht & Mueller, 2007; Spring et al., 2008), but the definition of 'palatable' is unclear. Generally, a 'palatable' food is one that is highly liked (Appelhans, Whited, Schneider, Oleski, & Pagoto, 2011), but researchers have also used high fat/high carbohydrate (Benton, 2002; Drewnowski & Greenwood, 1983; Groesz et al., 2012), high fat/high sugar (Oliver, Wardle, & Gibson, 2000; Pecoraro, Reyes, Gomez, Bhargava, & Dallman, 2004), and high sugar (Christiansen, Dekloet, Ulrich-Lai, & Herman, 2011; Ulrich-Lai et al., 2007) foods as 'palatable' foods, without measuring or reporting liking. Macht and Mueller (2007) demonstrated that palatable chocolate improved mood more than unpalatable chocolate. Before the experiment, participants tasted four types of chocolate and rated palatability (the researchers did not report how palatability was rated). During the experiment, sad mood was induced (via film clips) followed by ingestion of either the participant's highest-rated chocolate (deemed 'palatable'), lowest-rated chocolate (deemed 'unpalatable'), or water. Participants rated mood (on a 25-point scale, with points 1-5 = very bad, 6-10 = bad, 11-15 = medium, 16-20 = good, 21-25 = very good) and joy and sadness (on similar scales) before and after the mood induction and after chocolate consumption. Mood and joy ratings increased more for those who consumed palatable chocolate compared to unpalatable chocolate or water. Unpalatable chocolate did not improve mood more than water. Due to the variety of definitions of 'palatable' in the literature, and the fact that what is palatable for one person may not be palatable for another, individual differences in palatability of a food may indeed affect emotional response. However, this could mean that some of the positive experimental results of food intake on mood may just be because the foods were deemed palatable (or liked) by the participants, and not because of any specific macronutrient or post-ingestive effect. Then again, these effects are all so closely linked that they may act synergistically to elicit an emotional response.

1.5.3 Psychological associations

Psychological associations are another source of food-elicited emotions. Psychological associations serve to link the mental representation of a behavior, such as eating a food, with a positive or negative emotional state (Walsh & Kiviniemi, 2013). They align with what Macht et al. (2005) called 'subjective experiences' and Desmet & Schifferstein (2008) called 'personal and cultural meanings'. Psychological associations with a food stem from emotionally salient memories of prior experiences with that food. These memories seem to come from two sources: associations with social relationships and expectations regarding food experiences, discussed below.

1.5.3.1 Associations with social relationships

One source of food-elicited emotions is an association of foods with social relationships. Locher et al. (2005) surmised that associations with prior social experiences, such as eating a meal prepared by a beloved grandmother, were what made foods comforting and emotionally salient for their participants. A similar example from Desmet and Schifferstein's (2008) survey was the statement, "I love strawberries because they make me think of my girlfriend". When foods are eaten for comfort, they are generally eaten alone, but their consumption elicits memories of emotionally salient (usually positive) prior experiences with social relationships (Troisi & Gabriel, 2011). Troisi and Gabriel (2011) tested these ideas experimentally. In a pre-test, their participants stated whether or not they found chicken noodle soup to be a comfort food. During the experiment, participants consumed either chicken noodle soup or nothing, and then did a task in which they were asked to complete word fragments. The task included word fragments that could be completed as relationship words (include, welcome), emotion words (joy, worry), and control words (quiet, sort). The more relationship-related words completed, the more participants were said to recall relationships in the context of eating chicken noodle soup (or nothing). Participants also completed the

PANAS. For those participants for whom chicken noodle soup was considered a comfort food, more relationship words were completed when it was eaten compared to when it was not eaten. For those participants for whom chicken noodle soup was not a comfort food, there was no difference in number of relationship words completed when it was eaten compared to when it was not eaten. These results indicated that comfort food did, in fact, elicit associations with social relationships. If these social relationships were associated with positive emotions, we would expect the food to also elicit positive emotions. Troisi and Gabriel (2011) measured emotions, but did not present the results in a way that examined that idea.

1.5.3.2 Expectations

Expectations about how we think a food will taste, how it will make us feel, or how much we think we will like it are another aspect of psychological associations that will affect our emotional response to foods. Emotional associations can occur as a response to sensory cues such as aroma and appearance, and external cues such as food names, health claims, and ingredient statements (Cardello et al., 2012; Wansink & Park, 2002). These cues elicit expectations of how the food will taste and how much we will enjoy it. Cardello et al. (2012) asked participants to rate emotional response (EsSense Profile) to both food names and tasted foods. They found that for chocolate, emotional response (both positive and negative) to the name was greater than the actual food. Their results indicated that an expectation about how a food would taste is sometimes different from actually tasting the food. Our emotional response to a food (and how much we like it) depends on whether or not the food meets our expectations.

When a food meets our expectations, we will evaluate it accordingly. Focusing on, for example, the positive expectations, can lead to a positive sensory evaluation (Wansink, Payne, & North, 2007). Wansink et al. (2007) served the same wine, but labeled ‘California’ wine or ‘North Dakota’ wine, to participants and asked them to rate how tasty they expected it to be and how tasty it actually was, once sampled (tastiness rated from 1 = not very tasty to 9 = very tasty). Participants also tasted and rated a sample of goat cheese. Those who believed they sampled ‘California’ wine rated expected and actual tastiness of the wine and tastiness of the goat cheese higher than those who believed they sampled ‘North Dakota’ wine. Although the wine was the same in both conditions, the high quality expected of California wines compared to North Dakota wines resulted in tastiness ratings that confirmed those expectations. Since we consider liking (or tastiness, in this case) to also indicate positive emotional response, the fact that expectations of California wine led to higher tastiness ratings also suggested that participants felt positive emotions toward it.

If there is a large difference between expectations and the actual food experience, the food will be rated unfavorably (Yeomans, Chambers, Blumenthal, & Blake, 2008). Yeomans et al. (2008) developed a non-sweet ice cream that appeared to have a pink, fruity flavor, but was actually flavored with smoked salmon. Participants tasted the ice cream, and were told either that it was ‘ice cream’ or ‘frozen savory mousse’. Participants rated expected (before tasting) and actual (after tasting) pleasantness of the ice cream from 0 = not at all to 500 = extremely. We interpreted ‘pleasantness’ in this experiment to mean both liking and pleasant (positive) emotional response. Before tasting, the ‘ice cream’ was expected to taste more pleasant than the ‘frozen savory mousse’. After tasting, the ‘frozen savory mousse’ was rated more pleasant than the ‘ice cream’, and there was a greater decrease in pleasantness ratings from before to after tasting the ‘ice cream’ compared to the ‘frozen savory mousse’. The disconfirmation of expectations in the case of the ‘ice cream’ resulted in much lower pleasantness ratings than the ‘frozen savory mousse’, even though the products were exactly the same.

When novel foods are experienced for the first time, expectations will be based on a combination of associations from foods deemed similar to the novel food (Tuorila, Meiselman, Bell, Cardello, & Johnson, 1994). Emotional responses and sensory evaluation after tasting the novel food will depend on the degree to which the actual tasting experience matches that of the familiar food. Tuorila et al. (1994) had participants evaluate two novel foods (Finnish Easter pudding, Finnish non-alcoholic beer) with similar appearances to two familiar foods (apple butter, root beer). After tasting, participants rated liking of the four foods (from 1 = dislike extremely to 9 = like extremely). The participants were also asked to identify a food that closely resembled each test food, and to rate the degree of resemblance (from 1 = vaguely to 9 = extremely). The results showed that liking ratings of the novel foods were greater the more they resembled familiar foods.

1.5.4 Contextual effects on emotional response to food

The emotional response to food is also affected by the environmental and situational contexts of the eating experience. In other words, these are factors that become salient at time of consumption and may contribute to emotional responses in addition to psychological associations, sensory attributes, or post-ingestive effects. Features such as music/noise, lighting, ambient odors, cleanliness, temperature, and décor of the eating environment, as well as pleasantness of dining companions, can impact the eating experience (Macht et al., 2005; Velasco, Jones, King, & Spence, 2013; Wansink, 2004). Wansink and van Ittersum (2012) found that soft lighting and music (jazz ballads) in a fast food restaurant made the eating experience more enjoyable than harsh lighting and harsh music. Utensils and dishes in different colors and made with different materials also have an impact (Piqueras-Fiszman & Spence, 2012). Piqueras-Fiszman and Spence (2012) found that the color of a cup from which a hot beverage was consumed affected ratings of flavor, sweetness, and liking. Piqueras-Fiszman and Jaeger (2014) demonstrated that the appropriateness of the context in which a food is eaten impacted emotional response. Participants were asked to imagine eating a chocolate brownie or an apple in each of three consumption contexts: a weekend breakfast, a weekday afternoon snack, and a special dinner at home with friends. Immediately after imagining each context, participants rated their emotional response using a 36-item check-all-that-apply questionnaire as well as the ‘appropriateness’ of consuming the food in that context (from 1 = not at all to 9 = very). The apple was rated more appropriate for an afternoon snack compared to breakfast or dinner, and the chocolate brownie was more appropriate for dinner compared to breakfast or an afternoon snack. The selection frequency of some positive emotions (affectionate, friendly, loving, pleasant, polite, and tender) was higher in the dinner context (deemed more appropriate) for the chocolate brownie compared to the breakfast or afternoon snack contexts.

1.5.5 Putting it all together

The ideas discussed in the preceding paragraphs can be summed up nicely in this quote from Barlow (2001), in his discussion of the 19th-century scientist Helmholtz's perspectives on perception: "Perception results from the interaction of *apperception* – the immediate impact of sensory messages – with *remembered ideas* resulting from past experience." To translate this into the food-emotion experience, we could say that emotional responses to a food (a form of perception) result from the interaction of sensory cues with psychological associations and remembered post-ingestive effects (**Figure 1.2**). Every time we consume a food, we add more information to update our associations with that food. We use these perceptions and associations to determine what and when we eat (Weltens et al., 2014) to reach the desired outcome, emotional or otherwise. The valence of our emotional response depends on how well the immediate sensory cues agree with our past experiences. Positive emotional responses to a food are inversely related to the distance of the current food experience from the ideal situation in which that food is consumed (Booth, 1994); in other words, the degree to which our expectations are confirmed or disconfirmed.

The following two sections contain a discussion of the background information for the experiments presented in Chapters 2 and 3 of this thesis. Part I includes evidence for how certain aspects of the eating experience might affect emotions and stress after food consumption. Part II includes a discussion of how emotional associations with food might be formed in an experimental setting, and what factors must be considered.

1.6 Part I

1.6.1 Stress

Stress, although not technically an emotion, is a related factor that greatly affects people's health and health-related behaviors. Stress is defined as the combination of physical, emotional, and physiological responses to environmental change, demand, and/or threat (Baum & Posluszny, 1999). It can lead to many adverse effects, including anxiety, depression, diabetes, hypertension, and obesity (Born et al., 2010; Dickerson & Kemeny, 2004; Kandiah, Yake, Jones, & Meyer, 2006). Stress can be beneficial, as well. Certain types of stress, including those that help us achieve goals and perform well at our jobs, are necessary for positive emotional and physical well-being (Quick, Wright, Adkins, Nelson, & Quick, 2013). Stress itself can cause changes in mood, and it can also mimic the activation caused by negative emotions such as anger and fear (Baum & Posluszny, 1999). Psychological feelings of stress are so closely linked with some negative emotion words, such as 'anxious' and 'uneasy', that researchers often use these words as a proxy measurement of stress in questionnaires that assess negative mood. Much of the literature cited in this part of the literature review has used both negative emotion measurements and physiological measurements to assess the relationships between eating behavior and stress.

1.6.1.1 The stress response

When a person faces an acute threat, or 'stressor', the body reacts via two stress response pathways to reduce or eliminate the threat. The sympathetic-adrenomedullary (SAM) axis is activated first, which results in increased blood pressure and heart rate and the release of catecholamines (Creswell et al., 2005). Second, the hypothalamic-pituitary-adrenal (HPA) axis activates and cortisol and other glucocorticoids are released (Creswell et al., 2005). Different people activate these response pathways to varying degrees. Some people are more likely to exhibit elevated cortisol, and others elevated blood pressure and heart rate (McEwen, 1998). The stress response depends on the type of stressor, too. When a stressor involves social-evaluative threat and is uncontrollable, the HPA axis is preferentially activated (Creswell et al., 2005). If, however, the threat is controllable or seen as a challenge that can be met, SAM is preferentially activated over HPA (Creswell et al., 2005). Cortisol elevation, as a result of HPA activation, causes release of energy from the body's stores (Dickerson & Kemeny, 2004) to maintain normal blood glucose levels (Benton, 2002) and allow the person to cope with the stressor. This mobilization of stored energy, as well as decreased insulin levels (Baum, 1990) should result in decreased appetite, although sometimes food intake increases under stress. As the threat resolves, the brain releases endorphins, which help blood pressure, heart rate, and cortisol levels return to normal.

1.6.1.2 Laboratory stress induction

A common method for inducing stress in the laboratory is the Trier Social Stress Task (TSST; Kirschbaum, Pirke, & Helhammer, 1993; also see Appendix). Participants are initially given five minutes to prepare for a speech in which they describe the qualities that would make them a good candidate for a job. During the following five minutes, they deliver the speech to a panel of judges. The final five minutes consist of a mental arithmetic task in which they count backwards from a large number by sevens. The TSST reliably elicits increases in psychological stress, cortisol, and heart rate (Kirschbaum et al., 1993). Many researchers have made modifications to the standard protocol, including shortening or lengthening the preparation time (Raspopow, Abizaid, Matheson, & Anisman, 2010; Tomiyama et al., 2012), video or audio recording the speech (Tomiyama et al., 2011), or adding a stressful waiting period after the task (van Strien, Roelofs, & de Weerth, 2012). The TSST is effective because it is uncontrollable (i.e. the participants cannot study for the arithmetic task) and involves self-evaluative threat (i.e. the participants think they are being judged negatively) (Dickerson & Kemeny, 2004).

1.6.2 Food consumption & stress relief

Some people react to stress by increasing food intake (Greeno & Wing, 1994; Heatherton, Herman, & Polivy, 1991)[1]. Born et al. (2010) demonstrated that stress was associated with increased food intake. Their participants completed two sessions, one under stress, and one at rest. During each session they ate a test meal of their own choosing. Under the stress condition, participants consumed more total energy (with a greater proportion of energy from protein) than in the rest condition (Born et al., 2010). Wallis and Hetherington (2004) also demonstrated an increase in energy intake under stress. Participants completed three laboratory sessions: two stress sessions (involving different stress tasks each time) and a rest session. After the stress or rest tasks, participants ate as much chocolate as they wished. Participants consumed more chocolate after the stress tasks compared to the rest condition (Wallis & Hetherington, 2004).

People report that they typically consume unhealthy, energy-dense foods during stress (Groesz et al., 2012; Kandiah et al., 2006), although laboratory studies have found no differences in food choice during stress (Oliver et al., 2000). For example, Kandiah et al. (2006) surveyed college students about their appetite during stress, foods typically eaten under stress, and foods typically eaten when not under stress. Those who said they experienced increased appetite during stress reported choosing more sweets (chocolate, ice cream) and mixed dishes (hamburgers, pizza) when under stress compared to when they were not under stress. Groesz et al. (2012) surveyed women about their eating habits during stress. They found that participants' perceived stress and chronic stress ratings correlated with reported intake of certain foods, including chips, burgers, fried foods, and soda (Groesz et al., 2012). In contrast to these surveys, the study by Born et al. (2010), discussed above, found that only protein intake was greater under stress, which seems incongruent with the typical increases in high-carbohydrate/high-fat foods reported in the survey studies. In a laboratory choice study by Oliver (2000), participants completed either a stress task or a rest task and then chose foods from a buffet. Those in the stress

[1] A 'normal' reaction to the stress response is a decrease in food intake, mainly due to physiological actions being directed towards immediate survival rather than general bodily maintenance (Heatherton et al., 1991).

condition did not increase total energy intake or intake of carbohydrate, fat, or protein relative to those in the rest condition (Oliver et al., 2000).

1.6.2.1 Stress reactivity

Those with high stress reactivity are more likely to turn to food to relieve acute stress (Epel, Lapidus, McEwen, & Brownell, 2001), while those with low stress reactivity may be more resistant to the effects of stress. Epel et al. (2001) had participants complete two laboratory sessions, one under stress (induced via TSST), and one under rest. Salivary cortisol and negative mood (depression/dejection, anger/hostility, and tension/anxiety scales from the POMS) were measured to assess stress reactivity. At the end of each session, participants ate as much as they liked from a variety of snacks. Those with high stress reactivity (indicated by increases in cortisol and negative mood) consumed more food after the stress induction than those with low stress reactivity. A similar amount of food was consumed during the rest session for both those with high stress reactivity and those with low stress reactivity (Epel et al., 2001).

Certain personality factors are related to level of stress reactivity. Such factors as having an internal locus of control (Rotter, 1966), high self-control (Tangney, Baumeister, & Boone, 2004), and high self-esteem and empathy (Campbell & Ehlert, 2012) are associated with low stress reactivity. Those with external locus of control and low self-esteem show greater reactivity to stress (Pruessner, Hellhammer, & Kirschbaum, 1999). Other personality factors that indicate high stress reactivity include restrained eating (Rutters, Nieuwenhuizen, Lemmens, Born, & Westerterp-Plantenga, 2009), Type A behavior, hostility, and aggression (Campbell & Ehlert, 2012). These personality factors were measured as part of the experiment described in Chapter 2 as possible mediating/moderating factors of stress alleviation due to food consumption.

1.6.2.2 When food is consumed in response to stress, does it work?

Food consumption may relieve stress. Lua & Wong (2011) provided evidence that once food is eaten, stress is indeed alleviated. Their participants consumed 50 grams of dark chocolate or mineral water each day for three days. Self-reported anxiety, depression, and stress were measured on the first day (before consumption of chocolate or water) and the third day (after consumption). They found that self-reported anxiety, depression, and stress were reduced more for those who consumed dark chocolate for three days compared to those who consumed mineral water for three days (Lua & Wong, 2011). Another example of the effect of food consumption on stress comes from Martin et al. (2009): participants consumed 40 grams of dark chocolate per day for two weeks. Blood plasma and urine samples were collected at baseline, after one week, and after two weeks to assess changes in metabolite concentrations. They found that urinary cortisol (a measure of stress) was significantly lower after two weeks of dark chocolate consumption compared to urinary cortisol at baseline. Wagner et al. (2014) asked participants to identify foods that they believed would improve their mood (i.e. 'comfort' foods), and equally-liked foods that they believed would not change their mood. Later, in two laboratory sessions, negative mood was induced by showing participants a compilation of film clips meant to evoke sad, angry, anxious, fearful, and hostile emotions. On one of these visits, participants were served their 'comfort' food after the mood induction, and on the other visit, they were served their equally-liked non-comforting food. In additional studies, participants were served their 'comfort' food at one laboratory session and either a neutrally-liked food or no food at the other session. Negative mood was measured (via the negative affect subscale of the PANAS) before and after eating the foods. Consumption of 'comfort' food did not improve negative mood more than equally-liked, neutrally-liked, or no food after a negative mood induction (Wagner et al., 2014). Since negative mood assessments can be proxy measurements of stress, Wagner et al.'s (2014) studies provided evidence against the idea that food consumption relieves stress. Overall, it seems that the experimental evidence showing that food consumption relieves stress is ambiguous and needs further testing.

1.6.3 Behavioral modification of stress in the eating experience

Besides simply eating, other parts of the eating experience may impact the effect that food consumption has on stress. For example, having a choice of what one eats may result in increased feelings of satisfaction and enjoyment with the food (Altintzoglou et al., 2015; de Graaf et al., 2005; Hadi & Block, 2014). Preparing one's own meal may also lead to more satisfaction and enjoyment (Dahl & Moreau, 2007; Dohle, Rall, & Siegrist, 2014). On the other hand, having to choose and/or prepare a meal when feeling stressed may not be satisfying (Dahl & Moreau, 2007; Pocheptsova, Amir, Dhar, & Baumeister, 2009). The following sections explore these two aspects of the eating experience in more detail.

1.6.3.1 Does choice affect mood and/or stress?

Choice may mediate the effect of food consumption on stress, and while people generally enjoy the freedom of choice, their enjoyment can be dependent on factors such as number and type of options. Iyengar and Lepper (2000) offered taste tests of either six or 24 jam varieties to customers at a grocery store. Customers were invited to taste as many jams as they liked. Customers were more likely to subsequently purchase jam when they had been exposed to only six choices compared to 24 choices. Too many options make choice unappealing because although choice can be enjoyable, it can also be overwhelmingly frustrating (Iyengar & Lepper, 2000; Schwartz et al., 2002). Limited options may result in increased intrinsic motivation and perceived control, while increasing the number of options can result in greatly decreased satisfaction (Iyengar & Lepper, 2000). Choices also become more difficult when the options do not differ much from each other (Iyengar & Lepper, 2000), and when the chooser is stressed.

In his theory of Ego Depletion, Baumeister explained that individuals have limited inner resources for self-control and choice, and once those resources are depleted, it becomes harder to exercise self-control and make choices (Baumeister, Bratslavsky, Muraven, & Tice, 1998). Baumeister et al. (1998) had participants sit at a table in front of a plate of radishes and a plate of chocolate chip cookies. They were asked to taste either the radishes or the cookies, and to refrain from tasting the other food. Participants then completed a problem-solving task. Those who had to taste radishes quit sooner on the problem-solving task than those who had to taste cookies, indicating that they had used up their self-control resources to resist the cookies and were limited in their ability to complete the problem-solving task (Baumeister et al., 1998). Stress may be another way in which these resources become depleted, especially under stress induced by the TSST (Kirschbaum et al., 1993), in which the speech portion involves ‘ego depletion’. Requiring people to make choices after doing the TSST may thus be more detrimental than beneficial to feelings of stress.

The different ways in which people cope with choice may affect their mood response to choice. Schwartz’s Maximizer vs. Satisficer scale measures how an individual handles choice (Schwartz et al., 2002). Satisficers look for a ‘good enough’ option, while Maximizers have to make the ‘right’ choice, and spend a lot of time weighing and evaluating each option. The probability of failing to choose the ‘right’ option increases as number of options increases. Too many options, then, make the choice difficult, making Maximizers more likely than Satisficers to experience negative emotions and to be dissatisfied with their final choice. Schwartz et al. (2002) asked participants to think about purchasing decisions they had recently made and then complete the Maximizer vs. Satisficer scale, a regret scale, and a happiness scale. High scores on the Maximizer vs. Satisficer scale (indicating a tendency to maximize) were associated with low happiness ratings and high regret ratings. Satisficers, on the other hand, are likely to have more positive experiences with choice than Maximizers.

Decision-making is based on emotions and cognitions, both of which are especially important in food choices made during stress. Emotional reactions happen automatically and precede cognitive thoughts, which require more mental effort (Shiv & Fedorikhin, 1999). Depleted resources during stress, then, may cause people to make choices based on emotions rather than cognition (Shiv & Fedorikhin, 1999), because the mental effort required to make cognitive decisions is greater. Shiv and Fedorikhin (1999) demonstrated this in a snack-choice experiment. Participants were either depleted of mental resources (by having to memorize a seven-digit number) or not depleted (by having to memorize a two-digit number), and then asked to choose either chocolate cake or fruit salad as a snack. The chocolate cake was meant to be a more emotionally positive and cognitively negative choice than the fruit salad. Participants were more likely to choose chocolate cake when processing resources were low compared to when processing resources were high (similar to Baumeister's loss of self-control, i.e. loss of the ability to choose the more cognitively beneficial, 'healthier' fruit salad). Emotional and cognitive thoughts about the snack choice were also measured. When processing resources were low, snack choice was based more on emotion (hence the choice of chocolate cake) than when processing resources were high (Shiv & Fedorikhin, 1999). This could explain why some people choose unhealthy but well-liked (i.e. more emotionally pleasant) foods when they are stressed. In such a resource-depleted state, the most emotionally-positive option is chosen, because it requires the least amount of mental energy and resources (Pocheptsova et al., 2009; Vohs et al., 2008). Making a healthier food choice may involve more rational thought and thus may be ignored during stress.

Garg and Lerner (2013) found that when participants were given the opportunity to make a choice (i.e. to exert control) after a sad mood induction, they subsequently consumed less food. Garg and Lerner (2013) induced sad or neutral mood in participants and then gave them either a choice between two rewards (chocolate or a ballpoint pen, assuming that most would choose the chocolate) or no choice (chocolate). The participants then completed another task during which they freely ate chocolate candies. For those participants in which sad mood had been induced, those who were given a choice of reward ate fewer chocolate candies than those who were not given a choice. In the neutral mood condition, the participants who had a choice and those who did not have a choice of reward ate a similar amount of chocolate candies.

1.6.3.2 Does food preparation impact mood and/or stress?

Certain activities, especially if they are enjoyable, can help to relieve stress. A review paper by Gutman and Schindler (2007) explored how activities induce relaxation and relieve stress. They discuss 'flow', which is a state in which people feel strong positive emotions in response to activities they enjoy. When engaged in these activities, fear and anxiety decrease, and personal satisfaction increases. These activities can also elicit a relaxation response, which counteracts the stress response (Gutman & Schindler, 2007). Relaxing activities require focus, are repetitive, and cause us to forget about our worries and stressors (Benson, Beary, & Carol, 1974). Food preparation can be one of these activities that elicit flow and relaxation. It fits the definition of a relaxing activity because it requires focus and involves repetitive tasks, such as chopping vegetables (Locher et al., 2005).

The three qualitative studies discussed earlier (Desmet & Schifferstein, 2008; Locher et al., 2005; Macht et al., 2005) identified food preparation as a source of food-elicited emotions. Several of Locher et al.'s (2005) participants talked about how preparing food with a loved one could elicit positive emotions, described by one participant as "This fifteen minutes of the day helped the bonding process between us. It was a time of sharing, listening, and getting to know each other more." Macht et al. (2005) identified 'preparatory activities', including food planning and preparation, as emotion-elicitors, and Desmet and Schifferstein's (2008) participants mentioned how the emotion 'pride' could stem from food preparation.

The effect of food preparation on stress may depend on context. Daniels et al. (2012) analyzed results from a time-use survey in which participants recorded how they spent their time for an entire week. For activities related to cooking/meal preparation, participants indicated whether each activity was motivated by obligation, a sense of duty, necessity, or pleasure. They found that cooking was primarily motivated by necessity (51% of the time) and secondarily by pleasure (23% of the time). Food preparation motivated by necessity may not necessarily involve stress and negative mood, but it is likely that food preparation motivated by pleasure would evoke pleasant emotions and perhaps relieve stress. A similar observation was made by Costa (2013) in an analysis of survey data. Some people reacted positively to food preparation if they felt they were fulfilling a duty to cook by providing for their families and loved ones (Costa, 2013). They may have cooked to *avoid* negative feelings of guilt or shame (Daniels et al., 2012), whereas others, who do not have this sense of duty, may feel more free to cook for pleasure and consequently derive greater satisfaction from the act (Aarseth & Olsen, 2008). Other contextual factors, such as feelings of hunger, distractions, and self-doubt may also make food preparation stressful (Dahl & Moreau, 2007; Daniels et al., 2012).

Having some autonomy over the process of creating something can result in greater satisfaction with the final product. This phenomenon was called the 'IKEA effect' by Norton, Mochon, & Ariely (2012). They gave participants an IKEA storage box kit and told them to assemble the box according to the instructions provided. Other participants were given a pre-assembled box and were asked to inspect it. All participants were then asked how much they would be willing to pay for the box, and to rate how much they liked it. Those who built their own boxes were willing to pay more, and rated liking higher, than those who did not build their boxes (Norton et al., 2012). Dohle et al. (2014) found a similar effect with food: half of their participants prepared their own milkshakes (by measuring four ingredients and mixing in a blender) and the other half was presented with already-prepared milkshakes of the same composition. Participants were then asked to taste the milkshakes and rate liking. Those who prepared their own milkshakes rated liking higher, and consumed more, than those who did not prepare their milkshakes (Dohle et al., 2014).

1.6.3.3 Combining food choice & preparation

The control provided by both choosing one's food and preparing it may result in an even greater reduction in stress (and improvement in mood) than either choosing or preparing alone. Control in general is related to well-being and life satisfaction (Tangney et al., 2004). Choosing and preparing one's own food is an easy way to be in control. Dahl and Moreau (2007) found that having the ability to personalize or customize (i.e. control) a project boosted satisfaction with the final outcome. They had participants bake and decorate a cookie. Participants were given 1) written instructions vs. no instructions and 2) a picture of how the final cookie should look vs. no picture. Participants enjoyed the cookie-baking task more when they were given instructions but were allowed to decorate the cookie as they wished than when they were given no instructions and/or were shown exactly how the cookie should look. The authors concluded that the personalization involved in decorating the cookie led to enjoyment, and providing instructions gave participants confidence in their ability to complete the task successfully (Dahl & Moreau, 2007).

1.6.4 Part I summary

The experiment described in Chapter 2 was designed to test the ideas discussed above: that food choice and food preparation may aid in stress alleviation due to food consumption. Some people eat in response to stress (and negative mood) but whether or not food works to relieve stress and/or improve mood is unclear. Having a choice of what one eats and preparing one's own food can be either positive or negative, depending on context. Neither has been tested in an explicitly stressful laboratory situation. The experiment in Chapter 2 will examine the effects of choosing and preparing on stress and negative mood after stress induction and a subsequent meal in a laboratory setting. Stress and mood will be assessed both physiologically and psychologically to adequately measure the stress response, and individual differences will be examined.

1.7 Part II

1.7.1 Formation of emotional associations

Opportunities for food-emotion associations to be formed are numerous and occur often. In a field study, Macht et al. (2004) set out to determine how often eating happens either in response to, or as a result of, an emotional state. They paged people randomly throughout the day and asked them to rate their current emotional state, whether they had eaten in the past 15 minutes, and if they had eaten, if it was motivated by their emotions. They found that approximately two-thirds of eating occasions were linked to positive or negative emotional states (Macht et al., 2004). Earlier in the review, we discussed reasons *why* people might have emotional associations with food. We considered that repeated exposure to a food during emotional experiences results in the formation of an emotional association with that food. Thereafter, a corresponding emotional response is experienced each time that food is consumed. Methods for testing these ideas experimentally in a laboratory setting are discussed in this section.

1.7.1.1 Conditioning emotional associations in the laboratory

Classical conditioning procedures may work to induce emotional associations with foods (Macht et al., 2003). Conditioning is a procedure used to induce characteristics of one stimulus (unconditioned) to another stimulus (conditioned) by repeatedly pairing them with each other (Domjan, 2005). When the conditioned stimulus is later presented on its own, the induced association (i.e. the 'conditioned response') is elicited. In his example of classical conditioning, Pavlov induced dogs to salivate (conditioned response) to the sound of a bell (conditioned stimulus) after repeated pairings of the bell sound with presentation of food (unconditioned stimulus) (Pavlov, 1927). Foods may also act as conditioned stimuli to which emotional associations (conditioned responses) are induced via repeated pairings with an emotional experience (unconditioned stimulus). Early evidence of this sort of conditioning comes from a study by Birch et al. (1980). Children were presented with a neutrally-liked snack food (conditioned stimulus) 42 times. The foods were 1) given as rewards (e.g. after the child had helped to clean up), 2) presented non-contingently by a friendly adult, 3) placed in the child's locker, or 4) presented normally at snack time. Being given a food as a reward or by a friendly adult could be perceived as an emotionally positive experience (unconditioned stimulus). Liking (conditioned response) of the snack foods increased from before to after the intervention when they were presented in the context of these emotionally positive experiences – either as a reward or by a friendly adult (Birch et al., 1980). More recent studies have attempted to induce positive emotional associations to foods rather than (or in addition to) inducing an increase in liking. These studies are described in more detail below.

Kuenzel et al. (2010) were unable to successfully condition emotional associations to a familiar flavored beverage. Participants viewed film clips meant to elicit 'joy', 'contentment', or 'control' (neutral) emotions for three consecutive days (unconditioned stimuli). While viewing the film clips, they consumed black tea (conditioned stimulus). Emotional associations (conditioned responses) were measured implicitly. Liking of the beverage was rated at each session. Neither emotional associations nor liking ratings changed as a result of the conditioning procedure. A reason for their failure to condition an emotional response may have been because it is likely more difficult to change associations with familiar foods than to induce associations with novel foods (Kuenzel et al., 2010).

Novel flavors were successfully conditioned to an ‘active’ state following repeated exposure to ‘active’ film clips (Kuenzel, Blanchette, et al., 2011). The participants in this study were subjected to five days of conditioning with 4-5 minute film clips meant to evoke ‘active’, ‘relaxed’, or ‘control’ (neutral) emotional states. Each participant was assigned to view one of the film clip types throughout all five days of the conditioning procedure. Participants consumed novel-flavored sweet beverages while watching the film clips. Three days after the last day of the conditioning procedure, participants returned to the laboratory to complete implicit measures of active emotion and self-focus (used as a proxy relaxation measurement) while drinking the beverage. Those who viewed the ‘active’ film clips rated implicit activity greater than those in both the ‘relaxed’ and ‘control’ conditions. Although conditioning of an ‘active’ state to a novel flavored beverage was successful, conditioning of a ‘relaxed’ state was not. Their implicit measurement (of ‘self-focus’) may not have measured relaxation accurately or completely. Including explicit measures may have provided a more complete picture of emotional associations (both active and relaxed) that had been induced to the novel flavors. Liking of the beverages was measured once, on the third day of the conditioning procedure, and did not differ among the ‘active’, ‘relaxed’, and ‘control’ groups.

Repeated pairing of positive images/words with images of fruit increased subsequent selection of fruit as a snack in a study by Walsh & Kiviniemi (2013), but not emotional associations. They used an ‘implicit priming paradigm’ to condition one of three emotional states (positive, negative, or neutral) to images of fruit. The implicit priming paradigm involved repeated presentation of sequential pairs of a positive, negative, or neutral image (such as chipmunk, junk cars, or basket, respectively) or word (such as terrific, upsetting, or impartial, respectively) followed by an image of fruit. Twenty of these pairs were interspersed among 230 total images presented to each participant. Emotional associations were measured before and after priming via ratings of ‘enjoyment’ of several foods (from 1 = not at all to 8 = extremely), and ratings of emotion words in response to prompts such as “When I think about eating fruits and vegetables, I feel ___” (seven positive and seven negative emotion words rated for each prompt, from 0 = not at all to 8 = extremely). At the end of the experiment, participants were asked to choose one snack among a selection of apples, bananas, and granola bars. Those in the positive condition were more likely to select fruit compared to those in either the neutral or negative conditions. Emotional associations with fruits and vegetables in were unchanged by the implicit priming paradigm.

Odors seem to be more easily conditioned to emotions than whole foods. Like food, our hedonic association with an odor is likely due to the emotional valence of prior experiences we have had with that odor (Herz, Beland, & Hellerstein, 2004), and for the most part, liked odors are associated with positive emotions, and disliked odors are associated with negative emotions (Herz, 2002). Herz et al. (2004) were able to demonstrate this experimentally by increasing pleasantness ratings of an initially unpleasant odor after conditioning to a positive mood. During two conditioning sessions, a novel, mildly unpleasant odor was infused into a testing room as an ambient scent. At each session, participants in the positive-conditioning group participated in positive mood-induction activities including playing an entertaining computer game (session 1) and watching funny film clips (session 2). Three control groups were subjected to 1) the same positive mood-induction activities in the absence of ambient odor, 2) viewing neutral film clips in the presence of ambient odor, or 3) perusing neutral magazines in the absence of ambient odor. Mood was rated via the Affect Grid (Russell, Weiss, & Mendelsohn, 1989) which returns scores of mood pleasantness and mood arousal (both rated from -4 = extremely low to +4 = extremely high). Participants rated pleasantness, familiarity, and intensity of four familiar odors and the novel (experimental) odor on 9-point hedonic scales before the conditioning sessions and at varying time points thereafter. After the conditioning procedure, the novel odor was rated as more pleasant and more familiar by those in the positive-conditioning group compared to the control groups. Ratings of the familiar odors were unchanged as a result of conditioning for all groups. A second experiment by Herz et al. (2004) assessed the effects of a negative-conditioning procedure on ratings of an initially pleasant novel odor. The negative mood-induction task was a computer game designed to be frustrating and included annoying sound effects. After conditioning, those in the negative-conditioning group rated the novel odor as less pleasant than those in the control groups.

Baeyens, Wrzesniewski, de Houwer, & Eelen (1996) conditioned restroom air freshener odors to positive and negative states. Air freshener systems were installed in workplace restrooms in which a spray of odor was dispensed every 15 minutes for two and a half weeks. People who regularly used the restrooms were surveyed one week after the odor-exposure period. They rated liking and emotional valence (on 21-point bipolar scales including good/bad, attractive/unattractive, and good-smelling/stinking) of the air freshener odor and a control odor. They also rated how they felt about using the restroom on a scale ranging from -10, labeled ‘necessary evil’, to +10, labeled ‘agreeable break from work’. Those participants who rated their feelings closer to ‘necessary evil’ (i.e. felt negatively about using the restroom) rated liking and valence of the air freshener odor lower than the control odor. Those participants who rated their feelings closer to ‘agreeable break from work’ (i.e. felt positively about using the restroom) rated liking and valence of the air freshener odor higher than the control odor.

1.7.2 Liking and emotional associations

Since liking and positive emotions are closely linked (as discussed earlier), evaluative conditioning may work to transfer positive emotions as well as liking. Evaluative conditioning occurs when liking of a conditioned stimulus increases after repeated pairings with an already-liked unconditioned stimulus (De Houwer, 2007). A positive emotional experience could serve as the ‘already-liked’ unconditioned stimulus required for evaluative conditioning. If a positive emotional experience can act as the unconditioned stimulus for both evaluative and emotional conditioning, then the conditioned stimulus (e.g. a food) should elicit both an increase in liking and an increase in positive emotional associations. An example of the co-occurrence of evaluative and emotional conditioning was described by Kuenzel, Zandstra, El Deredy, Blanchette, & Thomas (2011). Participants were trained to associate symbols (conditioned stimuli) with liked yogurt drinks (unconditioned stimuli) so that the symbols would elicit liking (conditioned response). To test whether this worked, participants completed a task in which they repeatedly saw each symbol on a computer screen immediately followed by an image of either a happy or disgusted face. Participants were asked to press the H key in response to a happy face and the D key in response to a disgusted face. After presentation of symbols representing liked yogurt drinks, participants responded more quickly to the happy faces compared to the disgusted faces, indicating that the symbols primed a positive response. The symbols were thus conditioned to both liking and happy faces (which may indicate a positive emotional response). The odor-conditioning studies discussed above demonstrated an increase in liking and an increase in positive emotional association when odors were conditioned to positive emotional states (Baeyens et al., 1996; Herz et al., 2004).

When evaluative conditioning occurs in tandem with emotional conditioning, its effects on liking may be greater than the effects of repeated exposure on liking. Repeated exposure is the phenomenon in which liking increases with increasing number of exposures to a food (Zajonc, 1968). Birch et al. (1980) provided evidence that the effects of evaluative conditioning on liking are not entirely due to repeated exposure. Emotions were never measured during their experiment, so we cannot say definitively that emotional conditioning occurred, but we can speculate that receiving food as a reward or by a friendly adult would have positive emotional connotations. They found that presenting snack foods to children as either a reward or by a friendly adult resulted in increased preference (liking) compared to presenting snack foods in ways that lacked positive emotional connotations. In other words, liking only increased when food was presented in tandem with emotionally positive experiences. These increases in liking cannot be attributed solely to repeated exposure, because liking did not increase for children whose exposure to the snack foods was unaccompanied by emotionally positive experiences. All children were exposed to the snack foods the same number of times.

1.7.2.1 Why measure both emotional response and liking?

Measuring emotional responses can provide valuable information about foods in addition to liking. First of all, emotion ratings can be more discriminating than liking ratings (i.e. liking of a set of foods may be equal, but emotional profiles of the foods are different) (Ng, Chaya, & Hort, 2013). Ng et al. (2013) had participants taste 11 fruit drinks and rate liking and emotional response (EsSense Profile). They found that emotional responses were different among drinks that were rated similarly in liking. For example, among four drinks that were highly liked, one drink was rated less 'adventurous', 'daring', and 'good-natured' than the other drinks. Additionally, they showed that positive emotion ratings correlated positively with liking ratings. Secondly, emotion ratings can predict food choice better than liking ratings (Dalenberg et al., 2014). Dalenberg et al. (2014) had participants taste seven breakfast drinks and rate liking and emotional response (using both the EsSense Profile and PrEmo (Desmet, Hekkert, & Jacobs, 2000), which is a series of cartoon figures depicting different emotional states). At a subsequent session, participants chose one of the seven drinks to consume in its entirety. The researchers used the liking and emotion data to try to predict which drink each consumer would choose. They found that emotion ratings predicted choice of breakfast drink significantly better than liking ratings (PrEmo vs. Liking $\chi^2 = 12.5$, $p < 0.001$; EsSense vs. Liking $\chi^2 = 1.8$, $p < 0.001$). The EsSense ratings correctly predicted drink choice around 55% of the time, PrEmo around 60% of the time, and liking around 40% of the time (Dalenberg et al., 2014).

1.7.3 Conditioning with novel foods

Novel foods may be easier to condition than familiar foods because they lack expectations and associations that cue an emotional response. All foods that a person has previously eaten have associations and expectations linked to them (Cardello et al., 2012). For conditioning to work, a conditioned stimulus must have no prior associations (Domjan, 2005), at least in the modality expected to be conditioned, such as emotional associations. De Houwer, Baeyens, Vansteenwegen, & Eelen (2000) demonstrated that pre-exposure to a conditioned stimulus inhibits evaluative conditioning: participants were subjected to an evaluative conditioning procedure in which pictures of human faces served as both conditioned (neutrally-rated faces) and unconditioned (positively-rated faces) stimuli. Participants in the control group viewed eight pairs of conditioned-unconditioned stimuli seven times each. Participants in the pre-exposure group viewed eight conditioned stimuli five times each before viewing the conditioned-unconditioned stimuli pairs. Liking of each face picture was rated (from -100 = dislike a lot to +100 = like a lot) before and after conditioning. Liking increased from before to after conditioning for the control group, but not for those in the pre-exposure group, indicating that prior experience with the conditioned stimulus prevented success of the conditioning procedure. An example of novel foods being conditioned more easily than familiar foods was Kuenzel et al.'s (2010; 2011) work, in which novel flavors were successfully conditioned to an 'active' emotional state, but familiar flavors were not.

Novel foods that have similar qualities as familiar foods may also inhibit conditioning effects. When a novel food is similar to a familiar food, associations may be elicited by the similarity of its visual, odor, and/or taste cues to the familiar food (Cardello, Maller, Masor, Dubose, & Edelman, 1985; Tuorila et al., 1994). In other words, expectations related to memories of the familiar food could override the effects of conditioning on the novel food. For example, Kuenzel et al. (2011) were unable to condition novel flavored beverages to a 'relaxed' emotional state. Kuenzel et al.'s (2011) use of a sweet beverage as the vehicle for the novel flavors may have imparted some familiarity to the drink as a whole, so enough memories of previously-experienced sweet beverages may have been elicited to result in a dampening of the conditioning effect. Sweet beverages are not a novel food for most people.

1.7.4 Part II summary

The research presented in Chapter 3 of this thesis attempted to determine whether positive emotional associations could be induced to novel foods in the laboratory. To our knowledge, no experimental evidence has shown that positive emotional associations have been successfully conditioned to foods. It has been done to a limited extent by conditioning sweet beverages to an active emotional state (Kuenzel, Blanchette, et al., 2011). Others have tried to induce emotional associations to foods, but have failed (Kuenzel et al., 2010; Walsh & Kiviniemi, 2013). Due to the limited effects of conditioning on implicit emotional associations shown by Kuenzel, Blanchette, et al. (2011) we will include measures of both implicit and explicit emotions. We will also directly measure changes in liking from before to after an emotional conditioning procedure. Liking of foods (yogurt; Kuenzel, Zandstra, et al., 2011) and odors (Baeyens et al., 1996; Herz et al., 2004) has only been indirectly shown to increase when conditioned to positive emotional experiences. Additionally, we want to know whether the calorie density of a food affects its susceptibility to emotional conditioning. Post-ingestive effects may contribute to emotional associations (Macht & Dettmer, 2006), but the idea has not been tested empirically. High-calorie foods may result in more salient post-ingestive effects and thus greater associations than low-calorie foods. Sufficient induction of emotional associations to low-calorie foods, however, would open the door to the creation of healthier, low-calorie ‘comfort’ foods (Dubé et al., 2005). We will also attempt to use truly novel foods that are as dissimilar as possible to familiar foods, to prevent the prior expectation effects seen by De Houwer et al. (2000) and Kuenzel et al. (2011).

1.8 RESEARCH OBJECTIVES & HYPOTHESES

Part I: Using food to reduce stress: Effects of choosing meal components and preparing a meal

Objective: To explore whether choice of meal components (vs. no choice) and/or preparation of a meal (vs. someone else preparing) influence the stress-reducing and mood-lifting effects of food and eating.

> *Hypothesis 1*: If participants do not choose their meal components, they will show a greater improvement in mood and a larger reduction in stress after eating than if they do choose their meal components.

> *Hypothesis 2*: If participants prepare the meal themselves, they will show a greater improvement in mood and a larger reduction in stress after eating than if someone else prepares the meal for them.

Part II: Use of a conditioning procedure to induce positive emotional associations with novel foods

Objective 1: To determine whether positive emotional associations can be made with a novel food.

> *Hypothesis 1a*: Subjects will exhibit greater positive mood after eating a novel food when it has been conditioned to a positive emotional experience than if the same food has been conditioned to a neutral emotional experience.

> *Hypothesis 1b*: These effects will remain apparent one week after conditioning.

Objective 2: To determine whether positive emotional associations induced to novel foods differ with food type/calorie density.

> *Hypothesis 2a*: Subjects will exhibit greater positive mood after eating a high-calorie novel food that has been conditioned to a positive emotional experience than after eating a low-calorie novel food that has also been conditioned to a positive emotional experience.

Hypothesis 2b: These effects will remain apparent one week after conditioning.

Objective 3: To determine whether liking of novel foods changes after positive emotional associations have been formed.

Hypothesis 3a: As positive emotional associations with a novel food increase, liking of the food will also increase.

Hypothesis 3b: Liking of novel foods will increase more after conditioning with a positive emotional experience compared to a neutral emotional experience, and high-calorie novel foods will be liked more than low-calorie novel foods.

CHAPTER 2 USING FOOD TO REDUCE STRESS: EFFECTS OF CHOOSING MEAL COMPONENTS AND PREPARING A MEAL

(a version of this chapter has been published in *Food Quality and Preference*: Osdoba, Mann, Redden, & Vickers, 2014)

2.1 Summary

Many people experience stress as a part of their daily lives. Chronic stress can have an impact on physical and mental health. Since food and eating are generally associated with positive moods, we explored how aspects of meal preparation can relieve stress and improve measures related to mood. Our main objectives were to determine whether choosing meal components and/or preparing a meal would improve measures related to mood and reduce stress. Participants came individually to our lab at dinner time. We measured stress (salivary cortisol, heart rate and blood pressure) and took measures related to mood on arrival. We then induced stress (Trier Social Stress Task) and took measures related to stress and mood again. Each participant was assigned to one of four experimental conditions. In the *prepare-choice* condition participants prepared a meal (pasta + sauce + inclusions) and had control over selection of meal components. In the *prepare-no-choice* condition participants prepared their meal, but had no control over the menu. In the *choice-no-prepare* condition participants had control over the menu, but the meal was prepared by someone else. In the *no-prepare-no-choice* condition participants were provided with a meal prepared by someone else. Food preference questionnaires conducted before the stress induction ensured that all participants received foods they liked. Having no choice produced greater reductions in the mood-related measures of anxiety and anger compared with the choice condition. Systolic blood pressure was reduced more in the no choice than in the choice condition after the meal. Preparing versus not preparing had little effect on measures related to stress and mood. People may find choosing to be a depleting task on their limited psychological resources; hence, choosing can add to their general stress. Not faced with choosing, one avoids this unnecessary stress. Consuming a meal without the burden of choosing has potential as a stress-reduction strategy.

2.2 Introduction

2.2.1 Importance of the food-mood relationship

Eating behaviors, stress, and negative mood all affect physical and mental health, but their interactions are complex and not well defined. Similar to unhealthy eating behaviors, negative mood and chronic stress can lead to anxiety, depression, diabetes, and cardiovascular disease (Kandiah, Yake, Jones, & Meyer, 2006; Dickerson & Kemeny, 2004). The process of choosing what food to eat can involve both physiological (i.e., hunger) and psychological (i.e., emotional) influences (Desmet & Schifferstein, 2008), and once eaten, those foods can affect our mood (King & Meiselman, 2010). If these relationships can be better understood, people may be able to make healthier food decisions that lead to a healthier physical and emotional state.

2.2.2 Effect of food on mood

Foods can elicit an emotional response when eaten, which is typically positive, but it is unclear why this response occurs. In recent years, the elicitation of emotions in response to food consumption has been explored using several methods in many different contexts (Cardello et al., 2012; Desmet & Schifferstein, 2008; Edward Leigh Gibson, 2006; King et al., 2010). The majority of emotions found to be associated with foods are positive, including 25 out of 39 words in King and Meiselman's (2010) EsSense Profile (three words are negative, and the remaining 11 are unclassified). Desmet and Schifferstein (2008) similarly found that positive emotions were experienced at a higher intensity than negative emotions in response to tasting both snack-type and meal-type foods.

Appetite levels could affect these emotional responses. People are typically alert and irritable when hungry, and calm and sleepy when full (Gibson, 2006). Intrinsic qualities of a food, such as the inherent pleasantness of a sweet product, may affect emotional responses (Steiner, 1974). Macht, Gerer, and Ellgring (2003) suggested that emotional responses could also be due to the psychological aspects of food and eating, such as guilt after eating high calorie foods. Other hypotheses support this psychologically-elicited view, including the role of cognitive expectations and prior associations, whereby memories and past experiences with foods can influence what our emotional response will be (Cardello et al., 2012; Mojet & Köster, 2002; Walsh & Kiviniemi, 2013; Wansink et al., 2007).

2.2.3 Effect of food on stress

In addition to prompting a positive emotional response, the consumption of food may also alleviate both psychological and physiological stress. Martin et al. (2009) found that consumption of 40 g dark chocolate per day for two weeks decreased urinary cortisol (an indicator of physiological stress levels) in participants with chronic stress. In another study on chocolate, just three days of dark chocolate consumption resulted in decreased levels of psychological stress captured by self-reported anxiety and depression (Lua & Wong, 2011). Finally, Pecoraro, Reyes, Gomez, Bhargava, & Dallman (2004) saw a decrease in stress hormone levels after consumption (by rats) of palatable, calorie-dense food during periods of stress. Therefore, food consumption may impact stress both physically and psychologically.

2.2.4 Choice

Too many choices and/or too many options per choice may cause increased stress and negative mood. Schwartz (2004) calls this the ‘Paradox of Choice’ as adding explicit choice to a situation may unknowingly increase stress and negative mood. Repeated acts of choosing deplete the resources needed for self-control (Vohs et al., 2008), which could further increase stress and negative mood. Experiencing stress itself can also deplete resources (Baumeister et al., 1998), further enhancing feelings of stress and negative mood. Too many options may make choice unappealing because although it can be enjoyable, choice can also be overwhelmingly frustrating (Iyengar & Lepper, 2000; Schwartz et al., 2002). When there are too many options, the added burden of weighing all the possibilities and making the ‘best’ choice can increase dissatisfaction with the final result (Schwartz et al., 2002). In other words, there will always be the underlying thought of regret that the consumer failed in their quest to find the best option. Indeed, Iyengar and Lepper (2000) found that greater dissatisfaction is experienced when the same option is chosen from an extensive set (24-30 options) than from a set with limited options (six). The more choices available, the greater the chance the consumer chooses the 'wrong' one, magnifying feelings of stress and negative mood.

On the other hand, common consensus is that people enjoy freedom of choice. Liking and consumption tend to increase when people choose their food (Cardello et al., 2012). While this increase in liking could presumably improve mood and stress, limited evidence suggests that this actually happens. When the participants of Garg and Lerner (2013) were given a choice of reward (chocolates vs. a ballpoint pen, with the idea that this would be an easy choice and most people would choose the chocolates) after induction of sad mood, sadness was reduced more than if the participants were just presented with chocolates as a gift. The work of Garg and Lerner (2013) and Iyengar and Lepper (2000) showed that simple choices, such as those with few options and/or trivial consequences, may result in less negative consequences for mood and stress. The detrimental effects of too many choices, however, especially when distressed, may outweigh the benefits of having the freedom to choose.

2.2.5 Food preparation

The alleviation of stress and improvement of mood are likely outcomes of food preparation, although limited evidence suggests that food preparation itself can be stressful. Benson, Beary, and Carol (1974) suggested that activities involving mindless, repetitive tasks elicit a relaxation response. Food preparation, which entails such tasks as chopping vegetables and repeated stirring, may fit well into this category. Food preparation may also result in improved mood when it is done out of a sense of duty (i.e., to feed the family) or to please others (Daniels et al., 2012). Building on this, Costa (2013) found that people ascribe strong, positive feelings towards cooking hot meals at home, whereas they feel guilty (along with other negative emotions) when they do not cook at home. Food preparation allows for a certain amount of autonomy and control. Control in general is related to well-being and life satisfaction (Tangney et al., 2004). Knowing the ingredients and processes that go into one's meal may be an easy way to exercise control and reap the psychological benefits. On the other hand, food preparation can be stressful, especially when hunger, distractions, and time constraints come into play (Daniels et al., 2012). In the case of mood improvement and stress relief, the advantages of preparing food may, under many circumstances, outweigh its detriments.

2.2.6 Objectives & hypotheses

The main objective of this study was to explore whether choice of meal ingredients (vs. no choice) and/or preparation of a meal (vs. someone else preparing) influence the stress-reducing and mood-lifting effects of food and eating.

Given the stressful consequences inherent to making choices, we expected choosing ingredients to have detrimental effects on mood and stress. We specifically hypothesized that if people did not choose their meal ingredients, they would show a greater improvement in measures related to mood and larger reduction in stress after eating than if they did choose their meal ingredients.

Given the positive consequences from preparing food, we expected preparing food to produce improvements in mood and stress. We specifically hypothesized that if people prepared the meal themselves, they would show a greater improvement in measures related to mood and larger reduction in stress after eating than if someone else prepared the meal for them.

2.3 Materials and Methods

2.3.1 Participants

One hundred eighteen participants (36% male, mean age = 28, SD age = 11, range = 18-63) were recruited via email listserv and posted flyers. They were screened for availability and liking of meal ingredients (**Table 2.1**). To be invited to participate in the study, each potential participant had to rate the pasta, at least one of the sauces, at least two of the inclusions, and at least one of the seasonings six or higher on a nine-point liking scale (Peryam & Pilgrim, 1957). We chose this cut-off point because it indicated that the participant liked the food as it was above the midpoint of the 9-point scale, and six corresponded to 'like slightly'. Exclusion criteria included those with food allergies or sensitivities; use of antidepressants, steroid medications, or tobacco; and pregnancy, as these can affect cortisol levels. Participants were compensated $20 for their participation. Participants were asked to avoid caffeine, alcohol, smoking, strenuous exercise, and eating for three hours prior to their appointment. The study protocol was approved by the Institutional Review Board of the university, and all participants gave informed consent prior to the study. The screening questionnaire can be found in **Appendix A1**.

Table 2.1 Meal components.

Ingredient	*Type*	*Manufacturer*	*Address*	*Portion (g)*
Pasta	Rotini	Creamette®	Allentown, PA	224*
Olive oil	Extra-virgin	Pompeian®	Baltimore, MD	3.4**
Salt	Iodized	Roundy's®	Milwaukee, WI	4.5***
Sauces				
Alfredo sauce	Four Cheese	Roundy's®	Milwaukee, WI	150
Marinara sauce	Traditional	Prego®	Camden, NJ	150
Inclusions				
Green chilies	Canned, diced, fire-roasted	Ortega®	Parsippany, NJ	15
Sun-dried tomatoes	Julienne cut, with extra virgin olive oil and Italian herbs	Bella Sun Luci®	Chico, CA	20
Olives	Kalamata, pitted, whole	Mezzetta®	American Canyon, CA	20
Mushrooms	Canned, stems & pieces	Roundy's®	Milwaukee, WI	25
Seasonings				
Parmesan cheese	Grated	Roundy's®	Milwaukee, WI	7
Basil	Dried	McCormick®	Sparks, MD	< 1
Black pepper	Dried	Roundy's®	Milwaukee, WI	< 1

*Cooked. This amount is approximately two servings (based on the Nutrition Facts panel on the pasta box).
**Tossed with cooked pasta (13.5 g/4 servings)
***Added to pasta cooking water (18 g/4 servings)

2.3.2 Study Design

The study had a two-factor between-participants design: *Choice* (participants did or did not get to choose the ingredients in their pasta meal) and *Prepare* (participants either prepared the meal themselves, or the experimenter prepared it for them). This design resulted in four treatment groups: *Choice/Prepare, No Choice/Prepare, Choice/No*

Prepare, and *No Choice/No Prepare*. Participants were scheduled individually for one test session lasting 1.5 to 2 hours. The study was conducted between 4:00 pm and 8:30 pm on weekday evenings. The four treatments were randomly assigned to each of four time slots per day, and participants were randomly scheduled to a slot according to their availability.

2.3.3 Participant Visit Protocol

A schematic of the study protocol is shown in **Figure 2.1**. When participants arrived at the site, they were greeted by an experimenter who would guide them through the study. To attenuate any experimenter effects, the experimenter was unaware of the theoretical constructs, the predictions of the study, or the outcomes of interest. As well, the experimenter read from a script (**Appendix A2**) to control for the content of instructions, and any interaction with the participant during food choice and preparation was limited to the degree required to execute the manipulation.

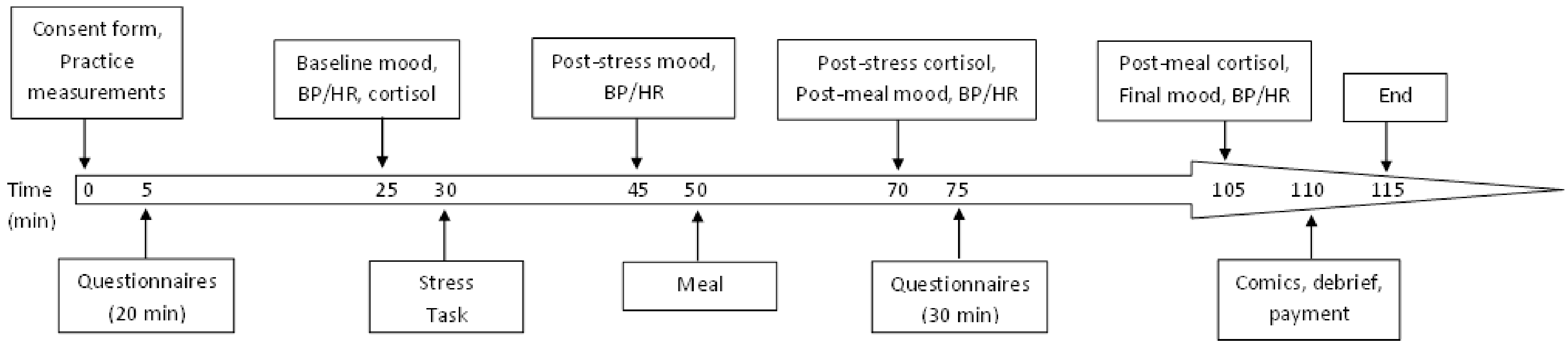


Figure 2.1 Experimental Protocol

After signing the consent form, the participant was guided to the meal preparation area. The experimenter described what would happen later in the study when it was time for the meal. This was done to familiarize the participant with the setting, so as to minimize any additional stress invoked by new surroundings and uncertain tasks. Then the participant and experimenter sat at a table with a computer. A blood pressure cuff was attached to the participant's non-dominant arm (so he/she could easily work the computer mouse with the dominant hand). A practice blood pressure measurement and saliva sample (for cortisol measurement) were taken. At this point, the experimenter left the room for 20 minutes (habituation period), during which time the participant answered computerized questionnaires (**Appendix A7**).

After 20 minutes, the experimenter returned and obtained baseline blood pressure/heart rate measurements and a saliva sample. Next, the participant completed a questionnaire containing mood-related words (**Appendix A8**) to get baseline measurements. Instructions were then given for the stress task.

The stress task closely followed the protocol of the Trier Social Stress Task (TSST) outlined by Kirschbaum and colleagues (1993) (**Appendix A5**). The experimenter told the participants that they would have five minutes to prepare a speech. They were told to pretend they were a job applicant interviewing for a position in a company. They were asked to explain why they would be the perfect candidate for the job. They were given paper and pen to take notes, but were told that they could not use the notes during the speech. The experimenter indicated that two people would come in to evaluate the speech, and then the experimenter left the room. This TSST approach has been widely used in laboratory settings to reliably induce both physiological and psychological stress. We should note that we slightly modified the original task in the following ways: the experimenter was unaware of the treatment group; the speech was not videotaped; the speech was shorted from 10 min to 5 min, and the arithmetic task began at a different number each minute.

When the five minutes had passed, two people (one male, one female; hereafter referred to as confederates) wearing white lab coats and holding clipboards entered. They asked the participant to stand up and deliver the speech into a microphone. The confederates told the participant that the speech would be recorded and a 'voice frequency analysis' would be done on the recording. (The speech was not actually recorded.) One of the confederates was introduced as being specially trained to monitor nonverbal behavior. This confederate would be taking notes throughout the task. The participant was then told to begin the speech. The participant was required to speak for the entire five minutes. Specific verbal prompts were used if the participant stopped speaking before the time was up.

After the speech, the participant had to perform a counting task. The participant was asked to start at 1022 and count back by 13s to zero. In reality, the task was timed for five minutes and the participant did not have to count back to zero. After each minute, the confederate instructed the participant to begin at a different number. Each time a mistake was made, the participant had to start over. Throughout the stress task, the confederates remained stoic and stern faced.

When the 15-minute stress task was finished, the confederates left the room and made a subjective rating of how good the participant was at the stress task (hereafter referred to as 'TSST Score', see **Appendix A6**), from 1 = Very Bad to 5 = Very Good. A participant who was 'Very Bad' at the TSST, for example, appeared very uncomfortable during the speech and was not able to make it past one or two subtractions on the mental arithmetic task. A 'Very Good' participant was able to speak easily for the entire five minute speech and complete 15-20 correct subtractions during the math task. Therefore, a participant who was 'Very Good' at the TSST presumably did not become as stressed as a 'Very Bad' participant.

After the stress task ended, the experimenter returned and immediately took post-stress blood pressure and heart rate measurements. Then the participant completed post-stress measures related to mood. The experimenter then gave the participant a menu sheet (**Appendix A4**). The sheet was either already filled out (for participants in the *No Choice* groups), or the participant was instructed to fill it out (*Choice* groups). The specific wording for each treatment group was as follows:

Choice/Prepare: “Fill out this menu sheet. You get to choose one sauce, 3 inclusions, and 1 topping for your pasta. Whichever ones you want, it’s up to you! Then we will go over there, and you will get to cook it yourself!”

No Choice/Prepare: “Look at this menu sheet. You have been assigned to eat a pasta dish with these specific ingredients. You don’t get to choose. Then we will go over there, and you will get to cook it yourself!”

Choice/No Prepare: “Fill out this menu sheet. You get to choose one sauce, 3 inclusions, and 1 topping for your pasta. Whichever ones you want, it’s up to you! Then we will go over there, and I will cook it for you.”

No Choice/No Prepare: “Look at this menu sheet. You have been assigned to eat a pasta dish with these specific ingredients. You don’t get to choose. Then we will go over there, and I will cook it for you.”

The purpose of this specific wording was to strengthen the *Choice/No Choice* and *Prepare/No Prepare* manipulations. Next, the participant was guided to the meal preparation area. For the *No Prepare* groups, the experimenter prepared the pasta and then left the room. For the *Prepare* groups, the participants were handed an instruction sheet (**Appendix A3**) and the experimenter left the room. The participant sat back down at the table with the pasta and was given ten minutes to eat.

At the end of the eating period, the experimenter returned and removed the plate from in front of the participant. Another saliva sample was taken (post-stress), as well as blood pressure/heart rate measurements (post-meal). The participant then began answering questionnaires again (including the post-meal measures related to mood). The experimenter then left the room for 30 minutes.

When the 30 minutes elapsed, the experimenter returned and took final blood pressure/heart rate measurements and the post-meal saliva sample. After that, the participant filled out the final measures related to mood. Finally, the participant read through a set of comic strips and rated how funny they were. This was done to ensure that any residual stress after the meal was gone by the time they left. Then the participant was debriefed and introduced to the two confederates who had administered the stress task. Lastly, the participant was paid and thanked for coming.

2.3.4 Meal

The meal consisted of a hot pasta dish prepared on site and a glass of water. The participants in the *No Choice* groups were given a subset of the ingredients that they had rated six or higher on the liking scales during the prescreening process. For these participants, menu sheets were filled out in advance by the experimenter. Participants in the *Choice* groups filled out their own menu sheets as described above in **section 2.3.3**. Each participant's meal consisted of one of two sauces, two or three of four possible vegetable inclusions, and one of three seasonings. However, all ingredient choices were presented at the meal preparation area to reinforce the fact that the *No Choice* participants were missing out on the other ingredients. See Table 1 for ingredients and portion sizes. Meal ingredients were pre-portioned and set out prior to the start of the study. Labels were placed behind each ingredient so each participant was exposed to the names of all the ingredients. Pasta was precooked according to the package directions with the addition of 18 g salt to the cooking water. Cooked pasta was tossed with 13.5 g olive oil, portioned, and refrigerated until needed. Cooked pasta was held refrigerated for no longer than 24 hours.

When it was time for the meal (right after the stress task), the experimenter brought the participant over to the meal preparation area (**Figure 2.2**). The experimenter removed the ingredients that the participant was not going to eat and placed them on a tray. For the *No Prepare* groups, the experimenter then added the selected ingredients to the bowl of pasta, stirred it, and microwaved it for two minutes. When it was heated, the experimenter transferred it to a plate. For the *Prepare* groups, the experimenter gave the participant an instruction sheet and asked if there were any questions about the meal preparation. The experimenter then left the room, taking the tray of extra ingredients. The participant was instructed to prepare the meal by adding the appropriate ingredients to the bowl of pasta, stirring, microwaving for two minutes, and then transferring it to a plate. All participants sat down to eat and were not required to finish the entire pasta dish. All meal ingredients were weighed prior to the start of the study. Leftover pasta was weighed at the end to calculate how much of each ingredient was eaten.

Figure 2.2 Meal Preparation Area.

2.3.5 Questionnaires

The questionnaire used to assess mood variables used the Profile of Mood States (POMS) (McNair et al., 1971) as a starting point. The questionnaire consisted of 24 mood-related words (15 from the original POMS scale), divided into five broader categories (*anxiety, anger, fatigue, positivity, and sadness*) derived from a factor analysis (**Table 2.2**; **sections 2.4, 2.5**). Words expressing threat (‘threatened’, ‘intimidated’, ‘pressured’) and self-consciousness (‘self-conscious’, ‘embarrassed’, ‘awkward’) were added for this experiment to measure emotions elicited by the TSST (which specifically elicits self-evaluative threat), and other adjectives from the full POMS scale were eliminated for lack of relationship to the TSST and concerns about the total length of the questionnaire for repeated administrations. Words expressing calmness (‘calm’, ‘content’, ‘satisfied’) were also added as additional positive emotions. Participants were asked to rate the extent to which they were experiencing each mood-related word on a seven-point scale (1 = not at all, 7 = extremely). The questionnaire was administered four times during the study: baseline, post-stress, post-meal, and final (**Figure 2.1**).

Table 2.2 Words in mood questionnaire
(adapted from the Profile of Mood States; McNair et al., 1971)

Category*	Emotion Words
Anxiety	Anxious Awkward Discouraged Embarrassed Intimidated On edge Pressured Self-conscious Uneasy
Anger	Angry Annoyed Resentful Threatened
Fatigue	Exhausted Fatigued Worn out
Positivity	Calm Cheerful Content Lively Satisfied
Sadness	Hopeless Sad
(uncategorized)**	Vigorous

*Categories are based on Principal Components Analysis (see sections 2.4, 2.5)
**'Vigorous' loaded below 0.5 on all of the factors. It was not included in the data analysis.

The rest of the questionnaires were inventories of personality characteristics and scales of individual differences (see **Table 2.3** for full list). Participants completed these questionnaires during the 20 minute habituation period and the 30 minute post-meal period. These waiting periods were included to allow for the lag time in detecting cortisol changes in saliva. Enough questionnaires were included to fill the time, but not all participants finished all of them. The goal was to keep the participants occupied during these waiting periods, but not induce positive or negative mood. Possibly these personality measurements could have affected stress and mood-related measures, so they were also potential covariates in our analyses. All questionnaires regarding eating behaviors were reserved for the post-meal period so as to minimize the effect of increased awareness of these behaviors while the participant was eating.

Table 2.3 Individual Difference Questionnaires

Questionnaire	*Source*
Sensation Seeking Scale	Arnett, 1994
Internal vs. External Locus of Control	Rotter, 1966
Maximizing vs. Satisficing	Schwartz et al., 2002
Perceived Stress Scale	Cohen, Kamarck, & Mermelstein, 1983
Sensation Seeking Scale	Zuckerman, Kolin, Price, & Zoob, 1964
Personal Need for Structure	Neuberg & Newsom, 1993
Eating Self-Efficacy	Glynn & Ruderman, 1986
Self-Control Scale	Tangney et al., 2004
Variety Seeking Scale (VARSEEK)	Van Trijp, Lähteenmäki, & Tuorila, 1992
Three Factor Eating Questionnaire (factors 1 & 2)	Stunkard & Messick, 1985
Self-Esteem Scale	Rosenberg, 1965
Life Orientation (Optimism) Scale	Scheier, Carver, & Bridges, 1994
Restrained Eating Scale	Polivy, Herman, & Warsh, 1978
Optimum Stimulation Level	Raju, 1980
Boredom Proneness Scale	Farmer & Sundber, 1986
Dutch Eating Behavior Questionnaire (external and restrained eating subscales)	van Strien, Frijters, Bergers, & Defares, 1986

After the meal, participants were asked to rate liking of the food ingredients they ate, as well as their overall enjoyment of the meal. They also answered questions about how well they liked choosing the ingredients, if they thought they were in control of the preparation/choice of ingredients, how difficult it was to prepare, and if they felt they were really cooking (as opposed to just mixing and microwaving). General questions also included how much the participants enjoyed cooking in everyday life, and how many hours per week they spent cooking. Hunger measures were obtained at the start of the study, after the meal, and at the very end of the study by asking the participants to "Rate the amount of food you desire" and "Rate the amount of food you could eat" on a scale from 0 (none) to 100 (greatest possible amount).

2.3.6 Blood Pressure & Heart Rate

Blood pressure cuffs (Omron Healthcare®, Lake Forest, IL) were worn by participants throughout the study. Blood pressure and heart rate measurements were taken in duplicate at four times: baseline, post-stress, post-meal, and final. Blood pressure and heart rate measurements determined the extent of activation of the sympathetic-adrenomedullary (SAM) axis, a physiological stress response pathway (Creswell et al., 2005).

2.3.7 Saliva Samples & Cortisol Analysis

Four saliva samples were taken from each participant: a practice sample, and then one each at baseline, post-stress, and post-meal. Samples were collected with an oral swab, or 'salivette' (Salimetrics, State College, PA). Changes in cortisol can be detected in saliva 20-40 minutes after changes in stress level. Therefore, the baseline sample was taken after a 20 minute habituation period. The post-stress sample was taken immediately after the meal (35 minutes post stress-induction). The post-meal sample was taken 30 minutes after the meal was finished. Samples were immediately frozen until a sufficient number were ready for analysis. Cortisol was detected via a salivary cortisol enzyme immunoassay kit (Salimetrics, State College, PA). Each sample was assayed in duplicate. Elevated cortisol is an indication of physiological stress, specifically activation of the hypothalamic-pituitary-adrenal (HPA) axis (Creswell et al., 2005).

2.4 Data Analysis

All data were analyzed using SAS® version 9.3 (SAS Institute Inc. Cary, NC, USA) using a significance level of $\alpha = 0.05$. SAS code for this section can be found in **Appendix B**.

A factor analysis was done on the changes in measures related to mood (from baseline to post-stress and from post-stress to post-meal). The factor analysis revealed five factors using a criterion of the Eigenvalue exceeding one (see **Table 2.2** for word groupings). Subsequently these factors were computed from each participant's data at each time point as the average of the scores of each emotion word in the factor. The emotion word ‘vigorous’ did not load onto any factor, and so was dropped from subsequent analyses. Duplicate systolic and diastolic blood pressure and heart rate measurements were averaged at each time point for each participant. Averages of the cortisol content of the two saliva aliquots at each time point were calculated for each participant. All subsequent analyses were done using the five mood-related factors (*anxiety, anger, fatigue, positivity, and sadness*), blood pressure (systolic and diastolic), heart rate, and cortisol as dependent variables, hereafter referred to as *responses*.

To determine whether stress and negative mood-related measures increased across all participants after the stress task (i.e., did the stress induction work?) and then decreased after the meal, one-sided t-tests on post-stress minus baseline differences and post-meal minus post-stress differences in *responses* were performed.

A 2 (*Choice* vs. *No Choice*) x 2 (*Prepare* vs. *No Prepare*) analysis of variance (ANOVA; PROC GLM in SAS) was done with baseline *responses* as the dependent variables to determine if there were differences in stress or in measures related to mood among treatment groups at baseline. The same ANOVA model was used with post-stress minus baseline *responses* as dependent variables to determine if stress and measures related to negative mood changed uniformly across the four treatment groups.

To test both the hypothesis that not choosing meal ingredients results in greater reduction of stress/negative mood than choosing and the hypothesis that preparing a meal results in greater reduction of stress/negative mood than not preparing, we performed 2x2 ANOVA using the differences between post-meal and post-stress values of the *responses* as dependent variables. Statistical significance was determined using one-tailed tests matching the direction of our hypotheses. Performing the analysis on the change in *responses* allowed us to take into account the differences in stress levels after the TSST. Potential covariates (i.e., age, gender, and personality scales) were also analyzed, but none reached statistical significance (all p-values > 0.05). Thus, we do not discuss them further. As well, the covariates did not differ between any of the experimental conditions (all pairwise p-values > 0.05), indicating our randomization appeared successful.

2.5 Results

The factor analysis of the mood-related measures revealed five factors with Eigenvalues greater than one (**Table 2.2**). Cronbach's alphas calculated for each factor showed good consistency (*anxiety*, $\alpha = 0.94$; *anger*, $\alpha = 0.88$; *fatigue*, $\alpha = 0.87$; *positivity*, $\alpha = 0.77$; *sadness*, $\alpha = 0.84$). Importantly, we noted that the *anxiety* factor encompassed self-conscious and threatening emotions as well as anxious emotions.

A check of baseline mood-related measures and stress *responses* found only one initial difference according to treatment. Those in the *Prepare* groups had lower baseline heart rates (M = 66 bpm, SE = 1.3) than those in the *No Prepare* groups (M = 70 bpm, SE = 1.3; $t = -2.19$, $p < 0.05$). All other responses showed no significant differences in baseline *responses* according to treatment group (data not shown). No interaction effects between *Choice* and *Prepare* were apparent at baseline. Means for all treatment groups for all *responses* at all time points can be found in **Table 2.4**.

Table 2.4 Means (SE) at each time point for each condition.

	Baseline				Post-Stress				Post-Meal			
Responses	**C/P**	**C/NP**	**NC/P**	**NC/NP**	**C/P**	**C/NP**	**NC/P**	**NC/NP**	**C/P**	**C/NP**	**NC/P**	**NC/NP**
Anxiety[a]	1.74	1.60	1.85	1.87	2.72	2.62	3.62	3.70	1.71	1.58	2.06	2.18
	(0.14)	(0.11)	(0.18)	(0.17)	(0.28)	(0.28)	(0.32)	(0.30)	(0.16)	(0.16)	(0.21)	(0.23)
Anger	1.34	1.20	1.27	1.32	1.87	1.89	2.44	2.48	1.40	1.56	1.63	1.59
	(0.13)	(0.07)	(0.10)	(0.14)	(0.24)	(0.18)	(0.24)	(0.28)	(0.13)	(0.21)	(0.16)	(0.19)
Fatigue	2.90	2.65	2.54	2.89	3.16	2.86	2.78	3.29	2.81	2.42	2.53	2.82
	(0.29)	(0.27)	(0.33)	(0.30)	(0.33)	(0.32)	(0.36)	(0.31)	(0.31)	(0.28)	(0.35)	(0.29)
Positivity	4.08	4.66	4.47	4.57	3.17	3.59	3.10	3.13	3.78	3.76	3.66	3.77
	(0.19)	(0.20)	(0.17)	(0.16)	(0.26)	(0.30)	(0.22)	(0.22)	(0.25)	(0.25)	(0.25)	(0.23)
Sadness	1.49	1.25	1.41	1.29	1.55	1.44	1.50	1.90	1.41	1.23	1.25	1.33
	(0.13)	(0.08)	(0.14)	(0.11)	(0.17)	(0.13)	(0.16)	(0.25)	(0.13)	(0.10)	(0.12)	(0.17)
Systolic BP	111	114	116	117	118	125	127	128	117	120	121	120
(mmHg)	(2.22)	(2.13)	(2.18)	(2.08)	(2.60)	(2.50)	(3.18)	(1.92)	(2.13)	(2.20)	(2.73)	(1.61)
Diastolic BP	68.9	72.3	70.1	73.0	73.8	79.2	76.1	80.3	73.0	77.6	75.6	77.6
(mmHg)	(1.59)	(1.67)	(1.76)	(1.42)	(1.75)	(1.35)	(2.18)	(1.22)	(1.68)	(1.57)	(1.96)	(1.28)
Heart rate	63.9	70.7	69.1	70.1	62.3	71.9	71.4	72.9	66.1	73.1	72.9	71.4
(bpm)	(1.38)	(2.27)	(1.66)	(2.14)	(1.23)	(2.51)	(2.60)	(2.91)	(1.38)	(2.48)	(1.75)	(2.11)
Cortisol	0.089	0.138	0.120	0.143	0.198	0.295	0.266	0.307	0.118	0.207	0.164	0.175
(µg/dL)	(0.011)	(0.029)	(0.015)	(0.034)	(0.039)	(0.056)	(0.041)	(0.074)	(0.016)	(0.035)	(0.018)	(0.029)

C/P = Choice/Prepare, C/NP = Choice/No Prepare, NC/P = No Choice/Prepare, NC/NP = No Choice/No Prepare, BP = Blood Pressure

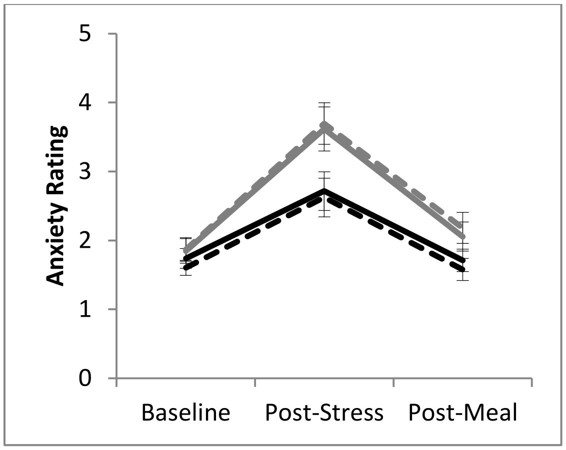
[a]Moods were rated on a 7-point scale, from 1 = not at all to 7 = extremely.

The stress induction task was effective at inducing stress and increasing negative measures related to mood (**Table 2.5**). *Anxiety*, *anger*, *fatigue*, and *sadness*, as well as systolic and diastolic blood pressure and cortisol all increased after the TSST (all p-values < 0.05). *Positivity* rating decreased after the TSST (p < 0.001). Heart rate was not affected by the TSST.

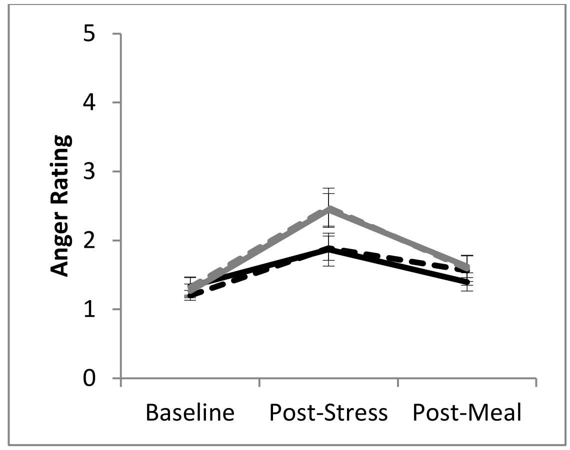
Post-meal *responses* indicated that stress and negative measures related to mood had decreased (**Table 2.5**). *Anxiety*, *anger*, *fatigue*, and *sadness*, as well as systolic and diastolic blood pressure and cortisol decreased after the meal (all p-values < 0.01). *Positivity* rating increased after the meal (p < 0.001). Heart rate did not change significantly. **Figure 2.3** shows trends in mood rating for each treatment group throughout the study.

Table 2.5 Changes in *responses* after the TSST and after the meal (for all subjects). Positive means indicate an increase in that response and negative means indicate a decrease. Standard errors (SE) are in parentheses. T-tests are one-sided.

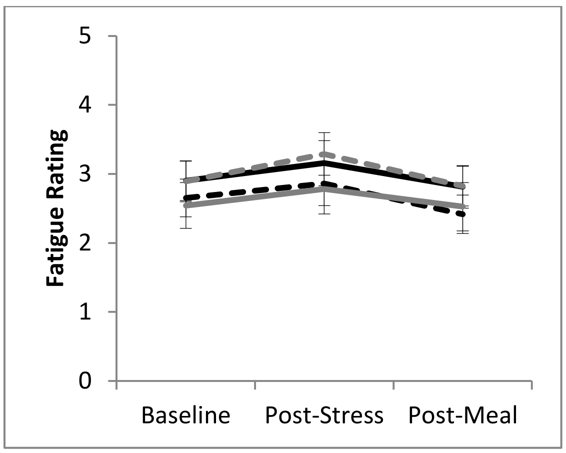
	Post-Stress			***Post-Meal***		
Response	**Mean (SE)**	**t**	**p**	**Mean (SE)**	**t**	**p**
Anxiety	1.37 (0.14)	10.0	<0.001	-1.28 (0.10)	-13.0	<0.001
Anger	0.86 (0.12)	7.1	<0.001	-0.63 (0.09)	-7.1	<0.001
Fatigue	0.24 (0.11)	2.1	0.019	-0.38 (0.08)	-4.6	<0.001
Positivity	-1.19 (0.10)	-11.6	<0.001	0.51 (0.10)	5.3	<0.001
Sadness	0.22 (0.09)	2.4	0.010	-0.29 (0.08)	-3.6	0.000
Systolic BP (mmHg)	10.0 (0.85)	11.8	<0.001	-5.12 (0.74)	-6.9	<0.001
Diastolic BP (mmHg)	6.40 (0.62)	10.3	<0.001	-1.41 (0.52)	-2.7	0.004
Heart rate (bpm)	1.18 (0.74)	1.6	0.058	1.23 (0.73)	1.7	0.953
Cortisol (μg/dL)	0.15 (0.03)	5.8	<0.001	-0.11 (0.02)	-5.8	<0.001



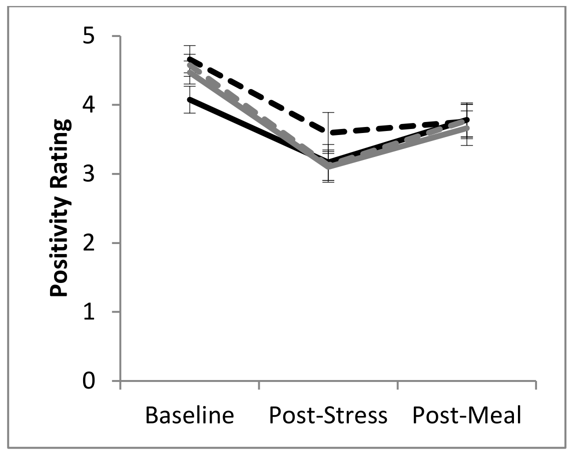
a. *Anxiety*



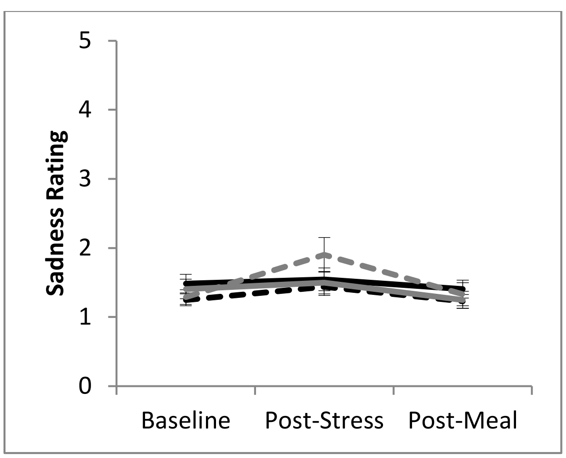
b. *Anger*



c. *Fatigue*



d. *Positivity*



e. *Sadness*

Figure 2.3 Change in mood ratings over time for each treatment group.
Moods were scored at each time point on a scale from 1 (not at all) to 7 (extremely). Each plot consists of means of mood word ratings for one emotion factor. *Choice/Prepare* = solid black line, *Choice/No Prepare* = dashed black line, *No Choice/Prepare* = solid gray line, *No Choice/No Prepare* = dashed gray line. a) *Anxiety*, b) *Anger*, c) *Fatigue*, d) *Positivity*, and e) *Sadness*.

Although there were no differences in experimental protocol before the meal, those in the *No Choice* groups experienced greater stress increases and deterioration in measures related to mood after the TSST than those in the *Choice* groups. *Anxiety* and *anger* increased more after the TSST for those in the *No Choice* groups versus the *Choice* groups (**Table 2.6**). *Positivity* ratings decreased more for those in the *No Choice* groups versus the *Choice* groups. No differences in stress increase or deterioration in measures related to mood were observed between those who prepared the meal and those who did not prepare the meal. No significant interaction effects were seen between the *Choice* and *Prepare* factors (data not shown).

Table 2.6 Changes in stress and mood *responses* from before to after the stress task. Least squares means for each factor level are given (standard errors in parentheses). 'Yes' under the 'Choice' heading indicates Choice group and 'No' indicates No Choice group. 'Yes' under the 'Prepare' heading indicates Prepare group and 'No' indicates No Prepare group. Positive means indicate increases in a response and negative means indicate a decrease. F-statistics and p-values are for 2x2 ANOVAs for each *response* and factor.

	Choice				***Prepare***			
Responses	**Yes**	**No**	**F**	**p**	**Yes**	**No**	**F**	**p**
Anxiety[a]	1.0 (0.2)	1.8 (0.2)	8.6	0.00	1.3 (0.2)	1.4 (0.2)	0.0	0.85
Anger	0.6 (0.2)	1.2 (0.2)	5.5	0.02	0.8 (0.2)	0.9 (0.2)	0.1	0.78
Fatigue	0.2 (0.2)	0.3 (0.2)	0.2	0.66	0.2 (0.2)	0.2 (0.2)	0.0	0.88
Positivity	-1.0 (0.1)	-1.4 (0.1)	4.1	0.05	-1.1 (0.1)	-1.3 (0.1)	0.5	0.47
Sadness	0.1 (0.1)	0.3 (0.1)	1.7	0.20	0.1 (0.1)	0.4 (0.1)	3.1	0.08
Systolic BP (mmHg)	9.1 (1.2)	11.3 (1.2)	1.7	0.20	9.6 (1.2)	10.7 (1.2)	0.4	0.53
Diastolic BP (mmHg)	6.3 (0.9)	6.5 (0.9)	0.0	0.86	5.9 (0.9)	7.0 (0.9)	0.7	0.40
Heart rate (bpm)	0.3 (1.0)	2.3 (1.0)	1.8	0.18	0.3 (1.0)	2.2 (1.0)	1.7	0.20
Cortisol (µg/dL)	0.1 (0.04)	0.2 (0.04)	0.0	0.91	0.1 (0.04)	0.2 (0.04)	1.5	0.23

[a]Mood words were rated on a 7-point scale, from 1 = not at all to 7 = extremely.

Preparing a meal versus not preparing a meal had little effect on reducing stress or improving measures related to mood. Heart rate increased more for those in the *Prepare* groups than in the *No Prepare* groups after the meal (**Table 2.7**). Systolic blood pressure decreased more for those in the *No Prepare* groups versus the *Prepare* groups. *Prepare* versus *No Prepare* had no effect on the other *responses*.

Table 2.7 Changes in stress and mood *responses* from after the stress task to after the meal.
Least squares means for each factor level are given (standard errors in parentheses). 'Yes' under the 'Choice' heading indicates Choice group and 'No' indicates No Choice group. 'Yes' under the 'Prepare' heading indicates Prepare group and 'No' indicates No Prepare group. Positive means indicate increases in a response and negative means indicate a decrease. F-statistics and p-values (one-sided) are for 2x2 ANOVAs for each *response* and factor.

	Choice				***Prepare***			
Responses	**Yes**	**No**	**F**	**p**	**Yes**	**No**	**F**	**p**
Anxiety[a]	-1.0 (0.1)	-1.5 (0.1)	7.0	0.00	-1.3 (0.1)	-1.3 (0.1)	0.0	0.50
Anger	-0.4 (0.1)	-0.9 (0.1)	6.6	0.01	-0.6 (0.1)	-0.6 (0.1)	0.1	0.41
Fatigue	-0.4 (0.1)	-0.4 (0.1)	0.0	0.42	-0.3 (0.1)	-0.5 (0.1)	0.9	0.18
Positivity	0.4 (0.1)	0.6 (0.1)	1.2	0.14	0.6 (0.1)	0.4 (0.1)	0.9	0.18
Sadness	-0.2 (0.1)	-0.4 (0.1)	2.0	0.08	-0.2 (0.1)	-0.4 (0.1)	1.4	0.12
Systolic BP (mmHg)	-3.3 (1.0)	-7.1 (1.0)	7.0	0.00	-4.0 (1.0)	-6.4 (1.0)	2.8	0.05
Diastolic BP (mmHg)	-1.2 (0.8)	-1.6 (0.7)	0.2	0.35	-0.7 (0.7)	-2.1 (0.8)	1.8	0.09
Heart rate (bpm)	2.4 (1.0)	0.0 (1.0)	2.9	0.05	2.7 (1.0)	-0.3 (1.0)	4.3	0.02
Cortisol (µg/dL)	-0.1 (0.03)	-0.1 (0.03)	0.5	0.24	-0.1 (0.03)	-0.1 (0.03)	0.9	0.17

[a]Mood words were rated on a 7-point scale, from 1 = not at all to 7 = extremely.

In agreement with our hypothesis, those in the *No Choice* groups showed a greater decrease in *anxiety*, *anger*, and systolic blood pressure after the meal than those in the *Choice* groups (**Table 2.7**, **Figure 2.4**, **Figure 2.5**). After the meal, heart rate increased more for those in the *Choice* versus the *No Choice* groups. *Choice* versus *No Choice* had no effect on the other *responses*.

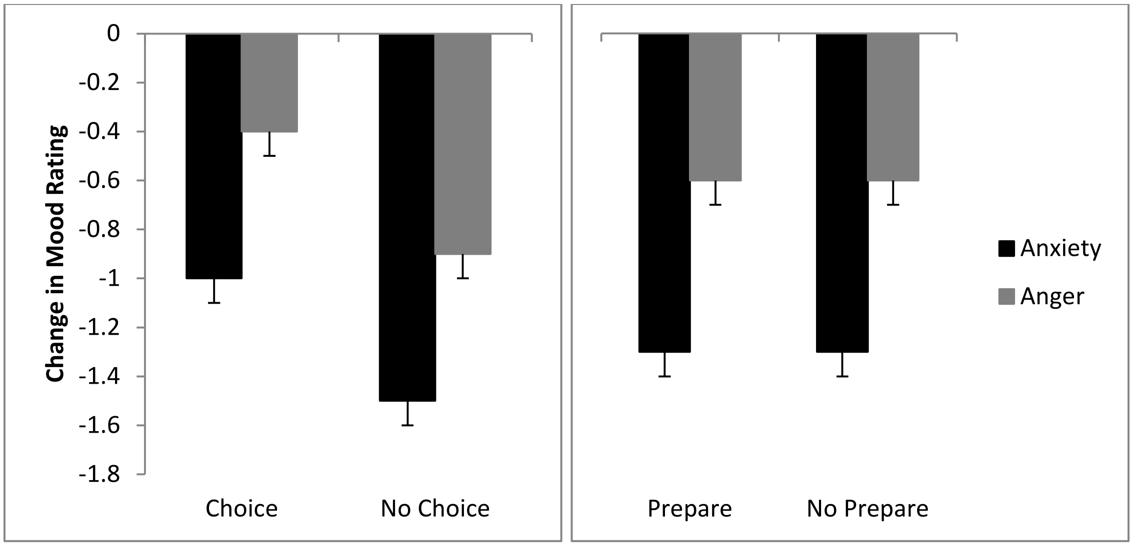


Figure 2.4 Change in *anxiety* and *anger* ratings after the meal.
Each bar represents the mean of the post-meal minus post-stress scores averaged across all words in either the anxiety or anger factor of the mood questionnaire. Mood words were rated on a scale from 1 (not at all) to 7 (extremely). The more negative the change, the more that emotion decreased after eating the meal.

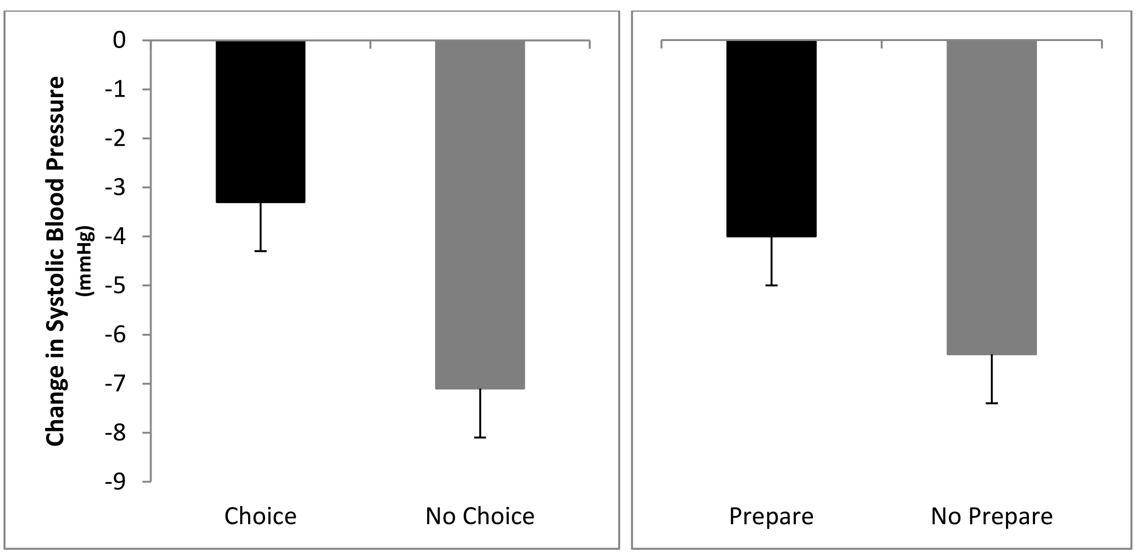


Figure 2.5 Change in systolic blood pressure after the meal.
Each bar represents the mean of post-meal minus post-stress systolic blood pressure (in mmHg) for participants in each group. The more negative the change, the more systolic blood pressure decreased after the meal.

2.6 Discussion

2.6.1 The No Choice groups reacted more strongly to the TSST

Stress and negative mood would have been predicted to have increased similarly for all groups of participants, but in the context of this study the *No Choice* groups reacted more strongly to the TSST than the *Choice* groups. Those in the *No Choice* groups had greater increases in *anxiety* and *anger* (**Figure 2.6**) and greater decreases in *positivity* after the TSST (**Table 2.6**) than did the *Choice* groups. The experimental protocol was the same for all participants through the end of the TSST. The manipulated differences occurred only during the meal portion of the study. However, at the very beginning of the experiment, participants were briefed on what would happen during the meal. This was done to prevent possible stress increases from worry about preparing a meal in an unfamiliar setting. Verbal cues were subtle, but there was a difference between what was said to the *Choice* groups versus what was said to the *No Choice* groups. Those in the *Choice* groups heard: “You will fill out a menu where you get to choose the ingredients for your pasta,” and those in the *No Choice* groups heard: “You will receive a list of ingredients that you will need to add to your pasta.” It is possible that these differences in wording were enough to induce the ‘choice’ manipulation before it was intended and allow for the *No Choice* groups to be more susceptible to stress increases because they felt they would not be in control of their meal choices. This potential susceptibility was possibly reflected by TSST scores. We observed a trend for those in the *Choice* groups ($M = 2.4$, $SE = 0.17$) to perform better (i.e., score higher) than those in the *No Choice* groups ($M = 2.2$, $SE = 0.17$; $F = 1.49$, $p = 0.22$). We could reasonably expect that performing better on the TSST would result in a smaller stress increase. *Anxiety*, *anger*, and *sadness* increased less after the stress task if the participant had a higher TSST score (**Table 2.8**).

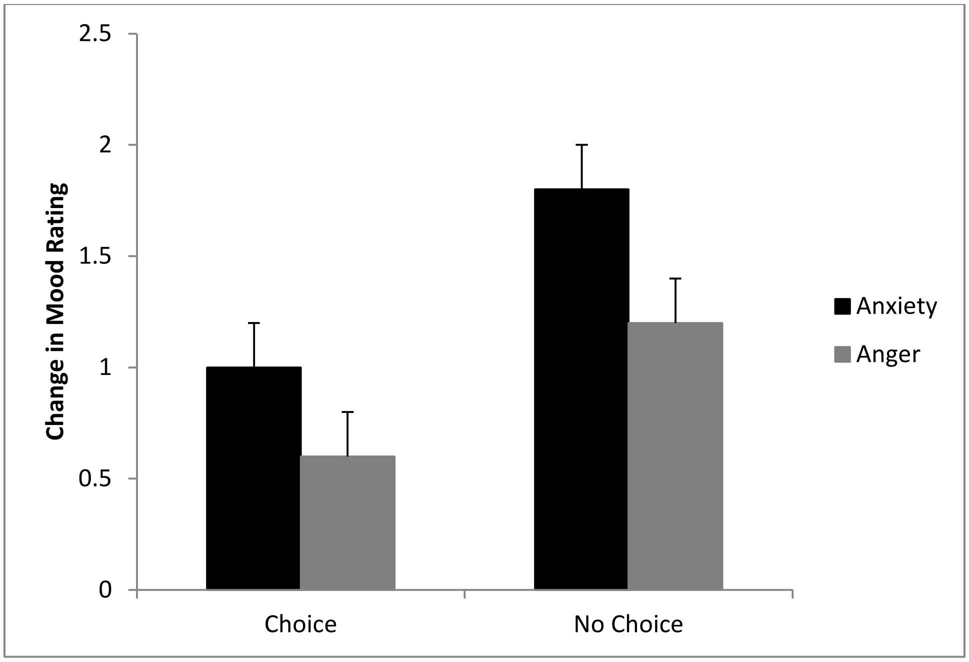


Figure 2.6 Increase in mood rating after the TSST for *Choice* vs. *No Choice* groups. Bars represent the mean change in mood (post-stress minus baseline) after the stress task. Mood words were rated from 1 (not at all) to 7 (extremely) and then averaged across all participants for all words in each mood category (*anxiety* or *anger*, in this plot). The more positive the change, the more that mood increased after the stress task.

Table 2.8 Correlations between TSST score and post-stress minus baseline *responses*

Responses	**Pearson Correlation Coefficient**	**p-value**
Anxiety	-0.27	0.01
Anger	-0.19	0.05
Fatigue	-0.17	0.09
Positivity	0.19	0.06
Sadness	-0.22	0.02
Systolic BP (mmHg)	-0.14	0.16
Diastolic BP (mmHg)	-0.01	0.90
Heart rate (bpm)	-0.04	0.68
Cortisol (µg/dL)	-0.06	0.60

2.6.2 No cortisol differences observed among factor levels

Differences in salivary cortisol levels between the *Choice* and *Prepare* factors were not observed in this experiment, possibly because of high inter-individual variability. Cortisol levels vary widely from person to person, both in baseline values and response to stress (Kirschbaum & Hellhammer, 1994). We tried to control for this by excluding smokers, pregnant women, and users of certain drugs, but genetics also contribute greatly to cortisol reactivity (Kirschbaum & Hellhammer, 1994). High variability may have masked detectable differences in salivary cortisol among factor levels after the meal. Given the observed variability of post-meal minus post-stress cortisol (overall M = -0.11 μg/dL, SD = 0.18, n = 96), a difference in means of 0.07 should have been detectable with 95% power. Our test was not sensitive enough to detect the small differences we actually observed (around 0.03).

Timing of sample collection may also have affected measured cortisol levels. Post-stress saliva samples were taken approximately 35 minutes after the start of the TSST. This is within the range of the cortisol peak time of 20-40 minutes post stress onset (Dickerson & Kemeny, 2004), although others have demonstrated the peak to be closer to the 20 minute time point (Creswell et al., 2005). Our measurement may have been during the decline of post-stress cortisol, which could have resulted in smaller differences between post-meal and post-stress samples and a decreased ability to detect separations between factor levels.

Different types of laboratory stress tasks elicit different types of stress. When a stress task involves social-evaluative threat and is uncontrollable, such as in the TSST, the hypothalamic-pituitary-adrenal (HPA) axis is preferentially activated (Creswell et al., 2005). If, however, the threat is controllable or seen as a challenge that can be met, sympathetic-adrenomedullary (SAM) axis is preferentially activated over HPA (Creswell et al., 2005). Possibly the TSST may not have been challenging enough for some participants, and as a result, the HPA axis was not activated enough to elicit a strong cortisol response. Our data, however, did not show that this was the case. In a meta-analysis by Dickerson & Kemeny (2004), the average effect size[2] for a psychosocial stressor (such as the TSST) was 0.92; for our study it was 1.21. Therefore, it appears that our stress induction was effective and the HPA axis was activated, as evidenced by high cortisol levels after the TSST.

Cortisol directly affects appetite and food-related brain activity, which may have blurred differences in the effects of choosing and preparing a meal on cortisol levels after eating. Consumption of high-carbohydrate foods may increase HPA-axis activity (indicated by elevated cortisol levels) (Lemmens et al., 2011). The pasta meal in this study may have had this effect, resulting in post-meal cortisol levels that were higher than they would have been had the meal been lower in carbohydrates. Percent carbohydrate intake was calculated based on each participant's pasta dish composition (from nutrition labels of each ingredient), taking into account amounts of each ingredient added and total amount of food consumed. In fact, cortisol change after the meal was negatively correlated with percent carbohydrate intake (r = -0.21, p = 0.04), indicating that the higher a participant's meal was in carbohydrates, the greater was the participant's cortisol decrease. Increased cortisol during stress can also cause increased food intake (Martens, Rutters, Lemmens, Born, & Westerterp-Plantenga, 2010). However, this was not seen in the present study, as cortisol increase after the TSST was not significantly correlated with food intake (r = -0.14, p = 0.18).

2.6.3 Not choosing resulted in greater improvement in mood and reduction in stress

The greater reduction in systolic blood pressure (SBP), *anxiety*, and *anger* for those in the *No Choice* groups versus the *Choice* groups may have occurred because, for those in the *Choice* groups, the act of choosing became more daunting after being stressed via the TSST. Stress can deplete the self-regulatory resources necessary to deliberate and make informed choices (Baumeister et al., 1998). When resources are depleted and choices need to be made, preference increases for the option requiring the simplest mental processing (Pocheptsova et al., 2009). This leads to increased dissatisfaction with the

[2] Effect size is defined as d: $d = \frac{Mean_{poststress} - Mean_{baseline}}{SD_{baseline}}$

final choice (Schwartz et al., 2002), which could be the reason for higher negative emotion ratings in the *Choice* groups. Plausibly, the lack of thought the participants had to put into their meal if they did not have to choose made it easier to relax, enjoy their meal, and ease their stress.

Another reason that not choosing had a greater effect on reducing stress and improving mood than choosing may have been because all of the participants received a meal that they liked. 'Likers' have more positive emotional responses to a food than 'non-likers' (King & Meiselman, 2010). In our study, if participants did not get to choose their ingredients, the choice was made for them based on previous liking ratings of the ingredients. 'Overall enjoyment', while generally high for all participants, did not differ between *Choice* (M = 72 out of 100, SE = 2.67) and *No Choice* (M = 66, SE = 2.67) groups (F = 2.68, p = 0.1), although the trend was for those in the *Choice* groups to enjoy their meal more. This effect was seen in a study by De Graaf et al. (2005), in which higher liking ratings were made for foods tasted in the laboratory if participants were allowed to choose which foods to sample than if they were simply given the same foods to taste. In the present experiment, none of the changes in stress or measures related to mood were significantly correlated with 'overall enjoyment' rating. We may have seen a greater stress-lowering effect of *Choice* in this experiment if the *No Choice* groups received a meal they did not like or felt neutral about. In that case, choosing should result in greater satisfaction with the meal if they chose something they like, and if so, greater would be the chance that choosing would reduce stress.

2.6.4 Meal preparation had little effect on stress and mood

Whether or not the participants prepared their own meal did not have an effect on their stress levels following the meal. Possibly the amount of preparing done by the participants was not enough to elicit many differences. Since the meal preparation consisted only of mixing items together and microwaving, participants may not have felt they were really 'cooking'. Indeed, when those in the *Prepare* groups were asked to respond to the statement "I felt like I was really cooking" (from 0-100, 0 corresponding to 'Strongly Disagree' and 100 corresponding to 'Strongly Agree'), the mean response was only 26. It is also possible that the effect of food preparation on stress relief and improvement in mood is affected by how much one enjoys cooking. When we included participants' responses to the question, "In general, how much do you enjoy cooking/preparing food?" (rated 0-100, 0 corresponding to 'Dislike Extremely' and 100 corresponding to 'Like Extremely') as a covariate in our 2x2 ANCOVA model, significance of the results did not change (for *anxiety* without "…enjoy cooking…", $F = 0.00$, $p = 0.83$; with "…enjoy cooking…" included as covariate, $F = 0.00$, $p = 0.94$). (The interaction between "…enjoy cooking…" and the *Prepare* factor was not significant).

We found that those who prepared their meal exhibited less of a decrease in 'self-conscious' ratings ($M = -1.5$, $SE = 0.2$) after the meal than those who did not prepare their meal ($M = -0.8$, $SE = 0.2$; $F = 7.0$, one-sided $p < 0.01$) (**Figure 2.7**). Being asked to perform a cooking task in an unfamiliar environment as part of a study where one is being evaluated may have increased feelings of self-consciousness during the meal preparation period. We did not take mood-related measurements after the meal was prepared but before it was eaten. If feelings of self-consciousness increased during this period, our results make sense. *Not* preparing the meal would result in 'self-conscious' ratings being reduced further than when preparing the meal, because they would not have increased in the period between mood-related measurements.

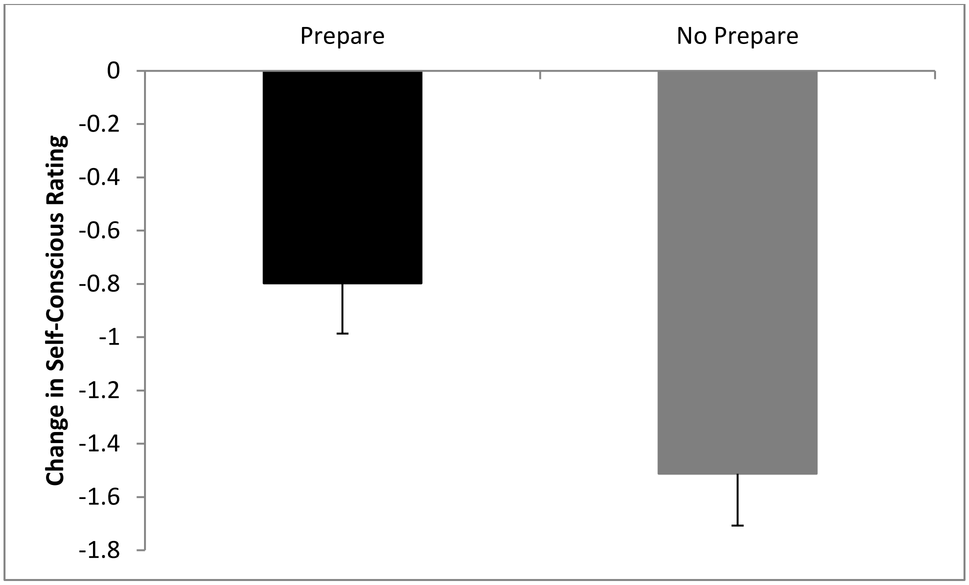


Figure 2.7 Decrease in self-consciousness after the meal for *Prepare* vs. *No Prepare* Each bar represents the mean of the post-meal minus post-stress score for the word 'self-conscious' in the mood questionnaire. Mood words were rated on a scale from 1 (not at all) to 7 (extremely). The more negative the change, the more self-consciousness decreased after eating the meal.

2.6.5 Negative mood changed more than positive mood

Many researchers have focused on positive mood words to capture the emotional responses associated with food, but the present study found larger changes in negative mood than in positive mood after the meal. This could simply be due to the fact that participants were put into a very negative mood. Negative mood increased after the TSST and decreased after the meal (**Table 2.5**). We would expect an equal and opposite pattern for positive mood if positive and negative mood are truly bipolar, but we did not find this. We did see an increase in positivity ratings after the meal (mean = 0.51, SE = 0.1), but not to the extent that we saw a decrease in anxiety (mean = -1.28, SE = 0.1). Some research suggests that positive and negative moods are not necessarily opposite sides of the same spectrum (Dubé et al., 2005; Peeters & Czapinski, 1990). For example, you could feel very lively (a positive mood), but also anxious (a negative mood) at the same time. Even if positive and negative emotions were asymmetric, we would still expect positive emotions to increase after the meal because foods are usually associated with positive emotional responses (Cardello et al., 2012). As shown above, we saw positivity increase after the meal, but not enough to return to baseline levels. Therefore, in this context, negative mood improvement was more prominent than positive mood improvement after the meal.

The arousal level and valence of the specific words used in emotion questionnaires can also impact the food-mood relationship (Dubé et al., 2005), and may be another reason we saw more changes in negative than positive mood. For example, some of the positive emotion words failed to increase after the meal. Positivity (consisting of the emotion words calm, cheerful, content, lively, and satisfied) increased, but ratings of another ‘positive’ word, vigorous (which did not load onto any factor), did not (mean = 0.04, SE = 0.1; t = 0.31, p = 0.75). The word ‘vigor’ has both a positive valence and high arousal level. It is possible that the relatively unexciting experience of participating in this study, coupled with the calming effects of eating (Gibson, 2006), did not allow for an increase in the more arousing or ‘vigorousness’ feelings of the participants. However, the fact that the stress task was over and their hunger was assuaged by the meal could be the cause of the increase in positivity. Eating the meal was therefore not an ‘arousing’ occasion, although it was positively valenced, as evidenced by increases in positivity. The minimal increase in positive mood after the meal is an interesting finding because of the general idea that foods are associated with positive emotional responses (Cardello et al., 2012; King & Meiselman, 2010). Possibly the mood changes after eating observed here are due more to negative mood improvement and less to positive mood enhancement.

2.6.6 Heart rate increased after the meal

Heart rate increased after the TSST, and surprisingly, increased again after the meal (**Figure 2.8**). Stress activates the sympathetic-adrenomedullary axis, typically resulting in increased heart rate and blood pressure, so elevated heart rate after the TSST was expected (Creswell et al., 2005). Increase in heart rate after the meal was unexpected, though, and may have been due to the actions of eating. Ingestion of food can increase heart rate (Gibson & Green, 2002), although post-meal, the needs of the digestive system take over and heart rate typically decreases within 30 minutes (Vatner, Patrick, Higgins, & Franklin, 1974; Vaz et al., 1995). Our post-meal heart rate measurements were taken before this digestive heart rate decline. The changes seen in heart rate after the meal were thus more likely due to the physiological effects of eating, and not due to decreases in stress.

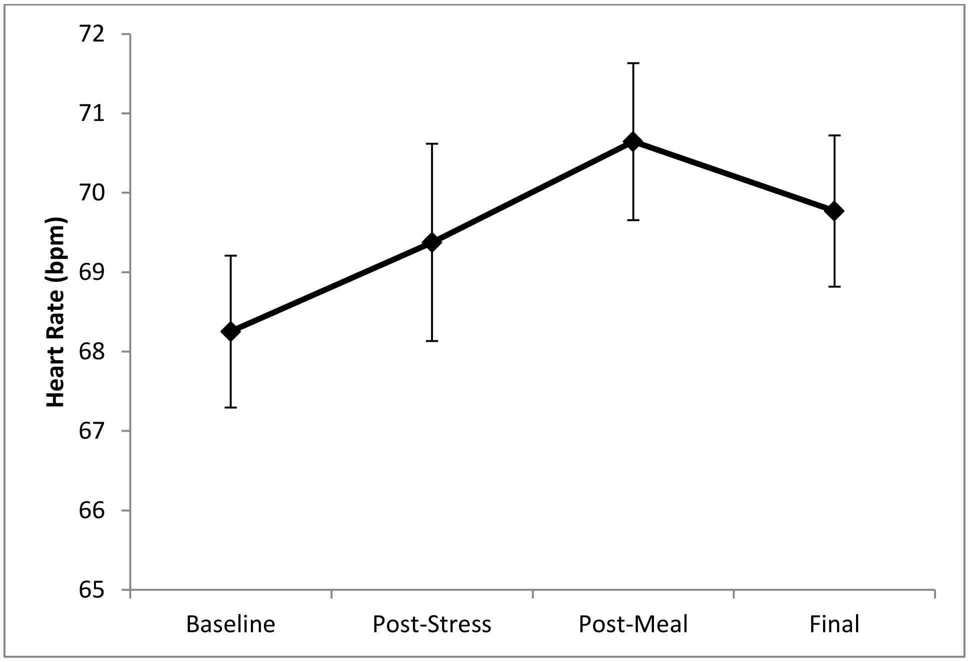


Figure 2.8 Mean heart rate for all participants at each time point.
Heart rate (in beats per minute) was measured in duplicate at each time point and the average was calculated for each participant.

2.6.7 Limitations

Several limitations to this study may have prevented us from seeing strong results. First of all, our ‘meal’ consisted of only one dish, and although it was large (providing approximately 1000 kilocalories if consumed in its entirety), participants may not have considered it a full meal. If we had provided more meal items, such as salad, beverage, and dessert, our participants may have been more satisfied with the meal. They also would have had to do more ‘choosing’ and ‘preparing’, which could have strengthened our manipulation. Secondly, the preparation of the pasta dish itself was not very extensive. Perhaps if we had included such steps as boiling the pasta and chopping vegetables, our *Prepare* manipulation would have been further strengthened. Finally, our mood questionnaire was only partially taken from a standardized and validated measure, the POMS. While many researchers take liberties with the adjectives used to measure mood, the modifications we made to the POMS may have resulted in non-standardized measures of specific mood constructs.

2.7 Conclusion

When the burden of choice is removed, food and eating relieve *anxiety* and *anger* and reduce systolic blood pressure more than when choice is involved. We found little evidence for an effect of preparing a meal on stress or measures related to negative mood.

CHAPTER 3 USE OF A CONDITIONING PROCEDURE TO INDUCE POSITIVE EMOTIONAL ASSOCIATIONS WITH NOVEL FOODS

3.1 Summary

The relationships between food and emotions are complex, and better understanding of them could hold significance for health promotion. People generally have positive emotional responses to food. One explanation is that prior associations with a food elicit these responses. Our primary objective was to use a conditioning procedure to induce positive emotional associations to a novel food. We also examined 1) if these induced associations were related to calorie content and 2) to what extent the conditioning procedure affected liking ratings of the foods. A novel test food was identified for each of 100 participants during a taste test. Half the participants received a *High-Calorie* test food (halvah or mochi) and half a *Low-Calorie* test food (jicama or rutabaga). Initial emotional associations (both implicit and explicit) with the test food and liking ratings were measured. On four consecutive conditioning days, participants ate a sample of their test food while watching a short film clip. Half the participants saw *Positive* and half saw *Neutral* film clips. On the day following conditioning, and again one week later, we measured implicit and explicit emotions and liking for the test food. We were unable to successfully induce positive emotional associations with novel foods. We observed no differences in emotional associations for *High-Calorie* compared to *Low-Calorie* novel foods. Liking ratings of the test foods increased throughout the study. Liking ratings were correlated with positive emotional associations. Future improvements in laboratory mood-induction procedures and emotion measurement may increase the efficacy of the conditioning paradigm and allow successful transfer of positive emotional associations to novel foods.

3.2 Introduction

3.2.1 Importance of the food-emotion relationship

If the complex relationships between food and mood were better understood, people would be able to make healthier food decisions that lead to better physical and emotional health. A person's motivation to eat is more than just physiological (i.e. driven by physical feelings of hunger or need for certain nutrients). It involves psychological influences, too, including emotions (Desmet & Schifferstein, 2008). Mood often drives food choice, and in turn, the foods we eat affect the way we feel (King & Meiselman, 2010; Wansink et al., 2003). Foods eaten under the influence of negative emotional states tend to be energy-dense, nutrient-poor foods (Oliver et al., 2000; Wansink et al., 2003) that, if consumed in excess, could lead to obesity and associated health problems, such as diabetes and heart disease (Tsenkova, Boylan, & Ryff, 2013). If emotionally-driven food choices can be altered to include healthier foods, people could have healthier diets and in turn, live healthier lives.

3.2.2 How do foods affect mood?

Foods typically elicit a positive emotional response. During development of scales specifically designed to measure emotional response to foods, researchers have discovered that people overwhelmingly identify positive emotion words in response to foods (Cardello et al., 2012; Desmet & Schifferstein, 2008; Gibson, 2006; King & Meiselman, 2010). Positive emotional responses to food likely occur because people generally eat foods they like and to which they know they will have a positive response (Desmet & Schifferstein, 2008). Desmet & Schifferstein (2008) conducted a survey in which they asked respondents to identify what emotions they associate with food and to describe why. They found that positive emotions were experienced much more often than negative emotions in response to food consumption. A variety of other reasons why we have emotional responses to food have been hypothesized (see Desmet & Schifferstein, 2008; Gibson, 2006; Locher et al., 2005; Macht et al., 2005), two categories of which will be explored in this study.

One explanation of why foods increase positive emotions is because of post-ingestive effects (i.e. alleviation of hunger due to calorie ingestion). People are generally alert and irritable when hungry, and calm and sleepy when full (Gibson, 2006). Macht & Dettmer (2006) had participants repeatedly consume chocolate bars (270 kcal), apples (90 kcal), or nothing, four times each, and rate mood (from 0 = extremely bad to 10 = extremely good) before and after consumption. The chocolate bar improved mood more than the apple and both the chocolate bar and the apple improved mood more than eating nothing. A survey-based study by Dubé, LeBel, & Lu (2005), in which participants were asked to recall changes in mood due to past eating experiences, produced similar results. Improvement of negative mood was greater following consumption of a high-calorie food (as in the chocolate bar, above) compared to a low-calorie food (as in the apple). Macht et al. (2003) found contradicting results. They had participants taste foods of low, medium, and high energy content and rate their emotional response (happy, angry, anxious, sad, ashamed, attentive, and sleepy from 0 = not at all to 6 = very strongly). Ratings of the negative emotion words increased with increasing energy content of the foods. However, these emotion ratings were made immediately after tasting and thus may not be indicative of post-ingestive effects. Another interesting finding was that the participants who were less hungry had less intense negative emotional responses to food than those who were more hungry (Macht et al., 2003). Together, the results of the aforementioned studies suggest that greater alleviation of hunger by high-calorie foods may improve mood more (or at least result in less intense negative emotions) than lesser alleviation of hunger by low-calorie foods.

Another explanation of why foods improve mood is that emotional responses are elicited by memories of past experiences or associations with a particular food. Many of the sources of food-elicited emotions identified by Desmet and Schifferstein (2008), Macht et al. (2005), and Locher (2005) involved past experiences, especially those associated with social relationships. For example, one of Desmet and Schifferstein's (2008) participants stated, "I love strawberries because they make me think of my girlfriend." Troisi and Gabriel (2011) examined the effect of social associations on emotional response to foods. In a pre-test, they had participants indicate whether or not they considered chicken noodle soup to be a comfort food. During the experiment, participants consumed either chicken noodle soup or nothing and then completed measures of positive social and relationship associations with chicken noodle soup. Those participants who considered chicken noodle soup to be a comfort food had more positive social/relationship associations with it compared to those who did not consider chicken noodle soup to be a comfort food. These results indicated that social associations and memories of past experiences play a role in what people consider comforting or emotionally-positive foods.

Emotional associations are thus formed as a result of repeated exposures to a food paired with an emotional experience or salient post-ingestive effects. These repeated pairings lead to expectations that food will have a positive (or negative) emotional impact (Gibson, 2006; Wansink & Park, 2002). The learned expectations drive food choice which, after consumption, elicits the desired emotional response, and these emotions subsequently reinforce repeat consumption of the chosen food (Adam & Epel, 2007; Hammersley et al., 2007).

3.2.3 Efficacy of conditioning

Conditioning is a process by which emotional associations with food may be formed via repeated pairings of a food with an emotional experience. Classical conditioning has been proposed to work well for foods (Macht et al., 2003). In classical (or Pavlovian) conditioning, an unconditioned stimulus (e.g. an emotional experience) is paired repeatedly with a conditioned stimulus (e.g. a novel food) so the emotional context of the unconditioned stimulus becomes associated with the conditioned stimulus (Domjan, 2005). When the conditioned stimulus is later presented on its own, the emotions originally associated with the unconditioned stimulus are activated (this emotional response to the conditioned stimulus is called the 'conditioned response') (Domjan, 2005).

Foods have been successfully conditioned to positive emotional associations by a few research groups. Kuenzel et al. (2011) were able to induce 'active' emotions (conditioned response) with novel flavored sweet beverages (conditioned stimuli) by pairing them repeatedly with film clips (unconditioned stimuli) that evoked an 'active' emotional state. Walsh and Kiviniemi (2013) repeatedly paired images of apples and bananas (conditioned stimuli) with positive images (unconditioned stimuli) and were able to induce people to choose apples or bananas as a snack food (conditioned response) more often than if the fruit images had been paired with neutral or negative images.

It remains to be seen whether a positive emotional state can be conditioned to a novel food for a period longer than a few days. Kuenzel et al. (2011) measured the effects of conditioning emotional responses to novel flavors three days after conditioning ended, and Walsh and Kiviniemi (2013) obtained their results (snack choice) immediately after conditioning. Positive emotional responses to *odors* have been shown to persist for up to one week (Baeyens et al., 1996). Baeyens et al. (1996) placed air fresheners (conditioned stimuli) in public restrooms (unconditioned stimuli) for 2.5 weeks. The air fresheners were then removed, and one week later, regular users of the restrooms took part in a testing session. They were asked to rate liking (conditioned response) of the air freshener odor and a control odor and to rate the extent to which they considered using the restroom to be a positive or negative experience. The regular users who had positive experiences using the restroom (i.e. considered it an 'agreeable break from work') rated liking of the air freshener odor higher than the control odor.

3.2.4 Liking and emotions

Emotional conditioning may be a form of evaluative conditioning, in which liking of a food increases when repeatedly paired with an already-liked food. Birch, Zimmerman, & Hind (1980) examined the effects of pairing positive experiences with snack foods on children's liking of the foods. Snack foods were presented to the children 1) as a reward, 2) by a friendly adult, 3) in absence of social contact, or 4) at normal snack time. The children rated liking (on a smiley-face scale) of the snack foods at baseline and after 42 presentations. Snack presentation in either of the two emotionally positive contexts (as a reward or by a friendly adult) resulted in greater increases in liking than snack presentation in the other contexts. In that case, increases in liking were not only a result of mere exposure (number of presentations was the same in all four contexts) but also enhanced by concurrent emotional conditioning. Other researchers have found links between liking and positive emotional response to foods. Cardello et al. (2012), King et al. (2010), and King & Meiselman (2010) asked participants to rate liking of foods as well as emotional response. They found that liking ratings positively correlated with ratings of many positive emotion words and that liking ratings negatively correlated with ratings of many negative emotion words.

3.2.5 Objectives & hypotheses

Objective 1: To determine whether positive emotional associations can be made with a novel food.

> *Hypothesis 1a*: Subjects will exhibit greater positive mood after eating a novel food when it has been conditioned to a positive emotional experience than if the same food has been conditioned to a neutral emotional experience.
>
> *Hypothesis 1b*: These effects will remain apparent one week after conditioning.

Objective 2: To determine whether positive emotional associations induced to novel foods differ with food type/calorie density.

> *Hypothesis 2a*: Subjects will exhibit greater positive mood after eating a high-calorie novel food that has been conditioned to a positive emotional experience than after eating a low-calorie novel food that has also been conditioned to a positive emotional experience.
>
> *Hypothesis 2b*: These effects will remain apparent one week after conditioning.

Objective 3: To determine whether liking of novel foods changes after positive emotional associations have been formed.

> *Hypothesis 3a*: As positive emotional associations with a novel food increase, liking of the food will also increase.

Hypothesis 3b: Liking of novel foods will increase more after conditioning with a positive emotional experience compared to a neutral emotional experience, and high-calorie novel foods will be liked more than low-calorie novel foods.

3.3 Materials and Methods

3.3.1 Participants

One hundred participants (mean age 31 years, range 19-65 years; 15% male) completed the study. Participants were pre-screened for qualification using an online survey (Qualtrics®, Provo, UT). The screening questionnaire (**Appendix C1**) included the Food Neophobia Scale (Pliner & Hobden, 1992), a measure of willingness to seek out and try new foods. Participants were excluded if they scored > 30, indicating high levels of food neophobia (based on the cutoff of Tuorila, Meiselman, Bell, Cardello, & Johnson, 1994). Participants were also excluded if they indicated any food allergies or sensitivities. Participants were monetarily compensated. The study protocol was approved by the Institutional Review Board of the University of Minnesota, and all participants gave informed consent prior to the study.

3.3.2 Study Design

Our conditioning procedure used novel test foods as the unconditioned stimuli and film clips as the conditioned stimuli. The study had a two-factor between-participants design: *Calorie* level of the test foods (high or low) and *Film* type (positive or neutral). This design resulted in four treatment groups: *High Calorie/Positive*, *High Calorie/Neutral*, *Low Calorie/Positive*, and *Low Calorie/Neutral*.

3.3.3 Test Foods

Test foods were chosen so they would likely be novel and unfamiliar to each participant. Two low-calorie foods (rutabaga and jicama) and two high-calorie foods (red-bean mochi and sesame halvah) were selected (**Table 3.1**). Rutabaga and jicama were peeled and cut into approximately one-centimeter cubes and served raw at room temperature. Mochi and halvah were also cut into approximately one-centimeter cubes and served at room temperature. For the taste test, two pieces of each food were placed in 2-ounce plastic cups with lids and labeled with 3-digit random numbers. For all other sessions, in which one food was served to each participant, foods were served in 8-ounce polystyrene bowls. Serving sizes were 60 g for the rutabaga, jicama, and halvah, and 90 g for the mochi. Calories were matched within each of the two calorie density categories (**Table 3.1**). All foods appeared to fill half the bowl.

Table 3.1 Name, manufacturer, calorie density, and serving size of the test foods

Test Food	Manufacturer	Calorie Density	Serving Size*
Jicama	Purchased fresh at a local supermarket	40 kcal /100 g	60 g (approx. 24 kcal)
Rutabaga	Purchased fresh at a local supermarket	40 kcal /100 g	60 g (approx. 24 kcal)
Halvah	Camel™ Vanilla Halvah, Noble Foods, Inc. Montreal, Quebec, Canada	500 kcal /100 g	60 g (approx. 300 kcal)
Mochi	Yuki & Love™ Japanese Style Red Bean Mochi, Walong Marketing, Inc. Buena Park, CA	310 kcal /100 g	90 g (approx. 300 kcal)

*Serving sizes for all sessions except the initial taste test. For the taste test, two small pieces of each food were served to each participant.

3.3.4 Experimental Protocol

Participants visited the laboratory up to seven times. Participants were disqualified at intervals if they failed to meet certain requirements or missed too many sessions. The timeline of visits, including measurements made at each visit, is diagrammed in **Figure 3.1**. Payments were spread out over all sessions as incentive for participants to keep returning.

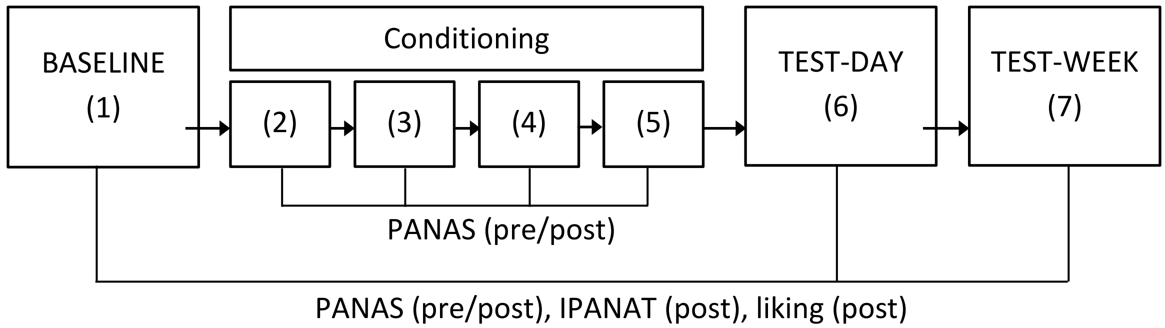


Figure 3.1 Study time line.
Participants visited the laboratory seven times. At the BASELINE, TEST-DAY and TEST-WEEK visits, participants completed the Positive and Negative Affect Schedule (PANAS), the Implicit Positive and Negative Affect Test (IPANAT), and the 9-point hedonic scale for liking. Visits 2-5 were conditioning visits, during which participants ate samples of their test food while watching film clips. The PANAS was also completed during these visits, both pre- and post-film.

3.3.4.1 Initial Visit – Taste Test (BASELINE)

The purpose of the first laboratory visit was to identify a test food for each participant and obtain baseline emotional association data. During this visit, the participant tasted small samples of each of the four potential test foods. Order of sample presentation was balanced by the online survey program. The participant was asked to taste each food and rate liking on a nine-point hedonic scale (ranging from 1 = dislike extremely to 9 = like extremely, Peryam & Pilgrim, 1957) (**Appendix C2**). The following questions were asked about each food:

> "Have you ever seen this food before?" (yes or no)
>
> "What is the name of this food?" (open text entry)
>
> "What does this food remind you of?" (open text entry)
>
> "Would you be willing to eat a small amount of this food at each session for the remainder of the study?" (yes or no)

After tasting and rating all four samples, the participant completed the Dutch Eating Behavior Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986) and the

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). As a measure of hunger, participants were also asked to "Rate the amount of food you desire" and "Rate the amount of food you could eat" on a scale from 0-100. The PANAS (further discussed in **section 3.3.6**, see also **section 1.3.1**) completed at this time served as the baseline explicit mood measure. While the participant was answering these questions, an experimenter determined an appropriate test food for that participant. An appropriate test food was neutrally-liked (rated 4-slightly dislike, 5-neither like nor dislike, or 6-slightly like on the 9-point hedonic scale) and unfamiliar to the participant. For a food to be 'unfamiliar', the participant must not have seen the food before, and must not have been able to name it. Choosing a novel and unfamiliar food was important to ensure that the participant had no prior experiences or expectations associated with the test food (Cardello et al., 1985). Participants must have also indicated that they would be willing to consume a small amount of that food at each session for the remainder of the study. If none of the foods met these criteria, any 'liked' food was given to the participant for the next part of the session, but the participant was disqualified from the remainder of the study.

A larger portion of the test food (**Table 3.1**) was then served to the participant with the instructions, "We would like you to re-taste this sample. Please sit quietly and eat as much as you would like while we prepare the next set of questions." The experimenter set a timer for 2.5 minutes, after which the sample was taken away and the participants were instructed to continue with the online survey. The remainder of the online survey included the Implicit Positive and Negative Affect Test (IPANAT, discussed in **section 3.3.6**, see also **section 1.3.2**; Quirin, Kazen, & Kuhl, 2009), a second PANAS, and various liking ratings including liking of the food's appearance, texture, and flavor. These ratings served as the baseline (BASELINE time point) measurements. After that, the participants were paid and allowed to leave.

Choosing the test food for each participant automatically placed them into either the *High-Calorie* or *Low-Calorie* group. The experimenter randomly assigned each participant to either the *Positive* or *Neutral* film group so that the number of participants in each of the four treatment groups (and the number receiving each test food) was roughly equal.

3.3.4.2 Conditioning Visits: Monday-Thursday

On four consecutive conditioning days, participants came to the lab each afternoon (between 12:00-5:00 pm) for a visit lasting about ten minutes. Time of arrival was recorded each day. If participants missed one day, they were allowed to continue, but if they missed a second day, they were disqualified from the remainder of the study.

Upon arrival, participants were seated at a computer with headphones. The participant completed the pre-film PANAS and then was served the test food. The online instructions read “When you have received your food, click the arrow at the bottom of the screen to begin the film clip. Feel free to eat as much of the snack as you wish during the film clip. You don’t have to eat all of it, but please taste at least a little.” After viewing the film clip, the participant was instructed to “Please pass any remaining snack back through the window.” Then, the participant completed the post-film PANAS, was paid, and was reminded to come back the following day. This procedure was repeated each of the four conditioning days (see questionnaire in **Appendix C3**).

3.3.4.3 Testing Days: 1 Day (TEST-DAY) and 1 Week (TEST-WEEK) post-conditioning

The testing days took place on the Friday following conditioning (TEST-DAY time point) and the Friday one week later (TEST-WEEK time point). Again, participants were asked to come between 12:00-5:00 pm.

Each participant was seated at a computer and told that there would not be a film clip to watch, but that they would be asked to sit quietly and eat their snack. The participant first completed the PANAS and rated their desire for food and the amount of food they could eat. The experimenter then served the participant the test food with the instructions, “Eat as much as you would like, and I will let you know when to continue.” The experimenter then set a timer for 2.5 minutes, after which the remaining food was taken away. The participant continued by completing the IPANAT, PANAS, and liking ratings (**Appendix C5**). Finally, the participant was paid and allowed to leave.

3.3.5 Film Clips

All film clips were approximately 2.5 minutes in duration. Positive film clips were chosen from comedy films and television shows based on emotion ratings of 12 clips by 15 participants (who did not take part in the actual study, but were from the same population as study participants) in a pre-test. They were asked to view the clips and rate, from 1 = not at all to 7 = very much, the degree to which the film clips made them feel happy, energetic, cheerful, excited, enthusiastic, and active. Ratings for each emotion word for each film clip were averaged, and these values were averaged across emotion words, resulting in one score for each film clip. The top four highest-scoring film clips (mean score of these four clips = 3.9) were chosen so a different clip could be shown each day of the conditioning period. The four neutral film clips were instructional videos, for example, how to tie a necktie, and were not pretested. (see list of film clips in **Appendix C4**)

We used 2.5-minute film clips because our film clip suggestions originally came from Schaefer, Nils, Sanchez, & Philippot (2010), who used clips of 1-7 minutes in length, and Gross & Levenson (1995), who used clips averaging 2.5 minutes in length. In other conditioning experiments, film clips have been between 2-5 minutes duration (Evers, Adriaanse, de Ridder, & de Witt Huberts, 2013; Kuenzel et al., 2011).

3.3.6 Dependent Measures

Emotional associations were determined both implicitly and explicitly. An implicit measure allows emotional associations to be assessed while minimizing demand effects (i.e. the chance the participant believes that their mood is supposed to change as a result of the experiment). To measure implicit associations, we used the Implicit Positive and Negative Affect Test (IPANAT; Quirin et al., 2009). The IPANAT consisted of six nonsense words each paired once with each of six emotion words (three positive and three negative). Participants were asked to rate, on a 5-point scale, how well each nonsense word expressed each emotion. If participants were feeling more positive, they would tend to rate the nonsense words higher on the positive emotion words. One small modification was made to the IPANAT for this study. The nonsense word ‘vikes’, which has meaning in Minnesota (it is the nickname of our professional football team, the Minnesota Vikings) was changed to ‘vekis’. Ratings for the positive and negative emotion words were averaged separately, resulting in measures of both positive and negative affect; hereafter denoted as ImpPos and ImpNeg. The IPANAT was completed three times: during the taste test to provide baseline measurements (BASELINE) and on both test days (TEST-DAY and TEST-WEEK) to assess post-conditioning emotional associations with the test foods. The IPANAT may only be administered once per session, because it would seem odd to ask participants’ opinions about the same nonsense words more than once within a session.

Explicit emotional associations were measured using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). Explicit measurements were used to assess the cognitive and motivational aspects of the effect of food on mood. The PANAS consisted of ten positive and ten negative emotion words, each rated by the participant on a scale from 1 = not at all to 5 = extremely, based on how the participant was feeling at that moment. The ratings in each category were averaged, resulting in one score for positive affect (ExpPos) and one score for negative affect (ExpNeg). The PANAS was used to obtain a before (Pre) and after (Post) measurement of emotional associations with the test food during the taste test and on both test days (TEST-DAY and TEST-WEEK). It was also used before and after the film clips on conditioning days as a manipulation check to assess mood changes due to watching the film clips.

In addition to the liking ratings of the four novel foods tasted at the start of the first session, liking of the chosen test food was rated again at the end of the first session. This end-of-the-first-session rating served as the BASELINE liking score for the participant’s test food. Liking ratings were not made again until the TEST-DAY and TEST-WEEK visits.

3.4 Data Analysis

All data analyses were done using SAS® 9.3 (Cary, NC). SAS code for this section can be found in **Appendix D**.

3.4.1 Effectiveness of mood induction

Changes in positive affect and negative affect (ExpPos and ExpNeg; from the PANAS, **section 3.3.6**) were calculated by subtracting the scores after viewing the film clip from the scores before viewing the film clip, and then averaging those differences over the four days in which participants viewed the film clips. These scores served as a measure of how much mood changed as a result of watching the film clips. To ensure that the positive film clips put participants in a better mood than the neutral film clips, we used one-way analyses of variance (ANOVA). The two dependent variables were 1) changes in ExpPos from before to after viewing the film clips and 2) changes in ExpNeg from before to after viewing the film clips. The predictor was *Positive* vs. *Neutral* film.

3.4.2 Individual differences among treatment groups

Demographic and individual difference measures (**Table 3.2**) were compared using 2 (*High-Calorie* vs. *Low-Calorie*) by 2 (*Positive* film vs. *Neutral* film) ANOVA to determine whether these differed among factor levels.

Table 3.2 Demographic and individual difference measures.

Measure Name	***Description***
DEBQ-Restrained[a]	A measure of restrained eating behavior from the Dutch Eating Behavior Questionnaire (DEBQ; van Strien et al., 1986)
DEBQ-External[a]	A measure of external eating behavior from the DEBQ
DEBQ-Emotional[a]	A measure of emotional eating behavior from the DEBQ
Age	Age of participant at time of study
Food Neophobia Score[b]	A measure of reluctance to seek out and try unfamiliar foods (Pliner & Hobden, 1992)
Percent Eaten	An average of the percent of food eaten on all study visits by each participant
Food Desired	An average of the ratings of 'Rate the amount of food you desire' (out of 100) and 'Rate the amount of food you could eat' (out of 100) on each test day
Average PA Change[c]	Amount that explicit positive affect changed (after viewing the film clip), averaged across the four conditioning days
Average NA Change[c]	Amount that explicit negative affect changed (after viewing the film clip), averaged across the four conditioning days

[a]Dutch Eating Behavior Questionnaire (van Strien et al., 1986). Restrained and External scales each consist of 10 eating-behavior questions, and the Emotional scale consists of 13 eating-behavior questions rated from 1 = never to 5 = very often. Ratings for each question are summed to result in one score for each of the three scales. Higher scores indicate higher levels of restrained, external, and emotional eating.
[b]Food Neophobia Score (Pliner & Hobden, 1992) consists of 10 statements about willingness to try new foods rated from 1 = strongly disagree to 7 = strongly agree. Total score is the sum of ratings for all 10 statements. Higher scores indicate higher levels of food neophobia.
[c]Average PA Change and Average NA Change. The degree to which positive (PA) and negative (NA) affect changed as a result of viewing the film clips. Calculated as the post-film clip minus pre-film clip PA and NA scores on the Positive and Negative Affect Schedule (Watson et al., 1988), averaged over the four conditioning days.

3.4.3 Model development

Full-factorial ANOVA models were developed using *Calorie* (*High-Calorie* vs. *Low-Calorie*), *Film* (*Positive* film vs. *Neutral* film) and *Time* (TEST-DAY vs. TEST-WEEK) as predictors. For the explicit measures (ExpPos and ExpNeg), an additional factor (Pre vs. Post) was created to account for the two ratings made at each testing session, one before eating the test food (Pre) and one after eating the test food (Post). Since BASELINE measures of ExpPos, ExpNeg, ImpPos, ImpNeg, and Liking were taken before assignment of treatment groups, they were included in their respective models as covariates. Other variables (from **Table 3.2**) were included as covariates if they improved the model fit (i.e. decreased the corrected Akaike Information Criterion (AICC)). All ANOVA models used unstructured covariance. Separate models were constructed for each dependent variable (ExpPos, ExpNeg, ImpPos, ImpNeg, Liking).

3.4.4 Hypothesis testing

To determine whether *Positive* films conditioned greater positive emotional associations than *Neutral* films (Objective 1), and to determine whether *High-Calorie* foods were more susceptible to conditioning than *Low-Calorie* foods (Objective 2), we constructed separate ANOVA models (as above, in **section 3.4.3**) with explicit positive emotion (ExpPos) as a dependent variable and implicit positive emotion (ImpPos) as a dependent variable.

To determine whether liking of novel foods increased as positive emotional associations increased (Objective 3), correlations between positive emotion ratings (ExpPos and ImpPos) and liking rating were calculated across all treatment groups.

To determine whether conditioning with *Positive* films resulted in greater liking ratings than conditioning with *Neutral* films, and to determine if *Calorie* level had an effect on liking ratings (Objective 3), we constructed an ANOVA model (**section 3.4.3**) with liking scores as the dependent variable.

3.4.5 Additional analyses

Although we did not hypothesize an effect of *Calorie* or *Film* on negative emotional associations, the nature of our scales provided negative as well as positive emotion ratings. To provide additional information about the effects of our treatments on negative emotional associations, we constructed ANOVA models (**section 3.4.3**) with explicit negative ratings (ExpNeg) as dependent variable and implicit negative ratings (ImpNeg) as dependent variable.

We also looked at *formation* of emotional associations with novel foods by looking at differences in the dependent variables between BASELINE and TEST-DAY and TEST-WEEK. To explore these changes in emotional associations over time, we developed ANOVA models for all five dependent variables with *Time* (BASELINE vs. TEST-DAY vs. TEST-WEEK) as a repeated measure.

3.5 Results

3.5.1 Effectiveness of mood induction

On average, the *Positive* film clips did not increase participants' positive affect (**Figure 3.2**). The *Neutral* film clips decreased positive affect more than the *Positive* film clips (mean change in positive affect for *Positive* films = 0.005, SE = 0.04; mean for *Neutral* films = -0.12, SE = 0.04, F = 5.6, p = 0.02). Negative affect decreased similarly in both the *Positive* (M = -0.14, SE = 0.02) and *Neutral* (M = -0.14, SE = 0.02, F = 0.02, p = 0.89) film groups (**Figure 3.2**).

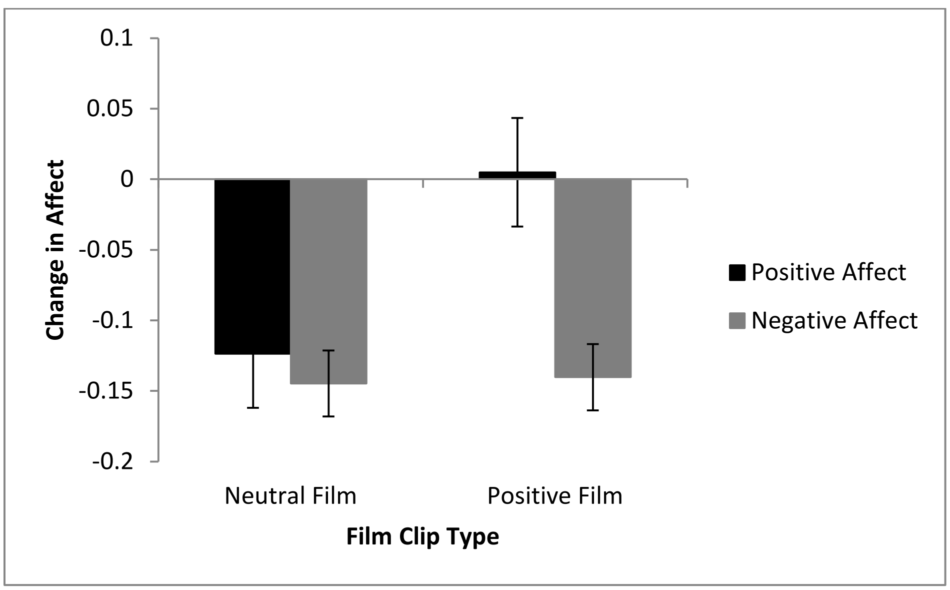


Figure 3.2 Effect of the mood induction (via film clips) on positive and negative affect. Participants completed the Positive and Negative Affect Schedule (PANAS) before and after watching the film clip each day. Change in affect (y-axis) is the calculated difference (after minus before) of the positive PANAS score (black bars) and the negative PANAS score (gray bars), averaged across the four conditioning days. Error bars represent standard errors.

A look at the mean positive mood ratings on each day of the conditioning period (**Figure 3.3**) reveals that the film clips affected positive mood on different days in different ways. For those in the *Neutral* film groups, positive mood tended to decrease from before to after viewing the film clips. The decrease in positive mood due to viewing the *Neutral* film clips is also reflected in **Figure 3.2**. For those in the *Positive* film groups, viewing the film clips resulted in a decrease in positive mood only on Day 1 of the conditioning period. On Day 2, mood did not change, and on Days 3 and 4, mood tended to increase from before to after viewing the film clips (**Figure 3.3**). On average, these mood changes due to viewing the *Positive* film clips (i.e. average effect of mood induction) were near zero, reflected in **Figure 3.2**. Those in the *Neutral* film groups generally arrived at the lab in a better mood than those in the *Positive* film groups, as evidenced in **Figure 3.3** by the fact that the *Neutral* film groups' 'Pre' mood ratings are greater than the *Positive* film groups' 'Pre' mood ratings.

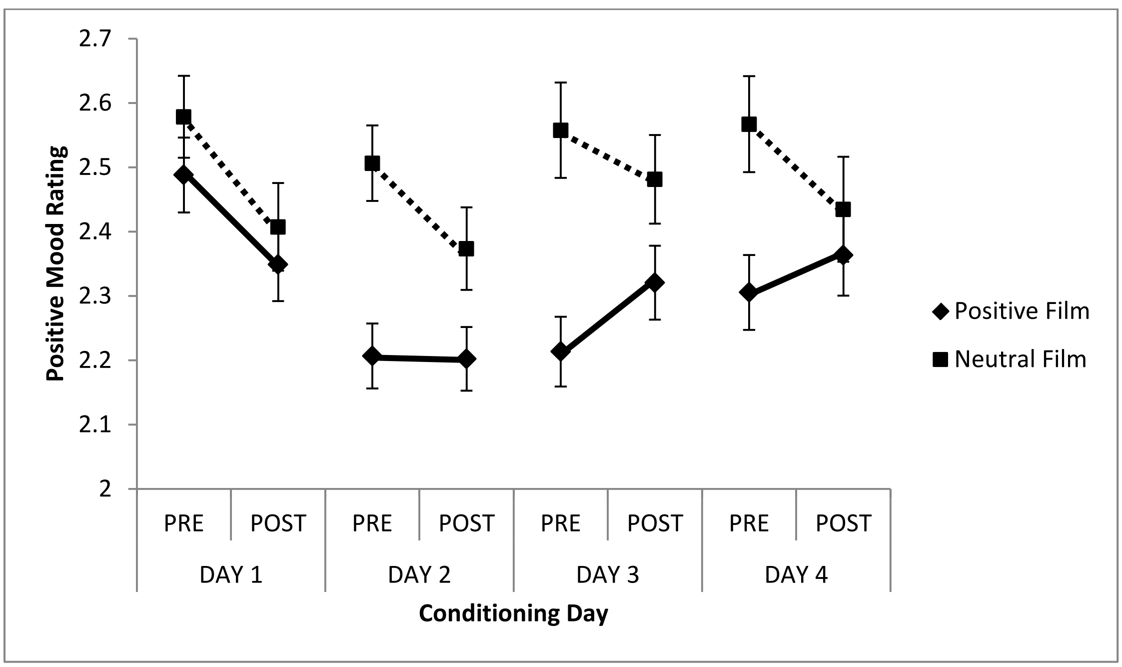


Figure 3.3 Effectiveness of the mood induction (via film clips) on mean positive mood ratings
for the *Positive* film groups (solid lines) and the *Neutral* film groups (dashed lines). Ratings of positive mood (PANAS) were made before watching the film clip (Pre) and after watching the film clip (Post) on each conditioning day. Error bars represent standard errors.

3.5.2 Individual differences among treatment groups

No differences among treatment groups were seen for ‘DEBQ-Restrained’, ‘DEBQ-External’, ‘DEBQ-Emotional’, ‘Age’, or ‘Food Neophobia Score’ (**Table 3.3**). Those in the *Low-Calorie* groups on average desired more food (‘Food Desired’; mean = 42 out of 100, SE = 2.4) than those in the *High-Calorie* groups (mean = 34, SE = 2.6; $F = 5.0$, $p = 0.03$); they also ate more (‘Percent Eaten’; mean for *Low-Calorie* = 43%, SE = 2.8 versus mean for *High-Calorie* = 29%, SE = 3.1; $F = 10.3$, $p = 0.002$) (**Table 3.3**).

Table 3.3 Means and standard errors of demographic and individual difference measures for each factor level. Definitions can be found in **Table 3.2**.

Measure Name	***Positive Film***		***Neutral Film***				***High-Calorie***		***Low-Calorie***			
	Mean	**SE**	**Mean**	**SE**	**F**	**p**	**Mean**	**SE**	**Mean**	**SE**	**F**	**p**
DEBQ-Restrained[a]	27	1.0	26	1.0	0.4	0.51	27	1.0	26	0.9	0.8	0.37
DEBQ-External[a]	33	0.7	31	0.7	1.9	0.17	31	0.7	33	0.6	3.5	0.06
DEBQ-Emotional[a]	33	1.2	34	1.2	0.3	0.61	33	1.3	35	1.1	1.1	0.29
Age	32	1.7	31	1.7	0.1	0.79	33	1.7	29	1.6	2.3	0.14
Food Neophobia Score[b]	20	0.7	20	0.7	0.4	0.54	20	0.7	19	0.7	0.5	0.49
Percent Eaten[c]	37	3.0	35	3.0	0.1	0.74	29	3.1	43	2.8	10	**0.002**
Food Desired[d]	38	2.5	39	2.5	0.1	0.77	34	2.6	42	2.4	5.0	**0.03**
Average PA Change[e]	0.0005	0.04	-0.12	0.04	4.6	**0.03**	-0.05	0.04	-0.06	0.04	0.1	0.80
Average NA Change[e]	-0.14	0.02	-0.15	0.02	0.1	0.83	-0.14	0.02	-0.15	0.02	0.1	0.83

[a]Dutch Eating Behavior Questionnaire (van Strien et al., 1986). Restrained and External scales each consist of 10 eating-behavior questions, and the Emotional scale consists of 13 eating-behavior questions rated from 1 = never to 5 = very often. Ratings for each question are summed to result in one score for each of the three scales. Higher scores indicate higher levels of restrained, external, and emotional eating.

[b]Food Neophobia Score (Pliner & Hobden, 1992) consists of 10 statements about willingness to try new foods rated from 1 = strongly disagree to 7 = strongly agree. Total score is the sum of ratings for all 10 statements. Higher scores indicate higher levels of food neophobia.

[c]Percent Eaten is the average of the percent of food eaten on all study visits by each participant.

[d]Food Desired is the average of the ratings of ‘Rate the amount of food you desire’ (out of 100) and ‘Rate the amount of food you could eat’ (out of 100) on each test day.

[e]Average PA Change and Average NA Change. The degree to which positive (PA) and negative (NA) affect changed as a result of viewing the film clips. Calculated as the post-film clip minus pre-film clip PA and NA scores on the Positive and Negative Affect Schedule (Watson et al., 1988), averaged over the four conditioning days.

3.5.3 ANOVA models

In some cases, demographic and/or individual difference measures resulted in better model fit when included in our ANOVA models as covariates (**Table 3.4**). Age was included as a covariate in the models for ExpPos, ImpPos, and Liking. Percent Eaten was included as a covariate in the models for ExpPos and Liking. Food Desired was included as a covariate in the model for ExpPos. Average NA Change was included as a covariate in the model for ExpNeg.

Table 3.4 Covariates selected for final ANOVA models.

	Dependent Variables				
Covariate	**ExpPos**	**ExpNeg**	**ImpPos**	**ImpNeg**	**Liking**
Age	X		X		X
Percent Eaten	X				X
Food Desired	X				
Average NA Change		X			

3.5.4 Hypothesis testing

Positive emotional associations (ExpPos and ImpPos) did not differ between those conditioned with *Positive* film clips compared to those conditioned with *Neutral* film clips, on both TEST-DAY and TEST-WEEK (*Film*Time*Pre-Post* interaction, ExpPos: $F = 0.56$, $p = 0.46$; *Film*Time* interaction, ImpPos: $F = 0.71$, $p = 0.40$; **Figure 3.4**, **Table 3.5**). These results failed to support our primary objective, which was to induce greater positive emotional associations with novel foods conditioned to positive films compared to neutral films.

Table 3.5 Mean (and standard error, SE) explicit positive (ExpPos) and implicit positive (ImpPos) emotion ratings
at TEST-DAY and TEST-WEEK for the *Positive* film vs. *Neutral* film groups and the *High-Calorie* vs. *Low-Calorie* groups.

	Time Point							
Emotion type	**TEST-DAY**				**TEST-WEEK**			
	Positive Film		**Neutral Film**		**Positive Film**		**Neutral Film**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
ExpPos PRE	2.27	0.10	2.43	0.10	2.39	0.10	2.56	0.10
ExpPos POST	2.38	0.10	2.47	0.10	2.40	0.10	2.56	0.09
ImpPos	1.91	0.04	1.89	0.04	1.95	0.04	1.89	0.04
	High-Calorie		**Low-Calorie**		**High-Calorie**		**Low-Calorie**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
ExpPos PRE	2.39	0.11	2.32	0.10	2.53	0.11	2.42	0.10
ExpPos POST	2.48	0.10	2.38	0.10	2.57	0.10	2.40	0.09
ImpPos	1.91	0.04	1.90	0.04	1.93	0.04	1.91	0.04

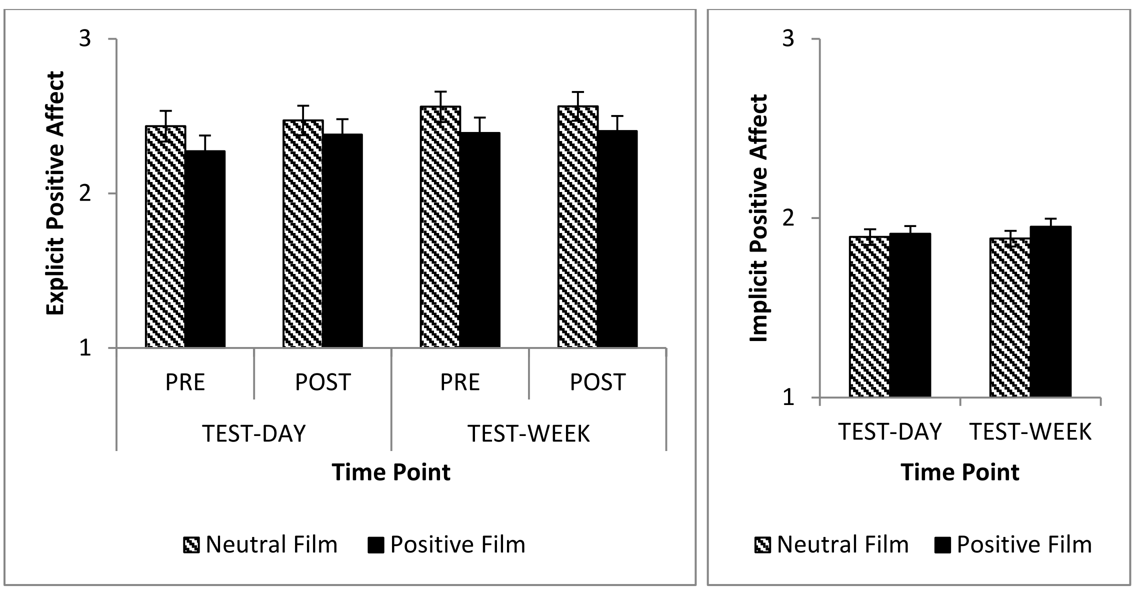


Figure 3.4 Explicit positive emotion ratings (ExpPos, left) and Implicit positive emotion ratings (ImpPos, right) for the *Positive* vs. *Neutral* film groups
at TEST-DAY and TEST-WEEK. Solid bars indicate *Positive* film groups and striped bars indicate *Neutral* film groups. Error bars represent standard errors.

The High-Calorie foods did not show greater positive emotional associations (either ExpPos or ImpPos) after conditioning than the Low-Calorie foods, on either TEST-DAY or TEST-WEEK (*Calorie*Time*Pre-Post* interaction, ExpPos: F = 0.15, p = 0.70; *Calorie*Time* interaction, ImpPos: F = 0.06, p = 0.81; **Figure 3.5**, **Table 3.5**).

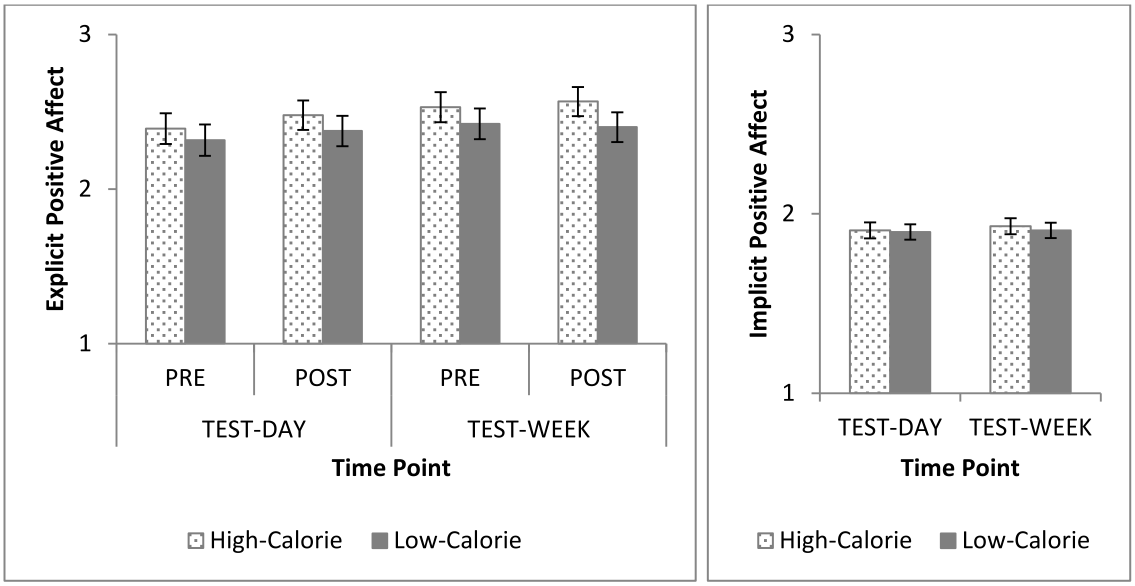


Figure 3.5 Explicit positive emotion ratings (ExpPos, left) and Implicit positive emotion ratings (ImpPos, right) for the *High-Calorie* vs. *Low-Calorie* groups at TEST-DAY and TEST-WEEK. Dotted bars indicate *High-Calorie* groups and solid bars indicate *Low-Calorie* groups. Error bars represent standard errors.

Liking ratings were positively correlated with both explicit positive emotion ratings (r = 0.32, p < 0.0001) and implicit positive emotion ratings (r = 0.17, p = 0.02), supporting our third hypothesis, that liking ratings would increase with increasing positive emotional associations. (However, liking ratings were also positively correlated with implicit negative emotion ratings (r = 0.18, p = 0.01)).

Liking ratings did not differ between those in the *Positive* film groups vs. *Neutral* film groups on TEST-DAY or TEST-WEEK (*Film*Time* interaction, F = 0.51, p = 0.48) (**Figure 3.6**, **Table 3.6**). Liking ratings did not differ between those in the *High-Calorie* vs. *Low-Calorie* groups on TEST-DAY or TEST-WEEK (*Calorie*Time* interaction, F = 0.03, p = 0.85) (**Figure 3.6**, **Table 3.6**). These results do not support our hypothesis that liking would increase more for those who consumed *High-Calorie* foods compared to *Low-Calorie* foods, or that liking would increase more for those in the *Positive* film groups compared to the *Neutral* film groups.

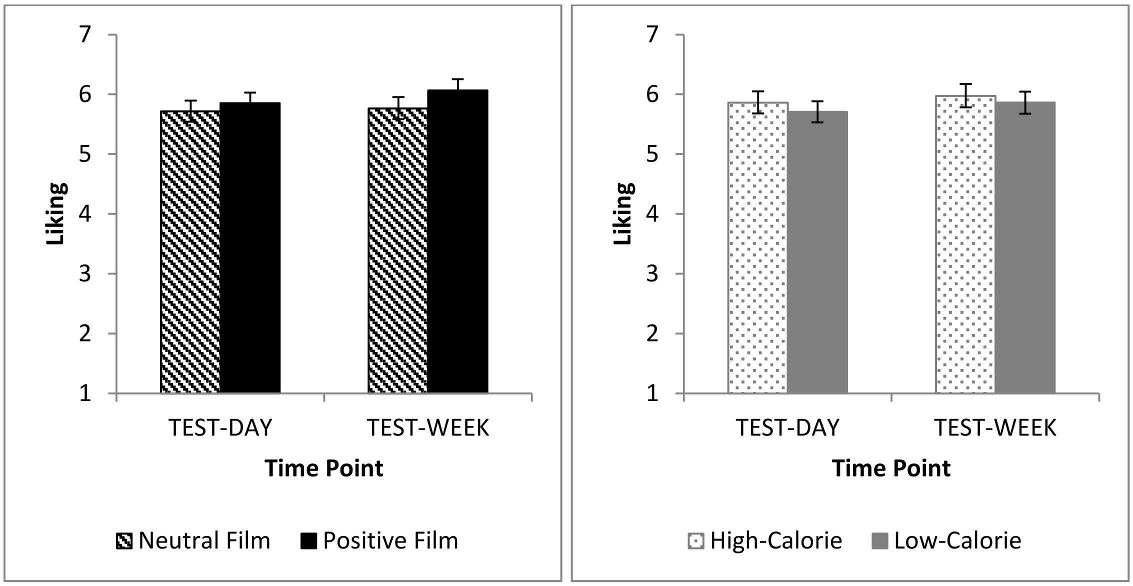


Figure 3.6 Liking ratings at TEST-DAY and TEST-WEEK for those in the *Neutral* film groups (black striped bars) vs. the *Positive* film groups (black solid bars) (left) and those in the *High-Calorie* groups (gray dotted bars) vs. the *Low-Calorie* groups (gray solid bars) (right). Error bars represent standard errors.

Table 3.6 Means and standard errors (SE) of liking ratings at TEST-DAY and TEST-WEEK for the *Positive* film vs. *Neutral* film groups and the *High-Calorie* vs. *Low-Calorie* groups.

	Time Point							
Liking ratings	**TEST-DAY**				**TEST-WEEK**			
	Positive Film		**Neutral Film**		**Positive Film**		**Neutral Film**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Liking	5.9	0.18	5.7	0.17	6.1	0.19	5.8	0.18
	High-Calorie		**Low-Calorie**		**High-Calorie**		**Low-Calorie**	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Liking	5.9	0.19	5.7	0.18	6.0	0.20	5.9	0.18

3.5.5 Additional analyses

3.5.5.1 Negative emotional associations

Those in the *Low-Calorie* groups exhibited greater negative emotional associations (ExpNeg) compared to those in the *High-Calorie* groups (mean *Low-Calorie* = 1.33, SE = 0.04; mean *High-Calorie* = 1.24, SE = 0.04; F = 3.0, p = 0.04). Additionally, looking at only the participants who viewed *Positive* film clips, those in the *Low-Calorie* groups had higher negative emotional associations with the novel foods than those in the *High-Calorie* groups on TEST-WEEK (mean *High-Calorie/Positive* = 1.19, mean *Low-Calorie/Positive* = 1.42; t = 2.5, p = 0.01; **Figure 3.7**). Implicit negative emotional associations were unaffected by our treatments.

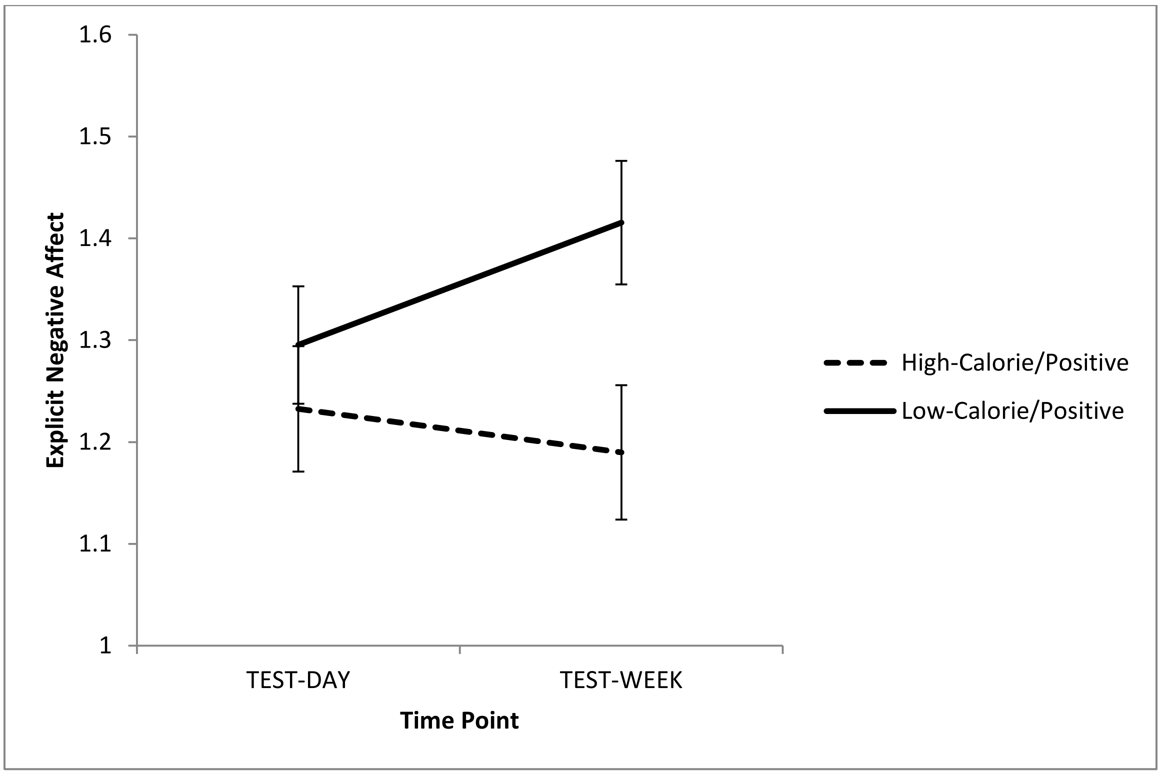


Figure 3.7 Explicit negative emotion ratings for the *High-Calorie* group who viewed *Positive* film clips compared to the *Low-Calorie* group who viewed *Positive* film clips Dashed line indicates *High-Calorie/Positive* group and solid line indicates *Low-Calorie/Positive* group. Error bars represent standard errors.

3.5.5.2 Overall emotional associations and liking

An examination of differences in emotional associations among BASELINE, TEST-DAY and TEST-WEEK allowed us to determine whether emotional associations were indeed induced, although they may not have differed by treatment group.

Since explicit positive emotional associations were measured twice on each test day, a single measurement was calculated by subtracting the pre-food ExpPos score from the post-food ExpPos score. Thus, ΔExpPos is a measure of how much explicit positive mood changed as a result of eating the food. At BASELINE, ΔExpPos was negative, indicating that mood decreased as a result of eating the food (**Figure 3.8**, **Table 3.7**). At TEST-DAY, this decrease in mood was not as great; indicating that after conditioning, eating the food lessened the decrease in mood. At TEST-WEEK, the preventative effect was still there, but was not as much as at TEST-DAY.

Table 3.7 Means and standard errors (SE) of emotion ratings for all participants. Change in explicit positive (ΔExpPos; before to after eating the test food), change in explicit negative (ΔExpNeg; before to after eating the test food), implicit positive (ImpPos), and implicit negative (ImpNeg) emotion ratings and liking ratings at each time point (all treatment groups combined).

	ΔExpPos		**ΔExpNeg**		**ImpPos**		**ImpNeg**		**Liking**	
Time Point	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
BASELINE	-0.21	0.04	-0.05	0.02	1.99	0.04	1.67	0.03	5.0	0.16
TEST-DAY	-0.01*	0.04	0.004	0.02	1.90*	0.04	1.69	0.03	5.8*	0.14
TEST-WEEK	-0.08*	0.03	-0.02	0.02	1.92*	0.04	1.66	0.04	5.9*	0.15

*Significantly different from BASELINE at $p < 0.05$.

ΔExpNeg scores were calculated in the same way as ΔExpPos scores, above. ΔExpNeg did not change over time (**Figure 3.8**, **Table 3.7**).

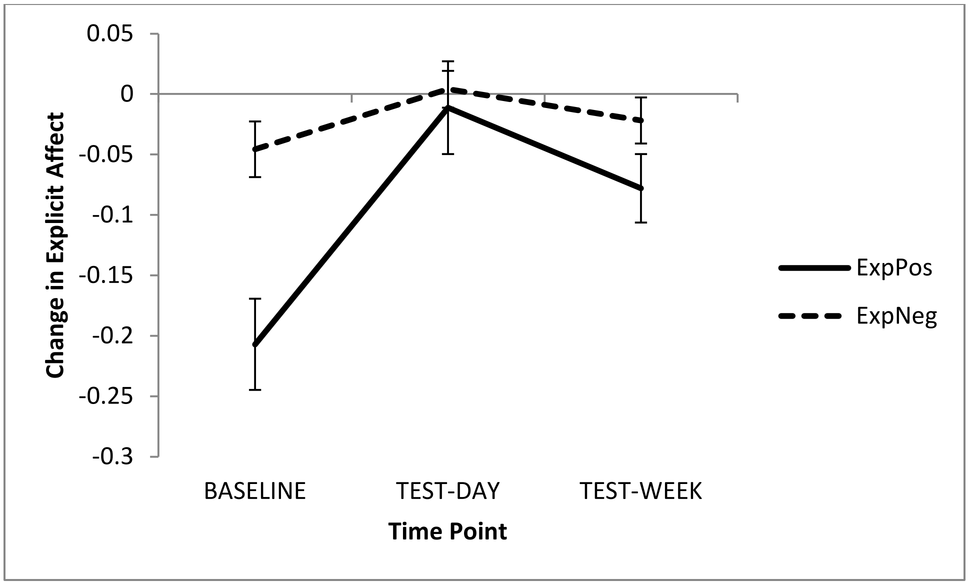


Figure 3.8 Change in explicit positive associations (ΔExpPos) and explicit negative associations (ΔExpNeg)
with novel foods (either *High-Calorie* or *Low-Calorie*) after conditioning with either *Neutral* film clips or *Positive* film clips. Solid line indicates changes in explicit positive associations and dashed line indicates changes in explicit negative associations. Error bars represent standard errors.

Implicit positive emotions decreased slightly from BASELINE to TEST-DAY and remained low on TEST-WEEK. Implicit negative emotions did not change over time (**Figure 3.9**, **Table 3.7**).

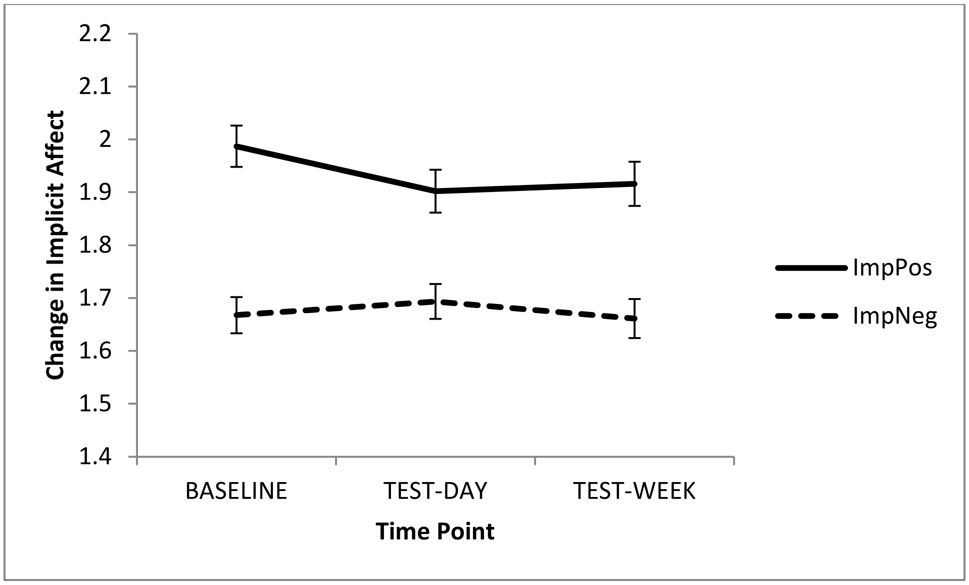


Figure 3.9 Mean implicit positive associations (ImpPos) and implicit negative associations (ImpNeg)
with novel foods (either *High-Calorie* or *Low-Calorie*) after conditioning with either *Neutral* film clips or *Positive* film clips. Solid line indicates implicit positive associations and dashed line indicates implicit negative associations. Error bars represent standard errors.

Liking ratings of the novel foods increased from BASELINE to TEST-DAY, regardless of treatment group (**Figure 3.10**, **Table 3.7**).

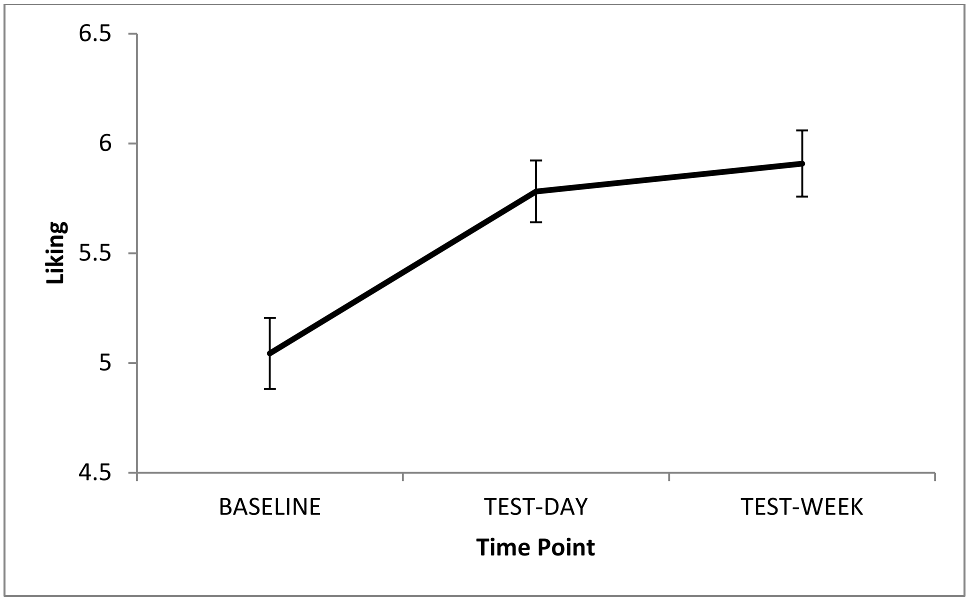


Figure 3.10 Mean liking ratings of novel foods at each time point
Liking rated on a 9-point hedonic scale; a score of 5 corresponds to 'neither like nor dislike' (all treatment groups combined; see **Table 3.6** for liking ratings separated by group). Error bars represent standard errors.

3.6 Discussion

3.6.1 Protective effects of food on lab-induced mood deterioration

Food may have a protective effect against the decline in mood often experienced in a laboratory study. Our participants' changes in explicit positive affect from the beginning to the end of a laboratory test session were typically negative. For example, at BASELINE, most participants experienced a decline in explicit positive mood from when they arrived at the lab to when they left (mean change = -0.21, SE = 0.04). This phenomenon happened to a lesser extent on TEST-DAY (mean change = -0.01, SE = 0.04; for the test of the difference between TEST-DAY and BASELINE, $t = -4.0$, $p = 0.0001$) and TEST-WEEK (mean change = -0.08, SE = 0.03; for the test of the difference between TEST-WEEK and BASELINE, $t = -3.0$, $p = 0.004$; also see **Figure 3.8** and **Table 3.7**). Since positive affect did not decrease as much on TEST-DAY or TEST-WEEK, it is possible that after conditioning, consumption of the test food prevented positive affect from decreasing to such a great extent as at BASELINE. Wagner, Ahlstrom, Redden, Vickers, & Mann (2014) demonstrated a similar phenomenon. They examined the effect of eating chocolate *before* a negative mood induction on subsequent mood changes. Half of their participants consumed chocolate before a negative mood induction and the other half consumed chocolate after a negative mood induction. Negative mood was induced via film clips, and participants rated mood (PANAS) at several time points throughout the experiment. Negative mood did not increase as much for those who ate before the mood induction (i.e. eating may have prevented a decline in mood) compared to those who ate after the negative mood induction.

3.6.2 Effectiveness of conditioning procedure

Although film clips are commonly used to induce mood states in a laboratory setting, they do not always reliably do so. In a meta-analysis, Westermann, Stahl, & Hesse (1996) compared mood induction techniques including film clips, mental imagery, music selections, and performance feedback, and found film clips to be the most effective at inducing positive emotional states. Schaefer, Nils, Sanchez, & Philippot (2010) identified a set of film clips intended to elicit specific emotional states (including amusement and tenderness, plus some negative emotions) ranging from 1-7 minutes in duration. Our film clips averaged 2.5 minutes in duration, similar to an earlier set of film clips identified by Gross & Levenson, (1995), and within Schaefer et al.'s (2010) range. To assess the emotional impact of the film clips, Schaefer et al. (2010) had participants rate how they felt after watching the film clips (PANAS). They found that the films that were expected to elicit 'amusement' resulted in Positive Affect ratings around 2.0 (on the 5-point PANAS scale) and Negative Affect ratings around 1.2. While these scores differentiated the 'amusement' films from emotional responses to the other types of films, the Positive Affect score of 2.0 was not very high. Our *Positive* film clips, which were also meant to elicit 'amusement', resulted in a mean Positive Affect score of 2.4 (SE = 0.05) after viewing. Our film clips were chosen based on an online pretest, in which participants viewed the film clips and rated how happy, energetic, cheerful, excited, enthusiastic, and active they felt on a 7-point scale (from 1 = not at all to 7 = very much). The positive emotion ratings after viewing the film clips in the pretest averaged 3.9 on the 7-point scale, which is equivalent to 2.8 on a 5-point scale. The film clips were thus more effective at inducing positive mood in the online pretest (when participants were likely viewing them comfortably at home or work) compared to when they were viewed in the laboratory (perhaps partly because of the negative effects mentioned in **section 3.6.1**).

Unlike Schaefer et al. (2010) or Gross & Levenson (1995), we measured mood both before and after viewing the film clips to get a sense of the *changes* in mood due to viewing the film clips (and at the same time controlling for initial mood state). Our *Positive* film clips did not reliably elicit an increase in positive mood from before to after viewing (mean change = 0.005, SE = 0.04), so perhaps they did not allow for conditioning to happen. Other groups have had more success using film clips to induce a positive change in mood. Turner, Luszczynska, Warner, & Schwarzer (2010) had participants view 7-minute positive or neutral film clips and complete the positive affect (PA) scale of the PANAS before and after. Post-film PA scores were greater for those who viewed the positive film clips (mean = 2.95) compared to the neutral film clips (mean = 1.90; $p < 0.001$) (these means were obtained from an ANOVA using pre-film PA ratings as covariates; mean changes from pre to post were not reported). Evers et al. (2013) had their participants rate positive emotions on a 7-point scale (from 0 = not at all to 6 = very much) before and after viewing either positive or neutral film clips. Mean positive emotion ratings increased by 0.7 after viewing the positive film clip, but were unchanged after viewing the neutral film clip.

Four conditioning sessions (utilizing 2.5-minute film clips) may not have been enough to successfully condition positive emotional associations with novel foods. Although similar short conditioning periods have been used successfully in the past (Kuenzel et al., 2010; Kuenzel, Blanchette, et al., 2011), the inability of our *Positive* film clips to induce positive mood (i.e. to act as unconditioned stimuli) likely limited their usefulness for conditioning. Four pairings of an unconditioned stimulus with a conditioned stimulus are well within the range for classical conditioning. In Watson and Rayner’s (1920) famous ‘Little Albert’ case study, they conditioned a fear response to the visual presentation of a rat for an 11-month old human baby. After only two presentations of the rat paired with the fear-eliciting unconditioned stimulus (a loud bang), a conditioned fear response (crying and running away from the rat) started to emerge.

We may not have appropriately measured emotional response to the novel foods on the testing days (TEST-DAY and TEST-WEEK). In a successful classical conditioning procedure, one expects the conditioned response to occur immediately upon presentation of the conditioned stimulus. In Pavlov's famous experiment, the bell (conditioned stimulus) made the dogs immediately salivate (conditioned response) (Pavlov, 1927). Putting this in terms of our experiment, the emotional response (conditioned response) should have happened immediately upon presentation of the food (conditioned stimulus). The emotional response would then be expected to decline in the moments following initial presentation. On the testing days, we measured the emotional response 2.5 minutes after the initial presentation of the food, so it is possible that the emotional response triggered by the initial presentation of the food had declined by that point. In other words, the timing of our measurements may have been inappropriate for testing the effects of our conditioning procedure.

3.6.3 What is it about food that elicits an emotional response?

If the above is true, that the conditioned emotional response should have happened immediately upon presentation of the food, then it would follow that the emotional response would not be due to consumption of the food itself, but to expectations triggered when the food was presented. The existing research on emotional responses to food has not truly separated emotional responses due to expectations from those strictly due to consumption of a food. Cardello et al. (2012) found that stronger emotional responses (both positive and negative) were elicited by chocolate compared to oatmeal and carrots. When someone eats chocolate, and is told to rate their emotional response, they cannot help but base it on all of their prior experiences with chocolate, their knowledge of its potential mood-boosting effects, or what they think is supposed to be an emotional response to chocolate. Carrots and oatmeal likely do not have the same emotional expectations as chocolate, so the emotional response to them would be less intense. The emotional response to food, then, may be mostly due to expectation effects. Perhaps these expectation effects help explain the findings of Wagner et al. (2014) (discussed in **section 3.6.1**). In addition to participants consuming chocolate either before or after negative mood induction, a third experimental condition involved giving participants a gift of chocolate prior to negative mood induction (participants were not allowed to eat the chocolate until the experiment was finished). They found that consuming chocolate or receiving it as a gift prior to negative mood induction prevented negative mood from increasing to such an extent as when participants had no exposure to chocolate before the negative mood induction. It is possible that exposure to the chocolate prior to negative mood induction (either via consumption or simply receiving it as a gift) triggered expectations and memories that produced a positive emotional response that protected against the effects of the negative mood induction. When negative mood was already elevated, chocolate consumption was not as effective at improving mood (and indeed, just as effective as no food at all).

3.6.4 Mere exposure effects on liking

The theory of 'mere exposure' (Pliner, 1982; Zajonc, 1968), that liking of a food increases with increased exposures to it, may explain why liking increased for the foods conditioned to both the *Neutral* films and the *Positive* films from BASELINE to TEST-DAY, in the absence of successful emotional conditioning. Pliner (1982) measured the effects of repeated exposure on liking for four varieties of novel tropical fruit juices. In a pretest, the four juices were rated below 4 ('neither like nor dislike') on a 7-point liking scale (from 1 = dislike extremely to 7 = like extremely). Later, participants tasted three varieties of juice, one variety 20, one 10, and one 5 times, and rated bitterness (to hide the main objective of the experiment). They then tasted the three juices again, plus one previously untasted juice (thus, zero exposures), and rated liking. Liking ratings were highest for the juices tasted 20 times, and decreased with decreasing number of exposures. Liking ratings for the novel foods in our experiment increased for those in the *Neutral* film groups (mean increase = 0.51, SE = 0.22; $t = 2.3$, $p = 0.02$) and those in the *Positive* film groups (mean increase = 0.97, SE = 0.23; $t = 4.3$, $p < 0.0001$) on a 9-point hedonic scale after six exposures. The increases in liking that we observed were probably partly due to the novelty of the test foods at the start of the study. Habituation and/or reduction of ‘newness’ are key features in mere exposure theory (Pliner, 1982): people may react negatively to new foods out of caution (neophobia – we do not know if it will harm us), but once a new food has been repeatedly experienced in the absence of negative consequences, people may react more positively toward it (i.e. liking increases).

3.6.5 Liking and emotional response

We found that liking ratings were positively correlated with positive emotional associations (explicit positive associations, $r = 0.32$, $p < 0.0001$; implicit positive associations, $r = 0.17$, $p = 0.02$). These positive correlations indicate a link between positive emotional state and liking, as evidenced by Birch et al. (1980), discussed in **section 3.2.4**. King and Meiselman (2010) found that ‘likers’ of a food product tend to have more positive emotional responses, while ‘non-likers’ tend to have more negative emotional responses. We saw similar differences between ‘likers’ (liking rating > 5 on TEST-DAY) and ‘non-likers’ (liking rating ≤ 5 on TEST-DAY) in their emotional responses (**Figure 3.11**). ‘Likers’ exhibited greater positive emotional response (mean explicit PA = 2.6, SE = 0.08) than ‘non-likers’ (mean explicit PA = 2.3, SE = 0.11; $t = 2.1$, $p = 0.04$), as well as higher scores on the individual PANAS words ‘attentive’ ($p = 0.05$), ‘determined’ ($p = 0.02$), ‘alert’ ($p = 0.01$), and ‘interested’ ($p = 0.03$). Negative emotional responses did not differ between ‘likers’ and ‘non-likers’ (**Figure 3.11**).

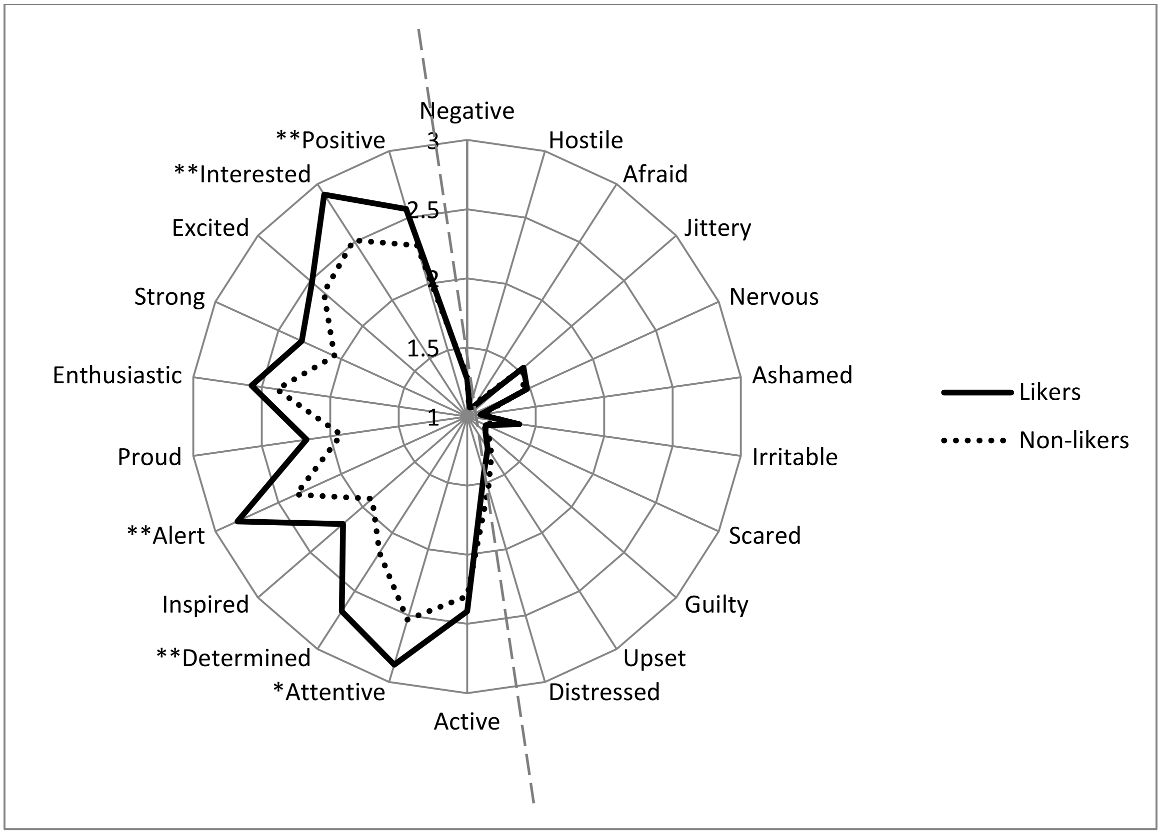


Figure 3.11 Mean explicit positive and negative emotional responses for 'Likers' compared to 'Non-likers'
'Likers' (solid line) had liking ratings of the novel food > 5 on TEST-DAY, and 'Non-likers' (dotted line) had liking ratings of the novel food ≤ 5 on TEST-DAY. Emotion words are from the PANAS. Words to the left of the dashed line are categorized as positive and words to the right are negative. 'Positive' and 'Negative' are averages of the 10 positive and 10 negative individual word scores, respectively. Words with '*' indicate a difference between 'likers' and 'non-likers' of $p < 0.10$, and '**' indicates $p < 0.05$.

3.6.6 Hunger and emotional response

Our participants' hunger state seemed to impact their explicit emotional responses. Average 'food desired' ratings (our measure of hunger, rated from 0 - 100 before eating the food on each day of the study; see **Table 3.3**) were positively correlated with explicit positive affect ($r = 0.43$, $p < 0.0001$). We further explored this relationship by dividing our participants into a 'hungry' group (average 'food desired' rating greater than the sample mean of 38.7, n = 47) and 'not hungry' group (average 'food desired' rating <

38.7, n = 52). We compared these groups using ANOVA with PANAS measures as dependent variables. ‘Hungry’ participants experienced greater positive emotional responses (mean explicit PA = 2.7, SE = 0.09) than ‘not hungry’ participants (mean explicit PA = 2.3, SE = 0.09; F = 10, p = 0.002) as well as higher scores on all of the individual positive PANAS words (**Figure 3.12**). ‘Not hungry’ participants scored higher on the individual negative PANAS words ‘irritable’ and ‘distressed’ compared to the ‘hungry’ participants (**Figure 3.12**). The satiating effects of foods eaten while hungry become more salient (Gibson & Desmond, 1999) , which may explain our observed relationships between hunger ratings and positive emotions. However, these results contradict those of Macht et al. (2003) described in the introduction (**section 3.2.2**). As in our study, their participants rated hunger before food consumption and emotional response after. They found that hungrier participants rated negative emotions higher than less hungry participants.

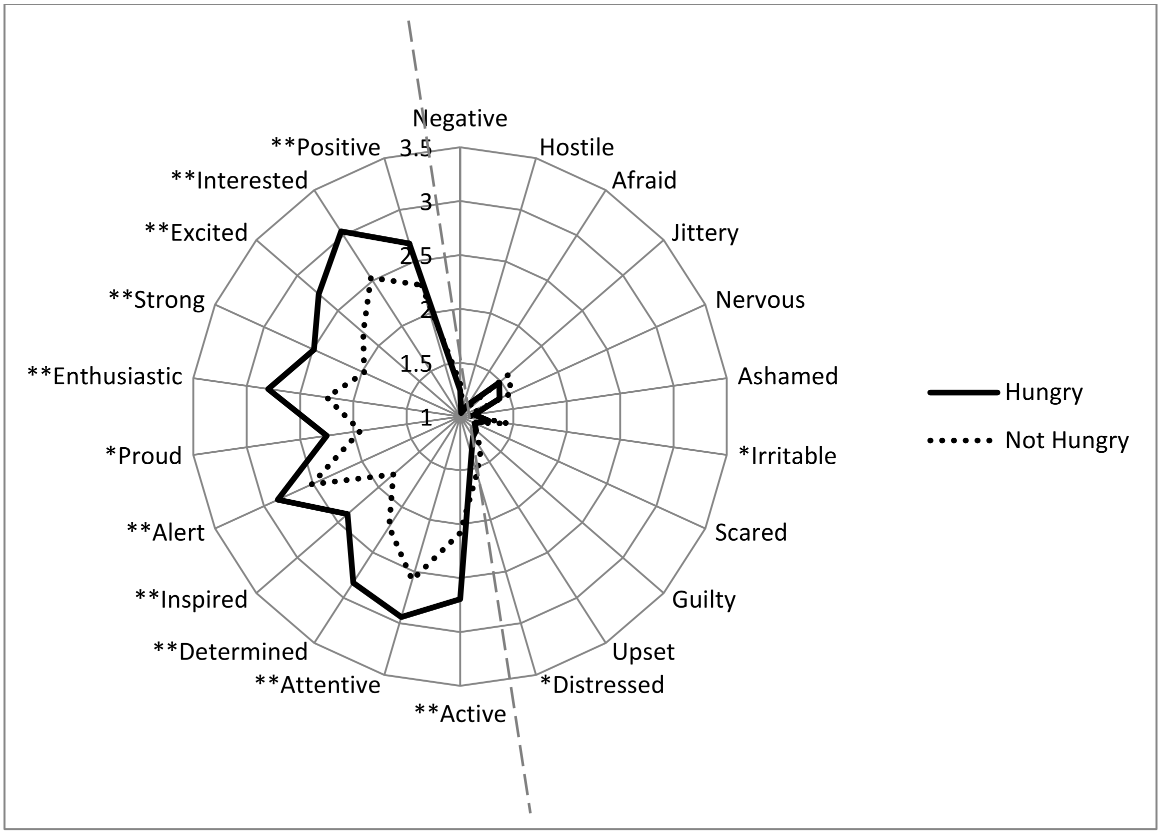


Figure 3.12 Mean explicit positive and negative emotional responses for 'Hungry' participants compared to 'Not Hungry' participants
'Hungry' (black line) defined as average 'food desired' ratings > 38.7, and 'Not Hungry' (dotted line) defined as average 'food desired' ratings < 38.7. Emotion words are from the PANAS. Words to the left of the dashed line are categorized as positive and words to the right are negative. 'Positive' and 'Negative' are averages of the 10 positive and 10 negative individual word scores, respectively. Words with '*' indicate a difference between 'hungry' and 'not hungry' of $p < 0.10$, and '**' indicates $p < 0.05$.

3.6.7 Importance of novelty for conditioning

Conditioning happens much more readily when the conditioned stimuli are novel, and thus have no existing associations or expectations. Cacioppo, Marshall-Goodell, Tassinary, & Petty (1992) examined the efficacy of conditioning with familiar (common English words, e.g. 'stream') compared to novel (nonsense words, e.g. 'tasmer') conditioned stimuli. They used a mild electric shock as the unconditioned stimulus (so they were conditioning to a negative state). Participants were in one of two treatment groups: 1) familiar word + shock, novel word + no shock; 2) familiar word + no shock, novel word + shock. Both groups were exposed to familiar words eight times and novel words eight times. Participants rated liking of each word before and after the conditioning procedure (from 1 = very pleasant to 9 = very unpleasant). In both treatment groups, pleasantness ratings of the words conditioned to the electric shock were lower than the pleasantness ratings of the words not paired with the electric shock. Novel words were rated less pleasant than familiar words when either were conditioned to an electric shock, indicating that conditioning was more successful for the novel words compared to the familiar words. Similar results were obtained by Kuenzel et al. (2010), in that they were unable to condition familiar beverages to a positive emotional state. Their participants consumed black tea while watching film clips meant to elicit ‘joy’, ‘contentment’ or no emotion (neutral) in three conditioning sessions. They rated liking of the tea and ‘activity’ (an implicit measure in which a high score indicates high activity or ‘joy’ and a low score indicates low activity or ‘contentment’). Neither liking ratings nor activity scores were different among the ‘joy’, ‘contentment’, or neutral emotional states. They had more success conditioning novel flavored beverages to a positive emotional state, as described in **section 3.2.3** (Kuenzel, Blanchette, et al., 2011).

Although, to the best of our abilities, we used test foods that were novel to the participants, it is possible that some participants’ test foods elicited some form of prior associations, which may have made conditioning more difficult. As the study progressed, the participants may have figured out what their test food was or possibly they were reminded of another food at some point. The vegetables used as our *Low-Calorie* stimuli, rutabaga and jicama, were unfamiliar, but they have some similarities to other raw vegetables. Rutabaga has a crunchy texture, not unlike carrots, and a cruciferous flavor, not unlike broccoli or cabbage. Jicama is similar to an apple or raw potato. During the initial taste test session, participants indicated of what each food reminded them. Six participants correctly identified rutabaga, and 23 correctly identified jicama, but in both cases the remaining participants identified them as other vegetables. The *High-Calorie* halvah and mochi were more unique. Only four participants correctly identified halvah, otherwise it was most commonly compared to a peanut candy bar filling. Twelve participants correctly identified mochi, or at least indicated that it contained red bean paste. The mochi also elicited comparisons to fig cookies and gummy bears, but these descriptions were less common and less accurate than those of the vegetables. We did not observe any notable differences in conditioning effects of the vegetables versus the high-calorie foods, but because of our failed conditioning procedure, it is not clear whether those participants receiving the vegetables as test foods had greater prior expectations than those receiving halvah or mochi.

3.6.8 Low-Calorie vs. High-Calorie foods

The differential effects of high-calorie vs. low-calorie foods on mood that have been demonstrated by other researchers (see Dubé et al., 2005; LeBel, Lu, & Dubé, 2008; Macht & Dettmer, 2006; Macht et al., 2003) were not observed in our experiment. We measured explicit positive and negative affect both before and after test food consumption on TEST-DAY and TEST-WEEK, which allowed us to determine whether mood changed as a direct result of eating the food. Neither explicit positive affect nor explicit negative affect changed from pre- to post-consumption for either High-Calorie or Low-Calorie test foods on TEST-DAY or TEST-WEEK (**Figure 3.13**)[3]. We saw a trend, however, for *High-Calorie* foods to be associated with higher positive affect compared to *Low-Calorie* foods, and for *Low-Calorie* foods to be associated with higher negative affect compared to *High-Calorie* foods (**Figure 3.13**). These emotional associations may be reflective of learned post-ingestive effects, as we postulated in **section 3.2.2**. Other studies have shown that high-calorie foods tend to decrease negative mood while low-calorie foods tend to increase positive mood (Dubé et al., 2005; LeBel et al., 2008). In both the Dubé et al. (2005) and LeBel et al. (2008) studies, participants completed a survey in which they identified their favorite comfort foods. They were then asked to remember instances in which they ate that food, and to rate what their emotional state had

[3] Although Figure 3.13 shows a trend for the *High-Calorie* foods to be associated with higher positive affect and the *Low-Calorie* foods with higher negative affect, we are concerned here with the changes in emotions from before to after consumption (from PRE to POST) for each of the groups, and not the comparisons between *High-Calorie* and *Low-Calorie* foods.

been during the moments immediately before and after consumption. Emotions (happy, calm, relaxed, depressed, anxious, sad, and upset in both studies, plus joyful, nostalgic, and lonely in Dubé et al., 2005) were rated on 7-point scales from 1 = not at all to 7 = very intensely. In both studies, approximately 65% of participants identified high-calorie and 35% identified low-calorie foods as their favorite comfort foods. Both high-calorie and low-calorie foods were found to decrease negative affect by LeBel et al. (2008). Similarly, all food types decreased negative affect in Dubé et al. (2005), but some high-calorie foods were more effective at reducing negative affect than low-calorie foods. Dubé et al. (2005) found that low-calorie foods improved positive affect more than some high-calorie foods. LeBel et al. (2008) found that high-calorie foods increased positive affect for some of their participants, while low-calorie foods increased positive affect for others. We likely failed to observe meaningful differences in the emotional effects of consuming *High-Calorie* vs. *Low-Calorie* foods (i.e. changes in emotion ratings from pre- to post-consumption) because of our ineffective conditioning procedure.

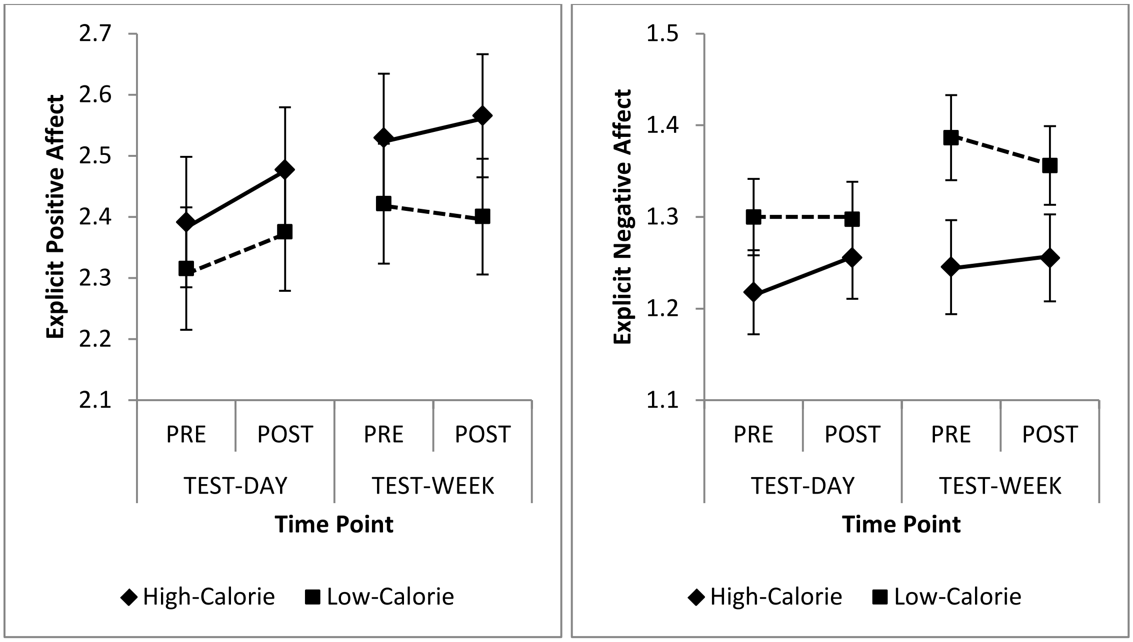


Figure 3.13 Explicit positive affect (left) and explicit negative affect (right) scores from PRE- and POST-consumption of the test food on TEST-DAY and TEST-WEEK. Solid lines link pre-consumption scores to post-consumption scores on each day for those in the *High-Calorie* groups. Dashed lines link pre-consumption scores to post-consumption scores on each day for those in the *Low-Calorie* groups. Error bars represent standard errors.

3.6.9 Future improvements

Improving our study methodology may increase the likelihood of successfully inducing positive emotional associations with novel foods. The failure of our positive film clips to reliably induce a positive emotional state was one major limitation of this study. A better emotion-induction technique, perhaps using longer film clips or music selections may result in a more reliable and robust positive emotional state. An increase in the number of exposures to the unconditioned stimulus (i.e. film/food pairings) could also increase the likelihood of inducing positive emotional associations with a novel food. Since we observed a deterioration in mood while our participants were in the laboratory, it may also be beneficial to further explore the effect that participation in laboratory experiments has on emotional state. One possible solution could be to ask participants to perform some sort of mood-equilibration task before engaging in the experimental tasks.

3.6.10 Importance of this work

If positive emotional associations with food can be induced or changed, healthy foods, such as vegetables, could be turned into comfort foods, and contribute to people's physical and mental well-being. People could get the same mood-boosting benefit from low-calorie foods as they may get from their current, less-healthy comfort foods. Current methods for dietary counseling and weight loss focus on behavior change. It may be better to try and change emotional associations rather than behaviors themselves. People have cognitive beliefs about what they *should* be eating, but negative mood can override these and lead to comfort food consumption (Kiviniemi, Voss-Humke, & Seifert, 2007). When a person's emotional associations align with cognitive beliefs about vegetable consumption (i.e. that we should eat more vegetables because they are good for us), the emotional associations could act as a type of 'shorthand', allowing for faster decision making when it comes to food choice (based on the Behavioral Affective Associations Model described by Kiviniemi, Voss-Humke, & Seifert, (2007); see also Damasio (1994)). If someone's 'comfort' foods are healthy, conflict between cognition and emotion could be avoided, and food choices would become easier. The procedures used in our study, with further development and improvement, could potentially be used to help people develop healthier 'comfort' foods that could improve their physical and emotional health.

3.7 Conclusion

We were unsuccessful in our attempt to condition positive emotional responses with novel foods, likely because of our ineffective emotion-induction procedure. Because conditioning was unsuccessful, we also failed to observe differences in emotional associations with High-Calorie compared to Low-Calorie novel foods. We did, however, demonstrate an increase in liking for novel foods after seven exposures. We remain hopeful that positive emotional associations with novel foods can be induced in a laboratory setting if a more reliable method of positive mood induction is used.

Abbreviations:

ImpPos: implicit (IPANAT) positive affect score
ImpNeg: implicit (IPANAT) negative affect score
ΔExpPos: change in explicit (PANAS) positive affect (post – pre)
ΔExpNeg: change in explicit (PANAS) negative affect (post – pre)
BASELINE: initial taste test visit
TEST-DAY: first testing day, one day after the conditioning period
TEST-WEEK: second testing day, one week after the conditioning period

CHAPTER 4 GENERAL DISCUSSION

The experiments discussed in this thesis were designed to further the understanding of the complex relationships among food, eating, and emotions. We examined how food behaviors – choosing meal components and preparing a meal – affected emotional response in a stressful state, and whether emotional associations with novel foods could be induced in a laboratory setting. We began by noting that emotional associations with food stem from many sources, including post-ingestive effects, sensory properties, psychological associations, and contextual effects, and we also examined how different food/eating behaviors may affect these emotional associations.

The experiment in Chapter 2 tested whether choosing meal components and/or preparing a meal would affect the mood-enhancing abilities of food and eating. We found that during stress, not having a choice of meal ingredients resulted in greater relief of both stress and negative mood (anger, anxiety) compared to having a choice. Stress may likely sap mental resources generally used to make choices. Under stress, then, making choices becomes more stressful, whereas when not under stress, choice may provide one with a positive sense of autonomy and control. Preparing a meal was not much better at relieving stress and negative mood than not preparing a meal. Ratings of ‘self-consciousness’ decreased more after eating for those who did not prepare their meal compared to those who prepared their meal. Our food preparation manipulation, in which participants simply mixed ingredients into a bowl of pasta and microwaved it, may not have been considered ‘cooking’ by many participants, and therefore may not have elicited the mood-boosting effects of cooking. The effects of food preparation on stress and mood are likely highly individual. Some people enjoy cooking and find it relaxing, while others do not like cooking.

The experiment in Chapter 3 was based on the premise that psychological associations are the main drivers of the emotional response to foods. Although we did not successfully induce emotional associations via conditioning with film clips, we showed that liking increased over repeated exposure to the novel foods, which may also be indicative of a positive emotional response. Increased liking ratings of the novel foods were positively correlated with positive emotional response. Further comparisons between ‘likers’ and ‘non-likers’ of the novel foods revealed that liker status was more associated with emotional response than either film type or calorie level. ‘Likers’ exhibited greater positive emotion ratings than ‘non-likers’ in response to the novel foods. The observed increases in liking due to repeated exposure were likely the result of a combination of many associations with the novel foods, including sensory properties, post-ingestive effects, emotional responses, etc. All of these associations built up over repeated exposures, resulting in the development of expectations about the food. When these expectations were good (as for the ‘likers’), the food was liked and elicited a positive emotional response.

After we discovered that liking ratings of the novel foods were correlated with positive emotions in the film study ($r = 0.32$, $p < 0.0001$) (Chapter 3), we looked back at the stress study (Chapter 2) and found that similarly, liking ratings of the pasta meal correlated with positive emotions. Responses to the question, “Overall, how much did you enjoy the food you just ate?” (rated from 0 = not at all to 100 = very much) served as liking ratings for the pasta meal. These ‘overall enjoyment’ ratings were positively correlated with post-meal ‘positivity’ (**Table 2.2**) ratings ($r = 0.30$, $p = 0.001$). ‘Overall enjoyment’ ratings were negatively correlated with post-meal ‘anger’ ratings ($r = -0.20$, $p = 0.03$) but none of the other negative mood measures. The results from both studies provide more evidence that positive emotional responses to food are related to liking ratings.

Although we learned valuable information about food and emotions, our research uncovered more questions about this complex topic than it answered. The emotional response to a food may not solely be due to the properties of the food itself, but also to expectations, thoughts, and memories associated with the food. Perhaps the emotional responses elicited by choosing and preparing foods are also the result of expectations, thoughts, and memories. Do we choose certain foods because we expect them to elicit certain emotions? Do the negative emotions experienced during stress contribute to depletion of mental resources, rendering choice detrimental during stress, as we saw in Chapter 2? Do we prepare food in order to elicit memories of prior positive preparation experiences? During food preparation, do we also anticipate the positive emotional effects that consumption of the food will elicit? Or do we anticipate the positive emotional effects of sharing that food with others? Do we use food choice and/or preparation to create a specific emotion-eliciting milieu? Maybe food preparation does something entirely different, at least for some people (e.g. relaxation). What exactly is the relationship between liking and positive emotions? Can we learn more about the role social relationships play in the elicitation of food-related emotions? These questions provide many opportunities for further exploration in the world of food and emotion.

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APPENDIX A: MATERIALS FROM CHAPTER 2

A1 Screening Questionnaire

Hello!

We are recruiting people to participate in a study on feelings, moods, emotions, and food.

Participants will attend a single session of about 1 hour 45 minutes. During this session you will complete a variety of cognitive tasks, complete several questionnaires, and eat and evaluate a pasta meal. The session will be held in McNeal Hall on the St. Paul Campus. We will pay you $20.00 after completing the session.

If you are interested in taking part in this study, please answer the questions below and return to: osdo0001@umn.edu. Your information will be evaluated to see if you qualify to be part of the study. We will contact you if you qualify to schedule your session. Sessions will take place between now and the end of Summer 2012.
You may choose not to participate, even if you have qualified.

Please provide the following information about yourself. All information you provide is strictly confidential.

Do you have any food allergies or food sensitivities (e.g. lactose intolerance, gluten sensitivity, etc.)?
___ Yes
___ No

Are you:

___Male
___Female

If you are female:

___ Yes ___No Are you currently pregnant?
___ Yes ___No Are you currently taking hormonal contraceptives? (i.e. birth control pill, NuvaRing, etc.)

Everyone:

___ Yes ___No Are you currently taking anti-depressants?
___ Yes ___No Are you currently taking steroid medications?
___ Yes ___No Are you a regular tobacco user?

___What is your age?

Please make an X next to the times you are available during a typical week this summer:

Monday
___ 4:30 – 6:30 pm
___ 4:45 – 6:45 pm
___ 6:15 – 8:15 pm
___ 6:30 – 8:30 pm

Tuesday
___ 4:30 – 6:30 pm
___ 4:45 – 6:45 pm
___ 6:15 – 8:15 pm
___ 6:30 – 8:30 pm

Wednesday
___ 4:30 – 6:30 pm
___ 4:45 – 6:45 pm
___ 6:15 – 8:15 pm
___ 6:30 – 8:30 pm

Thursday
___ 4:30 – 6:30 pm
___ 4:45 – 6:45 pm
___ 6:15 – 8:15 pm
___ 6:30 – 8:30 pm

Because we will provide you with a meal as part of this study, we need to know which of the following foods you are willing to eat, and how much you like them.

For each food, indicate whether you are willing to eat it, and then rate each food using a number from the scale below:

1	2	3	4	5	6	7	8	9
Dislike extremely				Neither like nor dislike				Like extremely

Pasta (e.g. penne, elbow macaroni, etc.)
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Sun-dried tomatoes
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Black olives (e.g. Kalamata)
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Canned mushrooms
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Canned green chilies
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Tomato based sauce (e.g. Marinara)
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

White pasta sauce (e.g. Alfredo)
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Parmesan cheese
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Dried basil
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

Black pepper
____Check here if you are willing to eat this food.
____Liking rating (using the above scale from 1 to 9).

If you have any questions about the study, please respond to **osdo0001@umn.edu**.

Thank you!

A2 Experimenter Script (all treatments)

Time	Experimenter
4:30	"Hi! Welcome to the mental abilities and food study! Please put all your stuff, including your cell phone, over here (point to corner of lab). Also, please put your phone on silent. If you have gum, please spit it out in the garbage can. Please sit here" (Experimenter will close door, and guide subject to a chair with a computer on the table in front of it.) "I will be reading off a script to make sure that I say the same things to each person participating in the study." "Please read through this consent form and sign it. While you are here, you will be performing mental abilities tasks and eating a pasta meal. You will be here for about an hour and 45 minutes (point to 'procedures' part of consent form). You will answer some questions about your moods and feelings, which are a personal topic. All of your answers will be anonymous. (point to 'risks and benefits' part of consent form) You will receive $20 at the end of the study today. You will be compensated even if you choose to discontinue participation at any time or leave any questions unanswered. (point to 'compensation' part of consent form) Do you have any questions?" (Experimenter also signs consent form) "Do you have any food allergies?" (If they say yes, ask them what they are allergic to) "Come over here, and I'll show you what you will need to do a little later in the study." (Take consent form, and then bring subject over to food prep area) <u>Choice/Prepare:</u> "I will bring you over here a little later. You will be preparing a pasta dish, and then eating it. You will fill out a menu where you get to choose the ingredients for your pasta. I will also give you an instruction sheet. Your ingredients will be laid out here, and you will add them to the bowl of pasta and stir. Then, you will microwave it for two minutes. Put the bowl in the microwave, enter the numbers 2, 0, 0, and push START. When the timer goes off, take the bowl out of the microwave, stir with the spatula, and dump the pasta onto this plate. Then, go sit over there (point to table) and eat the pasta. Do you have any questions?" <u>Choice/No Prepare:</u> "I will bring you over here a little later. I will be preparing a pasta dish for you to eat. You will fill out a menu where you get to choose the ingredients for your pasta. I will add the ingredients, microwave it, and serve it to you on a plate. Then, you will sit over there (point to table) and eat the pasta. Do you have any questions?" <u>No Choice/Prepare:</u> "I will bring you over here a little later. You will be preparing a pasta dish, and then eating it. You will receive a list of ingredients that you will need to add to your pasta. I will also give you an instruction sheet. Your ingredients will be laid out here, and you will add all of them to the bowl of pasta and stir. Then, you will microwave it for two minutes. Put the bowl in the microwave, enter the numbers 2, 0, 0, and push START. When the timer goes off, take the bowl out of the microwave, stir with the spatula, and dump the pasta onto this plate. Then, go sit over there (point to table) and eat the pasta. Do you have any questions?" <u>No Choice/No Prepare:</u> "I will bring you over here a little later. I will be preparing a pasta dish for you to eat. You will receive a list of ingredients that will be added to your pasta. I will add the ingredients, microwave it, and serve it to you on a plate. Then, you will sit over there (point to table) and eat the pasta. Do you have any questions?"

	"Okay, let's sit back down." (Take subject back to table) "Now I am going to attach this blood pressure cuff to your arm. Are you right-handed or left-handed? (attach cuff to non-dominant arm) I will be taking blood pressure measurements periodically. Please put your feet flat on the floor, and don't talk during the measurement. (make sure their feet are flat on the floor, and their arm is supported by the table) Whenever I take one I'll just be pressing this button, the cuff will inflate, the machine will give a number and I will be writing it down. I will do one now so you can see how it feels." (Take one reading here, to show them) "Most of the time, I will be taking two measurements in a row. I will also need four saliva samples. Let's practice one now. (take the cap off the tube for them, hand them the tube with the cotton pad in it.) **Slide the cotton pad into your mouth, and place it under your tongue. Leave it there for about 2 minutes, until it is saturated with saliva, then spit it back into the tube. Thanks."**
4:35	(Enter subject number into survey and push the next page button) "You will be using this computer program to guide you through the study. Please start answering the questions, and push the next page button when you get to the end of a page. Please read all instructions carefully, and do one page at a time. You can't go back a page once you've hit the next button. If you get to a page with a stop sign, please stop there and sit quietly until I return. Before I leave do you have any questions? I will be back in about 20 minutes, but if you have questions, you can ring this bell. I will be just outside the door." (Experimenter then leaves and sets a timer for 20 minutes)
4:40	
4:45	
4:50	
4:55	"Okay, now I'm going to ask you for another saliva sample, and I am going to measure your blood pressure twice." (If subject has not finished all questionnaires, experimenter advances survey to the blood pressure page.) (Experimenter hands salivette to subject, measures blood pressure twice – make sure their feet are flat on the floor and arm is supported, records numbers in the survey, and advances survey to POMS) "Please take this next questionnaire. (wait for them to finish) Now you will have 5 minutes to prepare a speech. Pretend you are job applicant interviewing for a position in a company. You need to explain why you would be the perfect candidate for the position. The speech will be audio-recorded. Two people will come in here in 5 minutes to hear your speech and evaluate it. You can take some notes (hand them paper & pen) but you will not be able to use them while you are giving the speech."
5:00	
5:05	(Stressors wait 5 minutes, then enter the room, looking very serious, holding clipboards and wearing lab coats.) "Please stand up. You will need to deliver your speech into this microphone (hands mic to subject and plugs into computer). A voice frequency analysis will be done on the recording. This is my assistant. He/she has been specially trained to monitor nonverbal behavior. Now, introduce yourself and tell us why you would be the perfect candidate for this job. You must speak for 5 minutes." If they stop talking, prompt them with "You still have some time left, please continue." If they stop talking a second time, be quiet for 20 seconds and then ask one of the following questions: "Is there anything else you can add?"

5:10	"Can you be more specific…" "You must keep talking until the time is up." "Go on," "keep going," etc. After 5 min: "We are going to do a counting test today. Starting at 1022, I want you to count backwards by 13, all the way to 0. Start now." If they are confused, you can repeat the instructions. If the subject makes a mistake, say "Stop. 1022." At 1 min, say "Stop. Now start at 3259 and count backwards by 17." At 2 min, say "Stop. Now start at 711 and count backwards by 13." At 3 min, say "Stop. Now start at 1939 and count backwards by 17." At 4 min, say "Stop. Now start at 2771 and count backwards by 13." When the 5 min are up, say "That's all, goodbye."
5:15	(Second experimenter leaves, and first experimenter enters room.) "I am going to measure your blood pressure two more times." (Experimenter measures BP IMMEDIATELY – make sure their feet are flat on the floor and arm is supported, and records data in survey, unplugs the BP monitor, then advances survey to POMS.) "Please complete this questionnaire, and…" (wait for them to finish the POMS) Please say the following words exactly: <u>Choice</u>: **"Fill out this menu sheet. You get to choose one sauce, 3 inclusions, and 1 topping for your pasta. Whichever ones you want, it's up to you! Then we will go over there, and you will get to cook it yourself!"** <u>No Choice:</u> **"Look at this menu sheet. You have been assigned to eat a pasta dish with these specific ingredients. You don't get to choose. Then we will go over there, and you will get to cook it yourself!"**
5:20	(When they finish, experimenter guides subject to cooking station. Look at subject's menu sheet and take away ingredients they will not be using. Put them onto the tray, and take the tray with you when you leave) <u>Prepare</u>: "The instructions I gave you earlier are printed here. Do you have any questions? When you're finished cooking, please sit at the table, and eat as much as you wish. I will be back in about 15 minutes, but if you have questions you can ring this bell. I'll just be in the next room. If you finish early, please stay seated." <u>No Prepare:</u> "I will be preparing the pasta for you." (Add ingredients to bowl, stir, then place in the microwave, and microwave for 2 minutes. Stir again, dump pasta onto plate, and give to subject.) "Please sit at the table, and eat as much as you wish. I will be back in about 10 minutes, but if you have questions you can ring this bell. I'll just be in the next room. If you finish early, please stay seated." (Experimenter then leaves the room to let the subject eat. Experimenter sets timer for 15 minutes.)
5:25	
5:30	
5:35	
5:40	(Take plate away and put on counter) "Okay, now I'm going to ask you for another saliva sample, and I am going to measure your blood pressure twice. Will you please rinse your mouth with water to make sure all the food is gone?" (Make sure subject has rinsed mouth with water to remove all food) (Experimenter hands salivette to subject, plugs BP monitor

	in, measures blood pressure twice – make sure their feet are flat on the floor and arm is supported, records numbers in the survey, and advances survey to POMS) "Please take the following questionnaires. I will be back in about 30 minutes. If you have questions, ring the bell. I'll just be in the next room." (Experimenter then leaves and sets timer for 30 minutes.)
5:45	
5:50	
5:55	
6:00	
6:05	
6:10	(Bring comics, ballot, receipt/payment, and food basket) "I need one last saliva sample, and I am going to measure your blood pressure twice." (If subject has not finished all questionnaires, experimenter advances survey to the blood pressure page.) (Experimenter hands salivette to subject, measures blood pressure twice – make sure their feet are flat on the floor and arm is supported, records numbers in the survey, and advances survey to POMS) "Please take this questionnaire."
6:15	(When they are finished, take off BP monitor) "The last thing I need you to do is look at these cartoons and rate how funny they are." (When they are finished, have payment ready.) "What did you think about this study? Do you think that the tasks you did meant what we said they were going to, or did they mean something else? Had you heard anything about this study before you came here today? The point of the backwards-counting task was to induce stress. We measured this stress by taking your blood pressure, and we will also analyze your saliva samples for a hormone that is an indicator of stress. Some of those questionnaires also measured stress, and some of them were just to pass time. The act of preparing and eating the pasta was meant to reduce stress. Do you feel like your stress level has returned to normal? Do you have any other questions? This study is part of a project that is researching ways to reduce the stress that astronauts encounter while they are in space. Let me introduce you to ______." (introduce subject to stressors) Stressors say, "Nice to meet you. Sorry I had to be so cold during the experiment. I had to do that as part of the study." Other experimenter says, "Here is your payment. Please sign the receipt saying you have received it. Thank you for participating in our study. Please take some more food on your way out." (Experimenter should jot down subjects' comments & questions, and be sure to keep the receipt)
6:20	(At this point, the experimenter weighs the leftover ingredients and leftover pasta + bowl, and records the weights.)

A3 Instruction Sheet

Instructions:

1. Add all of the ingredients to the big bowl of pasta.
2. Stir well with the spatula.
3. Place bowl in microwave, press the numbers 2, 0, 0, and then push START.
4. When timer beeps, take bowl out of microwave, and stir well.
5. Dump pasta onto plate.
6. Take plate to table, sit down, and start eating!
7. Eat as much as you like.

Questions? Ring the bell, and someone will come in to help you.

A4 Menu Sheet

Heading for Choice groups: “Create your own pasta! Tell us what you want!”

Heading for No Choice groups: “Food Study – Pasta. This is what you’ll be eating.”

Please choose one of the sauces:

_____ Tomato Sauce (red)

_____ Alfredo Sauce (white)

Please choose up to 3 of the inclusions:

_____ Kalamata Olives (black)

_____ Mushrooms

_____ Sun-dried Tomatoes

_____ Green Chilies

Please choose one of the toppings:

_____ Parmesan Cheese

_____ Black Pepper

_____ Dried Basil

A5 Trier Social Stress Task

(adapted from Kirschbaum et al., 1993)

Arithmetic section

"We are going to do a counting test today. Starting at 1022, I want you to count backwards by 13, all the way to 0. Start now." If they are confused, you can repeat the instructions. Monitor the clock (you can record start time) and stop them after 5 minutes. If the subject makes a mistake, say "Stop. 1022." At 1 min, say "Stop. Now start at 3259 and count backwards by 17." At 2 min, say "Stop. Now start at 711 and count backwards by 13." At 3 min, say "Stop. Now start at 1939 and count backwards by 17." At 4 min, say "Stop. Now start at 2771 and count backwards by 13." When the 5 min are up, say "That's all, goodbye."

Starting at 1022, count backward by 13:	Starting at 3259, count backward by 17:	Starting at 711, count backward by 13	Starting at 1939, count backward by 17:	Starting at 2771, count backward by 13:
1022	3259	711	1939	2771
1009	3242	698	1922	2758
996	3225	685	1905	2745
983	3208	672	1888	2732
970	3191	659	1871	2719
957	3174	646	1854	2706
944	3157	633	1837	2693
931	3140	620	1820	2680
918	3123	607	1803	2667
905	3106	594	1786	2654
892	3089	581	1769	2641
879	3072	568	1752	2628
866	3055	555	1735	2615
853	3038	542	1718	2602
840	3021	529	1701	2589
827	3004	516	1684	2576
814	2987	503	1667	2563
801	2970	490	1650	2550
788	2953	477	1633	2537
775	2936	464	1616	2524
762	2919	451	1599	2511
749	2902	438	1582	2498
736	2885	425	1565	2485
723	2868	412	1548	2472
710	2851	399	1531	2459

A6 Food Weights Record Sheet

Participant #:________________________ Date/Time:_________________________

Treatment:_________________________

Experimenter:_______________________ Stressor:____________________________

	Ingredient	Initial Weight	Final Weight	Change (Initial – Final)	Mult. by % in 16
1	Alfredo Sauce				
2	Marinara Sauce				
3	Olives				
4	Sun-dried Tomatoes				
5	Mushrooms				
6	Green Chilies				
7	Parmesan Cheese				
8	Basil				
9	Black Pepper				
10	Pasta				
				Weight	
11	**Total Amount Served (total lines 1 – 10)**				
12	**Leftover pasta**				
13	**Total amount eaten (11 – 12)**				
14	**Percent eaten (13/11 * 100)**				

Please rate the subject on how well they performed the Trier Stress Task. "Very Good" means they got at least halfway down the list of numbers for most columns. "Very Bad" means they only got 1 or 2 numbers for each column.

	1. Very Bad	2. Bad	3. Neither Good nor Bad	4. Good	5. Very Good
How well did the subject do on the Trier Stress Task?	❍	❍	❍	❍	❍

A7 Qualtrics Questionnaire

Please enter subject ID number:

Do you have any food allergies?

- ❍ Yes
- ❍ No

How much time has passed since you last ate?

The last time you ate, what did you have to eat?

How many days ago did you last eat pasta?

Generally, how many times per month do you eat pasta?

Have you consumed caffeine in the last 3 hours?

- ❍ Yes
- ❍ No

Have you consumed alcohol in the last 3 hours?

- ❍ Yes
- ❍ No

Have you exercised in the last 3 hours?

- ❍ Yes
- ❍ No

If No Is Selected, Then Skip To Have you had any tobacco products in ...

What kind of exercise did you do?

For how long did you exercise?

Have you had any tobacco products in the last 3 hours?

- ❍ Yes
- ❍ No

What is your gender?

- ❍ Male
- ❍ Female

If Male Is Selected, Then Skip To Based on your feelings RIGHT NOW, Are you currently pregnant?

- ❍ Yes
- ❍ No

Are you currently taking hormonal contraceptives (i.e. birth control pill, NuvaRing, etc.)?

- ❍ Yes
- ❍ No

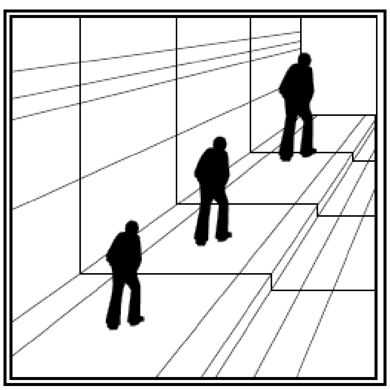
When was the first day of your last period?

Based on your feelings RIGHT NOW, on a scale from 0 to 100, with 0 being ‘None’ and 100 being ‘Greatest possible amount’:

______ Rate the amount of food you desire.

______ Rate the amount of food you could eat.

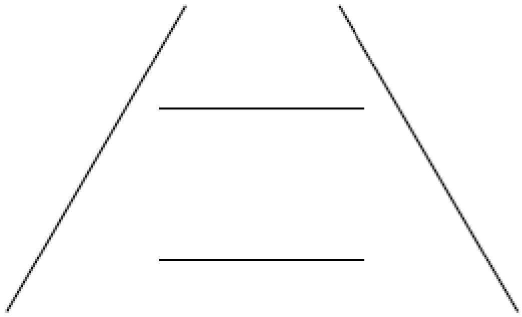
Arnett Inventory of Sensation Seeking (Arnett, 1994)



Which figure in the picture above is the largest?

- ❍ Left
- ❍ Center
- ❍ Right

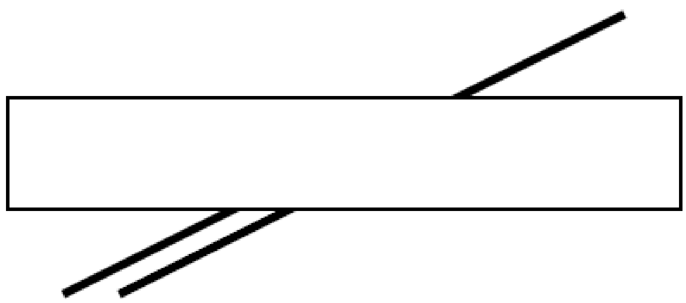
Internal vs. External Locus of Control Scale (Rotter, 1966)



Which one of the two horizontal lines is longer?

- ❍ Top
- ❍ Bottom

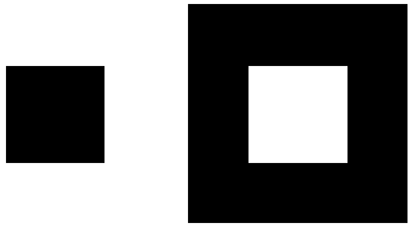
Maximizing vs. Satisficing Scale (Schwartz et al., 2002)



Which one of the lines below the rectangle is a direct continuation of the line above the rectangle?

- ❍ The one on the left
- ❍ The one on the right

Perceived Stress Scale (Cohen et al., 1983)



Which square is larger?

- ❍ Small black square on white background (left)
- ❍ Small white square on black background (right)

Sensation Seeking Scale (Zuckerman et al., 1964)

Please wait quietly until the experimenter provides further instructions.

Reading 1

Systolic
Diastolic
Heart Rate

Reading 2

Systolic
Diastolic
Heart Rate

**Profile of Mood States* (adapted from McNair et al., 1971) *BASELINE*

Please wait quietly until the experimenter provides further instructions.

Reading 1

Systolic
Diastolic
Heart Rate

Reading 2

Systolic
Diastolic
Heart Rate

Profile of Mood States POST-STRESS

Please wait quietly until the experimenter provides further instructions.

Reading 1

Systolic
Diastolic
Heart Rate

Reading 2

Systolic
Diastolic
Heart Rate

Profile of Mood States POST-MEAL

On a scale from 0 to 100, with 0 being ‘Dislike Extremely’, and 100 being ‘Like Extremely’, please rate your liking of the foods you just ate. If you did not eat the food, write ‘N/A’.

______ Pasta

______ Alfredo Sauce (white)

______ Marinara Sauce (red)

______ Olives

______ Sun-dried Tomatoes

______ Mushrooms

______ Green Chilies

______ Parmesan Cheese

______ Basil

______ Black Pepper

On a scale from 0 to 100, with 0 being ‘Not at all’ and 100 being ‘Very much’, please answer the following questions:

______ Overall, how much did you enjoy the food you just ate?

______ How much desire do you have to continue eating more of this food right now?

______ How much would you like to eat this same food again tomorrow?

On a scale from 0 to 100, with 0 being ‘Dislike Extremely’, and 100 being ‘Like Extremely’, please answer the following question. If you did not get to choose your ingredients, write ‘N/A’.

______ How well did you like being able to choose the ingredients in your pasta today?

Based on your feelings RIGHT NOW, on a scale from 0 to 100, with 0 being ‘None’ and 100 being ‘Greatest possible amount’:

______ Rate the amount of food you desire.

______ Rate the amount of food you could eat.

On a scale from 0 to 100, with 0 being 'Strongly Disagree' and 100 being 'Strongly Agree', please indicate how well you agree with the following statements regarding the meal you just ate:

______ I enjoyed cooking/preparing my pasta dish. *(This question was only seen by those in the Prepare groups)*

______ I felt like I was really cooking. *(This question was only seen by those in the Prepare groups)*

______ I felt like I was in control of the preparation of my meal.

______ I felt like I was in control of the ingredients in my meal.

On a scale from 0 to 100, with 0 being 'Very Easy' and 100 being 'Very Difficult', please answer the following question:

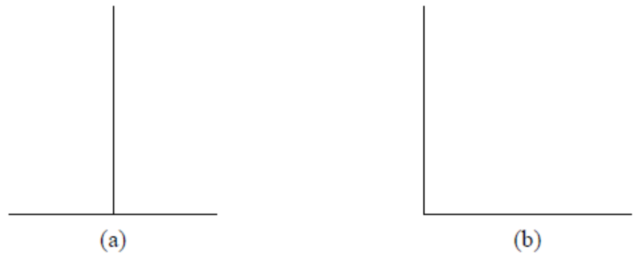
______ How difficult was it to prepare the pasta dish? *(This question was only seen by those in the Prepare groups)*

On a scale from 0 to 100, with 0 being 'Dislike Extremely' and 100 being 'Like Extremely', please answer the following question:

______ In general, how much do you enjoy cooking/ preparing food?

In general, how many hours per week do you spend cooking/preparing food?

Personal Need for Structure Scale (Neuberg & Newsom, 1993)



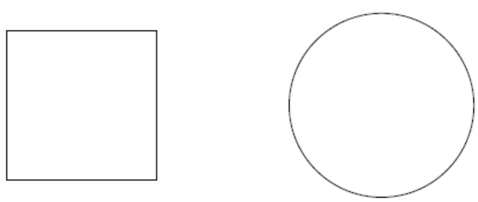
In figure (a), which line is longer?

❍ Vertical
❍ Horizontal

In figure (b), which line is longer?

❍ Vertical
❍ Horizontal

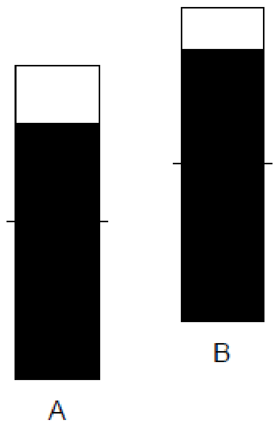
Eating Self-Efficacy Scale (Glynn & Ruderman, 1986)



Which figure has the larger area?

❍ Square
❍ Circle

Self-Control Scale (Tangney et al., 2004)

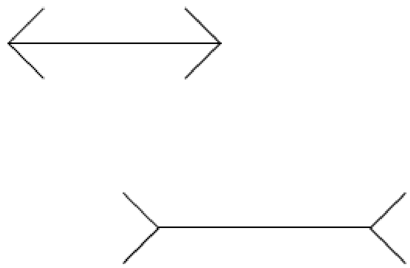


Which bar is longer?

- O A
- O B
- O Both are the same length
- O

Variety Seeking Scale (VARSEEK) (Van Trijp et al., 1992)

Three Factor Eating Questionnaire (factors 1 & 2) (Stunkard & Messick, 1985)



Which one of the two horizontal lines is longer?

❍ Top
❍ Bottom

Self-Esteem Scale (Rosenberg, 1965)

Life Orientation (Optimism) Scale (Scheier et al., 1994)

Restrained Eating Scale (Polivy et al., 1978)

Optimum Stimulation Level Scale (Raju, 1980)

Boredom Proneness Scale (Farmer & Sundber, 1986)

Dutch Eating Behavior Questionnaire (external and restrained eating subscales) (van Strien et al., 1986)

For the following statements, please make a liking rating on a scale that ranges from 'Dislike Extremely' to 'Like Extremely.' Please make your ratings based on how you felt right after eating the pasta meal.

______ Rate your overall liking of the food you last ate

______ Rate your liking of the appearance of the food you last ate

______ Rate your liking of the odor of the food you last ate

______ Rate your liking of the flavor of the food you last ate

______ Rate your liking of the texture of the food you last ate

Please wait quietly until the experimenter provides further instructions.

Reading 1

Systolic
Diastolic
Heart Rate

Reading 2

Systolic
Diastolic
Heart Rate

Profile of Mood States FINAL

Based on your feelings RIGHT NOW, on a scale from 0 to 100, with 0 being 'None' and 100 being 'Greatest possible amount':

______ Rate the amount of food you desire.

______ Rate the amount of food you could eat.

Please wait quietly until the experimenter provides further instructions.

A8 Mood Questionnaire

Adapted from the Profile of Mood States (McNair et al., 1971)

<u>Instructions</u>: Using the scale below, please indicate the extent to which you are experiencing these moods RIGHT NOW:

1 2 3 4 5 6 7
Not at all Extremely

___ Anxious	___ On edge	___ Uneasy
___ Threatened	___ Sad	___ Cheerful
___ Content	___ Embarrassed	___ Exhausted
___ Worn out	___ Fatigued	___ Intimidated
___ Annoyed	___ Vigorous	___ Calm
___ Self-conscious	___ Discouraged	___ Angry
___ Hopeless	___ Pressured	___ Resentful
___ Lively	___ Satisfied	___ Awkward

Note:
Scores were subjected to a principal components analysis that revealed five factors (**Section 2.4**). The score for each category is the average of the scores for all words in that category.

Anxiety: Anxious, Awkward, Discouraged, Embarrassed, Intimidated, On edge, Pressured, Self-conscious, Uneasy

Anger: Angry, Annoyed, Resentful, Threatened

Fatigue: Exhausted, Fatigued, Worn out

Positivity: Calm, Cheerful, Content, Lively, Satisfied

Sadness: Hopeless, Sad

‘Vigorous’ loaded below 0.5 on all of the factors. It was not included in the data analysis.

APPENDIX B: SAS CODE FROM CHAPTER 2

```
libname xxx'G:\FSCN\Vickers_Lab\Katie Osdoba\SAS files';

proc sort data=xxx.pcastress;
by choice prepare;
run;

/*Section 2.5, Table 2.2: Factor Analysis of POMS emotion words
using absolute values of post-stress minus baseline and post-meal
minus post-stress means*/
proc factor data=xxx.pcastress rotate=varimax;
var
absAnxiouspoststress
absonedgepoststress
absuneasypoststress
absthreatenedpoststress
abssadpoststress
abscheerfulpoststress
abscontentpoststress
absembarrassedpoststress
absexhaustedpoststress
abswornoutpoststress
absfatiguedpoststress
absintimidatedpoststress
absannoyedpoststress
absvigorouspoststress
abscalmpoststress
absselfconsciouspoststress
absdiscouragedpoststress
absangrypoststress
abshopelesspoststress
abspressuredpoststress
absresentfulpoststress
abslivelypoststress
abssatisfiedpoststress
absawkwardpoststress
;run;
/*Section 2.5: Cronbach's alphas for new factors*/
/*Anxiety*/
proc corr data=xxx.pcastress alpha nomiss;
var absAnxiouspoststress
absonedgepoststress
absuneasypoststress
absawkwardpoststress
absdiscouragedpoststress
absembarrassedpoststress
absintimidatedpoststress
```

```
absselfconsciouspoststress
abspressuredpoststress
absanxiouspostmeal
absonedgepostmeal
absuneasypostmeal
absawkwardpostmeal
absdiscouragedpostmeal
absembarrassedpostmeal
absintimidatedpostmeal
absselfconsciouspostmeal
abspressuredpostmeal;
run;

/*Anger*/
proc corr data=xxx.pcastress alpha nomiss;
var absannoyedpoststress
absangrypoststress
absresentfulpoststress
absthreatenedpoststress
absannoyedpostmeal
absangrypostmeal
absresentfulpostmeal
absthreatenedpostmeal;
run;

/*Fatigue*/
proc corr data=xxx.pcastress alpha nomiss;
var absexhaustedpoststress
abswornoutpoststress
absfatiguedpoststress
absexhaustedpostmeal
abswornoutpostmeal
absfatiguedpostmeal ;
run;

/*Positivity*/
proc corr data=xxx.pcastress alpha nomiss;
var abscheerfulpoststress
abscontentpoststress
abscalmpoststress
abslivelypoststress
abssatisfiedpoststress
abscheerfulpostmeal
abscontentpostmeal
abscalmpostmeal
abslivelypostmeal
abssatisfiedpostmeal ;
run;
```

```
/*Sadness*/
proc corr data=xxx.pcastress alpha nomiss;
var abssadpoststress
abshopelesspoststress
abssadpostmeal
abshopelesspostmeal;
run;

/*Section 2.5, Table 2.4, Figure 2.3: Means at each time point for
each treatment group (Choice/Prepare, Choice/No Prepare, No
Choice/Prepare, No Choice/No Prepare). */

proc means data=xxx.pcastress;
by choice prepare;
var Baseline_Systolic_Average    = average systolic blood
                                   pressure at baseline
Baseline_Diastolic_Average       = average diastolic blood
                                   pressure at baseline
Baseline_HR_Average              = average heart rate at baseline
BASELINESTRESS                   = 'stress' rating at baseline
BASELINEANGER                    = 'anger' rating at baseline
BASELINEFATIGUE                  = 'fatigue' rating at baseline
BASELINEPOSITIVE                 = 'positivity' rating at
                                   baseline
BASELINESAD                      = 'sadness' rating at baseline
NEWSTRESSpoststress              = 'stress' rating post-stress
NEWANGERpoststress               = 'anger' rating post-stress
NEWFATIGUEpoststress             = 'fatigue' rating post-stress
NEWPOSITIVEpoststress            = 'positivity' rating post-
                                   stress
NEWSADpoststress                 = 'sadness' rating post-stress
Post_stress_systolic_average     = average systolic blood
                                   pressure post-stress
Post_stress_diastolic_average    = average diastolic blood
                                   pressure post-stress
Post_stress_HR_average           = average heart rate post-stress
NEWSTRESSpostmeal                = 'stress' rating post-meal
NEWANGERpostmeal                 = 'anger' rating post-meal
NEWFATIGUEpostmeal               = 'fatigue' rating post-meal
NEWPOSITIVEpostmeal              = 'positivity' rating post-meal
NEWSADpostmeal                   = 'sadness' rating post-meal
Post_meal_systolic_average       = average systolic blood
                                   pressure post-meal
Post_meal_diastolic_average      = average diastolic blood
                                   pressure post-meal
Post_meal_HR_average             = average heart rate post-meal
Base_Cortisol                    = baseline cortisol
Post_str_cortisol                = post-stress cortisol
Post_ml_cortisol                 = post-meal cortisol
;
```

```
output out=meansnewfactors mean=
Baseline_Systolic_Average
Baseline_Diastolic_Average
Baseline_HR_Average
BASELINESTRESS
BASELINEANGER
BASELINEFATIGUE
BASELINEPOSITIVE
BASELINESAD
NEWSTRESSpoststress
NEWANGERpoststress
NEWFATIGUEpoststress
NEWPOSITIVEpoststress
NEWSADpoststress
Post_stress_systolic_average
Post_stress_diastolic_average
Post_stress_HR_average
NEWSTRESSpostmeal
NEWANGERpostmeal
NEWFATIGUEpostmeal
NEWPOSITIVEpostmeal
NEWSADpostmeal
Post_meal_systolic_average
Post_meal_diastolic_average
Post_meal_HR_average
Base_Cortisol
Post_str_cortisol
Post_ml_cortisol
stderr=
sBaseline_Systolic_Average
sBaseline_Diastolic_Average
sBaseline_HR_Average
sBASELINESTRESS
sBASELINEANGER
sBASELINEFATIGUE
sBASELINEPOSITIVE
sBASELINESAD
sNEWSTRESSpoststress
sNEWANGERpoststress
sNEWFATIGUEpoststress
sNEWPOSITIVEpoststress
sNEWSADpoststress
sPost_stress_systolic_average
sPost_stress_diastolic_average
sPost_stress_HR_average
sNEWSTRESSpostmeal
sNEWANGERpostmeal
sNEWFATIGUEpostmeal
sNEWPOSITIVEpostmeal
```

```
sNEWSADpostmeal
sPost_meal_systolic_average
sPost_meal_diastolic_average
sPost_meal_HR_average
sBase_Cortisol
sPost_str_cortisol
sPost_ml_cortisol ;
run;

/*Section 2.5, Table 2.5: t-tests to determine if stress and
negative mood increased after TSST (post-stress minus baseline)
and decreased after the meal (post-meal minus post-stress).*/
proc ttest data=xxx.pcastress H0=0;
var POSTSTRESSSTRESS                  = post-stress minus baseline
                                      'stress' rating
POSTSTRESSANGER                       = post-stress minus baseline
                                      'anger' rating
POSTSTRESSFATIGUE                     = post-stress minus baseline
                                      'fatigue' rating
POSTSTRESSPOSITIVE                    = post-stress minus baseline
                                      'positivity' rating
POSTSTRESSSAD                         = post-stress minus baseline
                                      'sadness' rating
Post_stress_minus_baseline_systo = post-stress minus baseline
                                      average systolic blood pressure
Post_stress_minus_baseline_diast = post-stress minus baseline
                                      average diastolic blood pressure
Post_stress_minus_baseline_HR    = post-stress minus baseline
                                      average heart rate
Cortisol_post_str_minus_base     = post-stress minus baseline
                                      cortisol
STRESSPOSTMEAL                        = post-meal minus post-stress
                                      'stress' rating
ANGERPOSTMEAL                         = post-meal minus post-stress
                                      'anger' rating
FATIGUEPOSTMEAL                       = post-meal minus post-stress
                                      'fatigue' rating
POSITIVEPOSTMEAL                      = post-meal minus post-stress
                                      'positivity' rating
SADPOSTMEAL                           = post-meal minus post-stress
                                      'sadness' rating
Systolic_post_meal_minus_post_st = post-meal minus post-stress
                                      average systolic blood pressure
Diastolic_post_meal_minus_post_s = post-meal minus post-stress
                                      average diastolic blood pressure
HR_post_meal_minus_post_stress   = post-meal minus post-stress
                                      average heart rate
Cortisol_post_ml_minus_post_str; = post-meal minus post-stress
run;                                  cortisol
```

```
/*Section 2.5: 2x2 ANOVA to determine if there were differences
in stress or mood among treatment groups at baseline (Choice:
Choice vs. No Choice; Prepare: Prepare vs. No Prepare)*/
proc glm data=xxx.pcastress;
class choice prepare;
model BASELINESTRESS
BASELINEANGER
BASELINEFATIGUE
BASELINEPOSITIVE
BASELINESAD
Baseline_Systolic_Average
Baseline_Diastolic_Average
Baseline_HR_Average
Base_Cortisol = choice prepare choice*prepare;
lsmeans choice prepare choice*prepare / pdiff=all adjust=tukey
stderr;
run;
quit;

/*Section 2.5: Table 2.6, Figure 2.6: 2x2 ANOVA to determine if there
were differences in post-stress minus baseline mood and stress
among treatment groups (Choice: Choice vs. No Choice; Prepare:
Prepare vs. No Prepare)*/
proc glm data=xxx.pcastress;
class choice prepare;
model POSTSTRESSSTRESS
POSTSTRESSANGER
POSTSTRESSFATIGUE
POSTSTRESSPOSITIVE
POSTSTRESSSAD
Post_stress_minus_baseline_systo
Post_stress_minus_baseline_diast
Post_stress_minus_baseline_HR
Cortisol_post_str_minus_base = choice prepare choice*prepare;
lsmeans choice prepare choice*prepare / pdiff=all adjust=tukey
stderr;
run;
quit;

/*Section 2.5: Table 2.7, Figure 2.4, Figure 2.5: 2x2 ANOVA to
determine if there were differences in stress reduction and mood
improvement among treatment groups after the meal (Choice: Choice
vs. No Choice; Prepare: Prepare vs. No Prepare)*/
proc glm data=xxx.pcastress;
class choice prepare;
model stresspostmeal
angerpostmeal
fatiguepostmeal
positivepostmeal
```

```
sadpostmeal
Systolic_post_meal_minus_post_st
Diastolic_post_meal_minus_post_s
HR_post_meal_minus_post_stress
Cortisol_post_ml_minus_post_str = choice prepare choice*prepare;
lsmeans choice prepare choice*prepare / pdiff=all adjust=tukey
stderr;
run;
quit;

/*Section 2.6.1, : Differences in TSST score (Trier_score) among
treatment groups (Choice: Choice vs. No Choice; Prepare: Prepare
vs. No Prepare)*/
proc glm data=xxx.pcastress;
class choice prepare;
model Trier_score = choice prepare choice*prepare;
lsmeans choice prepare choice*prepare / pdiff=all adjust=tukey
stderr;
run;
quit;

/*Section 2.6.1, Table 2.8: Correlations between TSST score
(Trier_score) and post-stress minus baseline responses.*/
proc corr data=xxx.pcastress;
var
POSTSTRESSSTRESS
POSTSTRESSANGER
POSTSTRESSFATIGUE
POSTSTRESSPOSITIVE
POSTSTRESSSAD
Post_stress_minus_baseline_systo
Post_stress_minus_baseline_diast
Post_stress_minus_baseline_HR
Cortisol_post_str_minus_base;
with Trier_score;
run;

/*Section 2.6.2: Correlations of cortisol changes with food
eaten*/
proc corr data=xxx.pcastress cov plots=matrix outp=julyfirst;
var Grams_food_eaten
Percent_food_eaten
kcals_eaten
Fat_percent
Carb_percent
Pro_percent ;
with Cortisol_post_str_minus_base
Cortisol_post_ml_minus_post_str;
run;
```

```
/*Section 2.6.3: 2x2 ANOVA to determine if 'overall enjoyment' of
the meal differed among treatment groups (Choice: Choice vs. No
Choice; Prepare: Prepare vs. No Prepare)*/
proc glm data=xxx.pcastress;
class choice prepare;
model Overall__how_much_did_you_enjoy = choice prepare
choice*prepare;
lsmeans choice prepare choice*prepare / pdiff=all adjust=tukey
stderr;
run;
quit;

/*Section 2.6.4: Mean of 'I felt like I was really cooking' for
Prepare groups (Prepare vs. No Prepare), and 2x2 ANOVA on anxiety
factor to determine if including 'In general, how much do you
enjoy cooking/preparing food?' improved the model.*/
proc means data=xxx.pcastress;
by prepare;
var I_felt_like_I_was_really_cooking;
run;

proc glm data=xxx.pcastress;
class choice prepare;
model STRESSpostmeal = choice prepare choice*prepare
In_general__how_much_do_you_enj
In_general__how_much_do_you_enj*choice
In_general__how_much_do_you_enj*prepare;
lsmeans choice prepare / pdiff=all adjust=tukey stderr;
run;
quit;

/*Section 2.6.4, Figure 2.7: To show a decrease in self-
consciousness ratings after the meal for those in the Prepare vs.
No Prepare groups*/
proc glm data=xxx.pcastress;
class choice prepare;
model Self_conscious_post_meal_minus_p = choice prepare
choice*prepare;
lsmeans choice prepare choice*prepare / pdiff=all adjust=tukey
stderr;
run;
quit;

/*Section 2.6.5: Changes in 'vigorousness' after the meal*/
proc ttest data=xxx.pcastress H0=0;
var Vigorous_post_meal_minus_post_st;
run;
```

```
/*Section 2.6.6, Figure 2.8: Average heart rate at all time points
for all subjects*/
proc means data=xxx.pcastress;
var Baseline_HR_Average
Post_stress_HR_average
Post_meal_HR_average
HR_final_average
;
output out=meansheartrate mean=
Baseline_HR_Average
Post_stress_HR_average
Post_meal_HR_average
HR_final_average
stderr=
sBaseline_HR_Average
sPost_stress_HR_average
sPost_meal_HR_average
sHR_final_average;
run;
```

APPENDIX C: MATERIALS FROM CHAPTER 3

C1 Screening Questionnaire

Thank you for your interest in the Film/Snacks Study! Please complete this survey so we can determine if you qualify for our study.

We are testing the effect of film clips on mood, and since most people eat snacks while they are watching movies, we are also providing food. Since this research is for the Department of Food Science & Nutrition, the foods are new.

If you qualify based on this survey, you will be invited to come to the lab for a 30-minute session, and up to 6 more visits after that. This is a complex study with many 'qualification' steps. It is possible that you will not be asked to return after completing 1 or more of the visits. Remember, this is not a reflection of you, but a consequence of the strict requirements for the study. These strict requirements are part of the experimental design to make this a sound, scientifically meaningful study.

All lab sessions will take place in the Sensory Center (room 97) in the Food Science & Nutrition building on the St. Paul Campus of the University of Minnesota.

Each participant can potentially earn up to $50.The results of this survey will be kept confidential.

Please enter your email address (so we can contact you directly):

Click the arrow (>>) at the bottom of the screen to continue.

What is your age?

What is your gender?

- ❍ Male
- ❍ Female

Do you have any food allergies and/or sensitivities?

- ❍ Yes
- ❍ No

Food Neophobia Scale (Pliner & Hobden, 1992)

The first visit will be a scheduled visit between Jan 27 - Feb 7. This visit will last approximately 30 minutes and you will be compensated $5. Please indicate all days/times you are available.

	Mon, Jan 27	Tue, Jan 28	Wed, Jan 29	Thu, Jan 30	Fri, Jan 31
1:00 - 1:30 pm	❑	❑	❑	❑	❑
1:30 - 2:00 pm	❑	❑	❑	❑	❑
2:00 - 2:30 pm	❑	❑	❑	❑	❑
2:30 - 3:00 pm	❑	❑	❑	❑	❑
3:00 - 3:30 pm	❑	❑	❑	❑	❑
3:30 - 4:00 pm	❑	❑	❑	❑	❑
4:00 - 4:30 pm	❑	❑	❑	❑	❑
4:30 - 5:00 pm	❑	❑	❑	❑	❑

	Mon, Feb 3	Tue, Feb 4	Wed, Feb 5	Thu, Feb 6	Fri, Feb 7
1:00 - 1:30 pm	❑	❑	❑	❑	❑
1:30 - 2:00 pm	❑	❑	❑	❑	❑
2:00 - 2:30 pm	❑	❑	❑	❑	❑
2:30 - 3:00 pm	❑	❑	❑	❑	❑
3:00 - 3:30 pm	❑	❑	❑	❑	❑
3:30 - 4:00 pm	❑	❑	❑	❑	❑
4:00 - 4:30 pm	❑	❑	❑	❑	❑
4:30 - 5:00 pm	❑	❑	❑	❑	❑

The rest of the visits must happen on 5 consecutive days (Mon-Fri) plus the following Friday. For these visits, you will be required to drop-in to the lab for 10 minutes between 1:00 - 5:00 pm each day. You will be compensated $5 for each visit, plus a bonus at the end. Please indicate which week(s) you are available.

"I am available to drop in once per day between 1:00 - 5:00 pm..."

- ❑ Monday, Feb 10 - Friday, Feb 14, AND Friday, Feb 21
- ❑ Monday, Feb 17 - Friday, Feb 21, AND Friday, Feb 28
- ❑ Monday, Feb 24 - Friday, Feb 28, AND Friday, March 7
- ❑ Monday, March 3 - Friday, March 7, AND Friday, March 14

Thank you!

C2 Taste Test Questionnaire

Welcome to the Film/Snacks Study!

During this session, you will be asked to taste and answer questions about a variety of foods. Make sure you taste the sample that matches the sample number on the screen. If you don't want to taste one of the samples, you can click ahead to the next sample.

Please enter your Subject ID number and pass the card through the window.

When you receive your sample tray, please click the arrow (>>) at the bottom of the screen.

Please taste Sample 457 and answer the following questions:

Overall, how much do you like this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Have you ever seen this food before?

- ❍ Yes
- ❍ No

What is the name of this food?

What does this food remind you of?

Would you be willing to eat a small amount of this food at each session for the remainder of the study?

- ❍ Yes
- ❍ No

Please taste Sample 192 and answer the following questions:

Overall, how much do you like this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Have you ever seen this food before?

- ❍ Yes
- ❍ No

What is the name of this food?

What does this food remind you of?

Would you be willing to eat a small amount of this food at each session for the remainder of the study?

- ❍ Yes
- ❍ No

Please taste Sample 253 and answer the following questions:

Overall, how much do you like this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Have you ever seen this food before?

- ❍ Yes
- ❍ No

What is the name of this food?

What does this food remind you of?

Would you be willing to eat a small amount of this food at each session for the remainder of the study?

- ❍ Yes
- ❍ No

Please taste Sample 638 and answer the following questions:

Overall, how much do you like this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Have you ever seen this food before?

- ❍ Yes
- ❍ No

What is the name of this food?

What does this food remind you of?

Would you be willing to eat a small amount of this food at each session for the remainder of the study?

- ❍ Yes
- ❍ No

Thank you! Please pass your tray back through the window, but don't leave yet!

Please click the arrow at the bottom of the screen.

Please rate your overall liking of the following items/situations:

The softness of a kitten's fur:

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

People shouting while you're trying to sleep:

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

The taste of your favorite dessert:

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

The feeling that you're about to be sick:

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Dutch Eating Behavior Questionnaire (van Strien et al., 1986)

Positive and Negative Affect Schedule (Watson et al., 1988) *(PRE)*

Based on your feelings RIGHT NOW, on a scale from 0-100,

______ Rate the amount of food you desire.
______ Rate the amount of food you could eat.

Please wait until the experimenter gives you another sample.

We would like you to re-taste this sample. Please sit quietly and eat as much as you would like while we prepare the next set of questions.

We will let you know when to click to the next page.

Implicit Positive and Negative Affect Test (Quirin et al., 2009)

Positive and Negative Affect Schedule (POST)

Please answer the following questions about the snack you just ate:

Overall, how much do you like this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

How much do you like the appearance of this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

How much do you like the texture of this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

How much do you like the flavor of this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Please indicate your agreement with the following statements:

Overall, I enjoyed this food.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

I wish to continue eating more of this food right now.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

I would like to eat this same food again tomorrow.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

Thank you! Please pass your tray through the window to receive your payment. Make sure to sign the receipt!

C3 Conditioning Questionnaire

Welcome Back!

Please enter your Subject ID number and pass your card through the window.

Positive and Negative Affect Schedule (PRE)

When you have received your food, click the arrow (>>) at the bottom of the screen to begin the film clip. Feel free to eat as much of the snack as you wish during the film clip. You don't have to eat all of it, but please taste at least a little.

<< FILM CLIP >>

If the clip doesn't start right away, please click play.

When the clip has ended, please click on the arrow (>>) at the bottom of the page to continue.

Feel free to close any pop-up ads.

Please pass any remaining snack back through the window.

Positive and Negative Affect Schedule (POST)

Thank you! Please sign the receipt and take your payment. Don't forget to come back tomorrow!

C4 List of Film Clips

- Positive
  - The IT Crowd
  - Friends
  - Benny and Joon
  - Bruce Almighty
- Neutral
  - How to Use Chopsticks
  - How to Make a Sawhorse/How to Fold a Paper Airplane
  - How to Tie a Tie
  - The Secrets of Simple Packing

C5 Test-Day and Test-Week Questionnaire

Welcome Back!

Please enter your Subject ID number and pass your card through the window.

Positive and Negative Affect Schedule (PRE)

Based on your feelings RIGHT NOW,

______ Rate the amount of food you desire.
______ Rate the amount of food you could eat.

Please sit quietly and eat as much as you would like while we prepare the next set of questions.

We will let you know when to click to the next page.

Implicit Positive and Negative Affect Test

Positive and Negative Affect Schedule (POST)

Please answer the following questions about the snack you just ate:

Overall, how much do you like this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

How much do you like the appearance of this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

How much do you like the texture of this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

How much do you like the flavor of this food?

1	2	3	4	5	6	7	8	9
Dislike Extremely	Dislike Very Much	Dislike Moderately	Dislike Slightly	Neither Like nor Dislike	Like Slightly	Like Moderately	Like Very Much	Like Extremely

Please indicate your agreement with the following statements:

Overall, I enjoyed this food.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

I wish to continue eating more of this food right now.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

I would like to eat this same food again tomorrow.

1	2	3	4	5	6	7
Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

Thank you! Please sign the receipt and take your payment.

APPENDIX D: SAS CODE FROM CHAPTER 3

```
libname xxx'G:\FSCN\Vickers_Lab\Katie Osdoba\SAS files';

/*Section 3.5.1 Manipulation Check, Figure 3.2: Effect of film clip
type (Positive vs. Neutral) on positive emotion (avepachange:
average of the post film clip minus pre film clip Positive Affect
scores on the four conditioning days) and negative emotion
(avenachange) during conditioning.*/
proc sort data=xxx.onehundred;
by film;
run;
proc mixed data=xxx.onehundred;
class film;
model avepachange = film  / solution;
lsmeans  film  / pdiff=all ;
run;
quit;

proc mixed data=xxx.onehundred;
class film;
model avenachange = film  / solution;
lsmeans film / pdiff=all ;
run;
quit;

/*Section 3.5.1, Figure 3.3: Mean Positive Affect ratings (by Film
group: Positive vs. Neutral) before and after viewing the film
clips on conditioning days; cipapre is the pre-film positive
affect score on conditioning day one, cipapost is the post-film
positive affect score on conditioning day one, ciipapre is the
pre-film positive affect score on conditioning day two, etc.*/
proc sort data=xxx.prepostseparate;
by film;
run;
proc means data=xxx.prepostseparate;
by film;
var cipapre cipapost ciipapre ciipapost ciiipapre ciiipapost
civpapre civpapost;
output out=meansconditoning mean=
cipapre cipapost ciipapre ciipapost ciiipapre ciiipapost civpapre
civpapost
stderr=
scipapre scipapost sciipapre sciipapost sciiipapre sciiipapost
scivpapre scivpapost;
run;
```

```
/*Section 3.5.2, Table 3.3: Demographic and individual difference
measures for Film group (Positive vs. Neutral) and Calorie group
(High-Calorie vs. Low-Calorie).
  • debqrest = Dutch Eating Behavior Questionnaire Restraint
    Score
  • debqext = Dutch Eating Behavior Questionnaire External
    Eating Score
  • debqemot = Dutch Eating Behavior Questionnaire Emotional
    Eating Score
  • age = subject's at time of experiment
  • fnscore = Food Neophobia Score
  • avepachange = average of the post film clip minus pre film
    clip Positive Affect scores on the four conditioning days
  • avenachange = average of the post film clip minus pre film
    clip Negative Affect scores on the four conditioning days
  • avehunger = an average of the ratings of 'Rate the amount
    of food you desire' (out of 100) and 'Rate the amount of
    food you could eat' (out of 100) on each test day; labeled
    "Food Desired" in Table 2
  • totalportion = average percentage of food eaten over all
    lab sessions; labeled "Percent Eaten" in Table 2*/
proc sort data=xxx.onehundred;
by subjectid film calorie;
run;
proc glm data=xxx.onehundred;
class subjectid film calorie;
model debqrest debqext debqemot age fnscore avepachange
avenachange avehunger totalportion
= film calorie film*calorie;
lsmeans film calorie film*calorie / pdiff=all stderr;
run;
quit;

/*Section 3.5.4 Hypothesis testing, Figure 3.4, Figure 3.5, Table 3.5
(Table 3.5 shows the Calorie*Time*PrePost and Film*Time*PrePost
least squares means); also Discussion section 3.6.9, Figure 3.13;
Effect of Film (Positive vs. Neutral), Calorie (High-Calorie vs.
Low-Calorie), Time (Test-Day and Test-Week), and/or PrePost
(explicitpos only, for which there were two measures each day,
pre-food and post-food) on explicit positive affect (explicitpos)
and/or implicit positive affect (implicitpos); Baseline measures
(baseexplicitpos, baseimplicitpos) were used as covariates, and
other covariates were included if they improved the model (they
have 'zero' on the end of their names because they were centered
around zero for analysis; they are defined above, in the
explanation for section 3.5.2)*/
proc sort data=xxx.prepostseparate;
by subjectid film calorie time prepost;
```

```
run;
proc mixed data=xxx.prepostseparate;
class subjectid film calorie time prepost;
model explicitpos = film|calorie|time|prepost baseexplicitpos
avehungerzero agezero totportionzero / ddfm=kr ;
repeated  / subject=subjectid type=un;
lsmeans film|calorie|time|prepost / diff;
run;
quit;

proc sort data=xxx.prepostimpliking;
by subjectid film calorie time;
run;
proc mixed data=xxx.prepostimpliking;
class subjectid film calorie time;
model implicitpos = film|calorie|time baseimplicitpos agezero /
ddfm=kr ;
repeated  / subject=subjectid type=un;
lsmeans film|calorie|time / diff;
run;
quit;

/*Section 3.5.4 Hypothesis testing - Liking ratings; Figure 3.6,
Table 3.6 (Table 3.6 shows the Film*Time and Calorie*Time least
squares means). A) Correlations between liking ratings and
implicit/explicit positive/negative affect ratings. B) Effect of
Film (Positive vs. Neutral), Calorie (High-Calorie vs. Low-
Calorie), Time (Test-Day and Test-Week) on liking ratings;
Baseline liking ratings used as covariates, and other covariates
were used if they improved the model.*/
A) proc corr data=xxx.prepostimpliking;
var liking;
with explicitpos explicitneg implicitpos implicitneg;
run;

B) proc mixed data=xxx.prepostimpliking;
class subjectid film calorie time;
model liking = film|calorie|time baseliking agezero
totportionzero / ddfm=kr ;
repeated  / subject=subjectid type=un;
lsmeans film|calorie|time / diff;
run;
quit;

/*Section 3.5.5.1 Negative emotional associations, Figure 3.7
(Figure 3.7 shows the Film*Calorie*Time interaction); also
Discussion section 3.6.9, Figure 3.13; Effect of Film (Positive vs.
Neutral), Calorie (High-Calorie vs. Low-Calorie), Time (Test-Day
and Test-Week), and/or PrePost (explicitneg only, for which there
```

```
were two measures each day, pre-food and post-food) on explicit
negative affect (explicitneg) and/or implicit negative affect
(implicitneg); Baseline measures (baseexplicitneg,
baseimplicitneg) were used as covariates, and other covariates
were included if they improved the model.*/
proc mixed data=xxx.prepostseparate;
class subjectid film calorie time prepost;
model explicitneg = film|calorie|time|prepost baseexplicitneg
avenachangezero / ddfm=kr ;
repeated  / subject=subjectid type=un;
lsmeans film|calorie|time|prepost / diff;
run;
quit;

proc mixed data=xxx.prepostimpliking;
class subjectid film calorie time;
model implicitneg = film|calorie|time baseimplicitneg / ddfm=kr ;
repeated  / subject=subjectid type=un;
lsmeans film|calorie|time / diff;
run;
quit;

/*Section 3.5.5.2, Table 3.7, Figure 3.8, Figure 3.9, Figure 3.10; also
Discussion section 3.6.1; Effect of Time (Baseline, Test-Day,
Test-Week) on explicit/implicit positive/negative affect and
liking; if covariates were included in the models above, they
were also included here.*/
proc sort data=xxx.plustime;
by subjectid time;
run;
proc mixed data=xxx.plustime;
class subjectid time;
model exppos = time avehungerzero agezero totportionzero /
ddfm=kr;
repeated time / type=un subject=subjectid;
lsmeans time / diff;
run;
quit;

proc mixed data=xxx.plustime;
class subjectid time;
model expneg = time avenachangezero / ddfm=kr;
repeated time / type=un subject=subjectid;
lsmeans time / diff;
run;
quit;
```

```
proc mixed data=xxx.plustime;
class subjectid time;
model imppos = time agezero / ddfm=kr;
repeated time / type=un subject=subjectid;
lsmeans time / diff;
run;
quit;

proc mixed data=xxx.plustime;
class subjectid time;
model impneg = time / ddfm=kr;
repeated time / type=un subject=subjectid;
lsmeans time / diff;
run;
quit;

proc mixed data=xxx.plustime;
class subjectid time;
model liking = time agezero totportionzero / ddfm=kr solution;
repeated time / type=un subject=subjectid;
lsmeans time / diff;
run;
quit;


/*Discussion section 3.6.2: Mean PA scores after watching
Positive films; filmpapre is the mean explicit positive affect
score before watching the Positive film clips on the conditioning
days; filmpapost is the score after watching the film clips,
filmnapre and filmnapost are the same measures for explicit
negative affect*/
proc means data=xxx.meanfilmscores;
var filmpapre filmpapost filmnapre filmnapost;
output out=meansfilms mean =
filmpapre filmpapost filmnapre filmnapost
stderr=
xfilmpapre xfilmpapost xfilmnapre xfilmnapost;
run;
proc print data=meansfilms;run;


/*Discussion section 3.6.4: Changes in liking over for both the
Positive and Neutral film groups; 'liking' is the liking rating
at each of the Time points (baseline, test-day, test-week) for
each of the Film groups (Positive film vs. Neutral film)*/
proc sort data=xxx.plustime;
by subjectid film time;
run;
proc mixed data=xxx.plustime;
```

```
class subjectid film time;
model liking = film time film*time agezero totportionzero /
ddfm=kr solution;
repeated time / type=un subject=subjectid;
lsmeans film time film*time / diff;
run;quit;

/*Discussion section 3.6.5, Figure 3.11: Likers vs. Non-likers;
'liker' has two levels (liker vs. non-liker); time has two levels
(TEST-DAY, TEST-WEEK); explicitpos is the explicit positive
affect score (PANAS), and baselineexplicitpos is the explicit
positive affect score at BASELINE;
This model was repeated with explicitneg (explicit negative
affect) and all of the individual PANAS words as additional
dependent variables*/
proc sort data=xxx.likers;
by subjectid liker time;
run;
proc mixed data=xxx.likers;
class subjectid liker time;
model explicitpos = liker time liker*time baseexplicitpos /
ddfm=kr ;
repeated  / subject=subjectid type=un;
lsmeans liker time liker*time / diff;
run;
quit;

/*Discussion section 3.6.6: Correlation of 'food desired' with
explicit positive affect (explicitpos) and explicit negative
affect (explicitneg); 'food desired'= avehunger, and is the
average rating of 'Rate how much food you desire' and 'Rate the
amount of food you could eat'*/
proc corr data=xxx.hungry;
var explicitpos explicitneg;
with avehunger;
run;

/*Discussion section 3.6.6, Figure 3.12: Hungry vs. Not Hungry;
'hungry' has two levels (hungry vs. not hungry); time has two
levels (TEST-DAY, TEST-WEEK); explicitpos is the explicit
positive affect score (PANAS), and baselineexplicitpos is the
explicit positive affect score at BASELINE;
This model was repeated with explicitneg (explicit negative
affect) and all of the individual PANAS words as additional
dependent variables*/
proc sort data=xxx.hungry;
by subjectid hungry time;
run;
proc mixed data=xxx.hungry;
```

```
class subjectid hungry time;
model explicitpos = hungry time hungry*time baseexplicitpos /
ddfm=kr ;
repeated  / subject=subjectid type=un;
lsmeans hungry time hungry*time / diff;
run;
quit;
```