

**ESSAYS ON CONSUMPTION:
TOP-DOWN MOTIVATIONAL PROCESSES IN FOOD CONSUMPTION**

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1. INTRODUCTION

Given the prevalence of obesity in our society today, it is imperative to understand how food intake is regulated. Appetite and food consumption are not only influenced by the sensory properties of food such as smell, taste, or texture of the food (i.e., bottom-up sensory processes), but also by the mental representation of the food (top-down cognitive, affective, and motivational processes). While consumer research has traditionally investigated the former, the focus has recently shifted towards understanding how top-down motivational processes regulate food consumption. My dissertation investigates how exposure to a food influences the motivation to consume other foods, especially complements and substitutes.

The first chapter examines how exposure to a food increases consumers' motivation to consume complementary foods. Eating a food engenders habituation, a decrease in one's response toward—and motivation to obtain—that food. General-process theories of motivation posit that eating a food also sensitizes one to other foods, an increase in one's responsiveness toward that food. For which foods such cross-stimulus sensitization occurs, however, is unclear. I hypothesize that eating a food sensitizes one to foods that are typically consumed in conjunction with the eaten food (i.e., complementary foods), but not to foods that are unrelated to the eaten food or foods that are merely associated with the eaten food. In six experiments, repeated exposure to a food or consumption of a food reduced subsequent consumption of that food (i.e., habituation), increased consumption of a complementary food (i.e., sensitization), but did not affect consumption of unrelated or merely associated foods. I show that cross-stimulus sensitization for complementary foods is due to changes in the motivation to obtain the food (wanting), rather than to an increase in the hedonic value of the food (liking). The results suggest

that motivational top-down processes cause cross-stimulus sensitization, which is more specific than previously believed.

In the second chapter, I examine how consumption of substitutes influences consumption of a desired target food. Substitutes are goods that can replace one another by satisfying, at least partly, the same consumers' needs (Nicholson 1998). When a desired product is not available or its price is deemed too high, consumers may look for and switch to a substitute. Substitutes can be classified as within-category and cross-category substitutes based on whether they belong to the same or a different product category as the target product. Within-category substitutes—by definition—share many features with the target and satisfy the same consumer needs. However, substitution can occur across product categories, too, where the cross-category substitute satisfies a higher level consumer need as the target. Although cross-category substitution is common (Park and Gupta 2011), surprisingly little research has examined how cross-category substitutes influence consumption experiences. I examine how consumption of cross-category versus within-category substitutes influences craving for and consumption of the desired target food. Specifically, I show that although consumers prefer within-category substitutes over cross-category substitutes when the target is not available, consuming a cross-category substitute is more effective in reducing craving for the target food than consuming a within-category substitute. Participants who had consumed a cross-category substitute subsequently consumed less of the target food than those who had consumed a within-category substitute. Compared to the consumption of a within-category substitute, consumption of a cross-category substitute decreased wanting—but not the liking—of the target food.

Overall, my dissertation adds to the growing literature demonstrating the involvement of top-down processes in the regulation of food consumption. The results of my studies deepen our

understanding of the psychological processes that govern consumers' cravings for and intake of food.

2. CROSS-STIMULUS SPECIFICITY IN FOOD CONSUMPTION: CONSUMING A FOOD INCREASES MOTIVATION TO CONSUME COMPLEMENTARY FOODS

Whether eating a delicious food, listening to a fantastic song, or watching one's favorite television show, continued and repeated exposure to a stimulus changes one's response to both that stimulus and to other stimuli. Exposure habituates one to the stimulus, which decreases one's motivation to consume it. A tenth bite, stanza, or minute, for example is usually less desired than the first (Rolls et al. 1981). Exposure to a stimulus also sensitizes one to other stimuli, which increases one's motivation to consume them. An appetizer, for example, whets one's appetite for the meal (Wadhwa, Shiv, and Nowlis 2008). General-process theories of motivation suggest that a common motivational process drives both habituation and sensitization (McSweeney and Swindell 1999; McSweeney and Murphy 2000). That is, sensitization and habituation denote changes in the motivational state of an organism as a function of repeated exposure to or consumption of some stimulus.

Habituation is stimulus-specific. In other words, one only habituates to the stimulus to which one has been exposed or one has consumed. Unlike habituation, the breadth of stimuli to which one becomes sensitized is unclear. Previous research suggests that sensitization has great breadth, but few direct tests of its scope have been conducted in humans (McSweeney and Swindell 1999). A notable exception is the research by Wadhwa et al. (2008), which suggests that humans generally sensitize across hedonic (positive) stimuli. We test the specificity of sensitization in food consumption. We hypothesize that sensitization occurs for foods frequently consumed in conjunction with the food to which one has been exposed (i.e., complementary foods), but does not occur for unrelated or merely associated foods. Furthermore, we demonstrate that sensitization to complements is driven by top-down motivational processes.

2.1. THEORETICAL BACKGROUND

2.1.1. Sensitization and Habituation in Consumption

Sensitization and habituation explain various types of goal-directed behaviors, including food acquisition and consumption. Sensitization refers to an organism's increase in responsiveness, and habituation refers to a decrease in responsiveness, to a stimulus with repeated exposure (McSweeney and Swindell 1999; Groves and Thompson 1970). Assuming that stimuli (e.g., food) act as reinforcers for motivated behaviors, general-process theories of motivation suggest that sensitization and habituation reflect changes in the organism's motivational state that modulate the reinforcing power of the stimuli. When sensitization occurs, the reinforcement power of stimuli increases, and goal-directed behavior increases (e.g., eating). When habituation occurs, the reinforcement power of the stimulus decreases, and the goal-directed behavior decreases or stops.

The sensory characteristics of food and digestive feedback (e.g., stomach distension, changes in blood glucose) are certainly important contributors to food intake (Bartoshuk 1991; Cabanac 1990), but do not alone determine how much one eats. The motivation to consume a food is greatly affected by top-down cognitive processes such as thoughts, memory, and mental imagery (Epstein et al. 2009; McSweeney and Swindell 1999). Habituation to a food, for example, is slowed down when people are distracted while eating by watching television or by other demanding tasks. It is slowed when people perceive the food they eat to possess greater variety (e.g., in flavor, color, or texture) even when it does not (Redden 2008; Rolls et al. 1982). Indeed, top-down processes such as mental simulation alone can habituate one to a food. Repeatedly imagining eating a food, alone, can cause one to subsequently consume less of that

food (Morewedge, Huh, and Vosgerau, 2010).

The stimulus-specificity of habituation is well established. People habituate to the stimulus to which they have been exposed, but that habituation does not affect other stimuli. Participants who ate small pieces of a cheese burger showed a steady decrease in pleasantness ratings and salivation as they consumed each additional piece, but when participants ate a different food (e.g., pizza) their pleasantness ratings and salivation rebounded (Wisniewski, Epstein, and Caggiula 1992).

Unlike habituation, specificity of sensitization is unclear (see McSweeney and Swindell 1999, for a review). Sensitization may occur to the same stimulus, especially during the initial presentation of the stimulus before habituation occurs. After the first bite of a liked food, for example, often an increase in hunger and eating rate is observed (i.e., a “whetting” or “appetizer” effect; Yeomans 1993). Repeated exposure to a stimulus has also been found to lead to sensitization to other stimuli, which is called cross-stimulus sensitization. For example, physical stimulation such as repeated exposure to shocks and tail pinches increases the tendency of rats to eat, drink, aggress, copulate, and explore (McSweeney and Swindell 1999). While these findings suggest that cross-stimulus sensitization occurs over a wide variety of stimuli, other findings suggest that cross-stimulus sensitization may be more specific. Wadhwa and colleagues (2008), for example, showed that consuming a small amount of hedonic goods increases one’s motivation to consume other hedonic goods, but does not increase one’s motivation to consume utilitarian goods. Even greater stimulus specificity has been documented in responses to drug administration. An injection of one drug increases responsiveness to another only when the two drugs elicit similar neurological responses (de Wit 1996). Injections of d-amphetamine sensitize rats to cocaine, and injections of morphine sensitize rats to heroin, but morphine does not

sensitize rats to cocaine and vice versa (de Wit and Stewart 1981, 1983).

Concluding, evidence for and against specificity in cross-stimulus sensitization has been found across a variety of stimulus categories such as food, sex, aggression, and hedonic versus utilitarian stimuli. As a consequence, there is no theory to date that describes the processes that govern sensitization to other stimuli. In the current research, we propose that cross-stimulus sensitization in food consumption will occur for complementary but not for unrelated foods. We explain this cross-stimulus specificity by behavioral scripts that prescribe which foods are typically consumed in conjunction.

2.1.2. Behavioral Scripts determine Food Complementarity

People routinely perform actions in conjunction, such as drinking coffee while reading the newspaper, which forges associations in memory between those actions. Once these associations are formed, merely perceiving a contextual cue (seeing a newspaper) can trigger and motivate associated responses (increase one's motivation to drink coffee; Wood and Neal 2007; Aarts and Dijksterhuis 2000; Dijksterhuis, Aarts, and Smith 2005). Consumption of a stimulus should thus evoke a desire to consume its complements. That is, the consumption of a stimulus may increase the desire to consume stimuli frequently consumed in conjunction with it. If one frequently eats cheese and crackers together, for example, the consumption of cheese should increase one's motivation to consume crackers. Conversely, stimuli that are unrelated should not sensitize to each other. As one does not frequently eat cheese and chocolate together, for example, the consumption of cheese should not affect one's motivation to consume chocolate.

Complementarity relations play an important role in consumption behavior.

Complements are goods that are customarily consumed together such as bread and jam, grapes and cheese, or cheese and crackers. In economics and marketing, complements are defined as goods that exhibit cross-price elasticities of demand < 0 , which means that an increase in the price of one good causes a decrease in the demand of both goods (e.g., Deaton and Muellbauer 1980). Such complementarity relations in consumption have also been demonstrated in other fields. Studies on drug addiction have shown that exposure to cues present during the consumption of a drug triggers physiological reactions associated with the consumption of that drug amongst current and former users (Carter and Tiffany 1999; Tiffany and Drobes 1990; Niaura et al. 1988). In these studies, addicts reported increased craving and showed changes in autonomic responses, such as increase in heart rate and skin conductance, when they were exposed to drug-related cues (e.g., the sight of an ashtray or smell of a cigarette) versus drug-neutral cues (e.g., pencils, glasses of water).

The power of drug-related cues to elicit reactions similar to the reactions induced by the consumption of drugs is explained by instrumental learning. Cues that are paired with a rewarded response take on the reinforcement power of the rewarding response (Pavlov 1927; Glautier and Remington 1995). Monkeys that learn that an environmental cue (e.g., a light) predicts a reward (e.g., a drop of juice) when a response is made (e.g., a lever press), for example, press the lever with repeated practice when the light is illuminated. Such conditioned responding is also found on the neural level, as mere exposure to the environmental reward-predicting cues activates the dopaminergic neurons that initially responded to the reward (see Schultz 2002 for a review).

Although these findings support the hypothesis that exposure to a food leads to sensitization to complementary foods by virtue of associations learned through experience, it is unclear whether the consumption of a food simply increases the salience of associated actions

such as eating a complementary food (e.g., Bargh, Chen, and Burrows 1996), or whether it changes the motivation to perform such actions. In other words, the consumption of a food may make complementary foods more accessible in memory and increase their consumption because they are more likely to be included in consideration sets of additional foods chosen for consumption, or the consumption of a food may increase the consumption of complementary foods because it increases the reinforcement value of complementary foods. Based on a general process theory of motivation according to which sensitization and habituation reflect changes in the organism's motivational state (McSweeney and Swindell 1999), we hypothesize that exposure to a food sensitizes one to complementary foods through an increase in the motivation to obtain the complementary food (wanting) rather than an increase in the complementary food's salience or hedonic value (liking).

We tested our hypotheses in six experiments that examined the influence of exposure to and consumption of a food on the subsequent consumption of complementary or unrelated foods. In Experiment 1, we tested whether repeated consumption of a food sensitizes one to complementary foods. In Experiment 2, we examined whether sensitization occurs due to mere association or complementarity relationships between foods. Participants in Experiments 3, 4, and 5 imagined consuming the food rather than actually consuming the food to reduce the impact of confounding sensory stimulation. In Experiment 3, we examined whether repeated exposure to a food habituates one to that food but sensitizes one to complementary foods. In Experiment 4, we tested the specificity of cross-stimulus sensitization. In Experiment 5, we examined whether cross-stimulus sensitization is caused by a change in motivation (wanting) or a change in the hedonic value of the complementary food (liking). Finally in Experiments 6A and 6B, we examined whether sensitization to complements is due to behavioral scripts by comparing

cultural differences in sensitization.

2.2. STIMULI PRETEST

To assemble a stimulus set of complementary and non-complementary (unrelated) foods, we conducted an online pretest with 30 participants (17 males and 13 females; $M_{\text{age}} = 36.37$, $SD = 12.56$). Participants saw ten different pairs of foods and indicated how often they consume each pair of foods together on a seven-point scale with endpoints, *Never* (1) and *Extremely often* (7). The pairs of foods were cheese and crackers, cheese and grapes, cheese and M&M's, cheese and yogurt, peanut butter and butter, peanut butter and grape jelly, pizza and cola, pizza and ketchup, pizza and rice, and strawberry jelly and grape jelly. Presentation order was random.

Based on paired comparisons, we classified cheese and crackers ($M = 5.00$, $SD = 1.74$), pizza and cola ($M = 4.47$, $SD = 2.13$), peanut butter and grape jelly ($M = 4.03$, $SD = 1.94$), and cheese and grapes ($M = 3.13$, $SD = 1.55$) as complements, and cheese and M&M's ($M = 1.27$, $SD = 0.83$), pizza and rice ($M = 1.33$, $SD = 0.96$), pizza and ketchup ($M = 1.53$, $SD = 1.50$), peanut butter and butter ($M = 1.60$, $SD = 1.30$), cheese and yogurt ($M = 1.63$, $SD = 1.27$), and strawberry jelly and grape jelly ($M = 1.97$, $SD = 1.59$) as non-complementary (unrelated) foods (see Table 1). The stimuli used as complementary foods were thus peanut butter and jelly in Experiments 1 and 2, cheese and grapes in Experiments 3 and 5, cheese and crackers in Experiment 4, and pizza and cola in Experiment 6. The stimuli used as non-complementary foods were strawberry jelly and grape jelly in Experiment 2, cheese and M&M's in Experiment 4, pizza and ketchup, and pizza and rice in Experiment 6.

Food Pair	Mean*	SD
Cheese and Cracker	5.00 _a	1.74
Pizza and Cola	4.47 _a	2.13
Peanut Butter and Grape Jelly	4.03 _a	1.94
Cheese and Grapes	3.13 _b	1.55
Strawberry Jelly and Grape Jelly	1.97 _d	1.59
Cheese and Yogurt	1.63 _d	1.27
Peanut Butter and Butter	1.60 _d	1.30
Pizza and Ketchup	1.53 _d	1.50
Pizza and Rice	1.33 _d	.96
Cheese and M&M's	1.27 _d	.83

Table 1: Complementarity relationships between different foods¹

¹ * Post-hoc pairwise comparisons (Tukey's tests) with different subscripts are significant at $p < .01$

2.3. EXPERIMENT 1: SENSITIZATION TO COMPLEMENTARY FOODS

In Experiment 1, we examined whether consumption of a food sensitizes one to complementary foods. Participants consumed either two plain crackers or two crackers topped with peanut butter before consuming crackers topped with grape jelly. Because peanut butter and grape jelly are complements, we expected participants who consumed crackers with peanut butter to subsequently consume more crackers with jelly than participants who consumed plain crackers.

2.3.1. Method

Participants

Sixty-five students at Carnegie Mellon university (40 males and 25 females; $M_{\text{age}} = 20.17$, $SD = 1.73$) volunteered to participate.

Procedure

Volunteers were recruited at the campus center for a “snack study,” which was run individually. At the beginning of the experiment, participants indicated how much they liked various kinds of food including grape jelly on a five-point scale with endpoints, *Dislike Extremely* (1) and *Like Extremely* (5). Participants were then randomly assigned to one of two conditions. Participants in the non-complementary food condition ate two plain Ritz crackers, whereas participants in the complementary food condition ate two Ritz crackers topped with peanut butter. After eating the crackers, all participants indicated how pleasant or unpleasant it

was to eat the crackers on a seven-point scale with endpoints, *Extremely Unpleasant* (1) and *Extremely Pleasant* (7).

Next, all participants were given 10 Ritz crackers topped with grape jelly and consumed ad libitum. When they were done, participants indicated how pleasant or unpleasant it was to eat those crackers on a seven-point scale with endpoints, *Extremely Unpleasant* (1) and *Extremely Pleasant* (7). The number of crackers with grape jelly eaten was measured surreptitiously and served as the primary dependent variable.

2.3.2. Results

No responses were classified as outliers (i.e., no one ate more than 3 standard deviation from their cell-means). The following analyses include the full sample.

Liking and Pleasantness Ratings of the Stimuli

We first checked whether random assignment to experimental conditions was successful and analyzed reported liking of grape jelly. No significant differences across the two experimental conditions were found ($M_{\text{non-complementary food}} = 3.24$, $SD = 0.94$; $M_{\text{complementary food}} = 3.53$, $SD = 0.92$), $F(1, 63) = 1.58$, $p = .21$.

Eating two crackers topped with peanut butter was rated as a marginally more pleasant experience ($M = 5.50$, $SD = 1.19$) than eating two plain crackers ($M = 4.94$, $SD = 1.12$), $F(1, 63) = 3.84$, $p = .06$.

Consumption of the Complementary Food

We examined the number of crackers with jelly consumed between conditions with reported liking for grape jelly as a covariate (the covariate was not significant $F < 1$). As predicted, we found that participants who had eaten two crackers topped with peanut butter subsequently consumed more crackers topped with grape jelly ($M = 3.31$, $SD = 2.52$) than did participants who had eaten two plain crackers ($M = 1.85$, $SD = 1.39$), $F(1, 62) = 7.60$, $p = .008$ (see Figure 1).

Both groups, however, considered the crackers topped with jelly to be similarly pleasant, whether participants had previously eaten two crackers with peanut butter ($M = 4.61$, $SD = 1.61$) or two plain crackers ($M = 4.69$, $SD = 1.91$), $F < 1$. The results are not substantively different when the covariate is not included in the analysis.

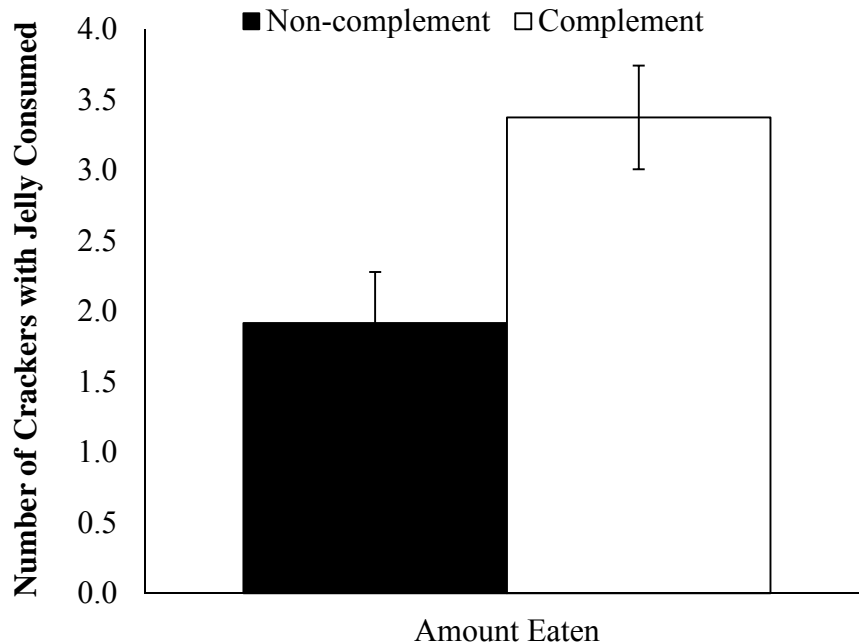


Figure 1: Amount of Crackers Topped with Grape Jelly Consumed in Experiment 1 as a function of the type of food that had been consumed. Error bars represent ± 1

2.3.3. Discussion

Participants who had eaten two crackers topped with peanut butter subsequently consumed more crackers topped with grape jelly than did participants who had eaten two plain crackers. In other words, the consumption of a food increased the consumption of its complement. Interestingly, despite consuming more of the complementary food than did controls, participants in the complementary food condition did not experience more pleasure from eating the complementary food. The results suggest that sensitization to complementary foods may be due to an increase in the motivation to obtain and eat the food, rather than to an increase in how much one likes it. However, this null effect in liking of the food may also be due to the different consumption amounts in the two experimental conditions as eating more generally decreases liking of the food (Rolls, Rolls, Rowe and Sweeney, 1981). In a later experiment (Experiment 5), we will further examine the role of motivation to obtain versus the hedonic value of the food as an underlying process of sensitization to complements.

We found that eating a food increases consumption of its complements. Although the results support sensitization to complements, the increased consumption of complements might be driven by different hedonic states between conditions. Because eating the crackers with peanut butter was marginally more pleasant than eating the plain crackers, people who had eaten peanut butter might want to continue the pleasant experience of eating and thus subsequently consume more food. Also one might question whether sensitization occurs due to the mere associations between foods (Anderson 1983), and not due to their complementarity. Exposure to a food stimulates thoughts of other foods, some of which are activated even though they are not

complements. For example, milk and yogurt are not consumed together but they are associated due to their common properties or category membership. If mere associations between foods underlie consumers' increased response to the associated stimuli by facilitated accessibility in memory, repeated exposure to a stimulus should increase response to anything associated with the stimulus, not only to its complements. We tested this possibility in Experiment 2, where we examined whether sensitization would occur only to complements or also to merely associated foods.

2.4. EXPERIMENT 2: SENSITIZATION TO COMPLEMENTARY FOODS

In Experiment 2, we examined whether sensitization occurs due to mere association or complementarity between foods. Participants consumed one of the three foods – two plain crackers (non-complementary food), two crackers topped with peanut butter (complementary food), or two crackers topped with strawberry jelly (merely associated food) before consuming crackers topped with grape jelly. As in Experiment 1, we expected participants who consumed crackers with peanut butter to subsequently consume more crackers with grape jelly than participants who consumed plain crackers. Because our proposition suggests that sensitization occurs due to behavioral scripts, we did not expect sensitization for merely associated foods.

2.4.1. Method

Pretest

To ensure that strawberry jelly is associated with grape jelly but not a complementary food, we conducted a pretest with 50 participants from a different sample (31 males and 19 females; $M_{\text{age}} = 30.06$, $SD = 10.63$). Pretest participants saw 10 different pairs of foods including a pair of strawberry jelly and grape jelly and a pair of peanut butter and grape jelly, and indicated how related each pair of foods seem to them (association) and how often they consume each pair of foods (complementarity) on seven-point scales with endpoints, *Not at all* (1) and *Very Related* (7), and *Not at all* (1) and *Very Often* (7), respectively.

We examined the rated association and complementarity between the two food pairs with a repeated-measures of ANOVA, which yielded a significant interaction, $F(1, 49) = 82.33$, $p < .0001$, $\eta_p^2 = .63$. Planned comparisons showed that strawberry jelly and grape jelly are more strongly associated with each other ($M = 6.30$, $SD = .95$) than are peanut butter and grape jelly ($M = 5.58$, $SD = 1.47$), $F(1, 49) = 11.97$, $p = .001$, but less frequently consumed together ($M = 2.16$, $SD = 1.72$) than peanut butter and grape jelly ($M = 4.94$, $SD = 1.89$), $F(1, 49) = 82.12$, $p < .001$. Thus we used strawberry jelly as an associated but not complementary food to grape jelly and peanut butter as a complementary food to grape jelly.

Participants

Two hundred and two students at Carnegie Mellon university (99 males and 102 females; $M_{\text{age}} = 20.62$, $SD = 4.12$) participated in exchange for \$2.

Procedure

The procedure was the same as the procedure in Experiment 1 except that participants were randomly assigned to one of three conditions. Specifically, participants in the *non-*

complementary food condition ate two plain Ritz crackers, participants in the *complementary food* condition ate two Ritz crackers topped with peanut butter, and participants in the *merely associated food* condition ate two Ritz crackers topped with strawberry jelly before eating Ritz crackers topped with grape jelly ad libitum.

2.4.2. Results

The responses of seven participants were classified as outliers (i.e., they ate more than 3 SD from their respective cell means). Their responses were not included in the subsequent analyses.

Liking and Pleasantness Ratings of the Stimuli

We first checked whether random assignment to experimental conditions was successful and analyzed reported liking of grape jelly. No significant differences across the three experimental conditions were found ($M_{\text{non-complementary food}} = 3.02$, $SD = 1.15$; $M_{\text{complementary food}} = 2.97$, $SD = 1.03$; $M_{\text{merely associated food}} = 2.89$, $SD = 0.95$), $F(2, 192) = .25$, $p = .78$.

Unlike Experiment 1 where we found marginally higher pleasantness ratings for eating crackers with peanut butter than eating plain crackers, pleasantness ratings for eating two crackers topped with peanut butter ($M = 5.20$, $SD = 1.26$), eating two plain crackers ($M = 4.84$, $SD = 1.37$), and eating two crackers topped with strawberry jelly ($M = 4.92$, $SD = 1.44$) were not significantly different, $F(2, 192) = 1.84$, $p = .29$.

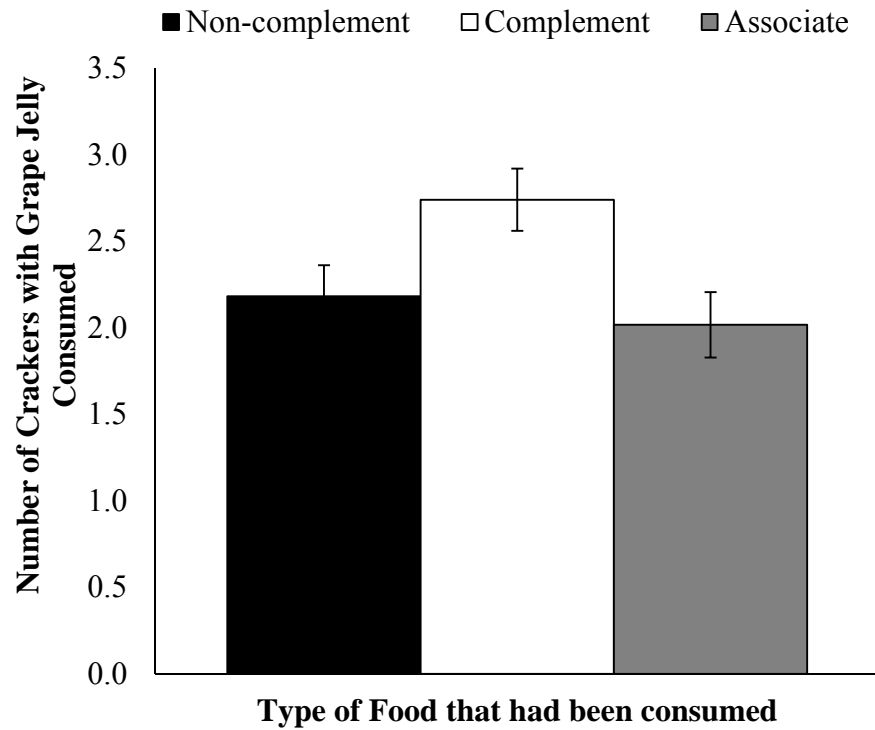


Figure 2: Amount of Crackers with Grape Jelly Consumed in Experiment 2 as a function of the type of food that had been consumed. Error bars represent ± 1

Amount of Crackers Topped with Grape Jelly Consumed

We examined the number of crackers topped with grape jelly consumed across conditions in an ANCOVA with reported liking for grape jelly as a covariate, ($F(1, 191) = 21.48, p < .001, \eta_p^2 = .10$). The analysis revealed a significant main effect for condition, $F(2, 191) = 4.31, p = .02, \eta_p^2 = .04$. Planned comparison revealed that participants who had eaten two crackers topped with peanut butter subsequently consumed more crackers topped with grape jelly ($M = 2.75, SD = 1.64$) than did participants who had eaten two plain crackers ($M = 2.21, SD = 1.53$), $F(1, 191) = 4.85, p = .03$, and those who had eaten two crackers topped with strawberry jelly ($M = 1.98, SD$

= 1.47), $F(1, 129) = 7.69, p = .006$. The amount of the crackers with grape jelly consumed by participants in the latter two conditions did not differ significantly, $F < 1, ns$ (See Figure 2). The pleasantness ratings of eating crackers topped with grape jelly were not significantly different across conditions, ($M_{\text{non-complementary food}} = 4.68, SD = 1.67$; $M_{\text{complementary food}} = 4.78, SD = 1.65$; $M_{\text{merely associated food}} = 4.55, SD = 1.34$), $F < 1, ns$. The results are not substantively different when the covariate is not included in the analysis.

2.4.3. Discussion

Replicating the findings of Experiment 1, we found that the consumption of a food increased the consumption of its complements. Participants who had eaten crackers topped with peanut butter subsequently consumed more crackers topped with grape jelly than did participants who had eaten plain crackers. Sensitization, however, did not occur for merely associated foods. Participants who had eaten crackers with strawberry jelly subsequently consumed the same amount of crackers with grape jelly as did participants who had eaten plain crackers. The findings suggest that sensitization is not due to mere association but caused by the complementarity of foods.

Although we found sensitization to complements, it is not clear whether it was driven by top-down processes or by bottom-up processes, because participants actually ate the complementary or control food before eating the target food. As an example of the influence of a bottom-up process, eating salty peanut butter may increase one's appetite for sweet jelly because the sweetness of the jelly partly compensates for the saltiness of the peanut butter. While such sensory compensation does not contradict our hypothesis of sensitization to complementary

foods, our theory predicts that sensitization to complements should occur even in the absence of sensory compensation. To rule out sensory input as a potential cause for sensitization and demonstrate that top-down processes are responsible for sensitization to complements, we used an established paradigm (Morewedge et al. 2010) in which the consumption of a food is repeatedly imagined to manipulate exposure in Experiment 3.

2.5. EXPERIMENT 3: HABITUATION AND SENSITIZATION

Experiment 3 examines whether sensitization to complements is driven by top-down processes, and whether the same top-down process involved in habituation to a food is also responsible for sensitization to complementary foods. Participants repeatedly imagined eating units of a target food (cheese) or a complementary food (grapes) three or thirty times, and were subsequently given the opportunity to actually consume cheese ad libitum. Because imaginary consumption is devoid of confounding sensory factors such as taste, smell, or fullness associated with the actual consumption of food, this design serves as a conservative test of the role of top-down processes in sensitization to the complements of a consumed food.

We predicted that participants who imagined eating 30 units of cheese would subsequently eat less cheese than participants who imagined eating 3 units of cheese, because the former would have habituated to the cheese (Morewedge et al. 2010). In contrast, participants who imagined eating 30 grapes would subsequently eat more cheese than participants who imagined eating 3 grapes, because the imagined consumption of grapes would sensitize them to cheese.

2.5.1. Method

Participants and Design

One hundred and fifty-two residents of Pittsburgh (85 males and 67 females; $M_{\text{age}} = 25.03$, $SD = 8.21$) participated in exchange for \$5. The experiment employed a 2 (food: target food vs. complementary food) x 2 (imagined consumption: 3 vs. 30 units) between-subjects design. The amount of cheese that participants consumed was measured surreptitiously and served as the primary dependent variable.

Procedure

Participants were recruited for an experiment about “imagery and size estimation,” and seated at computers in private cubicles. First, they were asked to rate the extent to which they liked grapes and Cheddar cheese on separate 100-point analog scales with endpoints, *Dislike Extremely* and *Like Extremely*. Next, they reported how often they used coin-operated laundry machines on a 5-point scale with endpoints, *Never* (1) and *Weekly* (5). Following Morewedge and colleagues (2010), for practice purposes participants then saw a bowl containing 3 US quarters and imagined inserting each quarter into a laundry machine one-at-a-time. Afterward, participants were asked to identify which of 5 different sized quarters was the correct size of a quarter.

Participants were then randomly assigned to one of four conditions. Participants in a target condition were shown a picture of a bowl containing either 3 or 30 Cheddar cheese cubes, and then imagined eating each cube, one-at-a-time. Specifically, they were shown a picture of one cheese cube every 3 seconds and imagined eating it. This was repeated a total of 3 or 30

times. Participants in a complement condition were shown a picture of a bowl containing either 3 or 30 grapes, and then saw a picture of one grape every 3 seconds and imagined eating it, following the same procedure. After finishing the imagination task, participants were shown 5 cheese cubes or grapes and identified the image that was the correct size.

Participants were then given a bowl containing 40 grams of cheddar cheese cubes, which they were told to sample in order to answer questions about its taste and texture. Participants ate ad libitum and notified the experimenter when they were done. The experimenter then removed the bowl and surreptitiously weighed it. Finally, participants reported demographic information, their current affective state on the PANAS (Watson, Clark, and Tellegen, 1988), when and what they last ate before the experiment, whether they performed the imagination task as instructed, and whether they had previously participated in a similar experiment.

2.5.2. Results

Ten participants indicated that they had not performed the imagination task as instructed, and five participants indicated that they had previously participated in a similar experiment. The responses of one participant constituted outlier (i.e., 3 SD from the cell mean). Their responses were not included in the subsequent analyses.

Pre-existing Differences in Liking of Cheddar Cheese

To test whether random assignment to experimental conditions was successful, we submitted the ratings of liking for cheese that were collected before the imagery induction to a 2

(food: target food vs. complementary food) x 2 (imagined consumption: 3 vs. 30 units) ANOVA. An unexpected interaction emerged ($F(1, 131) = 5.42, p = .02$), indicating that participants assigned to imagine eating the target 30 times liked cheese more ($M = 70.33, SD = 24.18$) than did participants assigned to imagine eating the target 3 times ($M = 58.19, SD = 26.93$), whereas participants assigned to imagine eating the complement 30 times liked cheese less ($M = 63.25, SD = 31.39$) than did participants assigned to imagine eating the complement 3 times ($M = 72.57, SD = 23.52$).

Amount of Cheddar Cheese Consumed

To account for these differences, we examined the impact of the imagination induction on cheese consumption with a 2 (imagined consumption: target, complement) x 2 (repetitions: 3, 30) between-subjects ANCOVA, using liking for cheese as a covariate ($F(1, 131) = 12.60, p = .001, \eta_p^2 = .088$). The predicted two-way interaction was significant ($F(1, 131) = 9.35, p = .003, \eta_p^2 = .067$; see Figure 3). Planned comparisons revealed that participants who had imagined eating 30 Cheddar cheese cubes subsequently ate less cheese ($M = 9.30g, SD = 6.86$) than did participants who had imagined eating 3 Cheddar cheese cubes ($M = 14.68g, SD = 9.12$), $F(1, 131) = 5.56, p = 0.02$. In contrast, participants who had imagined eating 30 grapes subsequently ate more cheese ($M = 16.72g, SD = 12.23$) than did participants who had imagined eating 3 grapes ($M = 11.71g, SD = 10.31$), $F(1, 131) = 4.09, p = .05$. Neither main effect was significant (imagined consumption $F(1, 131) = 1.77, p = .19$; repetitions $F < 1$) and the manipulations had no significant impact on participants' affective states (all $F_s < 1$).

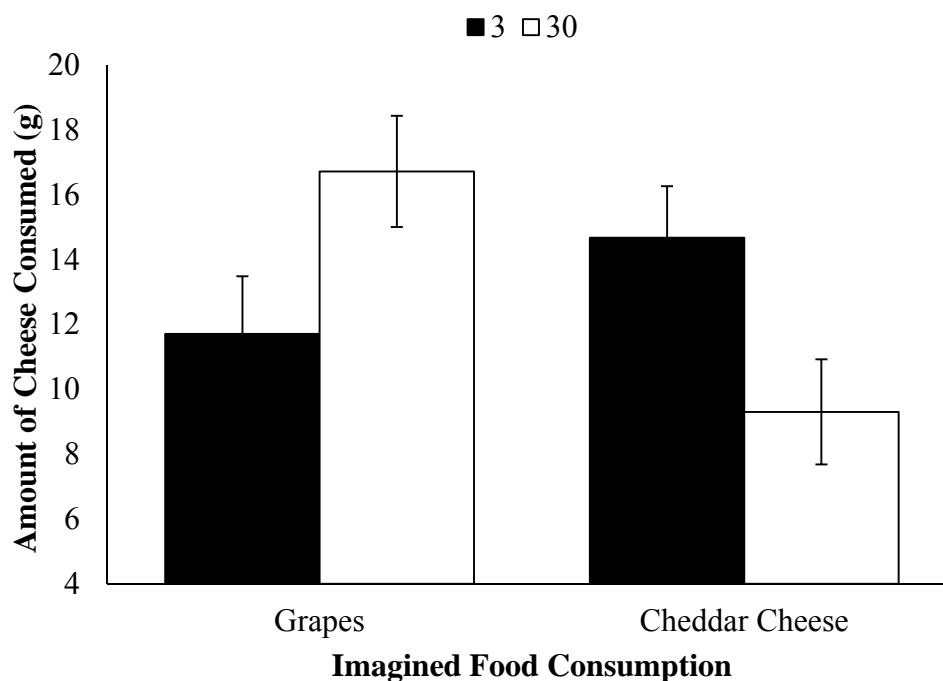


Figure 3: Amount of cheese intake after imagined food consumption in Experiment 3 as a function of the type of food and the quantity that had been imagined eaten. Error bars represent ± 1 SEM.

2.5.3. Discussion

The results suggest that similar top-down processes underlie both habituation and sensitization. Replicating previous research (Morewedge et al. 2010), participants who had repeatedly imagined consuming 30 units of a food habituated to that food and consequently ate less of it than did participants who had repeatedly imagined consuming 3 units of that food. More important, participants who had repeatedly imagined consuming 30 units of a complementary food ate more of the target food than did participants who had repeatedly

imagined consuming 3 units of the complementary food. As the consumption of the complementary food was imagined, the found sensitization effect can only be explained by top-down factors (Kosslyn, Ganis, and Thompson 2001), not by pre-ingestive sensory factors such as taste or smell.

2.6. EXPERIMENT 4: STIMULUS SPECIFICITY

Experiment 4 tested whether exposure to a food results in cross-stimulus sensitization for all foods, or only for complements of the food to which one has been exposed. Our predictions and the results of Experiments 1 to 3 suggest that sensitization should be specific to complements of the food. Before eating cheese ad libitum, participants imagined eating 3 or 30 units of a complementary food (crackers) or an unrelated food (M&M's). We expected that participants who imagined consuming more of a complement would sensitize to cheese, whereas participants who imagined consuming an unrelated food would not be affected by the imagination induction.

2.6.1. Method

Participants and Design

One hundred and nineteen students at Carnegie Mellon university (66 males and 53 females; $M_{\text{age}} = 21.13$, $SD = 5.85$) participated for partial course credit or \$5. The experiment employed a 2 (food: complementary vs. unrelated food) x 2 (imagined consumption: 3 vs. 30

units) between-subjects design. Amount of cheese consumed was measured surreptitiously and served as the primary dependent variable.

Procedure

The procedure was identical to that in Experiment 3 except for slight changes in the imagination task. To keep the number of imagined actions and thus the mental effort exerted constant across experimental conditions, all participants were asked to imagine performing 33 repetitive actions. Similar to Experiment 3, participants imagined either eating 3 or 30 crackers or M&Ms. Before they did so, however, they were asked to imagine inserting either 30 or 3 quarters into a laundry machine. Thus, participants imagined either inserting 30 quarters and then imagined eating 3 crackers or M&Ms, or they imagined inserting 3 quarters and then imagined eating 30 crackers or M&Ms. Thus, all participants imagined 33 actions in total. We also increased the presentation time for each stimulus (quarters, crackers or M&Ms) to 5 seconds to allow participants more time to imagine performing the control task and the consumption imagery.

2.6.2. Results

Nine participants reported that they did not perform the imagination task as instructed, 2 participants previously participated in a similar experiment, and the responses of 2 participants were classified as outliers (i.e., they ate more than 3 SD from their respective cell means). Their responses were not included in the subsequent analyses.

Pre-existing Differences in Liking of Cheddar Cheese

As in Experiment 3, we tested whether pre-manipulation liking of Cheddar Cheese differed across conditions. Random assignment was successful, as a 2 (food: complementary vs. unrelated food) x 2 (imagined consumption: 3 vs. 30 units) ANOVA on liking of Cheddar Cheese did not yield any significant effects (all $F_s < 0.1$).

Amount of Cheddar Cheese Consumed

We examined the amount of cheese consumed by participants in a 2 (food: complementary vs. unrelated food) x 2 (imagined consumption: 3 vs. 30 units) ANCOVA, using liking for Cheddar cheese as a covariate ($F(1, 101) = 12.49, p = .001, \eta_p^2 = .11$). The analysis revealed a marginally significant main-effect for food ($F(1, 101) = 3.17, p = .08, \eta_p^2 = .03$), and a significant main-effect for imagined consumption ($F(1, 101) = 7.56, p = .007, \eta_p^2 = .070$). More important, these were qualified by the predicted interaction, $F(1, 101) = 7.96, p = .006, \eta_p^2 = .073$.

Planned comparisons revealed that participants who had imagined eating 30 crackers ate significantly more cheese ($M = 17.49\text{g}, SD = 12.99$) than did participants who had imagined eating 3 crackers ($M = 8.44\text{g}, SD = 5.61$), $F(1, 101) = 16.50, p < .001$, whereas participants who had imagined eating 30 M&Ms ate an equivalent amount of cheese ($M = 10.01\text{g}, SD = 6.37$) as participants who had imagined eating 3 M&Ms ($M = 10.13\text{g}, SD = 7.85, F(1, 101) = 0.003, p = .96$ (see Figure 4). The manipulations did not influence the extent to which participants reported experiencing positive or negative affect, all $F_s < 1$.

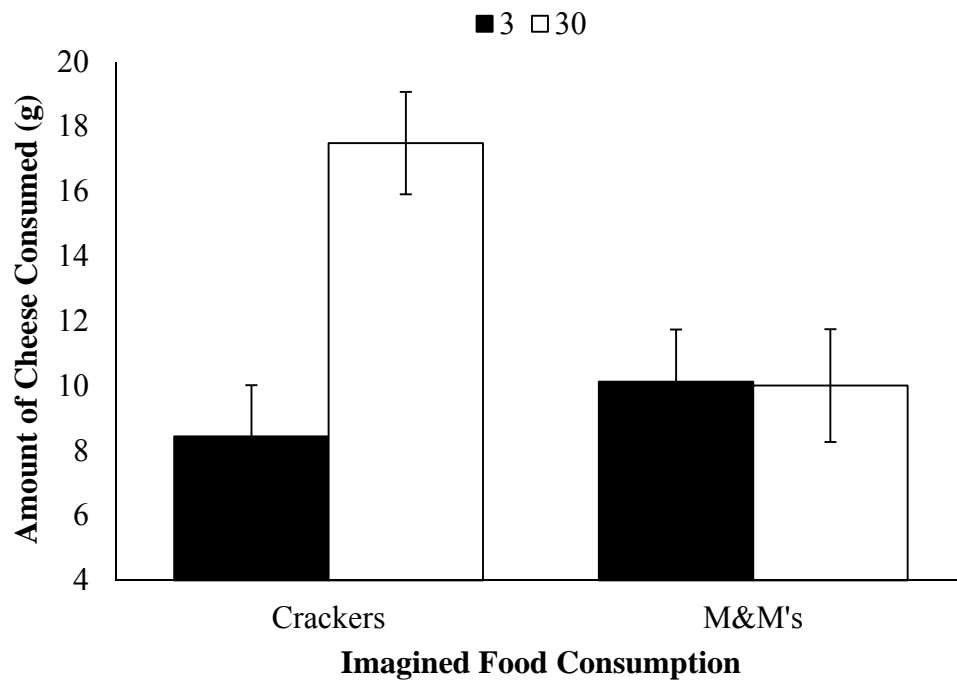


Figure 4: Amount of cheese intake after imagined food consumption in Experiment 4 as a function of the type of food and the quantity that had been imagined eaten. Error bars represent ± 1 SEM.

2.6.3. Discussion

Cross-stimulus sensitization appears to be specific. Participants repeatedly exposed to a complement of the target food were sensitized to the target, whereas participants repeatedly exposed to an unrelated food were not sensitized to the target. Specifically, participants who had imagined eating 30 crackers subsequently consumed more Cheddar cheese cubes than did participants who had imagined eating 3 crackers. The number of M&M's that participants

imagined eating, however, did not affect their subsequent cheese consumption. Participants who had imagined eating 30 M&M's ate as many cheese cubes as did participants who had imagined eating 3 M&M's. Together with our previous experiments, the results provide strong evidence that the top-down processes that engender habituation to a food also sensitize one to complementary foods but not to unrelated foods.

2.7. EXPERIMENT 5: LIKING VERSUS WANTING

Two distinct psychological processes regulate food intake (Berridge 1996, 2007). One is liking or palatability (i.e., the pleasure or hedonic value derived from eating a food), and the other is wanting or appetite (i.e., the motivation to obtain a food). Some researchers have argued on theoretical grounds that habituation and sensitization are fundamentally motivational processes (McSweeney and Swindell 1999; Epstein et al. 2009). This conceptualization is also consistent with the incentive-saliency theory of addiction according to which repeated administration of drugs increases cue-elicited wanting but not necessarily liking of a drug (Robinson and Berridge 1993, 2003). The theory has been primarily used to describe drug sensitization but should also be applicable to food stimuli (Berridge 2007; c.f., Tiffany 1990). Consuming a food should, like consuming a drug, increase the motivation to obtain complementary foods but should not affect the perceived hedonic value of those foods. Experiment 1 provided some evidence for this hypothesis, as participants ate more crackers with jelly when they had beforehand eaten two crackers with peanut butter (a complement) than did participants who had beforehand eaten two plain crackers. Even though participants in the complementary food condition ate more crackers with jelly, both groups reported liking the

crackers with jelly equally, suggesting that cross-stimulus sensitization increased the motivation to consume that food without affecting how much participants liked it.

In Experiment 5, we systematically tested which of these two processes, food wanting or liking, underlies sensitization to complements. Participants imagined eating 3 or 30 grapes and then indicated how pleasurable it would be to eat cheese (i.e., an index of liking), and how much they would be willing to pay for one pound of cheese (i.e., an index of wanting; Litt, Khan, and Shiv 2010). We expected that participants who imagined eating 30 grapes would be willing to pay more for cheese than participants who imagined eating 3 grapes, but that both would consider the consumption of cheese to be similarly pleasurable.

2.7.1. Method

Participants and Design

Five hundred and sixty nine Americans (215 males and 354 females; $M_{\text{age}} = 35.21$, $SD = 13.18$) completed an online study. The study employed a 2 (imagined consumption of grapes: 3 vs. 30; between-subjects) x 2 (wanting vs. liking of cheese; within-subjects) design.

Procedure

Participants first indicated how often they used coin-operated laundry machines on a seven-point scale with endpoints, *Never* (1) and *Daily* (7). As in Experiment 3, all participants then imagined performing 33 repetitive actions at their own pace. Participants in the *3-grapes* condition were first shown a bowl containing 30 quarters, and were then asked to imagine

inserting each quarter into a laundry machine, one at-a-time. After the quarter-imagination task, participants were shown a bowl of grapes, and then asked to imagine eating 3 grapes in the same way. Participants in the *30-grapes* condition first imagined inserting 3 quarters into a laundry machine, one-at-a-time, before they imagined eating 30 grapes, one at-a-time. By keeping the overall number of imagined actions constant, we ensured that all participants would engage in an equal amount of mental effort.

After participants imagined eating grapes, they indicated the kind of cheese they would eat with those grapes. As a measure of liking, participants indicated how pleasurable it would be to eat that cheese by choosing one of five different emoticons, ranging from a sad face ☹ (1) over a neutral face 😐 (3) to a smiley face 😊 (5). As a measure of wanting, participants indicated how much they would be willing to pay for 1 lb of that cheese by moving a slider on a scale ranging from \$1/lb to \$10/lb in \$1/lb increments. The order of the measures was counterbalanced. Finally, participants completed a PANAS, listed when and what they ate before the experiment, indicated whether they actually imagined the task as they were instructed to, and whether they had previously participated in a similar experiment.

2.7.2. Results

Twenty-six participants indicated they didn't perform the imagination tasks as they were instructed to. Their responses were not included in the subsequent analyses. No outliers were identified based on wanting and liking responses.

Liking and Wanting by Imagined Consumption

A mixed 2 (imagined consumption: 3 grapes vs. 30 grapes; between-subjects) x 2 (measure: wanting vs. liking; within-subjects) ANOVA yielded a significant main-effect for imagined consumption ($F(1, 541) = 6.57, p = .01, \eta_p^2 = .01$), and the predicted two-way interaction, $F(1, 541) = 4.33, p = .04, \eta_p^2 = .008$. Participants who had imagined eating 30 grapes were willing to pay more for cheese ($M = \$3.59, SD = 1.86$) than were participants who had imagined eating 3 grapes ($M = \$3.17, SD = 1.69$), $F(1, 541) = 7.50, p = .006$. In contrast, liking of cheese did not differ significantly between the two conditions ($M_{3\text{-grapes}} = 3.75, SD = 1.08$; $M_{30\text{-grapes}} = 3.84, SD = 1.10$), $F < 1$. The manipulations did not influence the extent to which participants reported experiencing positive or negative affect, all $F_s < 1$.

2.7.3. Discussion

Exposure to a food appears to sensitize one to its complements by increasing the motivation to obtain its complements rather than by increasing how much one likes them. Participants who had imagined eating 30 grapes were willing to pay more for cheese that they would typically eat with those grapes than were participants who had imagined eating 3 grapes. Liking for the complementary cheese, however, was not affected by the imagery induction. It should be noted that this effect emerged in an online study in which we had little control over how much effort participants exerted in the imagination tasks.

The results of Experiment 5 also lend support to the theorizing that food sensitization, like habituation to food, occurs as a result of motivational processes (McSweeney and Swindell 1999; Epstein et al. 2009). With pre-ingestive factors such as taste and smell eliminated, participants merely exposed to a food only through an imagination induction exhibited

sensitization both in their consumption of its complement and their motivation to obtain that complement. These findings mirror Morewedge and colleagues' (2010) findings that habituation to a food through imaginary consumption is driven by a decline in wanting the food rather than a decline in how much one likes it (i.e., its hedonic value).

2.8. EXPERIMENT 6A: CULTURAL DIFFERENCES IN SENSITIZATION

Experiments 6A and 6B examined the role of behavioral scripts in the sensitization process to complements. Because behavioral scripts are learned through culture, complementarity between foods may not be the same in different cultures. In Experiment 6A and 6B, we tested sensitization to complements in different cultures. In cultures where two foods are typically consumed together (i.e., they are part of the same behavioral script) we expected to find sensitization across these two foods. In contrast, in cultures where the same two foods are typically not consumed together (i.e., they are not part of the same behavioral script) no sensitization across the two foods should be observed. In Experiment 6A and 6B, we compared sensitization to the same pairs of foods between participants in India and USA.

2.8.1. Stimuli Pretest

To select food pairs which are complements in one country but not in the other, we first asked for advice to an Indian student who is familiar with both Indian and American foods. Pizza and cola were recommended as complements in both India and the US, whereas pizza and ketchup were recommended as complements in India but not the US. To confirm the difference

in behavioral scripts with these food pairs in India and the US, we conducted an online pretest with 50 Indians (35 males and 15 females; $M_{\text{age}} = 28.58$, $SD = 8.25$) and 50 Americans (33 males and 17 females; $M_{\text{age}} = 28.96$, $SD = 8.63$). Participants saw ten different pairs of foods, which included pizza and cola, and pizza and ketchup, and indicated how often they consume each pair of foods together on a seven-point scale with endpoints, *Not at all* (1) and *Very often* (7).

Because Indians gave higher ratings than Americans for all ten food pairs ($M_{\text{overall_India}} = 4.61$, $SD = 1.26$, $M_{\text{overall_USA}} = 3.05$, $SD = .96$), $F(1, 98) = 48.33$, $p < .001$, we standardized the frequency ratings across all food pairs within each country and used them for the analysis. As predicted, pizza and cola were frequently consumed together in both countries ($M_{\text{India}} = .32$, $SD = .96$, $M_{\text{USA}} = .48$, $SD = .90$), $F(1, 98) = .79$, $p > .38$, whereas pizza and ketchup were frequently consumed together in India ($M_{\text{India}} = .23$, $SD = .93$) but not in the US ($M_{\text{USA}} = -.81$, $SD = .47$), $F(1, 98) = 49.64$, $p < .001$.

2.8.2. Method

Participants

97 Indians (51 males and 46 females; $M_{\text{age}} = 29.65$, $SD = 7.79$) and 148 Americans (84 males and 64 females; $M_{\text{age}} = 32.03$, $SD = 10.97$) participated online.

Procedure

Experiment 6A was run online in both India and the US at the same time. Participants were randomly assigned to one of three conditions. Participants in a *cola* condition were shown a glass of cola and asked to imagine drinking one serving of cola, one sip at a time. Specifically, they were asked to imagine drinking one sip of cola, drinking another sip of cola, and so on until they had imagined drinking the whole serving. Participants in a *ketchup* condition were shown a spoonful of ketchup and asked to imagine eating one serving of ketchup, a little bit at a time. Similarly, participants in a *rice* condition were shown a spoonful of rice and asked to imagine eating one serving of rice, one bite at a time. After imagining eating one of the three foods at their own pace, all participants were asked to indicate how much pizza they would want to eat right then by choosing one of six different numbers of pizza slices, ranging from one slice (1) to six slices (6).

2.8.3. Results

We examined the role of behavioral scripts in sensitization in a 3 (food: cola vs. ketchup vs. rice) x 2 (country: India vs. US) ANOVA. The analysis revealed a significant main-effect for country, $F(1, 239) = 7.34, p = .007, \eta_p^2 = .030$ and a significant interaction, $F(2, 239) = 4.08, p = .02, \eta_p^2 = .033$. For participants in India, planned comparisons revealed that imagining drinking cola and imagining eating ketchup subsequently increased craving for pizza ($M_{cola} = 3.73$ slices, $SD = 1.72$, and $M_{ketchup} = 3.57$ slices, $SD = 1.80$) compared to imagining eating rice ($M_{rice} = 2.76$ slices, $SD = 1.44$), $F(1, 239) = 6.30, p = .01$ and $F(1, 239) = 4.19, p = .04$, respectively. The amount of pizza that participants wanted to eat between the first two conditions did not differ, $F(1, 239) = .16, p = .69$. For participants in the USA, we found no differences in

the amount of pizza that participants wanted to eat among the three conditions ($M_{cola} = 2.50$ slices, $SD = 1.33$, $M_{ketchup} = 2.92$ slices, $SD = 1.63$, and $M_{rice} = 2.96$ slices, $SD = 1.63$), $F(1, 239) = 1.28, p > .27$.

2.8.4. Discussion

Our theory predicts that sensitization to foods should occur only in a country where these foods are frequently consumed together. We thus predicted that for Indians, repeatedly imagining drinking a sip of cola or imagining eating a little bit of ketchup would increase wanting for pizza as it complements to cola and also to ketchup. For American participants, we predicted that repeatedly imagining drinking a sip of cola, but not repeatedly imagining eating a small amount of ketchup, would increase wanting for pizza because cola is a complement to pizza but not is ketchup.

For Indian participants, as we predicted, we found that participants who had imagined drinking cola or eating ketchup subsequently indicated greater craving for pizza than those who had imagined eating rice. These results lend support to our hypothesis that behavioral scripts underlie sensitization to complements. For Americans, we didn't find the predicted effect. One possible explanation for this null effect might be the primed fullness or feelings of guilt after imagining drinking cola. At the end of the survey, some participants in USA mentioned that they felt full or guilty after imagining drinking cola repeatedly. Because participants in the cola condition were shown a full glass of cola whereas those in ketchup or rice condition were shown only a spoonful of ketchup or rice, imagining drinking a full glass of cola might decrease the motivation to eat more foods due to feelings of fullness and guilt.

To rule out these possibilities, in Experiment 6B, we held the amount and type of food imagined constant and instead measured participants' motivation to eat either its complements or unrelated foods.

2.9. EXPERIMENT 6B: CULTURAL DIFFERENCE IN SENSITIZATION

2.9.1. Method

Participants

44 Indians (30 males and 14 females; $M_{\text{age}} = 32.77$, $SD = 10.25$) and 76 Americans (33 males and 43 females; $M_{\text{age}} = 31.97$, $SD = 12.28$) participated online.

Procedure

Experiment 6B was similar to the procedure of Experiment 6A. All participants first imagined eating a small bite of pizza repeatedly until they had imagined eating a whole big slice of pizza. After that, participants were randomly assigned to one of three conditions, in which they were asked to indicate their craving right then for one of three foods – cola, ketchup, or rice – on a seven-point scale with endpoints, *Not at all* (1) and *Extremely* (7).

2.9.2. Results

We examined the role of behavioral scripts in sensitization in a 3 (food: cola vs. ketchup vs. rice) x 2 (country: India vs. US) ANOVA. The analysis revealed a significant main-effect for country, $F(1, 114) = 20.83, p < .001$ and a significant main-effect for foods, $F(2, 114) = 9.07, p < .001$. More importantly, we found a significant interaction, $F(2, 114) = 3.38, p = .038$.

For American participants, a planned contrast revealed that after imaging eating a big slice of pizza, participants had greater craving for cola ($M_{cola} = 4.46, SD = 1.82$) than for ketchup ($M_{ketchup} = 1.68, SD = 1.07$) or rice ($M_{rice} = 2.72, SD = 1.60$), $F(1, 114) = 27.67, p < .001$. Among Indian participants, no differences in craving for three foods were observed, $F(2, 114) = .65, p > .53$.

2.9.3. Discussion

For American participants, as we predicted, repeatedly imagining consuming a food increased craving for a complementary food as compared to non-complementary foods. After imagining eating a whole slice of pizza, one bite at a time, participants indicated greater craving for cola than for ketchup or rice. Thus the results support sensitization to complements.

Unlike what we predicted, however, for Indian participants, there were no differences in craving for complement or non-complements after the imagined consumption. One possibility for this null effect is that it might be difficult for Indian participants to indicate their current states on a subjective Likert scales. Not only in this experiment but also in other pre-tests, we

found that Indian participants generally give much higher ratings than American participants, regardless of the question asked (i.e., greater acquiescence tendency).

2.10. GENERAL DISCUSSION

Foods are often acquired and consumed together, whether simultaneously or in sequence. We found that exposure to or consumption of one food can sensitize one to foods normally consumed in conjunction with that food by increasing the motivation to consume them. Furthermore, this effect appears to be driven by similar top-down processes that engender habituation. In Experiment 1, we found that the consumption of a food increases the subsequent consumption of complementary foods but not unrelated foods. In Experiment 2, we found that sensitization is not due to mere associations between foods. Consumption of a food increases subsequent consumption of its complements but not of merely associated foods. In Experiment 3, we found that the same top-down processes that habituate one to a food sensitize one to its complements. Repeatedly imagining the consumption of a food decreased subsequent consumption of that food, whereas repeatedly imagining the consumption of a complementary food increased its subsequent consumption. In Experiment 4, we tested the specificity of the sensitization effect induced by this top-down process. As in Experiment 3, we found that repeatedly imagined consumption of a food increased subsequent consumption of a complement. However, repeatedly imagined consumption of a food did not increase the subsequent consumption of an unrelated food. In Experiment 5, we investigated the underlying process by which the imagined consumption of a food sensitizes one to its complements. The imagined consumption of a food increased subsequent consumption of its complements by increasing how

much one wants, but not likes, foods complementary to the food imagined. Finally in Experiments 6A and 6B, we examined whether sensitization to complements is due to behavioral scripts by comparing sensitization to the same pairs of foods in difference cultures.

The present research makes three substantive contributions to the scientific understanding of consummatory behavior. First, this research provides a testable framework in which to examine the scope of sensitization effects. Unlike habituation, which is stimulus-specific, specificity of sensitization has not been well understood (McSweeney and Swindell 1999). Marketing research and economic theory have found important interdependencies in the consumption of items (Deaton and Muelbauer 1980; Wadwha et al. 2008), but it has not been clear which sets of goods are affected by the consumption of other goods. Just as the activation of goals and exposure to contexts can engage strongly associated goals, engaging in motivated behavior to consume a food appears to activate the goal to consume foods frequently consumed in conjunction with that food. Our theory and findings suggest that the consumption of a food should sensitize one to those foods that are frequently consumed in conjunction with that food, but should not sensitize one to all foods. Sensitization effects are likely to be determined by the co-consumption of foods independent of their combined sensory effects. Eating peanut butter, for example, will only increase one's desire for jelly if that particular combination of foods is one with which one is intimately familiar.

Second, the studies further elucidate the role of top-down motivational processes in sensitization effects. Both top-down cognitive/motivational processes and bottom-up sensory processes are believed to play important roles in food intake (McSweeney and Swindell 1999), but their specific roles and independence has yet to be delineated. Our findings suggest that the top-down processes involved in habituation to a food (Morewedge et al. 2010) can also engender

sensitization to its complements. Experiments 3, 4, and 5 demonstrated these effects in the absence of any sensory inputs.

Third, the current research contributes to an understanding of the different influences that food wanting and liking have on food intake. Berridge (2007) has noted that understanding food wanting and liking, which are the psychological determinants of eating behavior, is critical for dealing with problems in energy intake including obesity. Although prior research suggests a dissociation between wanting and liking, most of the research in this area has been demonstrated in animals or is based on neurological findings, whereas relatively little research has been done with humans (Berridge 2007). The current research shows a distinction between food wanting and liking and demonstrates the importance of food wanting in human food consumption. We believe that these findings contribute further to understanding the separable effects of food wanting and liking in the regulation of food intake, which may be critical factors for overconsumption, appetite control, and food choice.

In conclusion, we find specificity in sensitization in the domain of food. Exposure to or consumption of a food sensitizes one to complementary foods, foods consumed in conjunction with that food. This sensitization appears to occur as a result of changes in the motivation to consume the food, rather than a change in the palatability of the food or pleasure resulting from its consumption.

3. WITHIN-CATEGORY VERSUS CROSS-CATEGORY SUBSTITUTION IN FOOD CONSUMPTION

Suppose you have a craving for Godiva chocolate. Unfortunately, the chocolate is not available right now, but two substitutes are available: a less desired chocolate bar and a granola bar. Which one would you choose to reduce your craving for Godiva chocolate? In other words, which would be a better substitute for the Godiva chocolate?

When a desired option is unavailable, consumers often switch to substitutes. Substitution typically occurs within the same category, but consumers may also substitute across product categories. Although cross-category substitution is relatively common (Park and Gupta 2011), very little is known about how cross-category substitutes influence consumption experiences. The current research examines how the consumption of cross-category versus within-category substitutes influences craving for and consumption of the desired target food. We suggest that although most consumers prefer within-category substitutes (the less desired chocolate bar in the above example) over cross-category substitutes (the granola bar) when the target is not available, consuming a cross-category substitute may be more effective in reducing craving for the target (Godiva chocolate). We show that consuming cross-category substitutes reduce motivation to obtain the target (i.e., wanting) to a greater degree than consuming within-category substitutes without affecting the hedonic value of the target (i.e., liking). We suggest that this within- versus cross-category substitution effect is due to comparisons between the target and the substitutes, which occurs only within the same product category but not across different product categories.

3.1. THEORETICAL BACKGROUND

3.1.1. Substitutes

Substitutes are goods that can be used to replace one another by satisfying, at least partly, the same consumers' needs (Nicholson 1998). According to standard utility-models, if a desired product is unavailable or unaffordable, consumers will switch to the most similar alternative, which is the best substitute for the desired product (Bass, Pessemier, and Lehmann 1972). So a consumer whose most preferred drink is Coke would choose Pepsi over 7-Up as a substitute for Coke. Recent research, however, has challenged this assumption by examining how consumers react to substitutes when their top choice is not available. For example, Boland, Brucks, and Nielson (2012) found that when a top choice is unavailable, consumers may abandon a second best option and choose an option that shares the differentiating feature with the unavailable top choice. While this work has provided insight into how availability of choices influences consumers' preferences of substitutes, most research focuses only on substitution within the same product category (e.g., how unavailability of a top choice pen influences subsequent choice among nonselected pens). Substitution across different product categories has been paid little attention. In the current research, we examine how consumption of cross- versus within-categories substitutes influences consumption experiences.

Substitutes can be classified as within-category and cross-category substitutes based on whether they belong to the same or different product categories as the target product. Within-category substitutes—by definition—share many features with the target and thereby satisfy the same consumer needs. Store brand potato chips, for example, would be a within-category substitute for Lay's potato chip. However, substitution can occur across product categories, too,

where the cross-category substitutes typically satisfy a higher level consumer need as the target. For example, Rold Gold pretzels are not potato chips but satisfy a consumer's craving for snacks, so pretzels are a cross-category substitute for Lay's potato chips.

Although cross-category substitution is relatively common (Park and Gupta 2011), very little is known about how consumption of cross-category substitutes influences consumption experiences. In the current research, we examined consumers' preference between cross- versus within-category substitutes and how consumption of different types of substitutes influences craving for the desired target food.

3.1.2. Categorization of Substitutes

Consumers use categorical structures in memory to classify, interpret, and evaluate products. Using categorical representations often simplifies judgments and decision-making as consumers make useful inferences by comparing a target product to other category members (Loken, Barsalou, and Joiner 2008; Barsalou 1985; Alba and Hutchinson 1987).

The classic models on categorization suggest that similarity and typicality are based on the categorical representation of objects as sets of attributes. Specifically, Rosch and Mervis's (1975) model postulates that typicality depends on family resemblance, namely the degree to which a target object shares attributes with all other category members. For *birds*, for instance, *robin* is perceived as typical whereas *ostrich* is perceived as atypical (Barsalou 1985). Tversky (1977)'s model suggests that similarity is a function of the common and distinctive attributes of

objects. Two products should be perceived as similar to the extent that they share common attributes, and as dissimilar to the extent that each possesses distinctive attributes.

Further developing the similarity and typicality models, Barsalou (1983, 1985) suggests that consumers generate common taxonomic categories and goal-derived categories. Taxonomic categories are defined as those commonly used by members of a culture to classify objects, such as birds, furniture, and fruit, which share attributes with each other to some degree. In contrast, goal-derived categories refer to those categories that consumers construct for achieving goals such as things people might eat as snacks when in a hurry. Because the goal-derived categories of items related to goal achievement are constructed ad hoc, objects in the same category may share few features on the surface and initially not be associated with each other in memory. Within-category substitutes share many features with the target on the surface and thus should be classified into a common taxonomic category with the target. In contrast, cross-category substitutes should be classified into a common goal-derived category with the target because the cross-category substitutes satisfy the common goal as the target although they share relatively few features (Ratneshwar et al. 2001; Ratneshwar and Shocker 1991).

Because taxonomic categories are well established in memory, taxonomic category information should be easily accessible when consumers look for substitutes. Consumers are hence likely to prefer within- to cross-category substitutes, as the former belong to the same taxonomic category as the target, to satisfy their craving for the target. Goal-derived categories are typically not as salient as taxonomic categories. Cross-category substitutes are thus less likely to be preferred to within-category substitutes, even though they serve the same goal as within-category substitutes. In the current research, we show that most consumers prefer a within-category substitute when the target food is unavailable, but consuming a cross-category

substitute actually satisfies the consumer's need better than the within-category substitute. We examined whether this effect occurs as a result of the comparison between the target and the within-category substitute, which evokes an unfavorable contrast, whereas no such contrast arises when the target is compared to the cross-category substitute.

3.1.3. Contrast Effects with Substitutes

Perceptions or judgments of a stimulus are influenced by the context which provides a standard of comparison for the stimulus (Sherif and Hovland 1961). For example, a small gray square looks darker on a white background than a black background, and a dog looks smaller when it was placed next to an elephant than a mouse. Such contrast effects have been observed in various types of decision making processes, including perceptual judgments, product evaluation, social judgments, attitudes and beliefs, affect, and intergroup perceptions (Parducci 1992; Lynch, Chakaravarti, and Mitra 1991; Biernat 2005; Schwarz and Bless 1992).

Previous research suggests that contrast effects occur when there is categorical similarity between the target and context stimuli (Raghunathan and Irwin 2001; Zeller, Rohm, Bassetti, and Parker 2003; Zeller, Kern, and Parker 2002; Morewedge et al. 2010). So the context stimulus serves as a relevant comparison standard when it is perceived to be in the same category but not when it is perceived to be dissimilar to the target stimulus. When a within-category substitute is consumed, the less desirable substitute will be contrasted to the desired target since the substitute is perceived to be similar to the target. In contrast, consuming a cross-category substitute should not induce contrast as the substitute and the target are perceived to be in different categories. Therefore, consuming a cross-category substitute can satisfy consumer needs better than

consuming a within-category substitute as no negative contrast arises when the cross-category substitute is compared to the target food.

The current research examined how the consumption of cross-category substitutes influences consumption of the target in the domain of food consumption. We demonstrate that although consumers prefer the within-category substitute to the cross category substitute when the target is not available (Experiments 1A and 1B), consuming a cross-category substitute actually satisfies the consumer's need better than the within-category substitute (Experiment 2) by changing wanting for the target rather than liking (Experiment 3). As hypothesized, the effect occurs because the within-category substitute is compared to the target food resulting in a contrast effect, but no such contrast arises when the cross-category substitute is compared to the target food (Experiment 4).

3.2. EXPERIMENT 1A: CONSUMER PREFERENCE

The first experiment tested consumers' preference for a less desired within-category substitute and a cross-category substitute. We predicted that participants would prefer the within-category substitute to the cross-substitute category because the within-category substitute is more similar to the target than is the cross-category substitute.

3.2.1. Method

Participants

Thirty Carnegie Mellon University students (22 males and 8 females; $M_{\text{age}} = 20.47$, $SD = 1.83$) participated.

Stimuli

Ritters Sports Hazelnut chocolate was used as a target food, and Giant Eagle Peanut chocolate (generic brand of chocolate) and Oat's 'N Honey Nature Valley's granola bar were used as within- and cross-category substitutes, respectively (Appendix A)².

Procedure

The experiment was conducted at a university center. Participants were asked to imagine that they craved Ritter's chocolate (target) right then but it was not available. They were then told that they had access to a bag of Giant Eagle chocolate (within-category substitute) and a Nature Valley's granola bar (cross-category substitute), and asked to indicate which one they would prefer to satisfy their craving for Ritter's chocolate on a seven-point scale (1 = Definitely Giant Eagle chocolate, 4 = Indifferent, 7 = Definitely Nature Valley's granola bar). After indication of their preference, participants were asked whether they had participated in a similar experiment where they had consumed any of these snacks. Finally, participants indicated their age and gender.

3.2.2. Results

² Ritters' chocolate contains 6.30 calories per gram, Giant Eagle chocolate contains 5.25 calories per gram, and Nature Valley's granola bar contains 4.52 calories per gram.

One participant indicated that he had previously participated in a similar experiment. The data from this participant were excluded from the analyses.

As predicted, participants preferred the within-category substitute to the cross-category substitute ($M_{\text{preference}} = 2.21$, $SD = 1.74$) to satisfy their craving for the target (test again the midpoint of the scale: $t(28) = 5.55$, $p < 0.00001$). The same result was obtained when participants' preferences were recoded into a binary choice (82.8% chose the Giant Eagle chocolate, $\chi^2(1) = 12.45$, $p < .0001$)³.

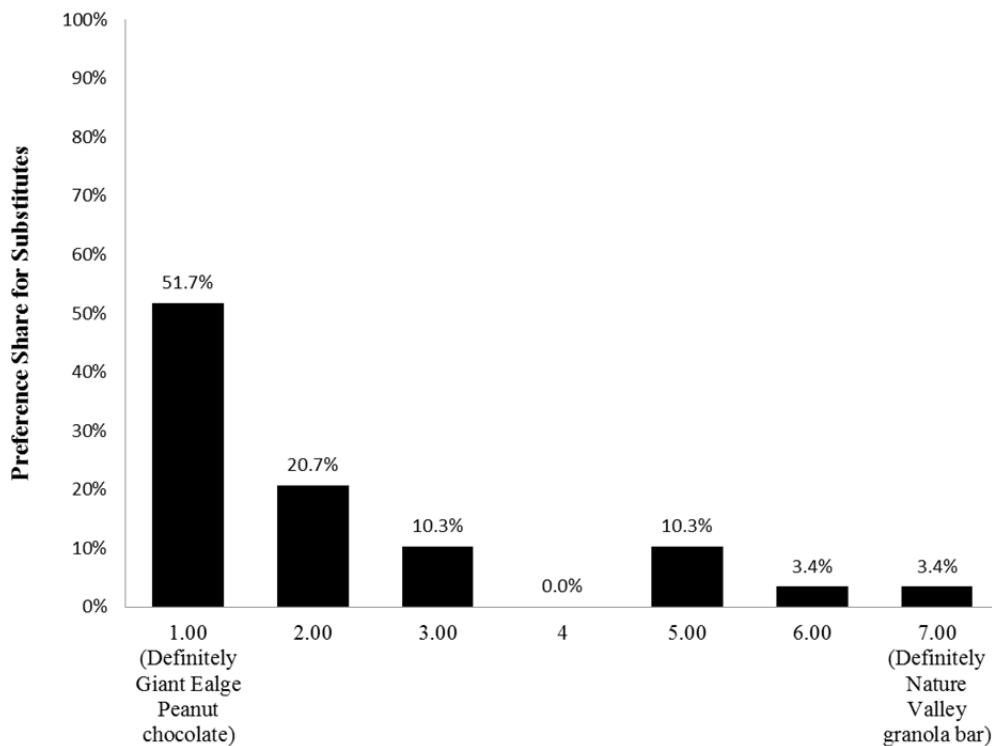


Figure 1: Preference share (%) for substitutes in Experiment 1.

³ No subject indicated 4 (indifference) for their preference.

3.2.3. Discussion

The results suggest that consumers prefer a within- to a cross-category substitute to satisfy their craving for a target. Although the results show consumers' preference for a within-category substitute, because of the hypothetical nature of the choice that participants made, the observed preference might not occur when a real choice is involved. To investigate this conjecture, the next experiment tested consumer preference on substitutes using a real choice.

3.3. EXPERIMENT 1B: ACTUAL CHOICE OF SUBSTITUTES

Experiment 1B tested consumers' actual choice for a within- and a cross-category substitute. After choosing, participants actually consumed their choice of substitutes. As in Experiment 1A, we predicted that participants would prefer the within-category substitute to the cross-substitute category.

3.3.1. Method

Participants

Forty-four Carnegie Mellon University students (17 males and 27 females; $M_{\text{age}} = 20.07$, $SD = 1.58$) participated for partial course credit.

Procedure

Participants in a “snack study” were run in groups ranging in size from 1 to 2; each participant was seated in a private cubicle. All participants first ate one piece of the Ritter’s chocolate (target) and rated how much they craved another piece of Ritter’s chocolate by moving a slider with end points, *Not at all* (1) and *Very much* (100). Next participants were shown pictures of Giant Eagle chocolate peanuts (within-category substitute) and a Nature Valley’s granola bar (cross-category substitute) and told that they could choose the food that would better satisfy their craving for Ritter’s chocolate and actually consume their choice of food. Participants indicated their choice and consumed 20 grams of the food that they had chosen.

After participants consumed their choice of substitute, they rated similarity among Ritter Sport Hazelnut chocolate, Giant Eagle Chocolate Peanuts, and Nature Valley Granola Bar (How similar are Sport Hazelnut chocolate and Giant Eagle Chocolate Peanuts?) on a seven-point scale with endpoints, *Very different* (1) and *Very similar* (7). Finally, participants reported their age and gender.

3.3.2. Results

72.7% participants chose and consumed the within-category substitute ($\chi^2(1) = 9.09, p = .003$). The results suggest that consumers prefer a within-category substitute to a cross-category substitute to satisfy their craving for the target. Furthermore, we examined whether craving for the target influenced participants’ choice of substitutes, using a logistic regression with substitute choice (0 = within-category substitute, 1 = cross-category substitute) as the dependent variable and craving for the target (continuous variable), which was measured after

participants had eaten one small piece of the target, as the independent variable. Participants who craved the target more were more likely to choose and consume the within-category than the cross-category substitute ($\beta = -.04$, $SE = .01$; $Wald(1) = 6.94$, $p < .01$).

3.3.3. Discussion

Replicating the results of Experiment 1A, we found that participants prefer a within- to a cross-category substitute to satisfy their craving for the target. Furthermore, participants who craved the target more were more likely to choose and consume the within-category than the cross-category substitute (Experiment 1B). In Experiment 2, we examined whether consumers are right in predicting that consuming within- rather than cross-category substitutes is more effective in satisfying their craving for the target.

3.4. EXPERIMENT 2: CONSUMPTION

In Experiment 2, we first whetted participants' appetite for a target stimulus (Wadhwa, Shiv, and Nowlis, 2008). After sampling the target, participants consumed one of three foods—the same target, a within-category substitute, or a cross-category substitute—before consuming the target ad libitum. If the within-category substitute better satisfies consumers' cravings than the cross-category substitute, participants who consumed the within-category substitute should consume less of the target than those who consumed the cross-category substitute.

3.4.1. Method

Participants

One hundred and thirty-two students at Carnegie Mellon University (62 males and 70 women; $M_{\text{age}} = 23.13$, $SD = 9.87$) participated for partial course credit or \$5.⁴

Procedure

All participants first ate one piece of the Ritter's chocolate (target) and rated how much they liked it on a 5-point scale with endpoints, *Not at all* (1) and *Very much* (5) and answered filler questions about the chocolate (e.g., "How sweet are they?" and "How salty are they?").

Participants were then randomly assigned to one of three conditions. Participants in the *same target* condition consumed 3 pieces of Ritter's Sports Hazelnut chocolate (19 grams). Participants in the *within-category substitute* condition consumed 19 grams of Giant Eagle Chocolate Peanuts (generic brand of chocolate), and those in the *cross-category substitute* condition consumed 19 grams of Nature Valley Oat n' Honey granola bar. Participants were asked to eat the entire snack that they received.

Next, all participants were given a bowl containing 50 grams of the target and were asked to sample as much as they would like. Participants notified the experimenter when they were done, who removed the bowl and surreptitiously weighed it. The amount participants ate served as dependent measure. After consuming the target, participants rated how similar were 1) Ritter's

⁴ Some data ($N = 13$) were collected during a severe storm. Those participants came to the lab just to flee the storm rather than to participate in an experiment as the building where our lab is located was the only building with power that day. When excluding their responses the effect becomes stronger, $F(1, 116) = 6.09$, $p = .003$, $\eta_p^2 = .95$.

chocolate and Giant Eagle chocolate, 2) Ritter's chocolate and Nature Valley's granola bar, and 3) Giant Eagle chocolate and Nature Valley's granola bar, on a 7-point scale with endpoints, *Very different* (1) and *Very similar* (7). Finally, participants reported demographic information, their current affective states on a PANAS (Watson, Cleark, & Telegren, 1988), when and what they last ate before the experiment, and whether they performed the imagined the task as instructed.

3.4.3. Results

No responses were classified as outliers (i.e., no one ate more than 3 standard deviation from their cell-means). The following analyses include the full sample.

Substitute's similarities to the target

To examine whether the within-category substitute is perceived to be more similar to the target than the cross-category substitute, we examined the similarity ratings on foods in a repeated-measures ANOVA, which yielded a significant main effect, $F(2, 262) = 69.86, p < .0001, \eta_p^2 = .40$. As expected, the cross-category substitute was perceived as more similar ($M = 3.82, SD = 1.62$) to the target than the within-category substitute ($M = 2.10, SD = 1.51$), $F(1, 131) = 87.17, p < .0001$.

Initial liking of the target

We checked whether random assignment to experimental conditions was successful and analyzed the initial liking of the target across conditions—which participants rated after they first sampled the target—with a one-way between subjects ANOVA. As expected, the initial liking for the target didn't differ across conditions, $F(2, 129) < 1$, *ns*.

Actual consumption of target after consuming substitutes

We examined the effect of having consumed pieces of substitutes/the target on the subsequent consumption of the target food in a between-subjects ANOVA, which yielded a significant main effect of condition, $F(2, 129) = 3.37$, $p = .04$, $\eta_p^2 = .05$. Planned comparisons revealed that participants who had eaten the within-category substitute subsequently ate more of the target ($M = 20.82\text{g}$, $SD = 14.95$) than did participants who had eaten the cross-category substitute ($M = 13.95\text{g}$, $SD = 10.61$), $F(1, 129) = 5.42$, $p = .02$, and those who had eaten the target again ($M = 14.43\text{g}$, $SD = 15.46$), $F(1, 129) = 4.69$, $p = .03$. The latter two conditions did not differ, $F < 1$, *ns*. The manipulations did not influence the extent to which participants reported experiencing positive and negative affect, all $F_s < 1$.

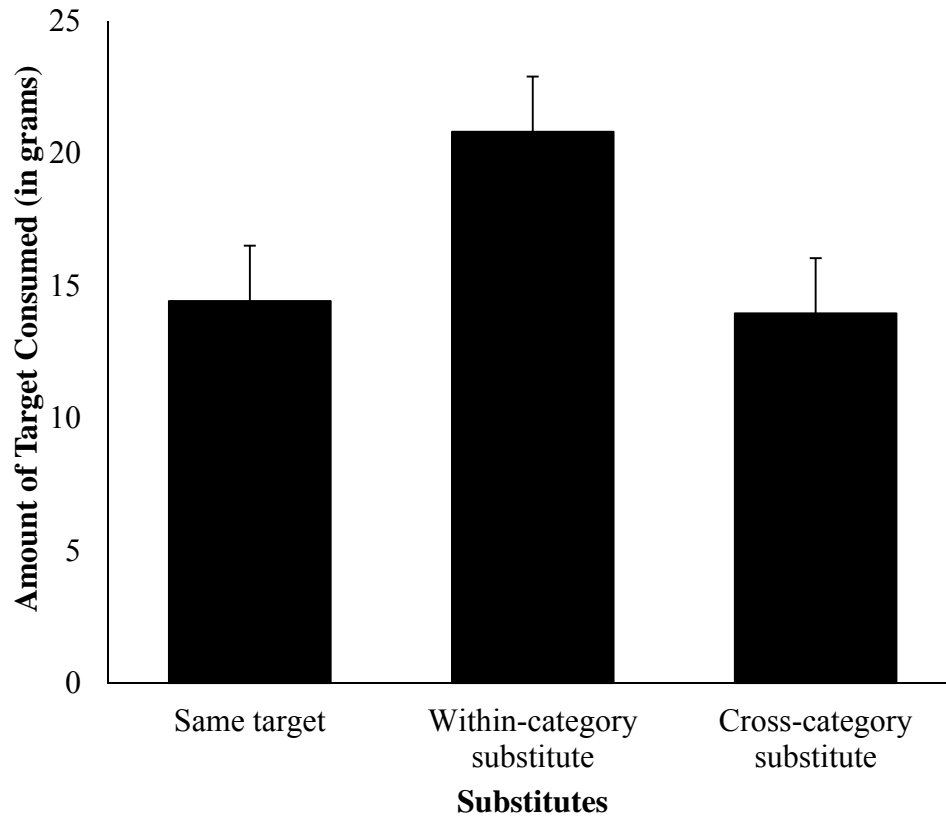


Figure 2: Amount of the target food consumed by condition in Experiment 2. Error bars represent ± 1 SEM.

3.4.4. Discussion

Although consumers believed a within-category substitute would better satisfy their craving for the target than a cross-category substitute (Experiments 1A and 1B), Experiment 2 shows that it does not. Participants who consumed the cross-category substitute subsequently consumed less of the target than participants who consumed the within-category substitute. The amount of the target consumed by participants who consumed the cross-category substitute did not differ from those who consumed the same target food. The results suggest that consuming a

cross-category substitute actually satisfies consumers' craving for the target better than consuming a within-cross category substitute.

3.5. EXPERIMENT 3: LIKING VERSUS WANTING

Two distinct psychological processes regulate food intake (Berridge 1996, 2007). One is liking or palatability (i.e., the pleasure or hedonic value derived from eating a food), and the other is wanting or appetite (i.e., the motivation to obtain a food). In Experiment 3, we tested which of these two processes, food wanting or liking, underlies the effect of substitutes on consumption of the target, using a standard procedure to test liking and wanting. As in Experiment 2, participants first sampled a target food and indicated how much they liked it. Then they consumed one of three foods: the same target food, a within-category substitute, or a cross-category substitute. After consuming the foods, participants re-indicated their liking for the target and their willingness to pay for the target. We calculated the difference between liking ratings for the target before and after the consumption of the substitute to create an index of change in liking (Rolls et al. 1981; Rolls et al. 1982), and willingness to pay for the target as an index of wanting (Litt, Khan, and Shiv 2010).

3.5.1. Method

Participants and Design

Sixty-six Carnegie Mellon University students (34 males and 32 females; $M_{\text{age}} = 20.42$, $SD = 1.39$) participated for partial course credit. The experiment employed a 3 (consumption of

foods: target vs. within-category substitute vs. cross-category substitute; between-subjects) x 2 (wanting vs. liking of the target; within-subjects) design.

Procedure

All participants first sampled the target food (Ritter's Sports Hazelnut chocolate). After sampling the target, they rated how much they liked it and answered filler questions about its taste. Participants were then randomly assigned to one of three conditions. Participants in the *same target* condition consumed 2 pieces of the target food (13 grams), participants in the *within-category substitute* condition consumed 13 grams of Giant Eagle chocolate peanuts, and participants in the *cross-category substitute* condition consumed 13 grams of Nature Valley's granola bar.

Next, all participants were asked to indicate their liking and wanting for the target food. To measure liking, participants were asked to indicate how pleasurable it would be to eat the target by choosing one of five different emoticons, ranging from a sad face ☹ (1) over a neutral face 😐 (3) to a smiley face 😊 (5). To measure wanting, participants were shown a series of pairwise choices and indicated their buying prices (Lerner, Small, and Loewenstein 2004). Specifically, for each pair of 9 options, participants indicated their preference between receiving one bar of Ritter's Sport Hazelnut chocolate and getting an amount of cash; the amount of cash ranged from \$0 to \$4.00 in \$0.5 increments. The order of the liking and wanting measures was counterbalanced. After indicating wanting and liking for the target food, participants rated similarities among the target food, the within-category substitute, and the cross-category substitute as in the previous experiment, and reported their current affective states on a PANAS (Watson, Clark, and Tellegen 1988) and their demographic information.

3.5.2. Results

Substitute-Target Similarity

We tested rated similarity between the substitute foods and the target food with a repeated-measures ANOVA, which yielded a significant main effect, $F(2, 130) = 70.86, p < .0001, \eta_p^2 = .64$. As in the previous experiment, the generic brand of chocolate was perceived as more similar ($M = 3.97, SD = 1.41$) to the target chocolate than the granola bar ($M = 1.89, SD = 1.04$), $F(1, 65) = 113.67, p < .0001$.

Initial liking of Ritter's chocolate

To make sure that there were no differences in the initial liking across conditions, which participants rated after they first sampled a piece of Ritter's chocolate, initial liking ratings were analyzed in an between-subjects ANOVA. As expected, liking for Ritter's chocolate did not differ significantly across conditions, $F(2, 63) = 1.23, p = .30$.

Liking and Wanting for the Target

To examine whether consumption of substitutes/target influenced liking and wanting of the target food, a repeated-measures ANOVA was conducted with conditions as the between-subject factor and the standardized liking (change in liking after the consumption of the substitute) and wanting scores (willingness to pay) as within-subject factor. The analysis yielded a significant interaction, $F(2, 63) = 4.70, p = .01, \eta_p^2 = .13$. To further examine the nature of this

interaction, simple effects were estimated. The simple effect of wanting was marginally significant, $F(2, 63) = 2.67, p = .08$, indicating that motivation to consume the target differed across the three conditions. Planned comparisons revealed that this effect was driven by a significantly lower WTP in the cross-category substitute condition ($M_{WTP} = \$1.48, SD = .70$) as compared to WTP in the within-category substitute ($M_{WTP} = \$2.07, SD = .97$), $F(1, 63) = 5.30, p = .03$. Willingness to pay in the same target condition ($M_{WTP} = \$1.82, SD = .87$) did not differ from WTP in the cross-category substitute and WTP in the within-category substitute conditions, $F(1, 63) = 1.75, p = .19$, and $F < 1, ns$, respectively.

The simple effect of liking was also significant, $F(1, 63) = 4.37, p = .02$, indicating that changes in liking of the target food differed across the three conditions. In contrast to wanting of the food, however, planned comparisons revealed that this effect was driven by those who had consumed the target again. Specifically, participants liked the target less after consuming it again ($M_{\text{change}} = -.77, SD = 1.02$), but no such change in liking of the target was observed in the within- and cross-category substitution conditions ($M_{\text{change}} = -.09, SD = .75$; $M_{\text{change}} = -.05, SD = .95$, respectively). The same target condition was significantly different from the within- and cross-category conditions ($F(1, 63) = 6.12, p = .02$, and $F(1, 63) = 6.98, p = .01$, respectively), but the latter two conditions did not differ, $F < 1, ns$. The observed decline in liking of the target after consuming the target again most likely denotes sensory-specific satiety caused by the repeated consumption of the target (Rolls et al. 1981).

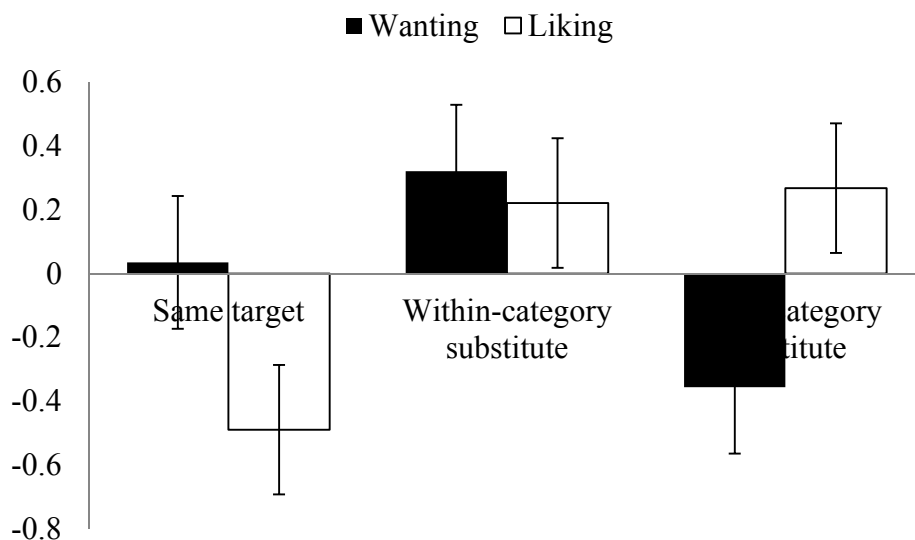


Figure 3: Wanting and liking for the target in Experiment 3. Error bars represent ± 1 SEM.

3.5.3. Discussion

The results of Experiment 3 suggest that consumption of substitutes changes the motivation to consumer the target. Consumption of the cross-category substitute decreased the motivation to obtain the target, however, it did not decrease the hedonic value of the target.

So far, we showed that although consumers prefer within-category substitutes to cross-category substitutes, the consumption of cross-category substitutes is actually more effective in reducing craving for and consumption of the target food. Consuming cross-category substitutes decreases consumers' motivation to obtain the target product (wanting) to a greater degree than consumption of within-category substitutes does. Liking of the target product, in contrast, is not affected by either cross- or within-category substitution.

In Experiment 4, we examined whether a contrast effect which occurs for within-category but not cross-categories comparisons underlies our findings. Specifically, we tested whether consuming an inferior substitute (vs. a substitute which is almost as good as the target) would increase craving for the target only when the substitute and the target belong to the same category.

3.6. EXPERIMENT 4: CONTRAST EFFECTS

Experiment 4 examined whether consumption of a within-category substitute results in an unfavorable contrast effects whereas a cross-category substitute does not evoke such contrast. Participants first consumed a small amount of the target and subsequently consumed a within- or cross-category substitute which was inferior to or as good as the target. We expected that when the substitute belongs to the same category as the target, consuming the inferior substitute would subsequently increase craving for the target as compared to consuming the substitute which is as good as the target. However, because cross-category substitution would not evoke contrast effects, we expected that subsequent craving for the target after consuming the cross-category substitute would not differ depending on the substitute's quality as compared to the target.

3.6.1. Stimuli Pretest

To assemble a stimulus set of substitutes, we conducted a pre-test with 27 residents in Pittsburgh (12 males and 15 females; $M_{\text{age}} = 23.85$, $SD = 6.32$) who participated in exchange for \$5. Participants tasted six different kinds of chocolate and five different kinds of granola bar.

After eating each snack, participants indicated how much they liked it on a seven-point scale with endpoints, *Not at all* (1) and *Very much* (7).

Based on paired comparisons, we classified Hershey's Almond Chocolate ($M = 6.48$, $SD = 1.58$) as the target food, Brach's Peanut Clusters Chocolate ($M = 6.07$, $SD = 1.75$) as the within-category substitute which is as good as the target, Giant Eagle Nonpariels Chocolate ($M = 5.19$, $SD = 2.06$) as the inferior within-category substitute, Nature Valley Dark Chocolate Peanut & Almond Granola Bar ($M = 5.81$, $SD = 2.42$) as the cross-category substitute which is as good as the target, and Giant Eagle Trail Mix Granola Bar ($M = 4.85$, $SD = 2.09$) as the inferior cross-category substitute (see Table 2).

Food	Mean*	SD
Hershey's Almond Chocolate	6.48 _a	1.58
Brach's Peanut Clusters Chocolate	6.07 _a	1.75
Giant Eagle Nonpariels Chocolate	5.19 _b	2.06
Nature Valley Dark Chocolate Peanut & Almond Granola Bar	5.81 _a	2.42
Giant Eagle Trail Mix Granola Bar	4.85 _b	2.09

Table 2: Liking of Target/Substitutes⁵

⁵ * Post-hoc pairwise comparisons (Tukey's tests) with different subscripts are significant at $p < .01$

3.6.2. Method

Participants and Design

One hundred and forty two residents in Pittsburgh (75 males and 67 females; $M_{\text{age}} = 23.49$, $SD = 8.10$) participated for \$5 or partial course credit. The experiment employed a 2 (category of a substitute: within vs. cross-category) x 2 (quality of a substitute as compared to the target: good vs. inferior) between-subjects design.

Procedure

The procedure of Experiment 4 was similar to the one in Experiment 2. All participants first sampled one piece of the target food (Hershey's Almond Chocolate). After sampling the target, participants consumed one of four substitutes, each of which contained 100 calories. Specifically, participants in the *good within-category substitute* condition consumed 19 grams of Brach's chocolate, participants in the *inferior within-category substitute* condition consumed 21 grams of Giant Eagle chocolate, participants in the *good cross-category substitute* condition consumed 22 grams of Nature Valley's granola bar, and participants in the *inferior cross-category substitute* condition consumed 25 grams of Giant Eagle granola bar. Participants were asked to eat the entire snack. Next, all participants were given a bowl containing 36 grams or 72 grams⁶ of the target and consumed as much as they wanted. The amount participants ate served as dependent measure.

⁶ Initially we gave 36 grams of the target to participants (N = 82). But because more than 30% of participants ate all 36 grams of the target, we increased the amount to 72 grams of the target. The change of the amount given was coded (0, 1) and included as a covariate in the analysis.

3.6.3. Results

The responses of 3 participants were classified as outliers (i.e., they ate more than 3 SD from their respective cell means). Their responses were not included in the subsequent analyses.

We examined the amount of the target food consumed in a 2 (category of the substitute: within- vs. cross-category) x 2 (quality of the substitute: good vs. inferior) ANCOVA with change in the amount given as a covariate (the covariate was not significant $F < 1$). The main-effects for quality of the substitute and for category were not significant, $F < 1$, *ns* and $F(1, 134) = 1.45$, $p = .23$, respectively. The two-way interaction was marginally significant, $F(1, 134) = 2.72$, $p = .10$, $\eta_p^2 = .02$.

As predicted, participants who had consumed the inferior within-category substitute subsequently consumed more of the target ($M = 27.14$ g, $SD = 16.95$) than did participants who had consumed the good within-category substitute ($M = 17.66$ g, $SD = 10.84$), $F(1, 134) = 8.19$, $p = .005$, $\eta_p^2 = .058$. No differences in the amount consumed were found between participants who had consumed the good cross-category substitute ($M = 18.71$ g, $SD = 12.36$) or the inferior cross-category substitute ($M = 20.38$ g, $SD = 14.60$), $F < 1$, *ns*.

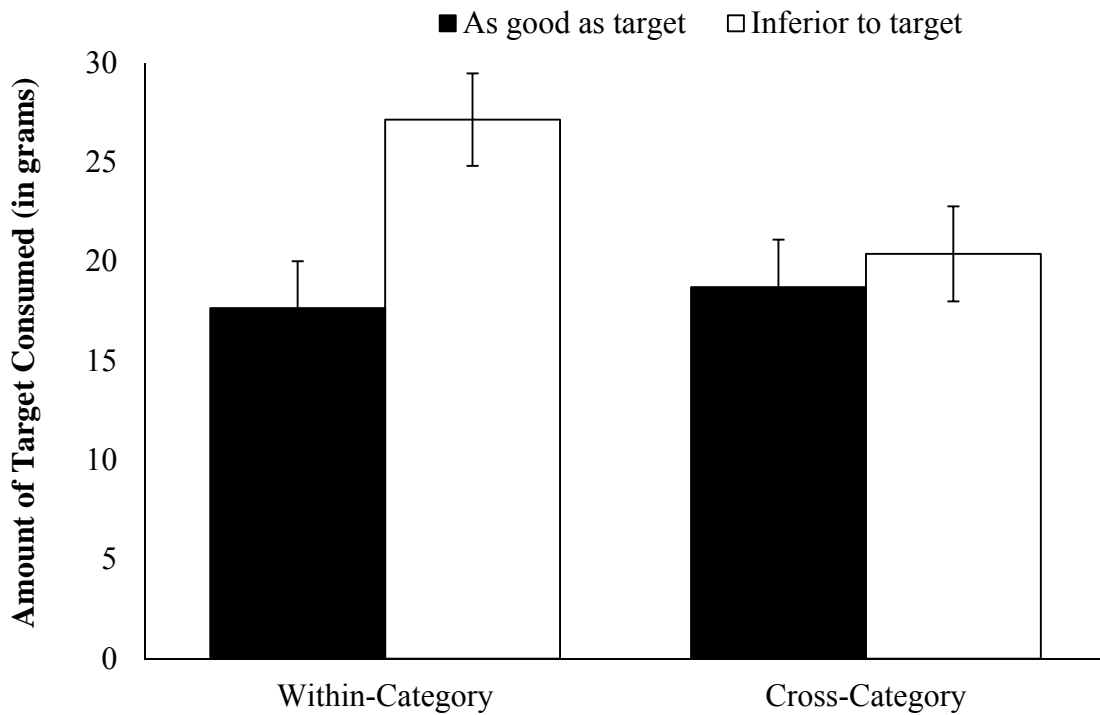


Figure 4: Amount of the target food consumed in Experiment 4 as a function of the category and the quality of the substitute. Error bars represent ± 1 SEM.

3.6.4. Discussion

Experiment 4 examined whether contrast effects, which occur in within-category but not cross-category comparisons, underlie our findings. The findings suggest that consumption of the within-category substitute results in a contrast effect whereas the cross-category substitute does not evoke such a contrast. Having consumed the inferior within-category substitute increased subsequent consumption of the target compared to having consumed the good within-category substitute. However, there was no difference in target consumption after having consumed the good or the inferior cross-category substitute. The results provide thus evidence that the within-

versus cross-category substitution effect occurs as a result of the comparison between the target and the within-category substitute, which evokes an unfavorable contrast, but no such contrast to the target arises when the cross-category substitute is consumed.

3.7. GENERAL DISCUSSION

The current research is among the first experimental research to investigate the effect of cross-category substitution on consumption. In Experiment 1A, we found that consumers prefer within- to cross-category substitutes to satisfy their craving for the target food. In Experiment 1B, we replicated the findings of Experiment 1 with actual choice and consumption. Furthermore, participants who craved the target more were found to be more likely to choose and consume the within-category rather than cross-category substitute. Experiment 2 and 3 examined whether consumption of within-category substitutes is more effective in reducing craving for the target food. In Experiment 2 contrary to consumers' belief, we found that the consumption of cross-category substitutes is actually more effective in reducing craving for and consumption of the target food. The results of Experiment 3 suggest that consuming cross-category substitutes decreases consumers' motivation to obtain the target product (wanting) to a greater degree than consumption of within-category substitutes does. Liking of the target product, in contrast, is not affected by either cross- or within-category substitution. In Experiment 4, we examined whether contrast effects which occur within-category but not across-categories underlie such substitution effect. We found that consuming an inferior substitute increases subsequent consumption of the target than consuming a good substitute, but only when the substitute and the target belong to the same category. For cross-category substitutes, the quality of the substitute did not influence the

subsequent craving for the target. Thus, the results suggest that the within- versus cross-category substitution effect occurs as a result of the comparison between the target and the within-category substitute, which evokes an unfavorable contrast, but no such contrast to the target arises when the cross-category substitute is consumed.

The current research contributes to research on substitutes by providing insights on how within- versus cross-category substitutes influence consumption experiences. Previous research found that cross-category substitution is common due to consumers' variety-seeking tendencies as well as frequent promotions in all relevant product categories (Park and Gupta 2011). However, there has been little research that examined how cross-category substitution influences consumption experiences. Our findings suggest that although consumers prefer within-category substitutes, consuming cross-category substitutes can be more effective in satisfying craving for the desired target.

The findings also contribute to our understandings of categorization processes. Barsalou (1983, 1985) suggests that consumers construct taxonomic categories and goal-directed categories. Previous research in this area (e.g., Ratneshwar et al. 2001) examined how personal and situational goals influence category representations of products, however little research has examined how different categorization influences consumer preference and consumption. We found that consumers prefer within-category substitutes, which share the taxonomic category membership with the target, but consuming cross-category substitutes, which are constructed based on goal-directed categorization, may satisfy consumers' craving for the target better. These findings imply that taxonomic categories which focus on physical similarities influence choice decisions but may not necessarily lead to better consumption experiences. Goal-derived category members may satisfy the higher level consumer need better than taxonomic category members.

Our findings also contribute to research on contrast effects. Consistent with previous research (Raghunathan and Irwin 2001; Zeller, Rohm, Bassetti, and Parker 2003; Zeller, Kern, and Parker 2002; Morewedge et al. 2010), we found that contrast effects occur when there is categorical similarity between target and context stimuli, but not when they are perceived to be dissimilar. The results of Experiment 4 suggest that the substitute is contrasted to the target when a within-category substitute is consumed, but no such comparison arises when a cross-category substitute is consumed. These findings suggest that contrasts between the target and the substitute influences consumption experiences (c.f., Novemsky and Ratner 2003).

Finally, our results contribute to the literature on food wanting and liking. As discussed earlier in Chapter 1, understanding food wanting and liking as determinants of food consumption is critical for understanding and alleviating problems of excessive energy intake including obesity (Berridge 2007). Although prior research suggests dissociation between wanting and liking, most of this research has examined in animals or is based on neurological findings. The current findings show dissociation between food wanting and liking with humans and demonstrates the importance of food wanting in food intake behaviors.

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APPENDIX A: STIMULI USED IN CHAPTER 2, EXPERIMENTS 1 TO 3

Target



Within-category substitute



Cross-category substitute



APPENDIX B: STIMULI USED IN CHAPTER 2, EXPERIMENT 4

Target		
	As good as target	Inferior to target
Within-category substitute		
Cross-Category Substitute		