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Taste Manipulation during a Food Cue-Reactivity Task: Effects on Cue-Elicited Food Craving and Subsequent Food Intake among Individuals with Overweight and Obesity

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Abstract

Food cue-reactivity tasks are used to induce and evaluate food cravings. Extant research has implicated the role of tasting foods in heightening cue-elicited food craving. The present study was the first to evaluate a taste manipulation during a food cue-reactivity task to optimize cue-elicited craving and predict food intake. Participants with overweight/obesity ($N=35$; M age=33.46 years [$SD=13.27$]; $MBMI=32.91$ kg/m² [$SD=5.34$]) engaged in one laboratory session and were randomized to a 'No Taste' or 'Taste' condition. All participants reported baseline food craving and observed two types of high-calorie food cues during a cue-reactivity task: photographic and real foods. The Taste group tasted real food cues and the No Taste group did not. Cue-elicited craving was assessed after the presentation of each food cue. Calorie intake of palatable foods was subsequently measured during a bogus taste test. Results indicated that cue-elicited craving to high-calorie foods was greater for the No Taste relative to the Taste group and that calorie intake was greater for the Taste relative to the No Taste group; both effects were nonsignificant, but of medium-size. Cue-elicited craving was significantly greater following exposure to high-calorie real food cues compared to photographic food cues. Results provide initial evidence that presenting high-calorie real (vs. photographic) food cues and forgoing taste manipulation during a food cue-reactivity task may optimize cue-elicited craving, and that taste manipulation could increase subsequent food intake. Future research should be conducted to replicate findings in larger samples with greater power to detect significant effects.

Keywords

food cue-reactivity; cue-elicited craving; food intake; taste; overweight/obese

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1. Introduction

Overweight and obesity are prevalent conditions (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016) associated with myriad adverse health outcomes (The GBD 2015 Obesity Collaborators, 2017). Though the etiology of overweight/obesity is multifactorial, one robust predictor is intake of high-calorie foods (Swinburn, Caterson, Seidell, & James, 2004). High-calorie foods are often readily available, contributing to the obesogenic environment (King, 2013), and serve as cues to indulge in these foods. Through learning and memory processes, cues consistently paired with consumption acquire the ability to elicit conditioned responses (Jansen, 1998) referred to collectively as ‘food cue-reactivity.’ Food cue-reactivity is comprised of cue-elicited food craving, or the intense desire to consume a specific food (Rodríguez-Martín & Meule, 2015; Weingarten & Elston, 1990), physiological reactivity, such as increased heart rate, skin conductance, and salivation, (Nederkoorn & Jansen, 2002; Nederkoorn, Smulders, & Jansen, 2000), and brain activation, including activity in the nucleus accumbens (Demos, Heatherton, & Kelley, 2012; Lawrence, Hinton, Parkinson, & Lawrence, 2012). Importantly, a recent meta-analysis indicated that food cue-reactivity significantly predicts food intake and weight gain (Boswell & Kober, 2016).

Food cue-reactivity tasks administered in the lab have helped elucidate the role of food cue-reactivity in subsequent food intake and weight gain. During these tasks, participants observe real foods and/or food cues presented via photographic or olfactory modes (Boswell & Kober, 2016), with cue-reactivity assessed during or following cue presentation. Thus, food cue-reactivity tasks aim to heighten cue-elicited craving and physiologic and neurologic responding via the presentation of food cues. Though food cue-reactivity tasks vary considerably across studies, they reliably involve ‘unreinforced’ food cue trials in which cues are presented to participants without actual consumption of the cues. Extant research provides initial evidence, however, that tasting food cues may further heighten food cue-reactivity, thus providing a means to optimize cued responding and observe subsequent behavior.

Prior studies among individuals with normal-weight and overweight have found greater cue-elicited craving when participants expect to taste vs. not taste foods during a food cue-reactivity task (Kemps et al., 2016), and when participants are instructed to imagine consuming foods now vs. later (Meule, Kübler, & Blechert, 2013). In one study, participants were shown high-calorie food photographs and instructed to either imagine their taste or were provided no instruction (Frankort et al., 2012). The authors did not compare brain activity between the two conditions among participants with overweight. However, they did report significantly greater activity in brain reward regions in response to high-calorie food cues when imagining tasting foods among participants with overweight relative to those with normal-weight. In contrast, when *not* instructed to imagine the taste of foods, there was greater reward-related brain activity among participants with normal-weight vs. overweight. These findings implicate potentially greater food cue-reactivity among individuals with overweight when imagining tasting foods.

Only a few studies have integrated tasting food cues during food cue-reactivity tasks. For example, two studies (Fett, Lattimore, Roefs, Geschwind, & Jansen, 2009; Nederkoorn et

al., 2000) instructed participants to lick, but not consume, various foods during cue-reactivity procedures, though there were no direct comparisons of tasting vs. not tasting the foods. To our knowledge, Lambert and colleagues (Lambert, Neal, Noyes, Parker, & Worrel, 1991) conducted the only study comparing taste relative to no taste effects on food cue-reactivity. Participants either tasted or viewed photographs of M&Ms® before reporting craving for the chocolate. Results indicated no significant difference in cue-elicited craving between the two groups. However, lack of direct comparison between tasting and not tasting the M&Ms® precludes conclusions about whether taste enhances cue-reactivity to foods. Additionally, the M&Ms® cues were presented only once, potentially limiting reliability, and cue-reactivity measures were restricted to M&Ms®.

Identifying methods, such as taste manipulation, that elicit high craving levels in the lab is a critical first step for understanding craving processes in the natural environment and elucidating how these processes predict subsequent behavior (e.g., food intake, weight gain). The present study evaluated the effect of tasting vs. not tasting high-calorie foods during a food cue-reactivity task on cue-elicited craving among individuals with overweight/obesity. We improved upon limitations of prior studies by (a) systematically testing the effect of tasting real foods on cue-elicited craving, and (b) administering several different high-calorie real and photographic food cues. All participants handled and smelled real foods, but only those randomized to the ‘Taste’ (vs. ‘No Taste’) group consumed the foods. Craving was assessed at baseline and following each food cue. Based on prior research, participants randomized to the Taste group were expected to report greater craving for high-calorie real food cues relative to participants in the No Taste group. We also hypothesized that real food cues would elicit stronger craving relative to photographic food cues. Finally, tasting food cues during a cue-reactivity task could presumably result in greater subsequent intake. Thus, we tested the effect of taste on a secondary outcome of food intake in the laboratory.

2. Materials and Methods

2.1 Participants

Participants with overweight/obesity were recruited through a University of Pittsburgh research registry, community postings, and undergraduate psychology courses. Eligibility was determined through phone screening. Inclusion criteria included age 18 to 59 years, body mass index (BMI) ≥ 25.0 kg/m² (confirmed in the lab), not currently taking weight-/appetite-affecting medication, not currently engaged in weight loss programs/treatments, no diabetes diagnosis, and not currently pregnant. Eligible individuals reported 4 scores ≥ 6 on a 0 (*not at all*) to 10 (*a lot*) rating scale assessing liking of high-calorie foods to be presented during the cue-reactivity task, willingness to taste foods presented during the cue-reactivity task, and no allergies or restrictions that would prevent them from consuming any real or photographic food cues to be presented during the cue-reactivity task.

All participants underwent a University of Pittsburgh Institutional Review Board-approved informed consent process prior to participation. Participants attended one laboratory session lasting 1.5-hr and were compensated \$25 ($n=29$) or psychology research credit ($n=7$).

2.2 Assessments

2.2.1 State food craving—Participants reported craving at baseline and after each food cue on a 1 (*strongly disagree*) to 5 (*strongly agree*) rating scale using the 3-item *Intense Desire to Eat* subscale of the Food Cravings Questionnaire-State (FCQ-S; Cepeda-Benito, Gleaves, Williams, & Erath, 2000). This subscale indicated above-adequate Cronbach's alpha reliability ($\alpha = .70$; Tavakol & Dennick, 2011) for baseline craving ($\alpha=0.85$) and cue-elicited craving in response to low- ($\alpha=0.85$) and high-calorie ($\alpha=0.94$) food cues (see supplementary materials for FCQ-S item modification and craving calculation).

2.2.2 Anthropometric measures—Height was assessed using a stadiometer and weight was assessed in street clothes without shoes. BMI was calculated as kg/m^2 .

2.2.3 Total calorie intake—Calorie intake was assessed using the validated 10-min bogus taste test (Robinson et al., 2017). Amount of food consumed (g) was calculated by subtracting post-from pre-task weights of each food bowl. Grams consumed were converted into energy intake (calories) for each food based on manufacturers' nutrition information and summed to calculate total calorie intake.

2.2.4 Demographics and baseline characteristics—Participants provided demographic information (e.g., age, sex, race). Time of last food/drink intake was assessed via an experimenter-administered food recall. Hunger was assessed using the FCQ-S item "I am hungry," rated on a 1 (*not at all*) to 5 (*extremely*) scale.

2.3 Stimuli

2.3.1 Photographic food cues—Low- and high-calorie photographic cues were from the *food-pics* database (Blechert, Meule, Busch, & Ohla, 2014). Low-calorie images depicted broccoli (practice trial; image #250) and (1) lettuce (image #228), (2) cucumbers (image #215), (3) cauliflower (image #303), and (4) brussel sprouts (image #550). High-calorie images depicted (1) french fries (image #22), (2) a cheeseburger (image #65), (3) chocolate cake (image #107), and (4) a donut (image #376).

2.3.2 Real food cues—All participants observed the same low-calorie real food cues: half of a baby carrot (practice trial) and (1) a pea, (2) a french style green bean, (3) half of a snow pea, and (4) a half slice of cucumber. The four high-calorie foods observed varied by participant and were the four foods with the highest liking ratings provided by that participant during their phone screen. The 10 foods assessed for liking during screening included: (1) Haribo Gold-Bears® (gummy bears), (2) M&Ms®, (3) Skittles®, (4) Nabisco Mini Chips Ahoy! cookies®, (5) Nabisco Mini Oreos®, (6) Lay's potato chips®, (7) Fritos®, (8) Ritz bits cheese crackers®, (9) Cheez-Its®, and (10) Cheetos Crunchy®. High-calorie foods were presented as a single piece of the food (e.g., one M&M®).

2.4 Procedure

Figure 1 provides an overview of study procedures. Consistent with prior research (e.g., Coelho, Jansen, Roefs, & Nederkoorn, 2009; Hume, Howells, Rauch, Kroff, & Lambert, 2015), participants were instructed to refrain from eating or drinking 2-hr prior to their

session. Upon providing consent, the experimenter assessed time of last food or drink intake via a food recall. Participants were then randomized to either a ‘No Taste’ or ‘Taste’ manipulation condition and completed the food cue-reactivity task.

2.4.1 Food cue-reactivity task—All participants provided baseline craving ratings, completed one low-calorie photographic and real food cue-reactivity practice trial, and then engaged in the 16-trial food cue-reactivity task. During the task, eight low- and eight high-calorie food cues (divided evenly by cue type [low-, high-calorie] and mode [photographic, real food]) were presented in randomized order. Each trial consisted of observing either a photographic or real food, providing craving ratings, and completing a breathing exercise designed to return craving to baseline levels (see supplementary materials for timing of trials and instructions for participants). Real food cues were presented in separate covered cups until a real food cue trial, during which participants were instructed to grab a specific cup, remove the cover, hold, look at, and smell the piece of food, and to either “imagine eating the food” (No Taste group) or to “slowly chew and swallow the food” in its entirety (Taste group). The only difference between groups occurred during real food trials in which participants in the Taste group consumed the foods whereas those in the No Taste group only observed the foods.

2.4.2 Bogus taste test—Participants were provided four, 12-ounce bowls, filled with a visually similar amount of the same four high-calorie foods they were presented during the food cue-reactivity task (M calories per bowl=455). Participants were instructed to have at least one bite, but to eat as much as they wanted, prior to answering questions about the food’s flavor, appeal, and other characteristics. Participants were instructed that they would have 10-min to complete this process for the four foods and that they could enjoy any leftovers while waiting for the experimenter to return. After 10-min, the experimenter returned and removed all foods to ensure no additional consumption. Food bowls were weighed after the participant’s departure.

Finally, participants completed demographic and other basic questionnaires on the computer. Participants’ height and weight were measured, and they were debriefed prior to receiving compensation.

2.5 Statistical Analysis

Data were analyzed from 98% (548/560) of food cue-reactivity trials. Data were lost among four participants (on one [$n=2$], two [$n=1$], or all eight real food trials [$n=1$]) due to participant error in either tasting ($n=2$; randomized to Taste group) or observing ($n=2$; randomized to No Taste group) real food cues in an incorrect order. Data were lost only on real food cue trials given the demands on participants to follow instructions of which food cup to grab for each trial. For the three participants with missing data on 2 trials, craving data were averaged across the two or three high-calorie real food cue trials available. Data were considered missing on all real food cue trials for the participant who observed the real food cues in an incorrect order. Missingness did not vary significantly by group, BMI, or any demographic variable (all $p>.18$), nor was there reason to believe the missingness was related to the unobserved value itself.

Group (No Taste, Taste) differences at baseline were assessed via *t*-tests for continuous variables and chi-square (χ^2) tests for categorical variables. As a manipulation check of the food cue-reactivity task, linear mixed effects models were used to test differences between: (1) craving following high-calorie food cue presentation compared to baseline (i.e., non-cue-elicited) craving; and (2) cue-elicited craving following high-relative to low-calorie food cue presentation. Our primary interest was the effect of No Taste vs. Taste condition on cue-elicited craving to high-calorie real foods. A linear mixed effects model included main and 2-way interaction effects of group (Taste vs. No Taste) and cue mode (real vs. photographic) on cue-elicited craving to high-calorie foods. A random intercept was used to account for within-subject correlation resulting from repeated measures. In the case of a significant group X cue mode interaction, we planned to estimate the effect of group on cue-elicited craving following presentation of real food cues using the LSMESTIMATE statement in SAS 9.4. Our secondary interest was the main effect of group on total calorie intake, evaluated through a generalized linear model with group as the predictor variable. All models included the group variable and were adjusted for sex, BMI, income, and baseline hunger (see supplementary material for covariate rationale).

Effect sizes (partial eta squared; η_p^2) with 95% confidence intervals (CIs) were used to evaluate magnitude of effects, with η_p^2 values of 0.01, 0.06, and 0.14 corresponding to “small,” “medium,” and “large” effects, respectively (Cohen, 1969; Richardson, 2011). Models were noted as statistically significant with an uncorrected two-sided $p < .05$. Analyzed data are available through Mendeley Data (Germeroth, 2018).

3. Results

3.1 Participant Characteristics

Thirty-six participants completed the laboratory session. One participant was excluded from analyses after disclosing that his age was greater than the maximum allowed for eligibility. Demographic and baseline characteristics are reported in Table 1. Annual household income ($p = .03$), BMI ($p = .02$), and baseline hunger ($p = .01$) differed significantly between groups.

3.2 Manipulation Check

Mixed effect models testing the effect of high-calorie food cue presentation on craving level indicated significantly greater craving: (a) following presentation of high-calorie food cues (adjusted $M = 10.82$ [$SEM = 0.48$]) compared to baseline craving (adjusted $M = 8.96$ [$SEM = 0.48$], $F(1,33) = 16.95$, $p = .0002$, $\eta_p^2 = 0.34$, 95% CI [0.13, 0.50]); and (b) following presentation of high-calorie ($M = 10.61$ [$SEM = 0.38$]) compared to low-calorie (additionally adjusted for cue mode and baseline craving; $M = 7.29$ [$SEM = 0.38$], $F(1,97) = 100.26$, $p < .0001$, $\eta_p^2 = 0.51$, 95% CI [0.39, 0.59]) food cues.

3.3 Cue-Elicited Craving Outcome

Mixed effect models examining high-calorie cue-elicited food craving indicated no significant main effect of group (Taste vs. No Taste) on cue-elicited craving (additionally adjusted for baseline craving; $p = .98$). However, there was a significant main effect of cue mode (real vs. photographic) on cue-elicited craving ($p < .0001$; see Table 2 for statistics),

such that cue-elicited craving was higher after exposure to real foods (adjusted $M=11.64$ [$SEM=0.46$]) compared to photographic food cues ($M=9.91$ [$SEM=0.46$]). Moreover, there was a significant two-way interaction between group and cue mode ($p=.0002$). When isolating the effect of group on cue-elicited craving after exposure to real foods, the No Taste group reported higher cue-elicited craving (adjusted $M=12.29$ [$SEM=0.67$]) compared to the Taste group (adjusted $M=10.98$ [$SEM=0.65$]); this effect was nonsignificant ($p=.17$), though of medium size ($\eta^2_p=0.06$).

3.4 Total Calorie Intake Outcome

Individuals in the Taste group consumed more calories (adjusted $M=392.36$ calories [$SEM=44.07$]) relative to individuals in the No Taste group (adjusted $M=333.06$ calories [$SEM=44.56$]); this effect was nonsignificant ($F(1,29)=1.86$, $p=.18$), but of medium size ($\eta^2_p=0.06$, 95% CI [0.00, 0.22]).

4. Discussion

The primary goal of this study was to evaluate the effect of tasting relative to not tasting high-calorie food cues on cue-elicited food craving among individuals with overweight/obesity. Contrary to our hypothesis, which was based on extant research implicating the role of taste in eliciting craving, observing but *not* tasting real foods during a food cue-reactivity task increased cue-elicited craving compared to tasting real foods. Although statistically nonsignificant, this effect of tasting foods on cue-elicited craving was of a medium-size. Thus, taking one bite of a high-calorie palatable food may satiate food craving in the moment, whereas being denied consumption of a food may further provoke food craving. This finding is consistent with prior research among individuals with normal-weight or overweight/obesity showing that observing palatable food cues without the ability to consume the foods induces an impairment in inhibitory control (Loeber et al., 2012) and that restricting oneself from consuming palatable foods may heighten craving for those foods (Jansen, Mulken, & Jansen, 2007; Massey & Hill, 2012). Though individuals who were instructed not to taste the high-calorie foods experienced greater cue-elicited craving, they did not consume more calories during the bogus taste test. Rather, individuals who tasted the high-calorie foods consumed *more* calories (again, this effect was statistically nonsignificant, though medium-sized). This greater food intake among individuals who tasted the high-calorie foods is consistent with prior research reporting that sampling a high-calorie consumption cue (e.g., Hawaiian Punch) enhanced subsequent high-calorie food and drink consumption (Wadhwa, Shiv, & Nowlis, 2008).

Results of the current study provide methodological implications for experimental food cue-reactivity tasks. First, the ability to provoke high levels of craving in the lab is important for mimicking cue-elicited food craving that may occur in the natural environment and that is most likely to predict subsequent behavior (e.g., high levels of cue-elicited craving predicting subsequent food intake and weight gain; Boswell & Kober, 2016). Our results provide initial evidence that researchers aiming to optimize cue-elicited food craving might consider forgoing taste manipulation during food cue-reactivity tasks. Avoiding taste manipulation may also benefit researchers interested in collecting objective measures of

food cue-reactivity that would be difficult to collect when chewing food, such as saliva excretion and psychophysiological reactivity which is prone to movement artifacts (e.g., chewing). However, researchers should keep in mind that tasting high-calorie food cues might increase subsequent high-calorie food intake. Second, the present study suggests that using high-calorie foods rather than photographs may be useful to bolster food cue-reactivity effects, a finding also observed in drug cue-reactivity (e.g., Johnson, Chen, Schmitz, Bordnick, & Shafer, 1998; Niaura et al., 1998). This suggestion, however, must be considered along with the fact that photographic food cues are less costly, less time-consuming to prepare, and simpler to administer than real food cues.

Despite the novelty of the present study's findings, limitations and directions for future research should be considered. First, our sample size was small and some of the results were nonsignificant. Though future research needs to clarify if similar results will emerge with larger sample sizes and greater power to detect effects, the magnitude of effects in the present research provides initial information on the effects of tasting food cues on cue-elicited craving and food intake (see literature emphasizing interpreting effect sizes; Halsey, Curran-Everett, Vowler, & Drummond, 2015; Kraemer, 2013; Sullivan & Feinn, 2012). Second, future research would benefit from comparing the effects of taste manipulation on cue-elicited craving and food intake between individuals of normal-weight vs. overweight/obesity. Extant research has indicated that individuals with higher BMI may have higher taste sensitivity thresholds, especially for fats (e.g., Dando, 2015), potentially differentially influencing the effects of taste on cue-reactivity among individuals with normal-weight vs. overweight/obesity. Moreover, given that food cue-reactivity tasks are designed to heighten cue-elicited craving, researchers would want to determine if a taste manipulation optimizes craving among individuals with normal-weight. Third, participants in the present study knew whether they would eat foods during the cue-reactivity task. Eating expectancies can influence cue-elicited craving and food intake (e.g., Kemps et al., 2016; Malik, McGlone, & Dagher, 2011) and could be explored in future work by manipulating expectations about food consumption while evaluating the role of taste. Fourth, all participants observed the same photographic food cues, but the high-calorie real food cues presented were those rated as the most liked by each participant. This variability in personalization of food cues may be a confounding factor in craving differences that emerged between the cue presentation modes.

Finally, future work can elucidate the clinical utility of integrating taste into interventions aimed at *reducing* responding to food cues. Initial research on cue exposure therapy, which involves repeated, prolonged presentation of high-calorie foods, has reported that intermittently reinforcing food cue exposure trials (i.e., allowing consumption) can *slow* the process of relapse to high-calorie food cue responding (Schyns, Roefs, Mulken, & Jansen, 2016; van den Akker, Havermans, & Jansen, 2015). However, these findings are in conflict with Robinson and Berridge's incentive-sensitization theory of addiction (Robinson & Berridge, 1993) and prior work showing that intermittent reinforcement *increases* sensitization to an associated cue, increasing craving overtime (e.g., Boileau et al., 2006; Strakowski & Sax, 1998).

4.1 Conclusions

Incorporating tasting of high-calorie foods during a food cue-reactivity task did *not* heighten cue-elicited food craving and may have suppressed it among individuals with overweight/obesity. This finding suggests that using a taste manipulation may not be useful for optimizing cue-elicited craving. However, results suggested that presenting high-calorie real, compared to photographic, food cues does maximize cue-reactivity effects. Results also suggest that a taste manipulation may increase subsequent intake of palatable foods, though future work with larger samples must be conducted to evaluate robustness of findings given that this result was nonsignificant in the present study. Continued research in the area of food cue-reactivity is critical for elucidating processes underlying consumption of high-calorie foods and the development and maintenance of overweight/obesity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Tasting high-calorie foods during a cue-reactivity task may suppress food craving
- Observing, but not tasting high-calorie food cues, may evoke cue-elicited craving
- Tasting high-calorie foods may increase subsequent calorie intake
- Real vs. photographic food cues elicited stronger cue-elicited food craving

Figure 1.

Schematic of study procedures. Photographic food cues from the *food-pics* database were presented on a computer screen (brussels sprouts [image #550], a cheeseburger [image #65], lettuce [image #228], and chocolate cake [image #107] are depicted). Real food cues were presented in a covered cup until the participant was instructed to handle the cue. After the presentation of each food cue, participants rated their craving for the food and completed a breathing exercise before continuing to the next cue trial. All food cues were presented in randomized order.

Table 1

Demographic and Baseline Characteristics of Total Sample and Groups

	Total sample (N=35)	No Taste group (n=17)	Taste group (n=18)	Statistic
Age (years) [†]	33.46 (13.27)	31.47 (14.78)	35.33 (11.79)	$t=-0.86$ $p=.40$
Sex ^f				
Female	26 (74)	12 (71)	14 (78)	$\chi^2=0.24$
Male	9 (26)	5 (29)	4 (22)	$p=.63$
Race ^f				
White	15 (43)	10 (59)	5 (28)	$\chi^2=3.44$
Minority	20 (57)	7 (41)	13 (72)	$p=.06$
Education ^f				
HS graduate/GED	8 (23)	6 (35)	2 (11)	
Some college/technical school	17 (49)	7 (41)	10 (55)	
4-year college graduate	6 (17)	3 (18)	3 (17)	$\chi^2=3.50$
Post-graduate degree	4 (11)	1 (6)	3 (17)	$p=.32$
Employed ^f				
Yes	24 (69)	10 (59)	14 (78)	$\chi^2=1.46$
No	11 (31)	7 (41)	4 (22)	$p=.23$
Annual household income ^f				
\$50,000	17 (49)	5 (29)	12 (67)	$\chi^2=4.86$
>\$50,000	18 (51)	12 (71)	6 (33)	$p=.03$
Body mass index (kg/m²) [†]	34.09 (5.43)	31.93 (4.61)	36.13 (5.47)	$t=-2.45$ $p=.02$
Time since last food/drink intake (hr/min) ^{†,a}	6 hr, 24 min (4 hr, 22 min)	6 hr, 51 min (4 hr, 38 min)	5 hr, 59 min (4 hr, 12 min)	$t=0.58$ $p=.56$
Hunger [†]	3.43 (1.27)	2.88 (1.17)	3.94 (1.16)	$t=-2.70$ $p=.01$

Note.

[†] indicates mean (standard deviation; *SD*);

^f indicates number (%);

HS=high school; GED=general education development. Group differences were assessed via *t*-tests (continuous) or χ^2 tests (categorical). For all *t*-tests, *df*=33 and for χ^2 tests, *df*=1 (except for the χ^2 test for education where *df*=3). All *p*-values are from two-tailed tests, with $\alpha<0.05$. Significant differences between groups are indicated in boldface.

^a Calculated by subtracting the time of last food/drink intake (other than water) from the time at which the food recall began.

Table 2**Linear Mixed Effects Model Predicting High-Calorie Cue-Elicited Food Craving**

Linear Mixed Effects Model		Statistic		
Predictor	F-value	t-value	p-value	η_p^2 (95% CI)
Group	0.00	.	.98	0.00 (0.00, 0.00)
Cue mode	30.71	.	<.0001	0.49 (0.27, 0.62)
Group X cue mode	17.28	.	.0002	0.35 (0.13, 0.51)
No Taste vs. Taste group for real food cues ^a	.	1.39	.17	0.06 (0.00, 0.21)

Note. η_p^2 =partial eta squared (η_p^2 values of 0.01, 0.06, and 0.14 correspond to “small,” “medium,” and “large” effect sizes, respectively); CI=confidence interval; group=No Taste or Taste condition; cue mode=photographic or real food cues. Statistics reflect results from the linear mixed effects model adjusted for baseline sex, BMI, income, baseline hunger, and baseline craving, where $df_{num}=1$, $df_{den}=32$ for F tests and $df=32$ for t -tests. All p -values are from two-tailed tests, with $\alpha<0.05$. Significant differences are indicated in boldface.

^aIsolating the effect of group on cue-elicited craving after exposure to real foods was conducted with contrasts using the LSMESTIMATE statement. The effect of group on cue-elicited craving after exposure to photographic cues was not of interest; those results are reported in the supplementary material.