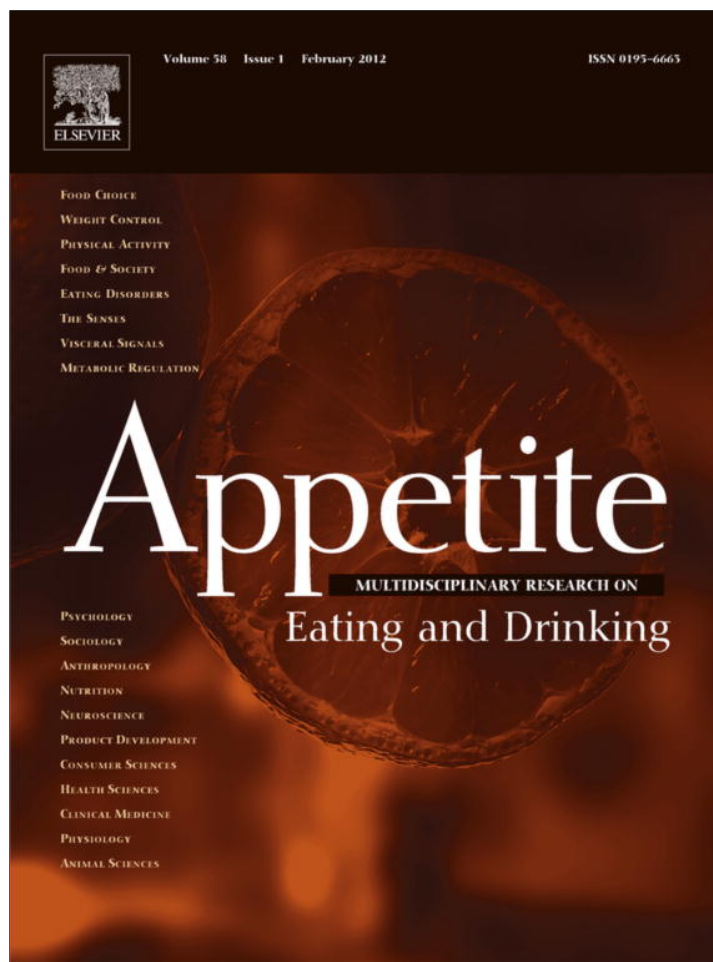


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Research report

Piece of cake. Cognitive reappraisal of food craving

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ABSTRACT

A common emotion regulation strategy, cognitive reappraisal, involves altering the meaning of a situation so that the emotional response to the situation is changed. Most research on reappraisal has focused on down-regulation of negative emotion; few studies exist on reappraisal of positive affect, and even fewer have examined the cognitive reappraisal of craving for energy-dense (e.g., “junk”) foods. In the present study we examined this form of cognitive reappraisal using a new adaptation of a classic emotion regulation task. Subjects chose idiosyncratic categories of craved (and not craved) energy-dense foods as stimuli, and were instructed either to look at the stimulus or to reappraise it in a way that reduced desire to eat the depicted food using a strategy that could be used in the real world. A repeated-measures ANOVA and follow-up tests revealed that reappraisal significantly reduced self-reported desirability of both Craved and Not Craved foods, but for a greater degree in Craved foods. In addition, the degree to which subjects decreased their desire to consume Craved foods positively correlated with the cognitive restraint subscale of the Three-Factor Eating Questionnaire, a measure of self-control of eating in everyday life.

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Introduction

Overeating and obesity are rapidly growing problems in industrialized societies. Eating in the absence of hunger, or non-homeostatic eating, involves consuming too much food relative to what is biologically required (Corwin & Hajnal, 2005), and contributes to obesity and other weight-related problems (van Strien, Herman, & Verheijden, 2009). Identifying a way to reduce this form of overeating would not only contribute to public health, but it would also help individuals with their personal goals; this year, two of the three top goals among Americans surveyed by the APA were to lose weight and eat a healthier diet (American Psychological Association, 2012).

Recent research has investigated strategies for regulating overeating behavior, including message framing aimed at increasing fruit/vegetable intake (Gerend & Maner, 2011), imagining eating an unhealthy food instead of actual consumption (Morewedge, Huh, & Vosgerau, 2010), and enacting full-fledged societal interventions (Robinson, 2012). While these strategies focus on controlling eating behavior itself, others have found that targeting the motivation to engage in overeating may be sufficient to prevent this type of behavior. Desires or cravings for unhealthy foods are qualitatively similar to those for alcohol, drugs, and tobacco in that they are associated with increased attention to and intrusive thoughts about the desired target (Kavanagh, Andrade, & May,

2005; May, Andrade, Panabokke, & Kavanagh, 2004). Consciously reducing the strength of these unwelcome desires to eat unhealthy foods is a potentially powerful means of decreasing overeating behavior in service of weight control.

The cognitive regulation of craving has only recently begun to receive empirical attention. The emotion regulation literature has demonstrated that affective responses can be modulated using reappraisal, a strategy that involves deliberately controlling how one cognitively appraises the meaning of an affective stimulus (Giuliani, McRae, & Gross, 2008; Ochsner & Gross, 2008). Although most research on cognitive emotion regulation targets affective stimuli like negative pictures, recent work has begun to test the efficacy of reappraisal on new targets and new affective states. Specifically, a small number of studies have now examined reappraisal aimed at the reduction of reward encoding (Staudinger, Erk, & Walter, 2011), expected value (Staudinger, Erk, Abler, & Walter, 2009), and the craving of cigarettes (Kober, Kross, Mischel, Hart, & Ochsner, 2010; Kober, Mende-Siedlecki, et al., 2010) and food (Hollmann et al., 2011; Kober, Kross, et al., 2010; Kober, Mende-Siedlecki, et al., 2010; Siep et al., 2012; Svaldi, Tuschen-Caffier, Lackner, Zimmermann, & Naumann, 2012). Related threads of research have also recently emerged documenting dysfunctional reward responses in adolescents (Galvan, 2010; Geier, Terwilliger, Teslovich, Velanova, & Luna, 2010) and among individuals with bipolar disorder (Gruber, 2011; Phillips & Vieta, 2007).

The question of how people down-regulate appetitive motivations like craving is a relatively new area, with several important open questions. For example, it is unknown whether various

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reappraisal strategies are more or less efficacious because most studies in this area focus exclusively on one reappraisal strategy (e.g., imagining the long-term consequences of eating an unhealthy food or smoking a cigarette). Any given strategy may work well for some people but not others. Allowing participants to self-generate tailored reappraisal strategies may allow for greater ecological validity of results.

Another open question is whether reappraisal is effective for individually-tailored stimuli. Like the strategies for its cognitive regulation, craving is also idiosyncratic: what may be a highly desired food for one person may be a greatly disliked food for another. Previous work investigating regulation of food cues used the same set of food stimuli for all subjects. Indeed, as with regulation, asking participants to regulate their desire to consume energy-dense foods tailored to their tastes may allow for greater and more realistic cravings for those foods to emerge, which may be harder to reduce through cognitive regulation than the generic stimuli used in previous studies. As such, in the present study we applied a validated emotion and craving regulation paradigm (e.g., Kober, Kross, et al., 2010; Ochsner & Gross, 2004) to this question by allowing participants to choose among seven categories of matched energy-dense foods and employ one of four cognitive reappraisal strategies to reduce their desire to consume the food. We hypothesized that cognitive reappraisal would significantly decrease self-reported desire, and be meaningfully related to validated measures of daily self-regulation of eating.

Methods

Participants

Eighty-two participants (28 male, age $M = 19.76$, $SD = 3.51$) completed a single-session study. All gave informed consent in accordance with the University of Oregon Institutional Review Board. Seven additional participants were excluded from analyses due to excessive missing data (>10%), failure to adhere to task instructions, or for food addiction as determined by the Yale Food Addiction Scale (Gearhardt, Corbin, & Brownell, 2009).

Procedure

After providing informed consent, participants were trained on the task, then asked to choose (a) their most and least craved categories of energy-dense stimuli and (b) the regulation strategy they believed would be most effective for them during Regulate trials per the instructions below. Participants then practiced the task with the experimenter (N.G. or R.C.), as detailed in the strategy training section below. Following the completion of the task, the experimenter interviewed each participant to ensure that he or she had indeed used the selected regulation strategy on all Regulate trials. Participants who could not report which strategy they used, or reported using different strategies on different trials, were removed from analyses. Lastly, participants completed the individual difference measures detailed below, reported their level of hunger on a 1 (“very hungry”) to 5 (“very full”) Likert scale, and were thanked for their time.

Stimuli

To elicit craving responses, pictures of foods were collected from two sources: prior research that has used similar photographic cues (Burger, Cornier, Ingebrigtsen, & Johnson, 2011; Kober, Kross, et al., 2010), and images downloaded from public online sources. In a separate pilot study, 61 participants (38 female)

rated images of 642 energy-dense foods in 12 categories, as well as 25 low energy-density foods on 1 (“not at all”) to 5 (“very much”) Likert scale. None of the pictures included people, and the foods in all pictures were prepared and ready for consumption. The final stimulus set consisted of 20 pictures of low energy-density food ($M = 2.48$, $SD = .27$), and 40 pictures in each of the following categories of energy-dense food (M s: 3.46–3.52, SD s: .17–.35): chocolate, cookies, donuts, fries, ice cream, pasta, and pizza. Importantly, images were chosen such that the means of the energy-dense food categories were not significantly different from each other (all paired-samples p -values > .05), and that the mean of each energy-dense food category was significantly greater than the mean of the low energy-density food stimuli (p -values < .001).

Task

Images of two types of palatable foods were included as stimuli: low energy density foods (“Neutral”), and energy-dense foods. All participants saw the same set of Neutral stimuli. For the energy-dense stimuli, participants chose the one category of food that they craved the most (“Craved”) and the one category of food they craved the least (“Not Craved”) from the categories listed above. Craving was defined as the desire and tendency to consume more of the target food, even when the individual is no longer hungry (i.e., overeating). Importantly, the stimuli in each category did not vary from participant to participant. For example, a participant who chose pizza as his Craved food and donuts as his Not Craved food would see the same stimuli as another participant who chose donuts as his Craved food and pizza as his Not Craved food. The energy-dense food trials were organized in a 2 (Stimulus: Craved vs. Not Craved) \times 2 (Instruction: Look vs. Regulate) design. The stimuli assigned to each condition were counterbalanced across participants, so the pictures of pizza seen under the Look instruction for one participant would be the stimuli seen under the Regulate instruction for the next participant who chose pizza as a stimulus category (independent of whether it was designated Craved or Not Craved). Thus, the final event-related design included five trial types (the 2 \times 2 of energy-dense foods plus Look Neutral), with 20 trials seen under each condition.

The Look instruction directed participants to focus on the pictured food, imagine that it is actually in front of them, and think about consuming it. The Regulate instruction again directed participants to focus on the pictured food and imagine that it is in front of them, and additionally to think about it in a way that reduces their desire to eat the depicted food (Regulate). To help participants generate a reappraisal strategy, we suggested the following four strategies that were developed on a separate sample in pre-testing: (1) imagine that you are currently very full, (2) focus on the negative consequences of eating that food (e.g., stomachache, weight gain), (3) remind yourself that you can save that food for later, and (4) imagine that something bad had happened to the pictured food (e.g., sneezed on). Participants were not required to use one of the suggested strategies, but were told that their reappraisal strategy should be applicable to the real world, and that they should choose one strategy before the task and use that same strategy on every trial. Importantly, the script used to train participants on the task instructed them to report their craving honestly at the end of each trial. To minimize the demand characteristics of the task regarding regulation success, we explicitly stated that “we don't expect you to be able to do this on every picture, so please just let us know where you ‘end up’ when all is said and done.” To minimize contamination of instruction across trials, we instructed participants to view each trial as a fresh event, and to do their best to only Look or only Regulate, as instructed by the cue.

Each trial began with a 2 s instructional cue (Look or Regulate), followed by a 5 s presentation of the stimulus, 4 s to rate the desirability of the stimulus, and a 1 s inter-trial-interval. Desirability ratings (“How much do you desire to eat this food?”) were made on a 1-to-5 Likert scale, where 1 = “not at all” and 5 = “very much.” The Craved and Not Craved trial types were viewed under both instruction conditions. Twenty stimuli were viewed in each condition, for a total of 100 trials divided across three runs with brief breaks in between.

Strategy training

Prior to beginning the task, participants underwent a structured training session, in which they received the strategy instructions described above, and viewed a sample trial for each of the two instructions. Sample trials provided participants experience with using the cognitive reappraisal strategies while looking directly at pictures of foods not used during the experimental session. The experiment began when the training session was complete and participants indicated to the experimenter that the directions and procedures were understood.

Individual difference measures

To establish the convergent and external validity of the task, we also administered several domain-general and food-specific measures assessing everyday affective reactivity and self-regulation. For general reactivity, we administered the Barratt Impulsivity Scale (BIS-10; Patton, Stanford, & Barratt, 1995; $M = 69.1$, $SD = 8.99$, $\alpha = .81$), and the activation portion of the Behavioral Inhibition/Activation Scale (BAS; Carver & White, 1994; $M = 3.75$, $SD = .38$, $\alpha = .73$). For food-specific reactivity, we administered the external subscale of the Dutch Eating Behavior Questionnaire (DEBQ-external; van Strien, Frijters, Bergers, & Defares, 1986; $M = 31.58$, $SD = 5.32$, $\alpha = .83$), and the disinhibition subscale of the short Three-Factor Eating Questionnaire (TFEQ-disinhibition; Stunkard & Messick, 1985; $M = 3.05$, $SD = 2.15$, $\alpha = .66$). For general regulation, we administered the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003; reappraisal $M = 30.4$, $SD = 5.67$; suppression $M = 13.6$, $SD = 4.61$, both subscales $\alpha > .76$) and the 13-item Brief Self-Control Scale (BSCS; Tangney, Baumeister, & Boone, 2004; $M = 52.98$, $SD = 12.11$, $\alpha = .83$). For food-specific regulation, we administered the restrained subscale of the DEBQ (DEBQ-restrained; $M = 22.43$, $SD = 8.44$, $\alpha = .93$) and the cognitive restraint subscale of the TFEQ (TFEQ-cogrest; $M = 3.02$, $SD = 2.12$, $\alpha = .73$).

Data analysis

Data were subjected to a 2 (Stimulus: Craved vs. Not Craved) \times 2 (Instruction: Look vs. Regulate) repeated-measures analysis of variance (ANOVA) to determine main effects of stimulus and instruction, and test the interaction of the two. Pairwise *t*-tests between conditions were performed to decompose observed effects. Due to the *a priori* hypotheses regarding the role of idiosyncratically craved foods, analyses focused on the energy-dense food categories identified as craved by each participant. Specifically, reactivity was defined as the percent difference in self-reported desire to consume the pictured food between Look Not Craved to Look Craved. While the design of the task provided two potential baseline conditions, Neutral and Not Craved foods, Not Craved foods were selected as a baseline for reactivity because they are matched to Craved foods on energy-density, and did not differ significantly in pre-testing on desirability from Neutral foods (see Results below). Regulation success was defined as the percent difference in self-reported desire between Look Craved to Regulate Craved. The alpha level was set to .05 for all analyses. Multiple

comparisons were corrected using the false discovery rate (FDR), which controls the expected proportion of false positives among all significant hypotheses by adjusting the *p*-value. The FDR assumes positive dependence or independence among variables, and is based on the Benjamini–Hochberg procedure (Benjamini & Hochberg, 1995), which is sufficient to use on data that are mostly independent or positively correlated (Benjamini & Yekutieli, 2001). To test the convergent validity of reactivity, we assessed the relationship between task-related reactivity and four individual difference measures (BIS-10, BAS, DEBQ-external, and TFEQ-disinhibition). To test the convergent validity of regulation, we assessed the relationship between task-related regulation and five individual difference measures (ERQ-reappraisal, ERQ-suppression, BSCS, DEBQ-restrained, and TFEQ-cogrest).

Results

Stimuli

The categories of energy-dense foods chosen by participants as Craved and Not Craved are presented in Table 1. Categories of energy-dense foods selected as Craved were not chosen equally by participants ($X^2(6) = 15.15$, $p = .02$), nor were Not Craved foods ($X^2(6) = 45.54$, $p < .001$). Inspection of the selection rates revealed that ice cream, pasta, and pizza were more often designated as “Craved” than cookies and donuts. For Not Craved foods, donuts appeared as the most frequently designated category. Category choice did not differ significantly by gender (Craved $X^2(6) = 9.84$, $p = .13$; Not Craved $X^2(6) = 5.82$, $p = .43$), nor was it related to reactivity or regulation success (all *p*-values $> .45$).

Effect of cognitive strategies on desire ratings

Across all subjects, we observed a significant main effect of Stimulus on self-reported desire to consume the food (Craved $M = 3.06$, $SD = .56$; Not Craved $M = 1.98$, $SD = .54$; $F_{(1,81)} = 251.37$, $p < .001$), as well as a significant main effect of Instruction on self-reported desire to consume the food (Look $M = 3.02$, $SD = .62$; Regulate $M = 2.01$, $SD = .49$; $F_{(1,81)} = 200.92$, $p < .001$). These main effects were qualified by a Stimulus \times Instruction interaction ($F_{(1,81)} = 81.12$, $p < .001$), indicating that the magnitude of regulation success (percent reduction in self-reported craving) was different between Craved and Not Craved foods. As shown in Fig. 1a, regulation successfully reduced self-reported desire to consume both the Craved and Not Craved foods as compared to the Look cue (Look Craved $M = 3.73$, $SD = .74$; Regulate Craved $M = 2.38$, $SD = .66$; $t_{(81)} = 14.66$, $p < .001$; Look Not Craved $M = 2.31$, $SD = .74$; Regulate Not Craved $M = 1.64$, $SD = .48$; $t_{(81)} = 9.99$, $p < .001$), but to a greater extent for the Craved foods. A paired-samples *t*-test between percent reduction in self-reported craving between Craved and Not Craved foods confirmed this (Craved % decrease $M = .34$, $SD = .18$; Not Craved % decrease $M = .25$, $SD = .19$; $t_{(81)} = 4.79$, $p < .001$). Regulated Craved foods were no more desired than the Not Craved foods in the Look

Table 1
Craved and not craved food stimulus categories chosen by subjects.

Food category	% Chosen craved	% Chosen not craved
Chocolate	15.9	17.1
Cookies	7.3	6.1
Donuts	3.7	39.0
French fries	13.4	9.8
Ice cream	20.7	7.3
Pasta	20.7	8.5
Pizza	18.3	12.2

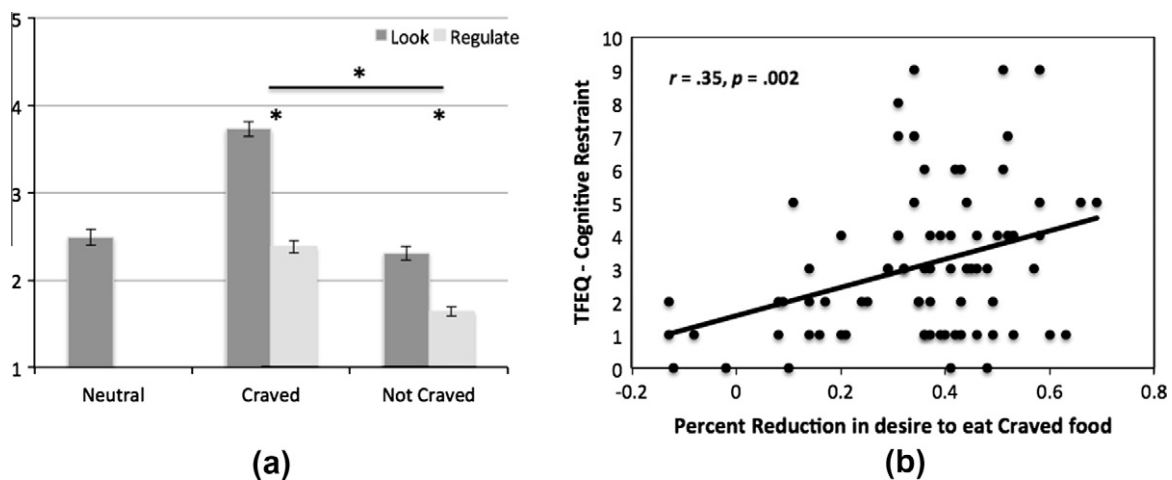


Fig. 1. (a) Mean self-reported desire to eat foods presented in the look neutral, look craved, regulate craved, look not craved, and regulate not craved conditions. Error bars are the standard error of the mean. Among the energy-dense foods (craved, not craved), both the main effects of Stimulus ($F_{(1,81)} = 251.37, p < .001$) and Instruction ($F_{(1,81)} = 200.92, p < .001$) were significant, as was the stimulus \times instruction interaction ($F_{(1,81)} = 81.12, p < .001$). * = $p < .001$. (b) Scatterplot showing the positive correlation between percent decrease in self-reported desire to eat the craved foods during the regulate condition compared to the look condition and the cognitive restraint subscale of the TFEQ ($r = .35, p = .015$ FDR corrected).

condition ($t_{(81)} = .78, p = .44$). As a manipulation check, we verified that Craved foods seen in the Look instruction condition were rated as significantly more desirable than Not Craved foods in the Look condition ($t_{(81)} = 15.98, p < .001$). Ratings of Neutral (low energy density) foods seen in the Look condition ($M = 2.5, SD = .84$) were not significantly different than Not Craved foods in the Look condition ($t_{(81)} = 1.62, p = .11$) or Craved foods in the Regulate condition ($t_{(81)} = .91, p = .37$). There was no effect of gender or hunger on any of these ratings (all p -values $> .3$).

Differences between cognitive regulation strategies

A qualitative survey of the types of cognitive regulation strategies used by subjects revealed that two strategies were employed most frequently: focusing on the short- or long-term negative consequences of eating the food and imagining that something was wrong with the food. As shown in Table 2, these two strategies were employed by 30.5% and 50% of the subjects, respectively. A one-way ANOVA revealed that the percent reduction of self-reported desire to eat the Craved food did not vary by cognitive strategy ($F_{(4,78)} = .36, p = .84$). There was no effect of gender on strategy choice ($X^2(4) = .36, p = .99$).

Convergent validity of the task

Reactivity

Percent increase in self-reported desire to eat the Craved vs. Not Craved foods was significantly positively correlated with the drive subscale of the BAS ($r = .27, p = .016$), which survived multiple comparisons correction using the false discovery rate (FDR-adjusted $p = .038$). No other scales or subscales were significantly related to task-based reactivity. This is not surprising given that the BAS-Drive subscale frequently has the highest statistical reliability and convergent validity of the three subscales (Jorm et al., 1998).

Regulation

As shown in Fig. 1b, percent decrease in self-reported desire to eat the Craved foods during the Regulate condition as compared to the Look condition was significantly positively correlated with the

cognitive restraint subscale of the TFEQ ($r = .35, p = .002$), which survived multiple comparisons correction using the false discovery rate (FDR-adjusted $p = .015$). No other scales or subscales were significantly related to task-based regulation success.

Discussion

These findings show that cognitive reappraisal strategies can successfully reduce self-reported desire to consume energy-dense foods, and particularly for food categories that are highly craved on an individual basis. These data replicate previous findings that the desire to consume desired foods can be cognitively regulated (Hollmann et al., 2011; Kober, Kross, et al., 2010; Siep et al., 2012), and extend this work in two important ways. First, we introduce a tight comparison condition—undesired but energy-dense foods—that controls for caloric density and can be regulated but to a lesser degree than idiosyncratically desired energy-dense foods. Second, we allowed subjects to generate their own cognitive reappraisal strategies, which revealed a diversity of strategies that were nonetheless equally effective.

Food desire and regulation of that desire measured by this task relate meaningfully to other measures of reactivity and food-specific regulation. Task-related reactivity positively correlated with the BAS-Drive subscale, which indexes general appetitive behavior (e.g., “I go out of my way to get things I want”). The Drive subscale has also been found to positively relate to other approach-related personality traits like extraversion and positive temperament (Carver & White, 1994). Other subscales of the BAS

Table 2
Cognitive regulation strategies employed by subjects.

Strategy	Example	% Subjects
Imagine currently full	“I looked at it as if I had just eaten a ton of food.”	9.75
Negative consequences	“If I ate it frequently, I'd get fat eventually.”	30.49
Save for later	“I don't have to eat it now, I can wrap it up and eat it later.”	7.32
Something wrong with food	“I imagined someone sneezed on the food.”	50
Other		2.44

Note: Percent reduction of self-reported desire to eat the craved food did not vary by cognitive strategy ($F_{(4,78)} = .36, p = .84$).

were not correlated with task-related reactivity, perhaps due to the more general nature of these items (e.g., “when good things happen to me, it affects me strongly”) and/or the lower degree of reliability of those subscales relative to Drive (Jorm et al., 1998). Task-related regulation success positively correlated with the cognitive restraint subscale of the TFEQ, indicating that responses on this task index real-world cognitive regulation of the desire to eat unhealthy foods. Interestingly, none of the domain-general indices of regulation (e.g., Tangney self-control) related to task-based food regulation, suggesting that the specific food-related regulation processes measured in this task may not be directly related to general self-control mechanisms.

We believe that a strength of this paradigm is the use of subject-specific regulation strategies. Though this does introduce a degree of between-subject variability, the fact that the various strategies were equally effective in down-regulating desire for energy-dense foods suggests that different people may use different strategies in their daily lives, and that the regulation success of a given individual might depend on that person identifying a strategy that works for him or her. Thus, one important consideration for future work is that training all participants in the use of one particular strategy might not yield the strongest regulation effects across the sample. Conversely, the implication for treatment interventions (e.g., for caloric intake reduction among overweight and/or obese individuals) is that allowing individuals to select an individually tailored strategy might produce the largest reductions in craving and ultimately intake.

The experimental task employed here is grounded in a theoretical framework for down-regulating affect broadly. Though we focused here on the down-regulation of one specific type of positive affect—craving for energy-dense foods—the theoretical model extends as well to the cognitive regulation of other types of positive affect, and our data suggest that this kind of regulation might be effective. For example, it is worth considering that the reappraisal strategies deployed by our participants might also be useful for regulating cravings for cigarettes among smokers (as has already been shown by Kober, Kross, et al. (2010) and Kober, Mende-Siedlecki, et al. (2010)), affiliative motivation (e.g., in the context of risky sexual behaviors or gang membership among adolescents), or other kinds of appetitive but ultimately harmful stimuli (e.g., drugs). An important direction for future research is to examine whether cognitive regulation using reappraisal is limited to cravings for food, or if it extends broadly to other kinds of positive stimuli.

Although our data suggest that cognitive reappraisal can powerfully reduce food craving, a potential limitation of the present work is that the data do not directly link these cravings to actual eating behavior. Nonetheless, the significant positive correlation between the cognitive restraint subscale of the TFEQ and task regulation success demonstrates that performance on the present task is related to a measure of broader cognitive regulation of appetitive desires with validated ecological validity. This achieves a necessary first step in connecting laboratory measurements to real-world behavior by creating and validating a robust laboratory model for studying the effects of cognitive reappraisal on food craving. An important next step is to test whether these regulation strategies affect not only cravings but also eating, and work is underway in our laboratory to do just that.

Because the present study did not aim to measure eating behavior, we relied on self-reports of craving, which may be subject to experimental demand. To mitigate the effects of experimental demand on self-reports, we took steps to train our participants to minimize their perception that we expected them to succeed on any given trial. We interpret the fact that five participants actually reported greater craving for foods seen in the Regulate condition as compared to Look as evidence that participants reported their

craving honestly at the end of each trial. In addition, previous work on the regulation of other affective states has shown that cognitive reappraisal modulates both autonomic and neural correlates of affective responding in addition to self-report (e.g., Ochsner & Gross, 2008). Therefore, we believe that demand is an unlikely explanation for our findings.

Another potential limitation of the task is the event-related nature of the design. Look and Regulate trials were pseudo-randomly presented to subjects, so participants were asked to switch between passive viewing of stimuli and cognitive regulation of craving from trial to trial. While used frequently in the emotion regulation literature (e.g., Kober, Kross, et al., 2010; Ochsner & Gross, 2004), trial-to-trial contamination is a known caveat of this design. However, as contamination between trials (e.g., participants accidentally regulating during Look trials, or vice versa) would serve to decrease the magnitude of the difference between conditions, the significant difference between conditions observed in the present study indicates that the effect of cognitive regulation on craving is robust enough to overcome any potential contamination effects.

Lastly, although we asked participants to use the same cognitive regulation strategy for all Regulate trials, we cannot guarantee that this is indeed the case. However, we took steps to encourage participants to employ exactly one strategy by reminding them to use the same strategy for all trials before each run and asking them which strategy they used at the end of the experiment. Furthermore, data from two participants who were unable to report which strategy they used at the end of the experiment were removed from analyses.

Until now, almost no studies examined regulation of food craving, and those that did limited subjects to one stimulus set and one regulation strategy. The present study demonstrates that people select and effectively deploy a variety of cognitive strategies to regulate their desire to consume energy-dense foods, and that these strategies are even more effective for foods that are highly craved compared to those that are less desired. In the future, this paradigm could be used to measure the efficacy of different cognitive strategies in changing real-world eating behavior in the service of meeting weight-loss goals.

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