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Craving is an Affective State and Its Regulation Can Be Understood in Terms of the Extended Process Model of Emotion Regulation

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We argue that craving is an affective state per the definition offered in the target article, and as such the Extended Process Model provides a strong theoretical framework to understand the self-regulation of craving. First, we briefly define craving in general and food craving in particular and relate those constructs to the definitions of affect and emotion in the target article. We then apply the Extended Process Model to cognitive strategies for self-regulation of food craving and related clinical interventions. In doing so, we illustrate how the Extended Process Model of Emotion Regulation is a useful tool for bridging related topics within affective science (e.g., craving and emotion) and for analyzing and improving programs that target affective states (e.g., dietary interventions).

What is food craving and is it an affective state?

Food craving can be defined as the subjective sense of wanting a certain food, and features both food-related affective/motivational components (e.g., wanting to eat the food, being motivated to approach it) and cognitions (e.g., intrusive thoughts about the food; see Kavanagh, Andrade, & May, 2005). The “definitional chaos” noted in the targeted article that plagues affective science (Buck, 1990) is echoed in the field of craving. Craving and related constructs have been given an assortment of names, including urges, motivated behavior, incentive motivation, reward, and wanting, each with subtly different meanings that vary from study to study and subdiscipline to subdiscipline, but all referring to phenomena that are more similar than dissimilar. Though people can crave a broad range of stimuli, research has largely focused on craving for two of these: drugs (e.g., nicotine, cocaine) and food. The degree to which food and drug craving are similar is up to debate: the underlying neurobiology is apparently quite similar (e.g., Blum, Liu, Shriner, & Gold, 2011; Volkow, Wang, Fowler, Tomasi, & Baler, 2012), but psychological models of food craving are not necessarily applicable to drug craving (Weingarten & Elston, 1990). There are also important qualitative differences in the substances themselves that differentiate the two types. For example, consuming drugs isn’t essential to sustain life, but consuming food is (Hill, 2007). To simplify the present argument, we limit our focus here to food craving, but we note that several studies have applied an emotion regulation approach to the study of drug craving as well (e.g., Kober et al., 2010; Sayette et al., 2000).

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Like stress and mood, craving also maps well onto Gross's working definition of affect. Craving, too, is a psychological state that involves valuation, unfolds over time, can be helpful or harmful, and involves loosely coupled changes in the domains of subjective experience, behavior, and peripheral physiology. We and others have shown that cravings can be rated via self report, motivate behavior toward the craved food, and involve changes in central physiology (e.g., Giuliani, Mann, Tomiyama, & Berkman, 2014). And, critically, craving is not necessarily followed by increased eating (Hill, 2007), suggesting that craving can be regulated much like other affective states. Indeed, the neural bases of craving regulation appear to overlap considerably with those underlying the regulation of negative emotion, including the dorsolateral prefrontal cortex, inferior frontal gyrus, and dorsal anterior cingulate cortex (Buhle et al., 2013; Giuliani et al., 2014). Based on this evidence, we believe that greater integration between the fields of affective science and craving could be mutually beneficial and potentially transformative to both.

The Process Model of Emotion Regulation applied to food craving

One direct way to leverage the high degree of conceptual overlap between craving and other affective states is to apply the Process Model of Emotion Regulation to food craving. There exists a growing body of evidence suggesting that cravings can be down-regulated using cognitive techniques (e.g., Giuliani, Calcott, & Berkman, 2013; Giuliani et al., 2014; Hollmann et al., 2011; Kober et al., 2010; Siep et al., 2012; Yokum & Stice, 2013), including some that are explicitly included in the "cognitive change" step of the Process Model. If craving is an affective state, then the Process Model may be a useful framework to better understand the various ways that craving may be regulated. Here, we apply this model to craving, and review select evidence that different food craving regulation strategies fit within this model.

Situation selection

For many people, food craving regulation begins and ends with situation selection. In these cases, individuals might avoid purchasing craved foods to prevent themselves from having a lapse during a moment of weakness or avoid dining at places where their craved food is found (e.g., fast food restaurants). Interventions at this step have been used to decrease exposure to situations that will trigger other cravings, such as those for drugs (Kober & Bolling, 2014), but to our knowledge there are no systematic interventions that focus on situation selection to reduce food craving and intake.

Situation modification

Situation modification is an alternative strategy for food craving regulation when being around a craved food is unavoidable. This strategy can take many forms, including eating a substitute food (e.g., ordering a side salad instead of French fries) or moving a serving container of a craved food to the other end of the table to avoid reaching for more. As with situation selection, we are not aware of formal interventions aimed at increasing usage of this strategy. It may be that combining the two contextually-focused techniques (situation selection and modification) could form a potent and flexible food craving regulation strategy. In any case, it was only when applying the Process Model to food craving

regulation that this gap in scientific knowledge became apparent, illustrating one kind of utility the model has in this area.

Attentional deployment

Attentional deployment refers to regulating food cravings by focusing attention away from the craved food. This strategy has received more empirical investigation than the first two, beginning with the delay of gratification work mentioned in the target article (Mischel & Ebbesen, 1970), which consistently finds that children who spontaneously engage in distraction are able to wait longer to eat the delicious marshmallow in front of them than those who do not distract their attention away (Rodriguez & Mischel, 1987). The degree to which personally-craved foods distract attention correlate with self-reported craving levels (Smeets, Roefs, & Jansen, 2009), suggesting that attentional bias training away from food may affect its consumption. However, the story seems to be more complicated. Training attention away from food words can decrease caloric intake (Boutelle, Kuckertz, Carlson, & Amir, 2014), but not always (Hardman, Rogers, Etchells, Houstoun, & Munafo, 2013), and chronically restrained eaters—who, for the most part, are successful in their regulation—actually display attentional biases toward their craved foods (Papies, Stroebe, & Aarts, 2008). These mixed findings may be attributable to attentional accuracy: among chocolate lovers, individuals with high attentional accuracy consumed more chocolate when they were trained to attend to chocolate, but low accuracy individuals consumed more chocolate when they were trained to attend to a non-food item (Werthmann, Field, Roefs, Nederkoorn, & Jansen, 2014). This indicates that attention bias interventions away from food may be more affective in reducing food consumption only among individuals with high attentional accuracy, and that those lower in attentional accuracy may benefit from interventions at different stages in the Process Model or even training toward the food. In any case, attentional deployment seems to be a promising if nuanced strategy for food craving regulation that is quickly garnering empirical support.

Cognitive change

Reappraising desire for a craved food, or thinking about the food in a different way, can effectively decrease food craving. Focusing on the “cool,” descriptive qualities as compared to the “hot,” appetitive qualities of an otherwise attractive food increased delay of gratification time among preschoolers (Mischel, Shoda, & Peake, 1988). We and others have also found that focusing on the negative consequences of consuming the food (e.g., a stomachache) or the beneficial consequences of not consuming the food (e.g., weight loss) also function as powerful ways of decreasing food craving through cognitive change in adolescents and adults (e.g., Giuliani et al., 2013; Kober et al., 2010; Yokum & Stice, 2013). The considerable knowledge from emotion regulation about cognitive change strategies could easily be leveraged to refine parallel strategies to reduce food craving.

Response modulation

As a last resort, people have the option to simply “gut it out,” to sit in front of their craved food and try not to eat it. With craving as with emotion, the efficacy of this strategy is mixed. The paradoxical effect of restriction on consumption—that restriction goals generally lead to increased consumption in many cases (Polivy, 1998; Soetens, Braet, Van

Vlierberghe, & Roets, 2008; Stirling & Yeomans, 2004)—fits with the finding that attempting to ignore a craved food is less effective for decreasing consumption than attending to the food (Mischel & Ebbesen, 1970). In Process Model terms, these results support the increased efficacy of cognitive change over distraction or response modulation for reducing food craving, which parallels the general pattern in the emotion regulation literature. However, and as with emotions, there are individual differences in the efficacy of this strategy to reduce craving. For example, when contrasted with normal weight adolescents and low-restraint individuals, only highly-restrained obese adolescents showed the paradoxical rebound after suppressing thoughts about food and eating (Soetens & Braet, 2006), suggesting the presence of important moderators. A key contribution of the Process Model in this area is to provide theoretical structure to a complex set of findings that are otherwise difficult to conceptualize.

The Extended Process Model of Emotion Regulation applied to food craving interventions

In the previous section, we applied the Process Model of Emotion Regulation to food craving to generate new testable predictions, identify gaps in the literature, and organize disparate results. Here, we illustrate how the Extended Process Model of Emotion Regulation presented in the target article can be additionally useful as a tool to evaluate and improve existing food craving interventions, and perhaps even to develop new ones. Understanding how to regulate food craving and refining new ways to do so is highly significant because many of the most pervasive and costly health problems faced by society today, including diabetes, heart disease, and many cancers, can be traced directly or indirectly to consumption of unhealthy food (Jenkins et al., 2002). Therefore, tools that can help scholars analyze the strengths and weaknesses of the interventions designed to reduce cravings for unhealthy foods from a theoretical perspective are critically important.

Valuation

The first way that Gross extends the Process Model of Emotion regulation is by segmenting emotion regulation into three components of a second-level system that takes the emotion itself as the target: perception, valuation, and action. In this view, the process of regulating cravings involves first perceiving the craving, then placing a value upon it vis-à-vis other ongoing goals, and finally acting (or not) in some way to modify the craving, all in an iterative loop that evolves over time. The model represents a lens through which to view and understand the processes and systems targeted by various food craving interventions (which themselves can be seen as external second-level valuation systems), and to provide insight into when, why, and for whom the interventions succeed or fail.

Perception—A common first line of attack of dietary interventions is to merely increase awareness of cravings for unhealthy food, such as interventions that include food diaries and suggestions for healthy food “swaps” (e.g., “if you notice that you’re craving this unhealthy food, try this healthier version”). Indeed, people assigned to monitor their consumption of an unhealthy target food consume less of it than those who are assigned to restrict their consumption (Tomiyama et al., 2010). Other perception-based interventions have sought to

alter the intrusive thoughts that lead to craving by directing attention away from those thoughts. The Elaborated Intrusion theory of desire (EI theory) states that intrusive thoughts depend on the salience of the intrusion relative to competing attentional demands (Kavanagh et al., 2005), suggesting that distraction might be an effective way to minimize cravings. However, experimental research evaluating techniques to reduce intrusive thoughts has found mixed evidence for this idea (e.g., Hamilton, Fawson, May, Andrade, & Kavanagh, 2013; May, Andrade, Batey, Berry, & Kavanagh, 2010). The Extended Process Model might suggest that these interventions could be bolstered with additional components that target the subsequent two steps in the regulation process.

Valuation—The next stage where interventions may act to reduce food cravings is in changing the evaluation of the craving. There are two common routes to this in the literature, and both involve some degree of cognitive reappraisal. One is to amplify the evaluation of the craving as undesirable by juxtaposing it with ongoing dieting goals, thereby highlighting its negative value with respect to those goals. This may be accomplished by activating alternative, competing goals (e.g., health, appearance; Fishbach, Zhang, & Trope, 2009). For example, cognitive reappraisal can be used to focus either on the negative aspects of consuming a unhealthy desired food, or the positive aspects of not consuming a unhealthy desired food (Yokum & Stice, 2013). The other route is to mentally decouple the association between craving and eating—the undesired behavior typically linked with craving—thereby robbing craving of its relevance (and value) with respect to ongoing goals. This route is the central feature of interventions including or based on mindfulness acceptance, which uncouples craving from consumption and changes the valuation of the craving from harmful to innocuous (e.g., Alberts, Mulkens, Smeets, & Thewissen, 2010; Forman et al., 2007). These two possibilities for altering the value of craving are not likely to be exhaustive; future work in this area could borrow insights from other parts of affective science that have focused more extensively on the valuation process (e.g., intertemporal choice; Kable & Glimcher, 2007) to create innovative new interventions.

Action—Many classic dietary interventions act on the last stage in the valuation process, acting to decrease the gap between the perceived (“I am craving that food”) and desired (“I do not want to eat that food”) states of the world. These interventions typically use one or more emotion regulation strategies that were reviewed in the previous section (e.g., distraction and cognitive restructuring; Forman et al., 2007), though to our knowledge there has been no systematic attempt to survey dietary interventions in terms of the Process Model strategies to identify gaps in the literature and avenues for growth. Such a review is beyond the scope of this commentary, but in our view it is where the food craving intervention field could benefit most from the Extended Process Model. For example, though reappraisal is an effective means of reducing food craving (Giuliani et al., 2013; Giuliani et al., 2014), emotion intensity moderates the relative effectiveness of reappraisal versus distraction for regulating negative emotion (Sheppes, Scheibe, Suri, & Gross, 2011), suggesting that providing people with a range of regulation strategies would be the most robust intervention across a range of intensity levels. An intervention that imparts an assortment of techniques may be the most effective by enabling each individual to build his/her own idiosyncratic toolkit with which to address situations in the most adaptive way possible.

Stages

Another way Gross extends the Process Model is by proposing three separate stages of the emotion regulation cycle at which interventions may act: identification, selection, and implementation. These stages exist at every stage named in the Process Model, and reveal vulnerable points in the process where regulation strategies can fail. Because little work has investigated food-craving regulation at this level of granularity, we suggest ideas for future interventions at each of these stages.

Identification—In the identification stage, individuals detect that they are experiencing a craving and become concerned with whether to regulate their cravings. As in emotion regulation, where emotion awareness is useful for emotion regulation (Barrett, Gross, Conner, & Benvenuto, 2001), craving awareness is also useful for craving regulation. Individual differences in levels of interoceptive awareness correlate with sensitivity for gastric fullness (Herbert, Muth, Pollatos, & Herbert, 2012), but no one has yet explored how interoceptive awareness relates to craving awareness. This suggests two new potential targets for intervention: the awareness that a craving is being experienced (perception), and the decision whether to regulate those cravings (valuation, action). Mindfulness-based craving interventions may act on both of these targets. Craving precipitates binge eating (Gendall, Joyce, Sullivan, & Bulik, 1998), and interventions aimed at improving awareness of craving among individuals who binge or overeat have shown that mindfulness techniques reduce both cravings and binge eating episodes. These findings have been attributed to increased awareness of hunger and satiety cues (Kristeller & Hallett, 1999; Kristeller & Wolever, 2011), as well as food cravings (Alberts, Thewissen, & Raes, 2012). The mindfulness-based interventions discussed above, which are aimed at increasing nonjudgmental acceptance of cravings, appear to impact precisely the identification process —the decision whether to regulate the craving. Their focus is to change the valuation from harmful to innocuous, thereby removing the need to engage in a regulation action. Alternatively, in non-mindfulness based interventions, successful termination of the identification stage ideally consists of the “action” to trigger the selection phase, in which a strategy to reduce food cravings is chosen.

Selection—Selection involves choice among possible response options to regulate the craving. Here, failures may result from the lack of perception or availability of strategies, improper valuation of the strategies in light of the available situational demands or cognitive resources, and/or selection of a suboptimal action. Interventions may act at any of these points. When asked to generate a reappraisal that would help them reduce their desire to consume a craved target food, all of the participants in one of our studies were able to generate at least one reappraisal strategy they thought would work well for them (Giuliani et al., 2013). In the case of that study, we intentionally restricted participants only to reappraisal strategies, but it follows that participants would be able to generate idiosyncratic food craving regulation strategies across the spectrum of the Process Model when given the freedom to do so. In the same way that people seem to know to select reappraisal when their emotional intensity is low but prefer distraction when intensity is high (Sheppes et al., 2011), individuals may also know to choose more upstream food craving regulation strategies when cravings are high or resources are low. For example, if a person has had a

very hard day and knows that she wouldn't be able to resist a sweet pastry on her walk home from work, she may decide to take a different route to avoid having to engage in the hard work of reappraising her craving for the pastry. But this may not necessarily always be the case—perhaps people have very little meta-knowledge about which regulation strategies might be appropriate for a given context or possess only a limited number of strategies from which to select. Interventions that specifically teach individuals how to identify which strategies are available to them, balance the features of their present situation with the resources that are presently available, and select the most adaptive strategy may be particularly powerful in reducing unhealthy food cravings.

Implementation—In the implementation stage, individuals are concerned with enacting the selected tactic in a way that suits their present situation. As in the previous stage, interventions may target perceptions of the various ways of implementing the selected strategy, valuations of these various ways, and execution of the chosen regulatory action. While these steps can in theory be differentiated from those in the selection stage, interventions targeting both the selection and implementation stages may in practice be the most effective because selecting the most adaptive regulation strategy depends on an accurate assessment of the available strategies based on the features of the situation. For example, if a person has a birthday party to attend and his goal is to not eat sweets, the strategy he selects will depend on an accurate assessment of the situation ("How important is it for me to attend this party?"), his internal state ("How strong will my cravings for that cake be?"), his resources ("How effective do I think my reappraisal of focusing on my long-term goals will be?"), and his available regulation strategies ("Could I sit far away from the cake?"). Further, the food craving regulation strategy he chooses will depend greatly on the craved food itself. If he knows that he craves sweets, then he could employ situation selection and not purchase any sweet foods to keep in the house. However, if his craved food is fast food, it may be quite hard to avoid all fast food establishments as he navigates through his day. Therefore, as selecting a strategy depends so heavily on situational and other fluctuating factors, teaching the selection and implementation stages in concert may be the most effective form of practical intervention based on this model.

Conclusion

Applying the Extended Process Model of Emotion Regulation to food craving regulation is a useful way to organize and understand food-craving interventions and to build new ones based on the model. Like other affective states, food-craving regulation strategies can be engaged at many points along the unfolding affective trajectory, depend greatly on the idiosyncratic nature of the individual and the situation, and may vary based on the precise nature of the affective state. The Extended Model allows us to better understand how these strategies, and the interventions based on them, function at different levels of valuation and stages in the regulatory process. As with the regulation of other affective states, the ability to successfully regulate food cravings in service of weight loss or healthy eating goals depends on accurately identifying situational, personal, and affective factors influencing the craving, and flexibly engaging one or several regulatory strategies. As such, successful new interventions will likely involve broadening the set of response options beyond those

typically included in current interventions and teaching people how to switch between those options depending on the nature of the changing context.

We've focused so far on the ways in which craving and its regulation are similar to other affective states, but there may be key ways in which craving is different. For example, cravings are enmeshed within a reinforcement learning system to a far greater degree than emotions are; few people are born with cravings for cocaine, but most people are born with emotions. That, in turn, may imply a key difference in the possibility for their regulation. For instance, like other learned responses, cravings are subject to extinction (see Berkman, Dickenson, Falk, & Lieberman, 2011 for an example with nicotine craving), but it is unlikely that suppressing sadness will eventually lead to its demise within a person. As the field advances, an important direction of growth will be to learn how and when ideas and constructs from emotion regulation can and cannot be applied to the area of craving. A more detailed map of the boundaries between the fields will facilitate a robust and productive interchange between them. We hope that this commentary will serve as a chart of the initial contours.

References

Alberts HJEM, Mulkens S, Smeets M, Thewissen R. Coping with food cravings: Investigating the potential of a mindfulness-based intervention. Appetite. 2010; 55(1):160–163. [PubMed: 20493913]

Alberts HJEM, Thewissen R, Raes L. Dealing with problematic eating behaviour. The effects of a mindfulness-based intervention on eating behaviour, food cravings, dichotomous thinking and body image concern. Appetite. 2012; 58(3):847–851. [PubMed: 22265753]

Barrett LF, Gross JJ, Conner T, Benvenuto M. Knowing what you're feeling and knowing what to do about it: Mapping the relation between emotion differentiation and emotion regulation. Cognition and Emotion. 2001; 15:713–724.

Berkman ET, Dickenson J, Falk EB, Lieberman MD. Using SMS text messaging to assess moderators of smoking reduction: Validating a new tool for ecological momentary measurement of health behaviors. Health Psychology. 2011; 30(2):186–194. [PubMed: 21401252]

Blum K, Liu Y, Shriner R, Gold MS. Reward circuitry copaminergic activation regulates food and drug craving behavior. Current Pharmaceutical Design. 2011; 17(12):1158–1167. [PubMed: 21492092]

Boutelle KN, Kuckertz JM, Carlson J, Amir N. A pilot study evaluating a one-session attention modification training to decrease overeating in obese children. Appetite. 2014; 76:180–185. [PubMed: 24512975]

Buck R. Mood and emotion: A comparison of five contemporary views. Psychological Inquiry. 1990; 1:330–336.

Buhle JT, Silvers JA, Wager TD, Lopez R, Onyemekwu C, Kober H, Ochsner KN. Cognitive reappraisal of emotion: A meta-analysis of human neuroimaging studies. Cerebral Cortex. 2013

Fishbach A, Zhang Y, Trope Y. Counteractive evaluation: Asymmetric shifts in the implicit value of conflicting motvations. Journal of Experimental Social Psychology. 2009; 46:29–38.

Forman EM, Hoffman KL, McGrath KB, Herbert JD, Brandsma LL, Lowe MR. A comparison of acceptance- and control-based strategies for coping with food cravings: An analog study. Behaviour Research and Therapy. 2007; 45(10):2372–2386. [PubMed: 17544361]

Gendall KA, Joyce PR, Sullivan PF, Bulik CM. Food cravers. Characteristics of those who binge. International Journal of Eating Disorders. 1998; 23:353–360. [PubMed: 9561425]

Giuliani NR, Calcott RD, Berkman ET. Piece of cake. Cognitive reappraisal of food craving. Appetite. 2013; 64:56–61. doi: 10.1016/j.appet.2012.12.020. [PubMed: 23313699]

Giuliani NR, Mann T, Tomiyama AJ, Berkman ET. Neural systems underlying the reappraisal of personally-craved foods. Journal of Cognitive Neuroscience. 2014; 26(7):1390–1402. [PubMed: 24392892]

Hamilton J, Fawson S, May J, Andrade J, Kavanagh D. Brief guided imagery and body scanning interventions reduce food cravings. Appetite. 2013; 71:158–162. [PubMed: 23962401]

Hardman CA, Rogers PJ, Etchells KA, Houstoun KV, Munafo MR. The effects of food-related attentional bias training on appetite and food intake. Appetite. 2013; 71:295–300. [PubMed: 24025548]

Herbert BM, Muth ER, Pollatos O, Herbert C. Interoception across modalities: On the relationship between cardiac awareness and the sensitivity for gastric functions. PLoS One. 2012; 7(5):e36646. [PubMed: 22606278]

Hill AJ. The psychology of food craving. Proceedings of the Nutrition Society. 2007; 66(2):277–285. [PubMed: 17466108]

Hollmann M, Hellrung L, Pleger B, Schlogl H, Kabisch S, Stumvoll M, Horstmann A. Neural correlates of the volitional regulation of the desire for food. International Journal of Obesity. 2011

Jenkins DJA, Kendall CWC, Augustin LSA, Franceschi S, Hamidi M, Marchie A, Axelsen M. Glycemic index: Overview of implications in health and disease. American Society for Clinical Nutrition. 2002; 76(1):2665–2735.

Kable JW, Glimcher PW. The neural correlates of subjective value during intertemporal choice. Nature Neuroscience. 2007; 10(12):1625–1633.

Kavanagh DJ, Andrade J, May J. Imaginary relish and exquisite torture: The elaborated intrusion theory of desire. Psychological Review. 2005; 112(2):446–467. [PubMed: 15783293]

Kober, H.; Bolling, D. Emotion regulation in substance use disorders. In: Gross, JJ., editor. Handbook of Emotion Regulation. 2nd ed. Guilford Press; New York, NY: 2014. (2 ed.)

Kober H, Mende-Siedlecki P, Kross EF, Weber J, Mischel W, Hart CL, Ochsner KN. Prefrontal-striatal pathway underlies cognitive regulation of craving. Proc Natl Acad Sci U S A. 2010; 107(33):14811–14816. [PubMed: 20679212]

Kristeller JL, Hallett CB. An exploratory study of a meditation-based intervention for binge eating disorder. Journal of Health Psychology. 1999; 4:357–363. [PubMed: 22021603]

Kristeller JL, Wolever RQ. Mindfulness-based eating awareness training for treating binge eating disorder: The conceptual foundation. Eating Disorders. 2011; 19(1):49–61. [PubMed: 21181579]

May J, Andrade J, Batey H, Berry LM, Kavanagh DJ. Less food for thought. Impact of attentional instructions on intrusive thoughts about snack foods. Appetite. 2010; 55(2):279–287. [PubMed: 20600411]

Mischel W, Ebbesen EB. Attention in delay of gratification. Journal of Personality and Social Psychology. 1970; 16(2):329–337.

Mischel W, Shoda Y, Peake PK. The nature of adolescent competencies predicted by preschool delay of gratification. Journal of Personality and Social Psychology. 1988; 54(4):687–696. [PubMed: 3367285]

Papies EK, Stroebe W, Aarts H. The allure of forbidden food: On the role of attention in self-regulation. Journal of Experimental Social Psychology. 2008; 44(5):1283–1292.

Polivy J. The effects of behavioral inhibition: Integrating internal cues, cognition, behavior, and affect. Psychological Inquiry. 1998; 9:181–204.

Rodriguez, ML.; Mischel, W. Cognitive strategies and delay behavior in impulsive older children. Paper presented at the Annual convention of the American Psychological Association; New York, NY. 1987.

Sayette MA, Shiffman S, Tiffany ST, Niaura RS, Martin CS, Shadel WG. The measurement of drug craving. Addiction. 2000; 95(Suppl 2):S189–210. [PubMed: 11002914]

Sheppes G, Scheibe S, Suri G, Gross JJ. Emotion-regulation choice. Psychological Science. 2011; 22(11):1391–1396. [PubMed: 21960251]

Siep N, Roefs A, Roebroeck A, Havermans R, Bonte M, Jansen A. Fighting food temptations: The modulating effects of short-term cognitive reappraisal, suppression, and up-regulation on mesocorticolimbic activity related to appetitive motivation. Neuroimage. 2012; 60:213–220. [PubMed: 22230946]

Smeets E, Roefs A, Jansen A. Experimentally induced chocolate craving leads to an attentional bias in increased distraction but not in speeded detection. Appetite. 2009; 53(3):370–375. [PubMed: 19646495]

Soetens B, Braet C. 'The weight of a thought': Food-related thought suppression in obese and normal-weight youngsters. Appetite. 2006; 46:306–317.

Soetens B, Braet C, Van Vlierberghe L, Roets A. Resisting temptation: effects of exposure to a forbidden food on eating behavior. Appetite. 2008; 51(1):202–205. [PubMed: 18342989]

Stirling LJ, Yeomans MR. Effect of exposure to a forbidden food on eating in restrained and unrestrained women. International Journal of Eating Disorders. 2004; 35:59–68. [PubMed: 14705158]

Tomiyama AJ, Mann T, Vinas D, Hunger JM, Dejager J, Taylor SE. Low calorie dieting increases cortisol. Psychosomatic Medicine. 2010; 72(4):357–364. [PubMed: 20368473]

Volkow ND, Wang GJ, Fowler JS, Tomasi D, Baler R. Food and drug reward: Overlapping circuits in human obesity and addiction. Current Topics in Behavioral Neuroscience. 2012; 11:1–24.

Weingarten HP, Elston D. The phenomenology of food cravings. Appetite. 1990; 15:231–246. [PubMed: 2281953]

Werthmann J, Field M, Roefs A, Nederkoorn C, Jansen A. Attention bias for chocolate increases chocolate consumption - an attention bias modification study. Journal of Behavior Therapy and Experimental Psychiatry. 2014; 45(1):136–143. [PubMed: 24140811]

Yokum S, Stice E. Cognitive regulation of food craving: effects of three cognitive reappraisal strategies on neural response to palatable foods. International Journal of Obesity. 2013