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Overcoming the urge to splurge: Influencing eating behavior by manipulating inhibitory control

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ABSTRACT

Background and objectives: When inhibitory control is lacking, people are more prone to indulge in high calorie food. This research examined whether increasing or decreasing inhibitory control influences food intake in opposite directions.

Methods: In this study, baseline inhibitory control ability was measured with the Stop Signal Task. Next, participants performed a modified Stop Signal Task with three within-subjects conditions: One type of high calorie food was always paired with a stop signal (inhibition manipulation), while another type of high calorie food was never presented with a stop signal (impulsivity manipulation). In the control condition, high calorie food was presented with a stop signal on half the trials. Following the manipulation, intake of the three food products that were used in the manipulation was measured during a taste test.

Results: Participants with low inhibitory control abilities consumed more of the control food compared to participants with high inhibitory control abilities. However, the inhibition manipulation decreased food consumption in participants with low levels of inhibitory control to the same level of food intake as that of participants with high levels of inhibitory control. Conversely, the impulsivity manipulation increased food intake in participants with high levels of inhibitory control to the level of consumption of participants with low levels of inhibitory control.

Conclusions: These findings demonstrate the causal role of inhibition in eating behavior and suggest that strengthening inhibitory control can help people regain control over the consumption of high calorie food.

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1. Introduction

In Western societies, where palatable, high calorie food is abundantly available, the prevalence of overweight and obesity is constantly increasing (Flegal, 2005; Wang & Beydoun, 2007). However, not everyone becomes overweight in this obesifying society: Some people can better resist the temptations of high-caloric food, and maintain a healthy weight than others. What distinguishes people with a normal weight from people with overweight? Although multiple factors contribute to overweight and obesity, one factor that seems especially important is inhibitory control: An executive function that is needed to overrule or inhibit impulsive reactions so that behavior can be regulated in line with one's long-term goals and standards (Logan & Cowan, 1984; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000). According to contemporary dual-process models (e.g., Strack & Deutsch, 2004), inhibitory control plays a critical role whenever conflicts arise between the impulse to give into temptation and personal dieting standards or health concerns.

Specifically, dual-process models state that behavior is determined by two qualitatively different types of processes. One the one hand, a fast-acting, high-capacity, associative "impulsive system" appraises stimuli automatically in terms of affective and motivational significance and predisposes individuals to either approach or avoid a certain stimulus (e.g., Strack & Deutsch, 2004). Such automatic, affective reactions toward tasty food trigger the motivational drive to indulge in these types of food (Appelhans, 2009; Dawe & Loxton, 2004; Strack & Deutsch, 2004). On the other hand, behavior is also guided by long-term goals and personal standards that reside in a slow-acting, low-capacity, controlled "reflective system" (e.g., Strack & Deutsch, 2004). Whenever conflicts arise between the motivational drive to indulge in high calorie food and personal goals such as dieting standards, the motivational drive needs to be overruled by higher-order inhibitory

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control processes, so that behavior is in line with more deliberate long-term goals (Strack & Deutsch, 2004). Consequently, when inhibitory control is somehow impaired, the motivational drive will be more dominant in guiding eating behavior, leaving one unable to resist the temptations of high calorie, palatable food.

Consistent with this theoretical perspective, empirical evidence shows a vital role for inhibitory control in overeating and overweight: People with a weaker ability to inhibit impulsive responses are more vulnerable to the temptations of tasty, high calorie food and eat more high calorie food (Guerrieri et al., 2007), are more often unsuccessful dieters (Jansen et al., 2009), and are more often overweight or obese (Guerrieri, Nederkoorn, & Jansen, 2008; Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006; Nederkoorn, Guerrieri, Havermans, Roefs, & Jansen, 2009; Nederkoorn, Jansen, Mulkens, & Jansen, 2007) than people with effective inhibitory control. Further, automatic affective responses more strongly determine consumption of high calorie food (Friese, Hofmann, & Wänke, 2008; Hofmann & Friese, 2008; Hofmann, Friese, & Roefs, 2009; Hofmann, Rauch, & Gawronski, 2007) as well as weight gain (Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010) when inhibitory control is weak.

Thus, the available evidence seems to suggest a causal role for inhibitory control in overeating and obesity. The clinical implication is that interventions aimed at reducing overeating and overweight might benefit from procedures that aim to strengthen inhibitory control abilities. If inhibitory control can somehow be enhanced, automatic impulses could be regulated more easily and control over food intake could be increased. While most of the studies examining the role of inhibitory control in obesity and overeating have been correlational in nature, there is also evidence supporting such a causal influence of inhibitory control on eating behavior: Guerrieri, Nederkoorn, Schrooten, Martijn, and Jansen (2009) demonstrated decreased food intake following a manipulation that primed inhibitory control compared to a manipulation that primed impulsive behavior. However, in this study, there was no control condition, which makes it impossible to determine whether both the impulsivity and the inhibition manipulation effectively influenced food intake relative to baseline. Moreover, Guerrieri et al. (2009) used a priming manipulation to induce a temporary state of impulsivity or inhibition. While such a priming paradigm is interesting to show causal relationships, it is highly unlikely that priming inhibition will induce long-term effects on both inhibitory abilities and eating behavior.

The current study takes this research a step further by examining whether increasing or decreasing inhibitory control respectively decreases or increases food intake relative to a control condition. Moreover, the present study tested a behavioral training of inhibition that consistently paired certain stimuli with a stopping response. A similar manipulation has been previously shown to effectively strengthen the ability to inhibit responses to those stimuli that were paired with a stopping response (Verbruggen & Logan, 2008). Since weak inhibitory control abilities can be considered a risk factor for overeating and obesity, such inhibition training may prove to be especially effective for people with low inhibitory control abilities. This issue was also investigated in the present research. Specifically, an adapted version of the Stop Signal Task (SST; Logan, Schachar, & Tannock, 1997), a behavioral task that is typically used to measure inhibitory control ability, was used to train participants to react impulsively toward a certain food product (i.e., acting fast toward palatable food stimuli) and to inhibit responding to another food product (i.e., stopping responses toward palatable food stimuli). A control food product was included toward which participants reacted on half the trials and inhibited their responses on the other half of the trials. In a subsequent taste test, consumption of these three food products was measured. By including a control condition, it was possible to unambiguously test (1) whether the impulsivity manipulation increased food intake, and (2) whether the inhibition manipulation decreased food intake. Further, baseline inhibitory control was measured using the original SST, to examine (3) if the manipulation had differential effects on food intake depending on the initial level of inhibitory control.

2. Method

2.1. Participants

Before inclusion in the study, participants were screened on attitudes toward the three types of food that were used in the manipulation: Attitudes toward crisps, nuts, and M&M's were measured with 5 semantic differentials that were scored on a 100 mm visual analog scale (unpleasant–pleasant, bad–good, foolish–wise, awful–nice, unpalatable–palatable). Only participants who liked crisps, nuts, and M&M's to a similar extent (i.e., mean attitude scores toward the three the types of food did not differ more than 25 points) were included in the study. In total, thirty-two female undergraduate students were selected for this study. Three participants were aware of the goal of the study and were therefore subsequently removed from the sample. The final sample consisted of twenty-nine participants (age: $M = 21.15$, $SD = 1.81$; Attitudes: Crisps: $M = 62.11$, $SD = 9.49$; Nuts: $M = 61.87$, $SD = 13.86$; M&M's: $M = 64.40$, $SD = 14.30$). Participants had a mean Body Mass Index (kg/m^2; BMI) of 23.12 ($SD = 4.27$; range 18.83–40.40), while 17.2% of the participants had a BMI higher than or equal to 25.

2.2. Materials and measures

2.2.1. Stop signal task

The Stop Signal Task (SST; Logan et al., 1997) as a measure of impulsivity, defined as a decreased ability to inhibit prepotent responses. The SST consists of go and stop trials. During the go trials, the letter O or the letter X is presented for 1000 ms, preceded by a 500 ms fixation point. During go trials, participants must respond as fast as possible to the X and the O using a left and a right response key on the keyboard (e.g., press left for X and press right for O; instructions were counterbalanced across participants). However, during stop trials, this learned response has to be inhibited. During stop trials an auditory stop signal is presented (through headphones), and participant are instructed not to respond when the stop signal is presented. Initially, the delay between the go signal (X or O) and the stop signal was set at 250 ms. Depending on the performance of the participants, a tracking procedure adapted the go–stop delay dynamically: if participants succeeded in inhibiting their response, the go–stop delay was increased by 50 ms, thereby making it more difficult to inhibit the next trial. If participants failed to inhibit their response, the go–stop delay was decreased by 50 ms, thereby making it easier to inhibit the next trial. The SST was designed to enable participants to correctly inhibit 50% of the stop trials.

Participants completed two practice blocks without stop signals and one with stop signals. Afterward, they completed four test blocks of 64 trials successively. There were an equal number of Xs and Os in each block and stop signals were presented on 25% of the trials, balanced over X and O trials. The order of trials was randomized. The two variables of interest were reaction time (RT) and stop delay. The dependent variable, stop signal reaction time (SSRT), was calculated by subtracting the stop delay from RT. Higher SSRTs indicate increased impulsivity or less inhibitory control.

2.2.2. Inhibitory control manipulation

The manipulation task was also an SST that was adapted based on the research by Verbruggen and Logan (2008) who

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