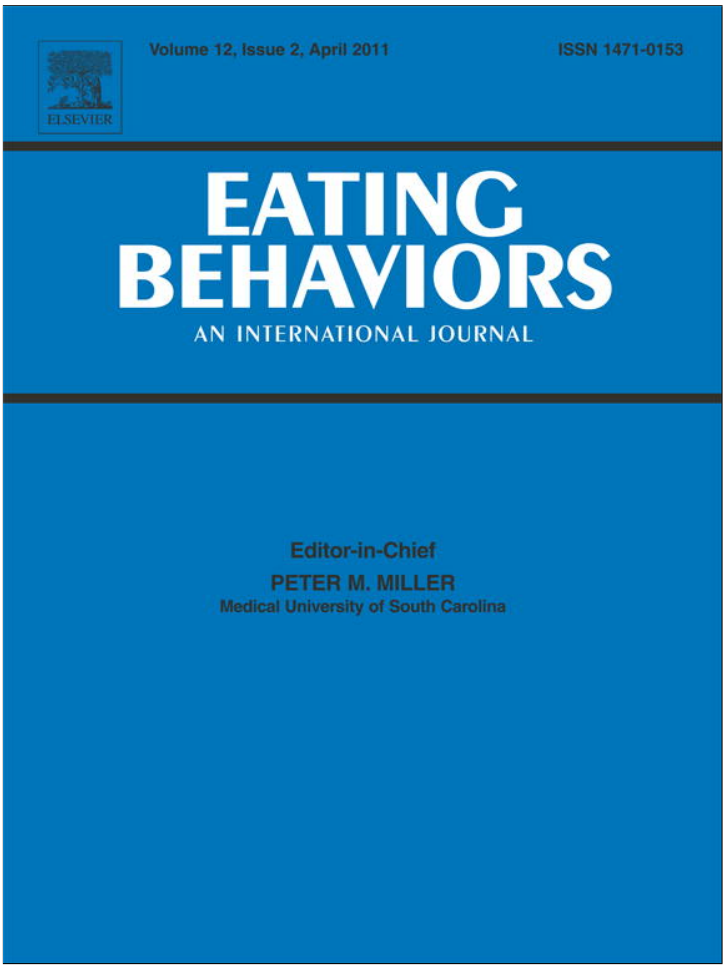

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Enhanced behavioral inhibition in restrained eaters

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ABSTRACT

Lack of inhibitory control has been found to play a decisive role in disordered eating behavior. Behavioral and self-report measures show impulsive tendencies to even occur in non-clinical samples, e.g. restrained eaters. In restrained eaters, these traits interact with high reactivity to food-related cues leading to overeating. The aim of the present study was to investigate if restrained eaters would show this behavioral disinhibition specifically in response to food cues. Participants performed a Go/No-Go-task with stimuli encircled by pictures of high caloric foods or neutral objects. In contrast to our hypotheses, restrained eaters made less commission errors than unrestrained eaters independent of the picture type. Restrained eaters had higher reaction time as compared to unrestrained eaters solely when confronted with food pictures, indicating an attentional bias toward these stimuli. We interpret our results such that the lack of inhibitory control in restrained eaters is situation specific rather than general. We further speculate that exposure to food cues might have increased their behavioral inhibition as in real life situation when they succeed in maintaining their goal of restrained food intake.

1. Introduction

Recently there has been increased interest in the investigation of impulsivity as a component of disordered eating. Self-reports and behavioral measures indicate that individuals with morbidly increased food intake display a range of impulsive behaviors. For example, obese individuals, and those with binge eating disorder or bulimia nervosa have elevated scores in self-report measures of impulsivity and show deficits in executive function such as decision-making and response inhibition which are thought to contribute to the maintenance of overeating (Guerrieri, Nederkoorn, & Jansen 2008).

These impulsive tendencies and deficits in inhibitory control are not limited to individuals with eating disorder or obesity. For instance, Nederkoorn, Van Eijs, and Jansen (2004) showed that women with restrained eating behavior had higher self-reported impulsivity and impaired inhibitory control in a stop-signal task compared to unrestrained eaters.

Restrained eaters not only seem to have impulsive tendencies, but also react more sensitively to the presence of food and food-related cues. Prior food consumption or mere exposure to food cues were found to make dieters disregard their weight-related goals and engage in overeating (see Stroebe 2008 for an overview). Recently, Jansen et al. (2009) suggested that one mediating factor of this counter-regulation could be inter-individual differences in impulsivity. In their study, only those restrained eaters engaged in overeating who also had less inhibitory control in a stop-signal-task.

On the basis of these findings which indicate that women with high dietary restraint both are more sensitive to food cues and present with more impulsive behavior with regards to food intake, we hypothesized that food cues would affect participants' performance in a behavioral measure of inhibitory control and their subsequent food consumption. Comparable studies showed that patients with alcohol abuse or eating disorder exhibit problems in behavioral inhibition, particularly when they are confronted with disorder-related stimuli (Mobbs, Van der Linden, d'Acremont, & Perroud 2008; Noël et al. 2005; Noël et al. 2007). Consequently, we expected restrained eaters to exhibit more commission errors, i.e. poorer inhibitory control, in a Go/No-Go-task (XY task, Garavan, Ross, Murphy, Roche, & Stein 2002), specifically when they would be confronted with pictures of high caloric foods. To activate food-related goals, subjects were presented with a cover story that required them to rate the taste of provided snacks. The snacks remained visible and odorant throughout the task. Thus, we finally hypothesized, that subsequently to the XY task, when they were allowed to eat as much of the snacks as they wished, restrained eaters would consume more than unrestrained eaters as a result of prior food consumption and cue exposure during the task.

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2. Methods

2.1. Participants

Female participants were recruited among students at the University of Würzburg and via an advertisement on a local website. Seventy women responded to the advertisements. One was excluded before the experiment because of a nut allergy. The remaining 69 took part in the study. Participants either received course credits (if they were psychology students in their introductory study period) or 6 Euro. Data from five subjects with more than 200 omission errors were excluded from analysis due to possible non-compliance. Data from three more participants were excluded due to self-reported current diagnoses of psychiatric disorders and psychopharmacological medication, leaving a total of 61 participants ($M = 22.1$ years, SD ± 2.6) for analysis.

2.2. Questionnaires

For the assessment of dietary restraint, participants filled out the German version of the Restraint Scale (RS; Dinkel, Berth, Exner, Rief, & Balck 2005; Herman & Polivy 1980). Furthermore, participants indicated on a 7-point Likert-scale their hunger level before and during the task and their motivation to do their best.

2.3. XY task

A modification of the XY task (Garavan et al. 2002) was used in this study. The program was compiled using E-prime 2.0 (Psychology Software Tools Inc., Pittsburgh, PA) and displayed on a LCD TFT 22″ screen. In this Go/No-Go-task, subjects were required to press a button on every target that was different from the preceding one. When the same target appeared twice consecutively (= lure), the response had to be withheld. In addition, pictures of either high caloric food (F) or neutral objects (N) surrounded the targets (Fig. 1). The task was separated into four counterbalanced blocks (F-N-F-N or N-F-N-F). Each block consisted of 315 trials including 20 lures. A practice block of 80 trials with alternating food and neutral pictures was presented prior to the experimental blocks. The whole task lasted for approximately 20 min.

2.4. Food consumption and cover story

A preload was presented as a taste test. Upon arrival, participants were given an information sheet describing the cover story that the purpose of the study was to explore the performance of a computer task depending on individual taste preferences. Participants were asked to eat several snacks and rate its taste. The snacks presented were salty nuts ("Nic Nacs"), dough-coated almonds with bacon flavor, whole milk or dark chocolate coated peanuts, and chocolate raisins. All snacks had approximately the same size.

2.5. Procedure

All participants were asked not to eat at least 3 h prior to the experiment to standardize hunger levels. Participants were tested individually. Thirty-one pieces of each of five different sorts of food were placed on separate plates before participants arrived. After reading and completing the information sheet and signing the consent form, participants were asked to taste the snacks by eating only one piece from every plate and rate their liking on a 7-point Likert-scale. After the taste rating the XY task was performed. Afterwards, participants were asked to complete the questionnaires and were allowed to eat as much from the remaining snacks as they wanted. Meanwhile, the experimenter left the room during questionnaire completion to avoid causing social reservation in the participants. Finally, participants were debriefed, and the food consumption was counted after participants had left.

3. Results

3.1. Participant characteristics

Participants were classified in restrained and unrestrained eaters based on RS scores. Participants who scored below median ($Mdn = 13$) were included in the unrestrained group ($n = 30$). Those with a score of 13 or above were assigned to the restrained group ($n = 31$). Groups differed significantly in their body-mass-index (BMI; $t_{(59)} = 3.0$, $p < .01$) such that restrained eaters' BMI ($M = 21.6$, SD ± 2.0) was higher than that of unrestrained eaters ($M = 20.3$, SD ± 1.5). No group differences were found in age, hunger levels before and during the task and motivation.

3.2. Task performance

Measures of interest were reaction times (RTs), which should reflect attentional processes, and commission errors (CEs) as an indicator for inhibitory control. Trials with an RT of less than 150 ms were excluded from analyses.

A 2 (picture type) × 2 (group) ANOVA for repeated measures with RT as dependent variable yielded a significant main effect of group ($F_{(1,59)} = 4.4$, $p < .05$), but no difference between picture types was found ($F_{(1,59)} = 2.9$, *ns*). Post-hoc comparisons indicated that the restrained group ($M = 356.6$ ms, SD ± 27.5) reacted slower than the unrestrained group ($M = 339.2$ ms, SD ± 36.4).The group × picture type interaction proved marginally significant ($F_{(1,59)} = 3.7$, $p = .06$). Bonferroni-corrected post-hoc t-tests revealed that restrained eaters reacted slower than unrestrained eaters only in response to food pictures ($t_{(59)} = 2.5$, $p < .05$), but not in response to neutral pictures ($t_{(59)} = 1.5$, *ns*).

A 2 (picture type) × 2 (group) ANOVA for repeated measures with CEs as dependent variable also revealed a main effect of group ($F_{(1,59)} = 10.2$, $p < .01$) such that restrained eaters ($M = 42.7$, SD ± 10.3) made less errors than unrestrained eaters ($M = 51.5$, SD ± 11.1) independent of picture type (Fig. 2). The main effect of picture type ($F_{(1,59)} = 3.1$) and the group × picture type interaction ($F_{(1,59)} = .3$) were not significant.

3.3. Food consumption

According to the procedure adopted from Jansen et al. (2009) we further divided our sample into low and high impulsive individuals on the basis of task performance (median split on the number of CEs). A one-way ANOVA yielded a significant main effect of restraint status on food consumption ($F_{(1,57)} = 5.0$, $p < .03$) while the main effect of impulsivity was not significant ($F_{(1,57)} = 1.9$, *ns*). Restrained eaters consumed more food ($M = 7.5$, SD ± 8.3) compared to unrestrained eaters ($M = 3.9$, SD ± 7.0) after the task. There was a trend toward a significant restraint status × impulsivity interaction ($F_{(1,57)} = 2.8$, $p = .09$), supporting the notion that impulsivity modulated food intake of restrained eaters such that impulsive restrained eaters ($M = 11.5$, SD ± 11.6) ate more than all others (low impulsive restrained eaters: $M = 5.4$, SD ± 4.9; high impulsive unrestrained eaters: $M = 3.7$, SD ± 7.9; low impulsive unrestrained eaters: $M = 4.3$, SD ± 5.5).

4. Discussion

The current study showed that restrained eaters performed better in a Go/No-Go task compared to unrestrained eaters by making less commission errors. Moreover, reaction times of restrained eaters were slower compared to unrestrained eaters in response to high

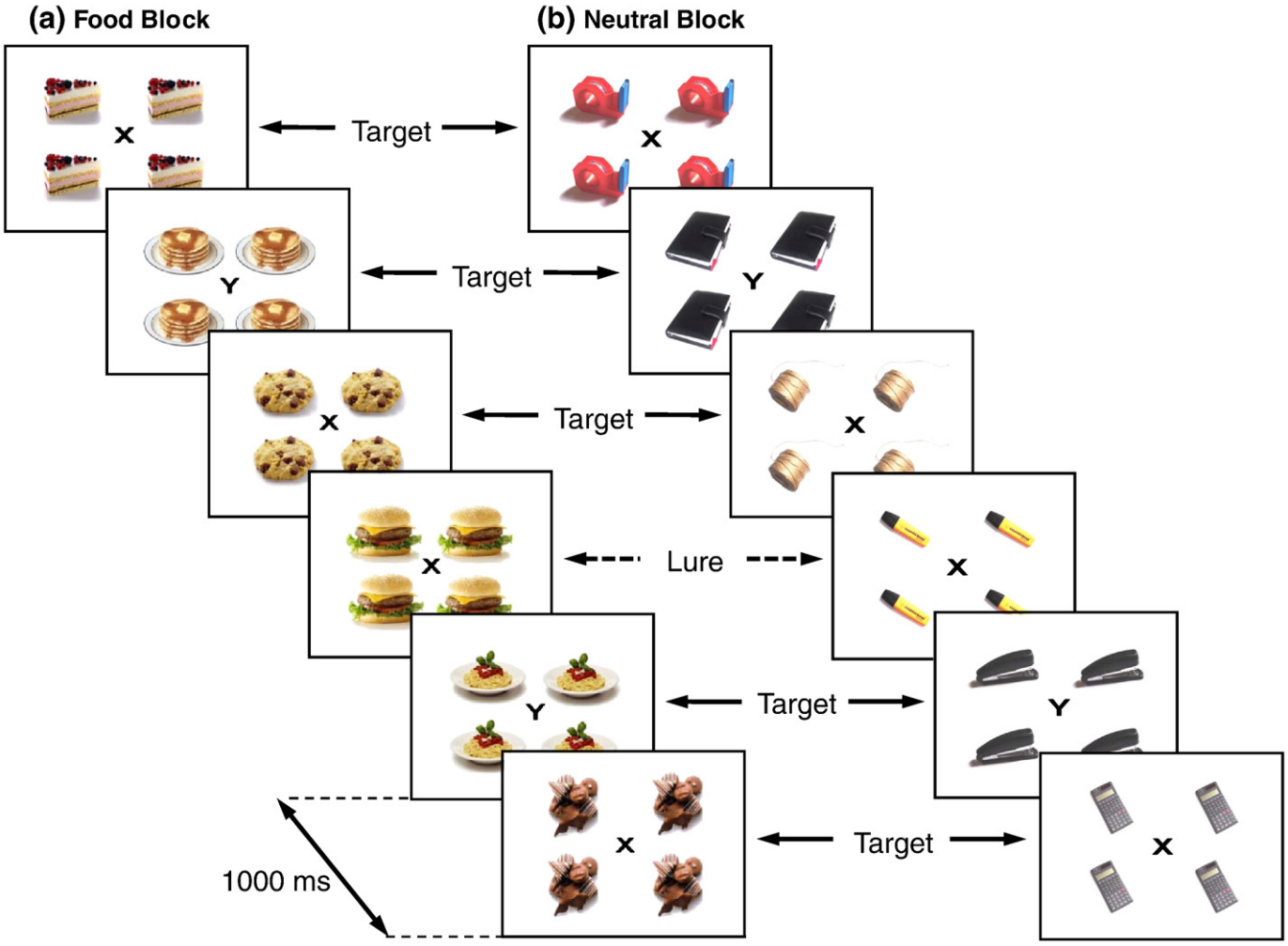

Fig. 1. XY task with representative screen displays from a (a) food and (b) neutral block. Targets were presented for 600 ms with an inter-trial interval of 400 ms.

caloric food pictures, reflecting a potential attentional bias toward food cues. After the task, restrained eaters showed the well-known increase in food consumption after they were confronted with food and food-related cues. The number of commission errors during the task—an indicator of impulsive behavior—modulated this effect.

Our findings contradict the results of Nederkoorn et al. (2004) who found that restrained eaters exhibit impaired inhibition in the stop-signal-task. We argue that the stop-signal-task and a classic Go/No-Go-task assess different aspects of inhibition. Accordingly, performance in both tasks is positively, but weakly correlated (Reynolds, Ortengren, Richards, & de Wit 2006). Recent evidence suggests that there is no advanced motor programming in Go/No-Go-tasks where participants have to decide on every trial whether to respond or not (Carlsen et al. 2008). In contrast, the stop-signal-task requires subjects to inhibit a response they have already initiated. The different outcomes between the stop-signal-task and the XY task might reflect restrained eaters' behavior in everyday life. They can control themselves better, i.e., restricting their food intake like withholding their responses in the XY task, but once a decision is made, i.e. to eat like in preload-studies or to press a button like in the stop-signal-task, they are more likely to lose inhibitory control over the already activated behavior.

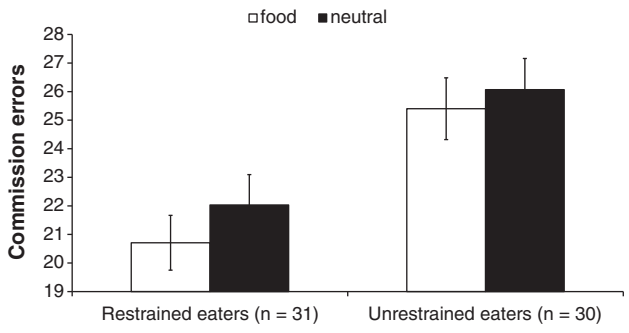

Fig. 2. Means and standard errors of the mean (error bars) of commission errors in the XY task for restrained and unrestrained eaters.

Reaction times also differed between groups. Restrained eaters reacted slower than unrestrained eaters but only when high caloric food pictures surrounded the targets. A recent study supported a heightened vigilance for food cues in restrained eaters, but without slower disengagement from such cues (Hollitt, Kemps, Tiggemann, Smeets, & Mills 2010). Accordingly, we speculate that restrained eaters perceived food pictures as more salient and were thus, distracted—as revealed by the higher RT—but could then disengage their attention from these cues—as revealed by the lack of the expected increase of commission errors when exposed to food cues (Hollitt et al. 2010). Hence, restrained eaters made few errors despite being initially attracted by the food pictures.

After the task food consumption of restrained eaters was higher than that of unrestrained eaters. This counter-regulation effect of increased food intake after eating a preload and being exposed to food-related stimuli has been previously found (Stroebe 2008). A recent study from Jansen et al. (2009) demonstrated that only those restrained eaters

overeat who are also impulsive. In line with these results, we found a trend toward a modulation of food intake by levels of inhibitory control as measured with the Go/No-Go-task (commission errors).

Some limitations of the present study should be noted. Firstly, all participants consumed a preload before the XY task. Consequently, it cannot be determined, which effect this food intake had (specifically in restrained eaters) on task performance. For instance, the preload may have acted as alarm signal that reminded restrained eaters to take care of their dieting goals. As a result, this food intake might have set them in a "prevention focus" (see regulatory focus theory, Higgins 1997). If a person is in this state, the preferred strategy is to react cautiously, so that the "inclination is to insure correct rejections and insure against errors of commission" (Crowe & Higgins 1997, p. 117). However, suggestions about the mechanisms that could have influenced task performance remain speculative due to confounding with prior food intake. Secondly, pictures were presented around each target rendering possible to ignore them when focusing on the letters. Elevated RTs as a result of food-cue presentation suggest that restrained eaters were not as able as unrestrained eaters to disregard them. However, the exact attentional mechanisms like fast engagement or slow disengagement cannot be determined. Future studies that include techniques that observe visual attention like eye-tracking are required.

In conclusion, the current study showed that restrained eaters do not show a lack of inhibitory control in any circumstance. When motor responses are not yet initiated, they can even inhibit their reactions better than do unrestrained eaters and distraction elicited by pictures of high caloric food does not coercively induce loss of inhibitory control.

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Contributors

Adrian Meule and Steve Lukito designed this study and performed data analyses. Adrian Meule wrote the first draft of the manuscript. Claus Vögele and Andrea Kübler aided in study design and manuscript preparation. All authors approved the final manuscript.

Conflict of interest

Neither author has any conflicts of interest.

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