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Research report

To eat or not to eat? Availability of food modulates the electrocortical response to food pictures in restrained eaters

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ABSTRACT

Restrained eating is a pattern of chronic dietary restriction interspersed with episodes of disinhibited overeating. The present study investigated whether this eating pattern is related to altered electrocortical processing of appetitive food stimuli in two different motivational contexts. Restrained ($n = 19$) and unrestrained eaters ($n = 21$) passively viewed high-caloric food pictures, along with normative emotional pictures in a first block. In a second block, food availability was manipulated: participants were told that half of the food items should later be eaten (available food items), whereas the other half of food items was said to be unavailable. While no group differences were obtained during the first block, restrained eaters' event-related potentials (ERPs) were significantly modulated by the availability manipulation: ERPs for available food cues were significantly less positive than ERPs to unavailable food cues. Restrained eaters might down-regulate their reactivity to available food cues to maintain their dietary rules.

Introduction

In Western cultures people usually have access to an abundance of all types of food, most of which they are able to afford and immediately consume. At the same time, the media mainstream idealizes a thin body shape for women, which has, in part, become the cultural norm. As one consequence, women are faced with having to constantly regulate food consumption—not only for health reasons but also to comply with the socio-cultural ideal of beauty. Additionally, current Western society promotes dieting as a pathway to thinness (e.g., Striegel-Moore, Silberstein, & Rodin, 1986).

According to Herman and Polivy (1980), eating patterns are influenced by the balance between physiological factors prompting the desire for food and efforts to resist that desire. This cognitively mediated effort to combat the urge to eat is termed *restraint*, which can be assessed with a 10-item scale (Herman & Polivy, 1980). A high score on eating restraint is considered a risk factor for eating disorders (e.g., Jacobi, Hayward, de Zwaan, Kraemer, & Agras, 2004; Stice, 2001), especially Bulimia Nervosa (BN) (Stice, 1998, 2001; Stice, Killen, Hayward, & Taylor, 1998), and has therefore received much research attention. Several possible mechanisms linking eating restraint to eating disorders have been proposed.

According to the boundary model (Herman & Polivy, 1984) restrained eaters have a higher tolerance toward hunger and satiety. As a result, they are assumed to be less responsive to *internal* stimuli (signs of satiety or hunger) but more responsive to the availability of *external* stimuli (food stimuli). One frequently used paradigm to study restrained eating is the "pre-load" paradigm: restrained and unrestrained eaters consume a high-caloric pre-load, e.g., a milk-shake, which is followed by a "taste test" during which the amount of food eaten is unobtrusively measured. Typically, restrained eaters consume more food during this taste test with a pre-load compared to without a pre-load, while unrestrained eaters show the opposite pattern (Herman & Polivy, 1980, 1984; Ruderman, 1986). A cognitive explanation for this counter-regulatory eating pattern assumes that restrained eaters hold an "all or nothing" dietary rule. Thus, once the rule is broken, for example by the consumption of a high-caloric pre-load, they become disinhibited and overeat (Herman & Polivy, 1984). An alternative account for the counter-regulatory eating pattern is based on restrained eaters' enhanced sensitivity to external stimuli. The exposure to the food cue (the pre-load), even without its consumption, could trigger stronger craving and preparatory physiological responses in restrained eaters leading to increased

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consumption (Nederkoorn & Jansen, 2002) which might be why their cognitive control of eating sometimes breaks down and they overeat. This sensitivity to external food cues (called *cue reactivity* in the following) has been studied with a number of methodologies.

Klajner and coworkers, for example found increased salivation to food cues in restrained relative to unrestrained eaters (Klajner, Herman, Polivy, & Chhabra, 1981). Measuring event-related potentials (ERPs) Hachel, Hempel, and Pietrowsky (2004) found more positive going ERPs to food-related words *and* control words in restrained compared with unrestrained eaters. Piacentini, Schell, and Vanderweele (1993) found *smaller* electrodermal orienting responses to food odors in restrained compared to unrestrained eaters. Similarly, Nederkoorn and Jansen (2002) found *reduced* salivation and heart rate responses to food cues in restrained eaters and attributed this finding to an automatic down regulation of responses in restrained eaters.

Thus, although some evidence exists for elevated cue reactivity, restrained eaters might down-regulate their responses to food under some circumstances. To address the present inconsistencies in the cue reactivity literature the present study sought to examine *under which conditions* enhanced cue reactivity or down-regulation of appetitive responses to high-energy food cues might occur. The pre-load literature suggests that actual consumption of high-calorie food disinhibits subsequent eating. Thus, when pictures are only passively viewed, without exposure to a pre-load, they might not be motivationally significant enough to trigger altered cue responses or give rise to inconsistent response patterns. Interestingly, Ruderman, Belzer, and Halperin (1985) showed that even the announcement the consumption of a high-caloric food during a subsequent taste test could trigger disinhibited eating just as would be expected after the consumption of a pre-load. Thus, the perceived availability and requirement to eat food in restrained eaters might lead to differential processing of food pictures.

In sum, the present study aimed to disentangle the motivational contexts that lead to enhanced cue reactivity from those that lead to down-regulation of appetitive responses by manipulating the perceived availability of the food items displayed during picture viewing. In a first "passive viewing block" food pictures were passively viewed along with normative emotional pictures. During this block, the motivational context was unspecified and restrained eaters might not differ from controls at all. In a second "availability block", pictures were arranged in two separate "menus" and participants were instructed that they would be required to "taste" items from one of the menus (the "available" menu) after picture viewing but not from the other menu (the "unavailable" menu). We assumed that the announcement of the subsequent taste test would challenge the dietary rules of restraint eaters. In this context, restrained eaters might down-regulate any appetitive motivational tendencies elicited by these highly salient food stimuli to foster behavioral control on the taste test. Alternatively, they could "let go" of their usual restriction and show disinhibited appetitive responses.

To index the motivational significance of food stimuli we measured the late positive potential (LPP), a positive ERP around 300–700 ms after stimulus presentation which is larger for emotional and motivational significant stimuli than to neutral stimuli (Schupp, Junghofer, Weike, & Hamm, 2003; Schupp, Flaisch, Stockburger, & Junghofer, 2006). Thus, enhanced reactivity to food cues should be associated with an increased LPP. Importantly, recent evidence indicates that the LPP is also sensitive to the effects of emotion regulation: various instructions to down-regulate the emotional impact of a picture have been found to decrease the LPP (Foti & Hajcak, 2008; Hajcak, Moser, & Simons, 2006; Hajcak & Nieuwenhuis, 2006; Krompinger, Moser, & Simons, 2008; Moser, Hajcak, Bukay, & Simons, 2006). Thus, in restrained eaters, the LPP to available relative to unavailable pictures might indicate whether cue reactivity is enhanced (i.e., larger LPPs) or decreased (i.e., smaller LPPs). Unrestrained eaters' LPP, by contrast should not be modulated by the availability manipulation.

Methods

Participants

Participants were female students selected on the basis of their score on the Restraint Scale (Dinkel, Berth, Exner, Rief, & Balck, 2005a; Dinkel, Berth, Exner, Rief, & Balck, 2005b; Herman & Polivy, 1980) which was administered as part of an online screening ($N = 128$) 8–12 weeks before the study. From this sample, participants with a score within the lowest or highest three deciles of the restraint scale were invited to take part in a study of implicit self-esteem ($N = 80$, Hoffmeister et al., in press). Out of this group 19 restrained eaters (RES group) and 21 unrestrained eaters (UNRES) were willing to participate in the current investigation in exchange for either course credit or 20€. The RES group scored in the range 16–23 whereas the UNRES group scored 1–10, which is concordant with established cut-offs for restrained eating (Dinkel et al., 2005b). Eating disorder psychopathology as well as anxiety and depressive symptoms were assessed with the German versions of the EDE-Q (Hilbert, Tuschen-Caffier, Karwautz, Niederhofer, & Munsch, 2007), the State-Trait Anxiety Inventory (STAI, Laux, Glanzmann, Schaffner, & Spielberger, 1981), and the Beck Depression Inventory (BDI, Hautzinger, Bailer, Worall, & Keller, 1994). As indicated in Table 1, groups did not differ on age, anxiety symptoms, education (all were university students), and feelings of

Table 1
Means (SD) of sample characteristics.

	RES $n = 18$	UNRES $n = 21$	Statistic t(df), p	Direction
Age (years)	22.6 (3.27)	23.6 (5.03)	0.73(37), .471	RES = UNRES
Body mass index (kg/m^2)	24.1 (3.80)	20.1 (2.25)	4.03(37), <.001	RES > UNRES
Restraint scale	19.1 (2.22)	6.95 (2.56)	15.7(37), <.001	RES > UNRES
BDI	7.56 (4.36)	4.14 (5.05)	2.24(37), .032	RES > UNRES
STAI-state	37.9 (10.8)	34.5 (6.90)	1.20(37), .241	RES = UNRES
EDE-Q restrained	1.82 (1.21)	0.39 (0.55)	4.63(23.0), <.001	RES > UNRES
EDE-Q eating concerns	1.28 (1.08)	0.24 (0.53)	3.72(23.9), <.001	RES > UNRES
EDE-Q weight concerns	2.52 (1.02)	0.54 (0.63)	7.15(27.3), <.001	RES > UNRES
EDE-Q shape concerns	2.86 (1.16)	1.04 (0.99)	5.28(37), <.001	RES > UNRES
Time of testing (morning, noon, afternoon, evening, %)	27.8, 27.8, 16.7, 27.8	23.8, 23.8, 19.0, 33.3	$\chi^2(3) = 0.25$, .977	RES = UNRES
Hunger rating	5.11 (2.08)	5.00 (1.87)	0.18(37), .864	RES = UNRES
Mood rating	6.83 (1.43)	6.76 (1.09)	0.18(37), .865	RES = UNRES

Note: RES, restraint group; UNRES, unrestrained group; BDI, Beck Depression Inventory; STAI-State, State-Trait Anxiety Inventory; EDE-Q, Eating Disorder Examination Questionnaire.