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Impulsive reactions to food-cues predict subsequent food craving

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ABSTRACT

Low inhibitory control has been associated with overeating and addictive behaviors. Inhibitory control can modulate cue-elicited craving in social or alcohol-dependent drinkers, and trait impulsivity may also play a role in food-cue reactivity. The current study investigated food-cue affected response inhibition and its relationship to food craving using a stop-signal task with pictures of food and neutral stimuli. Participants responded slower to food pictures as compared to neutral pictures. Reaction times in response to food pictures positively predicted scores on the *Food Cravings Questionnaire — State* (FCQ-S) after the task and particularly scores on its hunger subscale. Lower inhibitory performance in response to food pictures predicted higher FCQ-S scores and particularly those related to a desire for food and lack of control over consumption. Task performance was unrelated to current dieting or other measures of habitual eating behaviors. Results support models on interactive effects of top-down inhibitory control processes and bottom-up hedonic signals in the self-regulation of eating behavior, such that low inhibitory control specifically in response to appetitive stimuli is associated with increased craving, which may ultimately result in overeating.

1. Introduction

Animal research and studies in humans have shown that food-cue exposure elicits pre-digestive hormonal reflexes, which include secretion of saliva, insulin, and gastric juices, etc. (Rodin, 1985). These cephalic phase responses prepare the organism for the consumption of food and are associated with an increase in craving (Legenbauer, Vögele, & Rüddel, 2004; Nederkoorn, Smulders, & Jansen, 2000). This cue-reactivity can also be observed when food pictures are presented instead of real food (e.g. Rodríguez, Fernandez, Cepeda-Benito, & Vila, 2005).

Previous studies on inter-individual differences in food-cue reactivity have mostly focused on dietary restraint, eating disorders, overweight/obesity, and trait levels of food craving. Results from these studies suggest elevated levels of food-cue reactivity in restrained eaters (e.g. Fedoroff, Polivy, & Herman, 1997, 2003), patients with binge eating disorder (e.g. Vögele & Florin, 1997) or bulimia nervosa (Legenbauer et al., 2004), overweight children (e.g. Jansen et al., 2003) and trait food/chocolate cravers (e.g. Kemps, Tiggemann, & Grigg, 2008; Meule, Skirde, Freund, Vögele, & Kübler, 2012; Moreno-Domínguez, Rodríguez-Ruiz, Martín, & Warren, 2012; Rodríguez et al., 2005) when compared to control participants.

Impulsivity is another possible source of individual variation in food-cue elicited craving. It can be defined as a predisposition toward rapid, unplanned reactions to internal or external stimuli without taking into account the negative consequences of these reactions (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Impulsivity represents a multifaceted construct and there are several measures that assess its different aspects. Two of the most widely used methods are self-report instruments and motor response inhibition tasks (e.g. go/no-go tasks or the stop-signal task (SST); Guerrieri, Nederkoorn, & Jansen, 2008). In such tasks, impulsive behavior is reflected in low inhibitory control as indicated by, e.g., more commission errors or higher stop-signal reaction time (SSRT, see below). Self-report measures of impulsivity and impulsive reactions in response inhibition tasks are positively, but weakly, correlated (Cyders & Coskunpinar, 2011, 2012; Lijffijt et al., 2004; Reynolds, Ortengren, Richards, & de Wit, 2006).

Both self-reported impulsivity and low response inhibition have been found to be positively associated with restrained eating or unsuccessful dieting (Meule, Papies, & Kübler, 2012; Nederkoorn, Van Eijs, & Jansen, 2004; van Koningsbruggen, Stroebe, & Aarts, 2013), binge eating (Nasser, Gluck, & Geliebter, 2004; Rosval et al., 2006), bulimia nervosa (Wu et al., 2013), overweight and obesity (Mobbs, Iglesias, Golay, & Van der Linden, 2011; Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006; Nederkoorn, Jansen, Mulkens, & Jansen, 2007; Nederkoorn, Smulders, Havermans, Roefs, & Jansen, 2006), and trait food craving (Meule, Lutz, Vögele, & Kübler, 2012a). Response inhibition has also been found to moderate food consumption such that only those restrained eaters with low inhibitory control showed increased food intake in a laboratory environment (Jansen et al., 2009; Meule, Lukito, Vögele, & Kübler, 2011).

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Besides those studies that related general response inhibition as assessed with neutral tasks to eating behavior, there are also some studies that investigated response inhibition directly in response to palatable, high-calorie food-cues. For example, low dieting success and higher body-mass-index (BMI) were associated with behavioral disinhibition, particularly in response to food pictures (Houben, Nederkoorn, & Jansen, 2012; Meule et al., in revision; Nederkoorn, Coelho, Guerrieri, Houben, & Jansen, 2012). In a recent study, food-cue affected response inhibition was related to participants' self-reported current hunger levels (Loeber, Grosshans, Herpertz, Kiefer, & Herpertz, 2013). In other studies, however, inhibitory control in response to food-cues was unrelated to BMI, trait eating behaviors, or current hunger (Loeber et al., 2012; Meule, Lutz, Vögele, & Kübler, 2012c; Mobbs et al., 2011). To summarize, some studies suggest that impulsive reactions, i.e. low inhibitory control, when exposed to food-cues are associated with higher BMI, low dieting success, and current hunger levels, but results are inconclusive.

Investigations on the relationship between self-reported impulsivity or response inhibition, and food-cue elicited craving are rare. Recent evidence from the addiction literature suggests that response inhibition may modulate cue-reactivity. Specifically, Papachristou et al. found that heavy social drinkers with low response inhibition had elevated levels of craving during alcohol cue-exposure as compared to those with high response inhibition (Papachristou, Nederkoorn, Havermans, van der Horst, & Jansen, 2012). Furthermore, low response inhibition was related to higher craving after alcohol cue-exposure when alcohol was perceived as available (Papachristou, Nederkoorn, Corstjens, & Jansen, 2012). Most recently, it was shown that both self-reported impulsivity and low response inhibition predicted alcohol craving in alcohol-dependent patients during cue-exposure in a real bar (Papachristou et al., 2013). In a series of studies by Doran and colleagues, self-reported impulsivity was related to higher smoking-cue induced craving in smokers (Doran, Cook, McChargue, & Spring, 2009; Doran, McChargue, & Spring, 2008; Doran, Spring, & McChargue, 2007). With regard to eating behavior, self-reported impulsivity was associated with increases in food craving after food exposure (Tetley, Brunstrom, & Griffiths, 2010). However, there have also been contradicting findings such that food-cue exposure did not affect food intake in high impulsive individuals (Larsen, Hermans, & Engels, 2012). Yet, it is important to note that food intake does not necessarily reflect levels of food craving (cf. Hill, 2007).

In the current study, we investigated impulsivity by means of self-report and the SST. Importantly, this task involved pictures of food and non-food related objects allowing for the direct assessment of impulsive reactions to food stimuli as compared to a neutral control condition. We hypothesized that inhibitory control in response to food stimuli would predict subsequent food craving. Specifically, as a higher SSRT in the SST indicates less inhibitory control (i.e. more impulsive reactions), we expected that higher SSRT in response to food-cues would be related to stronger food craving. Based on the finding that SSRT was positively correlated with self-reported impulsivity and that low food-cue affected response inhibition was associated with higher BMI, lower dieting success and current hunger (Houben et al., 2012; Loeber et al., 2013; Nederkoorn et al., 2012), we also explored if task performance was associated with self-reported impulsivity, current food deprivation, BMI, and self-report measures related to overeating (i.e., low dieting success and food addiction symptoms).

2. Method

2.1. Participants

Female participants were recruited among students at the University of Würzburg, Germany. Advertisements were posted on campus and additionally distributed via a mailing list of a student association. Women who responded to the advertisements were contacted by phone ($N = 82$) and screened for exclusion criteria which included mental disorders, psychoactive medication, under- or overweight (BMI < 17.5 or >25 kg/m^2), and age > 40 years. We decided to restrict the sample to women with normal-weight because only few participants of the screened sample were in the overweight range and, therefore, BMI distribution would have been skewed. A total of $n = 50$ participants took part in the study. Descriptive statistics of participant characteristics are reported in Table 1. Eighteen participants indicated that they were currently trying to control their weight (i.e. were dieters). Five participants reported to be smokers.

2.2. Measures and materials

2.2.1. BMI

Height (cm) was measured with a double meter stick and weight (kg) was measured with a digital personal scale (BG 22, Beurer GmbH, Ulm, Germany). BMI was calculated as weight in kg divided by height in meters squared.

2.2.2. Dieting status

Current dieting status (yes/no) was assessed with a single question ["Are you currently restricting your food intake to control your weight (e.g. by eating less or avoiding certain foods)?"].

2.2.3. Perceived Self-Regulatory Success in Dieting Scale (PSRS)

The PSRS (Fishbach, Friedman, & Kruglanski, 2003) was used to assess dieting success. In this three-item questionnaire, participants have to rate on 7-point scales how successful they are in watching their weight, in losing weight, and how difficult it is for them to stay in shape. Validity of the PSRS has been shown by negative associations with BMI, rigid dieting strategies and other correlates of disinhibited eating while it is positively related to flexible dieting strategies (Meule et al., 2012a; Meule, Papies, et al., 2012; Meule, Westenhöfer, & Kübler, 2011). Internal consistency of the German version is $\alpha > .70$ (Meule, Papies, et al., 2012) and was $\alpha = .79$ in the current study.

2.2.4. Yale Food Addiction Scale (YFAS)

The YFAS (Gearhardt, Corbin, & Brownell, 2009) measures addictive eating behavior and consists of 25 items. Validity of the YFAS has been indicated by positive associations with BMI, eating disorder symptomatology, emotional eating, food cravings, binge eating, difficulties in emotion regulation, and impulsivity in non-clinical samples and obese patients (Davis et al., 2011; Gearhardt et al., 2009, 2012; Meule, Heckel, & Kübler, 2012; Meule & Kübler, 2012; Meule, Vögele, & Kübler, 2012). Internal consistency of the German version is $\alpha = .81$ (Meule, Vögele, et al., 2012) and was $\alpha = .83$ in the current study.

2.2.5. Barratt Impulsiveness Scale — Short Version (BIS-15)

The BIS-15 was proposed by Spinella (2007) as short version of the BIS-11 (Patton, Stanford, & Barratt, 1995) for the measurement of impulsivity on the dimensions *motor*, *attentional*, and *non-planning impulsivity*. Instead of 30 items as in the long version, it consists of 15 items only. Moderate to strong relationships between the BIS-15 and the Frontal Systems Behavior Scale and the UPPS Impulsive Behavior Scale support convergent validity, while weak correlations with sensation seeking indicate discriminant validity (Meule, Vögele, & Kübler, 2011; Spinella, 2007). Internal consistency of the German version is $\alpha = .81$ and ranges between $\alpha = .68$–$.82$ for the subscales (Meule, Vögele, et al., 2011). In the current study, internal consistency of the total scale was $\alpha = .79$ and ranged between $\alpha = .68$–$.82$ for the subscales.

2.2.6. Food Cravings Questionnaires — State Version (FCQ-S)

Current food craving was measured with the FCQ-S (Cepeda-Benito, Gleaves, Williams, & Erath, 2000). This 15-item questionnaire assesses momentary food craving on the dimensions *intense desire to eat*, *anticipation of positive reinforcement that may result from eating*, *anticipation of relief from negative states and feelings as a result of eating*,