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Research report

Attentional bias for food cues in binge eating disorder ☆

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ABSTRACT

The aim of the present study was to investigate an attentional bias toward food stimuli in binge eating disorder (BED). To this end, a BED and a weight-matched control group (CG) completed a clarification task and a spatial cueing paradigm. The clarification task revealed that food stimuli were faster detected than neutral stimuli, and that this difference was more pronounced in BED than in the CG. The spatial cueing paradigm indicated a stimulus engagement effect in the BED group but not in the CG, suggesting that an early locus in stimulus processing contributes to differences between BED patients and obese controls. Both groups experienced difficulty disengaging attention from food stimuli, and this effect was only descriptively larger in the BED group. The effects obtained in both paradigms were found to be correlated with reported severity of BED symptoms. Of note, this relationship was partially mediated by the arousal associated with food stimuli relative to neutral stimuli, as predicted by an account on incentive sensitization.

Introduction

Binge eating disorder (BED) is characterized by the occurrence of repetitive binge eating episodes in the absence of compensatory behavior (American Psychiatric Association [APA], 2013). Cognitive models of eating disorders suggest the involvement of attentional biases for eating-related information (Vitousek & Hollon, 1990; Williamson, Muller, Reas, & Thaw, 1999). Accordingly, the activation of maladaptive food-related schemata is thought to impair information processing by selectively influencing attentional processes for eating-related information (Williamson, White, York-Crowe, & Stewart, 2004).

Specifically, some authors suggested that similar mechanisms may contribute to the acquisition and maintenance of binge eating as those identified in substance abuse (Berridge, 2007; Dawe & Loxton, 2004; Franken, 2003). For instance, Dawe and Loxton (2004) identified two major factors contributing to the development of substance use and eating disorders: reward sensitivity and rash-spontaneous impulsiveness. The first corresponds with activity in a motivational approach system that may be triggered by relevant stimuli in the environment. The second corresponds with impaired behavioral control.

Incentive-sensitization theory (Berridge, 2007; Franken, 2003) was proposed as an account of binge eating acquisition and maintenance. The model was originally developed to explain substance abuse and specifies cue-reactivity, an altered reward system, and craving as central factors in the maintenance of substance use and relapse (Robinson & Berridge, 1993, 2001). It was suggested that addiction-like mechanisms could also play a role in extremely obese individuals with severe overeating problems, such as binge eating (Davis & Carter, 2009). In line with principles of associative conditioning, it is assumed that stimuli frequently paired with reward, such as food items, result in incentive sensitization in the dopamine reward system. As a consequence, exposure to these stimuli would activate the reward system, lead to physiological arousal, the feeling of craving, and could finally result in a binge episode, particularly when late stage behavioral control fails. Importantly, as food items are learned to predict reward, an attentional bias toward food items is predicted. This, in turn, would contribute to the maintenance of binge eating and relapse.

To summarize, an extended version of the just sketched account could serve as a working model of BED acquisition and maintenance. This should comprise an attentional bias toward food, an altered reward system, arousal and craving, and a deficient impulse control. Of note, biased attentional processes are assigned a particular importance in this model, because they can automatically trigger a sequence of processes which can terminate in a binge episode. However, a number of additional factors deserve consideration: It was argued that not only external stimuli perceived in the environment may trigger the reward/approach system ("external eating"), but also their internal representations when they cannot

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be adequately suppressed (hence, a "cognitive bias"; Svaldi et al., 2014). Additionally, the activation of the reward/approach system will not deterministically result in a binge episode, as a number of mediating factors (e.g., arousal, craving) and moderating factors (e.g., behavioral inhibition) may oppose their effects. Finally, mood and hunger, among others, may moderate these processes (Hilbert & Tuschen-Caffier, 2007; Stein et al., 2007).

Aspects of this model have been empirically tested in previous studies with BED patients. Particularly, response-related processes were investigated. For instance, an electro-encephalogram (EEG) study suggested a general behavioral response preparedness for food stimuli that was more pronounced in BED relative to controls (Tammela et al., 2010). Additionally, a functional magnetic-resonance-imaging (fMRI) study revealed that food stimuli elicit greater activity in right pre-motor areas in BED than controls (Geliebter et al., 2006). Finally, there is evidence of impaired late-stage impulse control using behavioral performance tasks (Mobbs, Iglesias, Golay, & Van der Linden, 2011; Svaldi, Naumann, Trentowska, & Schmitz, 2014; but see Wu et al., 2013).

Compared with that, there is only limited evidence of early food-related biases in BED. This is surprising given the assumed role of attentional biases as triggers of binge episodes. Indirect evidence comes from a study which found increased regional cerebral blood flow (rCBF) in frontal and prefrontal regions during food exposure in BED subjects compared with overweight controls (Karhunen et al., 2000). A more recent study (Svaldi, Tuschen-Caffier, Peyk, & Blechert, 2010) tested food-related information processing by measurement of event-related potentials (ERPs) and found larger long-latency potentials (LLPs) for high-caloric food pictures in BED women compared with overweight controls. However, one issue that complicates interpretation of this latter effect is that the body mass index (BMI) in controls was significantly lower than in the BED group. In fact, previous research on cognitive control found obesity to be related with impaired cognitive control, whereas no difference was found between obese participants with and without BED (Galioto et al., 2012; Gunstad, Lhotsky, Wendell, Ferrucci, & Zonderman, 2010; Gunstad et al., 2007). Accordingly, it cannot be ruled out that the results reported by Svaldi et al. (2010) may be accounted for by weight rather than by the presence of BED.

Furthermore, while the long-latency potentials observed in the Svaldi et al. (2010) study support that food stimuli are processed differently in participants with BED, the findings do not elucidate which specific attentional processes may be biased. It was suggested to distinguish between a number of attentional processes that may take place after stimulus presentation, namely orientation (e.g., <30 *ms*), stimulus engagement (e.g., 30–500 *ms*), stimulus disengagement (e.g., 500–1000 *ms*), and avoidance (Fox, Russo, Bowles, & Dutton, 2001). The existence and exact durations of these processes may as well depend on the logic/affordances of the paradigm and the specific parameter settings. For simplicity, we will distinguish between the somewhat earlier stimulus engagement and the somewhat later stimulus disengagement in the current paper. The term *stimulus engagement* is used interchangeably with orienting, stimulus capture or attentional vigilance. Conversely, the term *stimulus disengagement* is used interchangeably with stimulus holding or attentional maintenance.

So far, studies examining the various components of attention in the processing of food-related items have been conducted on obese/overweight individuals, but not in individuals with BED. In an informative multivariate study (Nijs, Muris, Euser, & Franken, 2010), obese participants and normal-weight controls completed three different attentional paradigms: a visual probe paradigm, an eye-tracking task, and an ERP study (reported below). In the visual probe task, obese participants revealed (marginally) larger response-time based stimulus engagement effects than controls; however, stimulus disengagement effects of comparable magnitude were found in both groups. Similarly, an eye-tracking paradigm in which pairs of food-related and neutral pictures were shown offered evidence of a stimulus engagement effect (initial orienting) and a stimulus disengagement effect (gaze duration) in obese and controls, but no group difference was found. In another study using the visual probe task with simultaneous eye-tracking (Werthmann et al., 2011), obese participants had an increased stimulus engagement effect (direction bias), but a decreased stimulus disengagement (duration bias) relative to normal-weight controls. However, using a different eye-tracking paradigm with pairs of savory and sweet high calorie and low calorie food pictures (Graham, Hoover, Ceballos, & Komogortsev, 2011) did not confirm any pronounced stimulus engagement effect in obese participants. In contrast, controls were less likely to focus low calorie pictures first.

Another line of research has investigated ERPs while presenting food-related and neutral pictures. The P300 component indexing conscious allocation of attention or motivation-related processing was found to be generally increased when presenting food items relative to neutral stimuli; however, no group differences were found between obese and normal-weight participants (Nijs, Franken, & Muris, 2008; Nijs et al., 2010). Differently, high external eaters were found to display larger P300 to food pictures than low external eaters (Nijs, Franken, & Muris, 2009).

Some of the observed inconsistencies could be caused by a state-dependent variation of moderating factors. Evidence in this direction comes from a study in which hunger/satiation was experimentally manipulated (Castellanos et al., 2009). When obese and normal-weight participants completed a visual probe task, there was neither an effect of group nor of hunger in the behavioral data. However, simultaneously recorded eye-tracking data revealed that obese participants showed a stimulus engagement effect as well as a stimulus disengagement effect independent of hunger/satiation. In contrast, normal-weight controls showed these effects only when hungry, but not when satiated. These results are comparable with the EEG study by Nijs et al. (2010), in which group differences in the P300 component were found to be moderated by hunger/satiety. In hunger, normal-weight participants showed a larger P300, whereas in satiety, obese participants showed a larger P300. One tentative interpretation offered by the authors was that obese individuals may orient attention away from food stimuli when hungry because they may fear a loss of control.

To summarize, studies investigating biased food-related attentional processes in obese/overweight individuals relative to normal-weight controls yielded inconsistent results that seem to depend, in part, on specifics of the experimental paradigm, the kind of data analyzed, and state-dependent factors. Generally, it appears that obese participants have an increased food-related stimulus engagement effect. Additionally, some studies suggest they experience more difficulty to disengage attention from food cues compared with controls. However, evidence for the latter is mixed.

Irrespective of the kind of attentional process possibly biased, another important prediction derived from incentive-sensitization theory (Berridge, 2007; Franken, 2003) states that an attentional bias for relevant stimuli leads to craving. This relationship was investigated in a number of studies with overweight/obese and control participants. Behavioral performance data obtained with the visual probe task confirmed that the stimulus engagement effect is correlated with craving (reported hunger) in overweight participants but not in normal-weight participants (Nijs et al., 2010). Differently, in the visual-probe study conducted by Castellanos et al. (2009) there was no correlation with any of the behavioral scores, but simultaneously recorded eye-tracking data indicated a correlation of stimulus engagement (direction bias) and impaired stimulus disengagement (duration bias) with subjective hunger across the whole sample. A positive correlation between stimulus engagement and food craving was also reported by an eye track-