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Research report

Information processing of food pictures in binge eating disorder

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ABSTRACT

Previous research has yielded evidence of attentional biases for food-related cues in binge eating disorder (BED) using behavioural measures such as the Stroop and dot probe paradigm. Being a more direct measure of attentional processing, the present study used event related potentials (ERPs) to test reactivity to high caloric and low caloric food pictures in women with BED compared to overweight healthy female controls (HC). In order to detect a possible motivational ambivalence, self-report and psychophysiological measures of the sympathetic and parasympathetic response system were assessed additionally. The main results yielded evidence that in women with BED high caloric food pictures elicit larger long latency ERPs compared to HC. By contrast, no such group difference was found for low caloric food pictures. Peripheral measures did not yield any group differences with respect to the processing of the caloric value of food. The results suggest that for women with BED, high caloric food may have high motivational properties and consume large parts of attentional resources. In the context of an environment in which high caloric food is omnipresent, such an abnormal processing may be relevant for the maintenance of the disorder.

Binge eating disorder (BED) is characterized by recurrent binge eating episodes and loss of control in the absence of compensatory behavior. Even though cognitive behavioral therapy (CBT) has proven to be effective with regard to the reduction of binge frequency (Brownley, Berkman, Sedway, Lohr, & Bulik, 2007; Reas & Grilo, 2008; Vocks et al., 2009; Wilfley & Cohen, 1997; Wilson & Shafran, 2005; Wonderlich, de Zwaan, Mitchell, Peterson, & Crow, 2003), 30–50% of treated individuals do not sustain from binge eating in long-term follow-up assessments (Brownley et al., 2007; Vocks et al., 2009; Wonderlich et al., 2003). Therefore there is a further need for more research focusing on mechanisms contributing to the aberrant eating behavior in BED.

In the past two decades, several studies yielded evidence of an attentional bias for food related cues in eating disordered and obese individuals by means of the Stroop task (Channon, Hemsley, & de Silva, 1988; Cooper, Anastasiades, & Fairburn, 1992; Fairburn, Cooper, Cooper, McKenna, & Anastasiades, 1991; Green & Rogers, 1993; Long, Hinton, & Gillespie, 1994), the visual dot probe task (Kemps & Tiggemann, 2009; Leland & Pineda, 2006; Nijs, Muris, Euser, & Franken, 2010; Rieger et al., 1998; Shafran, Lee, Cooper, Palmer, & Fairburn, 2007), the visual search paradigm (Smeets, Roefs, van Furth, & Jansen, 2008), and eye movement monitoring (Castellanos et al., 2009; but see also Nijs et al., 2010). With the exception of eye tracking studies however, these paradigms are behavioral and thus reflect a more indirect measure of attention allocation or information processing. In addition, the interpretation of Stroop and dot probe effects are difficult as results may stem from sensory inhibition or response competition effects (Dobson & Dozois, 2004; Lee & Shafran, 2004).

A more direct approach to assess food-related information processing is the measurement of event-related potentials (ERPs) by means of electroencephalography (EEG). With regard to motivated attention, the P300 component, and the following Late Positive Potential (LPP) and Slow Positive Wave (SPW) are of particular interest. Recent studies indicate that emotionally arousing pictures (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Palomba, Sarlo, Angrilli, Mini, & Stegagno, 2000) are associated with enlarged LPP amplitudes. In longer presentation of emotional pictures (6 s), LPP amplitudes are followed by SPW, which are thought to be a marker of sustained attention (Schupp, Flaisch, Stockburger, & Junghofer, 2006). For example, larger LPP and SPW have been demonstrated in subjects with specific phobias for fear relevant stimuli (Miltner et al., 2005) and in heroin dependent men for drug-associated cues compared to healthy controls (Franken, Hulstijn, Stam, Hendriks, & van den Brink, 2004; Franken, Stam, Hendriks, & van den Brink, 2003).

With regard to eating disorders, one study (Nijs, Franken, & Muris, 2009) found an enlarged P300 amplitude in response to food

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pictures in high compared to low external eaters. As no group differences were found in response to pictures of babies and office related items, the results suggest that high external eaters display an enhanced processing of food related information. In another study (Nijs, Franken, & Muris, 2008) obese individuals did not display larger P300 and LPP amplitudes to food stimuli when compared to normal weight controls. Thus, rather than being a function of weight, enlarged P300 and LPP may rather reflect an index of eating disorders symptoms. As such, using the Posner paradigm (Posner, Snyder, & Davidson, 1980) one study (Leland & Pineda, 2006) found an increased amplitude of a late positive component (P450) for food compared to neutral cues in subjects under food deprivation, which is an empirically well validated antecedent of binge attacks in bulimia nervosa (BN) and BED (Davis, Freeman, & Garner, 1988; Howard & Porzelius, 1999; Stein et al., 2007; Wilfley, Pike, & Striegel-Moore, 1997). In line with that, food deprivation and hunger have been shown to be associated with enlarged positive potentials to food pictures both at an early stage (~170–300 ms; Stockburger, Weike, Hamm, & Schupp, 2008) and also at a later stage of the processing stream indexed by the LPP in healthy university students (Stockburger, Schmalzle, Flaisch, Bublatzky, & Schupp, 2009). In hungry obese compared to satiated obese participants, by contrast, the P300 for food-related cues was reduced, in spite of the significant positive correlation between hunger reports and the amount of food eaten during a bogus taste task (Nijs et al., 2010). Thus, having more difficulties to keep control of their eating behaviour when confronted with food, hungry overweight individuals may intentionally use cognitive strategies to reduce an attentional bias to food-related stimuli (Nijs et al., 2010).

When looking at the association of ERPs and craving, several studies found a significant positive correlation between P300 and self-reported food craving (Nijs et al., 2009), and between the LPP/P300 and self-reported increases of hunger (Nijs et al., 2008). This is consistent with addiction related studies, which reported long-latency ERPs to be associated with self-reported cocaine craving or the motivation to use drugs (Franken et al., 2004; Lubman, Allen, Peters, & Deakin, 2007). Stronger food cravings have also been shown to be correlated with increased startle responding during food cue presentation in binge and food deprived subjects compared to controls (Drobes et al., 2001). Thus, on the one hand, the confrontation with food elicits an appetitive response as indicated by increased long latency ERPs. On the other hand, appetitive cravings seem to prompt an aversive motivational reaction as indicated by the association of food craving and the increased startle reflex.

This motivational ambivalence becomes apparent when considering two experiments conducted by Drobes et al. (2001). The authors investigated the impact of food deprivation (experiment one), binge and restrained eating patterns (experiment two) on psychophysiological, emotional and behavioural reactions to food-related and other cues (pleasant, unpleasant and neutral). Results of experiment one yielded evidence of an enhanced startle response during food compared to pleasant control cues in food-deprived, but not non-deprived subjects. This is coherent with their self-reported stronger arousal and stronger loss of control feelings to food cues. This stands in contrast though to Hawk, Baschnagel, Ashare, and Epstein (2004), who found a stronger reduction of the startle reflex magnitude in deprived participants during food picture viewing. However, while Drobes et al. (2001) did not allow subjects to consume food immediately after the experiment, participants in the Hawk et al. (2004) were given access to eat the food after the experiment. This suggests that in food deprived subjects food pictures elicit an aversive motivational reaction when food consumption is not possible. In fact, deprived subjects in the Drobes et al. (2001) also showed an elevated heart rate response while viewing appetitive food cues. Nevertheless, there were no group differences with respect to changes in skin conductance. Electromyography (EMG), on the other hand, revealed an increased zygomatic and a decreased corrugator activity in response to food cues in strongly deprived subjects compared to other subjects, which is a facial pattern associated with positive valence. Thus, food pictures seem to have activated an appetitive approach response (EMG). However, because immediate reward (i.e. actual consumption) was not possible, defensive reflexes such as the increased startle response were prompted. Similar conclusions can be inferred for binge subjects. As such, binge and deprived subjects (experiment two) rated food cues as significantly more pleasant and reacted with an increased startle reflex while viewing food pictures compared to undeprived controls and restrained subjects. This is consistent with Mauler, Hamm, Weike, and Tuschen-Caffier (2006) who found increased startle response while viewing food pictures in BN patients when compared to healthy controls. Consistently, food cues – compared to other cues –, elicited stronger increments of currogator activity in BN women, while there was no such difference in healthy controls.

Altogether, evidence from studies using event-related brain potentials and psychophysiological measures suggest that subjects with altered eating behaviours are characterized by a differential processing of food pictures when compared to healthy controls. Also, there seems to be discordance between different response-systems, which may reflect the ambivalent nature of food in eating disturbed individuals. Another important factor seems to be the motivational context of participants. As such, Blechert, Feige, Hajcak, and Tuschen-Caffier (2010) found comparable ERP responses to food cues in restrained and unrestrained eaters during a passive viewing condition. However, restrained eaters who were told that they would have to eat some of the presented food after the experiment (availability condition) showed a reduced LPP amplitude compared to restrained esters who had not previously received this instruction (viewing condition). A possible explanation is that restrained eaters exerted cognitive control over their motivational tendencies by successfully down-regulating the salience of food pictures in the availability condition. In fact, one study showed that exposure to food compared to a control object lead to an increase in heart rate, gastric activity and saliva in unrestrained, but not restrained eaters. As gastric activity significantly correlated with subsequent food intake, it can be concluded that unrestrained eaters prepared for food intake, while restrained eaters may have used some form of cognitive control to block the physiological responding to food exposure.

While the above mentioned studies mainly focussed on clinically healthy subjects brought in a state of food deprivation, overweight individuals or on individuals with bulimic symptoms, the food processing in BED has comparably been neglected. In line with an "addiction model of BED", Davis and Carter (2009) propose that weight cycling in BED patients may be an analogue to craving in drug abusers, as it reflects the repeated defeat of one's effort to refrain from binge eating. Furthermore, the over-consumption of food in BED is regulated by dopamine pathways, which are also responsible for the reinforcing effects of addictive drugs (Corwin, 2006; Kelley, Baldo, Pratt, & Will, 2005). Although studies on the relation between ERPs and craving in BED are still pending, neuroimaging studies suggest that similar neural mechanisms maintain drug craving and the desire for natural rewards such as food. Recently, Schienle, Schafer, Hermann, and Vaitl (2009) reported an increased activation of the reward-related brain regions (orbitofrontal cortex [OFC]) during the exposure to food stimuli in BED patients compared to BN patients and normal/obese healthy controls. Such increased OCF activity has also been shown