Cognitive reappraisal fails when attempting to reduce the appetitive value of food: An ERP study

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A B S T R A C T

This event-related potential (ERP) study investigated neural correlates of cognitive reappraisal during the exposure to food cues. Thirty-three healthy, normal-weight women viewed images of high-caloric food and non-food items after an overnight fast. The participants were instructed to either passively look at the pictures, or to change (increase, decrease) the appetitive value of the food items.

The P300 and the late positive potential (LPP) were higher across all conditions for food relative to non-food pictures. In the ‘increase condition’ the food images were rated as more appetizing and arousing than during passive viewing which was accompanied by increased amplitudes of the P300 and LPP. In contrast, the ‘watch condition’ and the ‘decrease condition’ did not differ with regard to appetite and arousal ratings as well as ERPs. Amplitudes of late positive potentials in the ‘decrease condition’ were positively correlated with scores on eating disorder scales indicating bulimic tendencies.

The ERP data show that the appetitive value of food cues can easily be enhanced via reappraisal but is difficult to reduce, especially in women who display non-clinical forms of purging. The reduced ERP reactivity might constitute a risk factor for bulimia nervosa. Future longitudinal-prospective studies should follow up on this aspect.

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1. Introduction

Food is a primary reinforcer that automatically attracts attention. This bioevolutionary mechanism helps an organism to detect food cues in the environment and to acquire nutriment (e.g., Nummenmaa, Hietanen, Calvo, & Hyönä, 2011). Studies using event-related potentials (ERPs) have revealed evidence that the human attentional system is tuned to detect food targets and to differentiate them from nonfood items. Very consistently it has been shown that the viewing of pictures depicting food elicits enhanced late ERPs, such as the P300 and the late positive potential (LPP; e.g., Stockburger, Schmalzle, Flaisch, Bublatzky, & Schupp, 2009; Stockburger, Weike, Hamm, & Schupp, 2008). The P300 and the LPP are positive deflections that extend from the central to the parietal region of the scalp and differentiate negative and positive pictures from neutral ones (Schupp et al., 2000, 2004). Therefore, late posterior ERPs can be interpreted as indicators of emotional significance of a stimulus (Olofsson, Nordin, Sequeira, & Polich, 2008). Whereas the P300 is found between 300 and 500 ms after stimulus onset, the LPP can last up to 6000 ms (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000). According to the theory of motivated attention (Lang, Bradley, & Cuthbert, 1997) enhanced late positivity reflects the amount of attention and processing resources a person is allocating to a stimulus (for a review, see Bradley, 2009). Whereas the potentiation of the P300 amplitude is considered an indicator of a phasic increase of attention to task-relevant stimuli (targets; e.g., Weinberg, Hilgard, Bartholow, & Hajcak, 2012), the LPP reflects a sustained increase, which can be modified by different cognitive strategies. Some authors have suggested that the LPP is a neurophysiological marker for emotion regulation (for a review, see Hajcak & McNamara, 2010).

Earlier ERP components such as the EPN (earlier posterior negativity), which constitutes of a transient negativity over the posterior scalp between 200 and 300 ms after stimulus onset, can also be altered by affective stimuli. The EPN is able to distinguish between valenced and neutral pictures, and is sensitive to the elicited level of arousal (Schupp, Junghofer, Weike, & Hamm, 2003). Foti, Hajcak, and Dien (2009) reported that even earlier components such as the N100 are modulated by emotional stimuli.

Findings on food picture processing have been restricted to late ERPs. LPP amplitudes elicited by visual food cues are enhanced under food deprivation (e.g., Nijs, Muris, Euser, & Franken, 2010; Stockburger et al., 2009). Additionally, positive correlations have been found between late positivity (P300, LPP), self-reported hunger (Nijs, Franken, & Muris, 2008; Stockburger et al., 2008), and

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food availability in restrained eaters, who displayed a pattern of chronic dietary restriction interspersed with episodes of disinhibited overeating (Blechert, Feige, Hajcak, & Tuschen-Caffier, 2010). Thus, the P300 and LPP are valid indicators of food-related attention.

Whereas neural correlates of food-cue processing have been repeatedly analyzed in ERP studies with passive viewing designs, it still needs to be elucidated how individuals deal with the motivational aspects of food perception and how they regulate their affective responses to food stimuli. Especially in Western societies with oversupply and easy access of food it is important to regulate one’s own food consumption. This can be achieved by different strategies, such as situation selection or modification (e.g., preference of diet products) and visual distraction from food items. Also cognitive reappraisal can be used which refers to interpreting a situation’s meaning in a way that alters its emotional impact (Gross & Thompson, 2007). For example, one might focus on the negative consequences of food consumption such as weight gain, or tell oneself that although a food item looks appetizing it will not taste good.

Up until now EEG studies on reappraisal have predominantly been conducted for aversive stimuli, such as pictures depicting mutilation, human threat (weapons) or animal threat (attacking dog). The results showed that down-regulation strategies reduced LPP amplitudes. This was correlated with reductions in the experienced emotional intensity (e.g., Hajcak & Nieuwenhuis, 2006; Moser, Hajcak, Bukay, & Simons, 2006; Moser, Most, & Simons, 2010). Investigations on reappraisal of positive stimuli are rare. In an investigation by Krompinger, Moser, and Simons (2008) participants were exposed to neutral and positive pictures (e.g., children and animals, triumphant sports moments, and nudity) and were asked to either increase or decrease the experienced positive affect. Whereas the decrease instruction provoked LPP attenuation, there was no effect of the increase instruction.

We conducted an ERP study, where healthy, normal-weight women were exposed to pictures depicting high-caloric food and non-food items. The participants were instructed to either passively look at the pictures, or to regulate (increase, decrease) the positive affect arising from the food cues. We expected modulation of late event-related potentials (P300, LPP) in response to the emotion regulation instructions, with higher amplitudes in the ‘increase condition’ and lower amplitudes in the ‘decrease condition’. Moreover, we predicted that bulimic tendencies of the participants (binge-eating, purging, fear of weight gain) would be correlated with difficulties in down-regulating the appetitive value of food cues as indexed by verbal report and ERP amplitudes.

2. Method

2.1. Participants

Thirty-three healthy, normal-weight, right-handed women aged between 18 and 31 years (M = 22.5, SD = 3.2) participated in this study. Their body mass index (BMI) ranged from 18.93 to 24.61 kg/m² (M = 21.40, SD = 1.72). Participants were recruited via newspaper advertisements and announcements at the campus. Exclusion criteria were the presence of substance abuse or addiction, clinically relevant depression, eating disorders, neurological disorders, and the current use of any medication. Exclusion criteria were checked by means of screening questions (no standardized clinical interview was conducted). The study had been approved by the Ethics Committee of the Karl-Franzens-University of Graz in accordance with the Helsinki Declaration. All volunteers gave written consent prior to participation.

2.2. Stimuli and design

Participants were exposed to a total of 60 different pictures taken partly from the International Affective Picture System (Lang, Bradley, & Cuthbert, 2008) and partly from our own picture set (which has already been used in a study by Schienle, Schäfer, Hermann, & Vaill, 2009). Thirty pictures showed eating-related scenes with high-caloric food (e.g., French fries, chocolate) and thirty pictures showed neutral scenes with non-food items (e.g., geometric figures, household objects).

The pictures were shown in four conditions. Participants received standardized instructions. In the Watch Neutral condition, participants passively viewed neutral pictures. In the Watch Food condition, participants passively viewed food pictures. In both conditions the instruction was: “Please view each picture, understand its content and allow yourself to experience the appetite and any emotional response it might elicit”. In the Increase Food condition, participants viewed food pictures, and received the instruction: “Please re-appraise each picture so that the content is more appetizing for you. Imagine that the food tastes delicious and you are allowed to eat the depicted food items later on”. Finally, in the Decrease Food condition, participants viewed food pictures, and received the instruction: “Please re-appraise each picture so that the content is less appetizing for you. Imagine that the depicted food is not real, it is a plastic model”.

Pictures were shown in six blocks of five pictures of the same category (either food or neutral) for each condition. Consequently, each food picture was shown three times during the course of the experiment. Each block was preceded by a fixation cross (2–4 s random) and a key word for the instruction (Watch, Increase, Decrease; 4.5 s). Each picture was presented for 4 s. Subsequent to the presentation of each picture block participants were asked to rate within 10 s their experience during the picture viewing on 9-point Likert scales for the dimensions appetite, valence, arousal, and effort experienced during emotion regulation (the latter only in the Increase and Decrease conditions), with higher scores indicating higher appetite, pleasantness, arousal, and effort.

2.3. Procedure

The participants arrived at the University laboratory in the morning after an overnight fast starting at 8 pm the day before. Each participant was explicitly asked whether or not she had adhered to this protocol. Then detailed information about the study was provided and written informed consent was obtained. The body mass index (BMI) was measured. Bulimic tendencies were assessed via three subscales of the Eating Disorder Inventory (EDI; Diethl & Staufenbri, 1994; Cronbach’s alpha = 90). The three scales were ‘fear of weight gain’, ‘binge-eating’, and ‘purging’. Participants were only included if they had comparable scores on these subscales as a construction sample of 382 healthy female students (Diethl & Staufenbri, 1994).

The participants were seated in a dimly lit, sound-attenuated room and an elastic cap embedded with 29 electrodes was applied for EEG recording. Following a 10-minute adaptation period, they received a training session for the three conditions. They were presented with comparable pictures later used in the experiment and received standardized instructions for the experiment. Then they were asked to practice reappraisal via self-instructions. Directly before the experiment, participants were asked to indicate their subjective levels of hunger (1 = not hungry; 9 = very hungry).

2.4. Electrophysiological recordings and data analyses

The electroencephalogram (EEG) was recorded with a Brain Amp 32 system (Brain Vision, Munich) and an Easy-Cap Ag/AgCl electrode system (Falk Minow Services, Munich) from 29 sites (FP1, FP2, F3, F4, F7, F8, FC1, FC2, FC5, FC6, C3, C4, T7, T8, CP1, CP2, CP5, CP6, F3, F4, P7, P8, O1, O2, Fz, Cz, Pz) including the mastoids (TP9, TP10). All sites were referenced online to FCz and digitally re-referenced off-line to linked mastoids. For the purpose of artifact assessment, bipolar horizontal electrooculogram (EOG) was recorded from the epicanthus of each eye, and vertical EOG was recorded from the infra-orbital region of the right eye. All electrode impedances were kept below 5 kΩ. The EEG and EOG signals were band-pass filtered (0.016–70 Hz) and digitized at 200 Hz. Independent component analysis (ICA) was computed on all EEG channels in order to correct for EOG artifacts. EOG relevant ICs were identified by visual inspection as follows: individual components’ scalp distributions were inspected to identify typical artifact components (e.g., frontopolar maximum for blinks/vertical saccades and lateral frontal maxima with different polarity for horizontal saccades). In addition, identified components were compared to EOG channels. EEG data were then segmented into 3700-ms epochs from 200 ms before to 3500 ms after the onset of the stimulus. All epochs were re-filtered off-line with a low-pass filter set at 30 Hz (12 dB/oct, zero phase filter) and then baseline-corrected against the mean voltage during the 200-ms prestimulus period. All epochs were visually scored for residual artifacts, and each portion of data containing artifacts greater than ±80μV in any channel was rejected for all the recorded channels prior to further analysis. Artifact-free epochs were separately averaged for each subject in each experimental condition.

Based on visual inspection of grand average ERP waveforms (Fig. 1) and the existing literature, the mean amplitude of the P300 component was computed in the 280–400 ms time window, and LPP activity was measured as mean amplitude within two successive time windows (500–1000 ms and 1000–1500 ms). We further looked at earlier ERP components (N100, early posterior negativity (EPN)), which have been proven to be differentially sensitive to the processing of positive and negative valence related to emotion. As the results for these early components were all non-significant, they are not reported in the result section.
Participants were excluded from subsequent analyses if there remained less than 25 artifact-free trials in a single category. The mean numbers of artifact-free trials were as follow: Increase Food = 28, Decrease Food = 27, Watch Food = 27 Watch Neutral = 29.

In order to explore the topographical distribution of amplitude effects, ERP activity at 16 non-midline electrodes was averaged into 4 main clusters: fronto-central left (F3, F7, FC1, FC5), fronto-central right (F4, F8, FC2, FC6), centro-parietal left (CP1, CP5, P3, P7), centro-parietal right (CP2, CP6, P4, P8).

Separate repeated-measures analyses of variance (ANOVAs) were conducted on mean ERP amplitudes with region (fronto-central, centro-parietal), hemisphere (left, right), and condition (Increase, Decrease, Watch Food, Watch Neutral) as within-subjects factors. Subjective ratings (experienced effort, appetite, valence, and arousal) were submitted to separate ANOVAs with condition as within-subjects factor. For all ANOVAs we report nominal degrees of freedom and Greenhouse-Geisser $\varepsilon$ where violation of sphericity was observed, as well as partial $\eta^2$ as effect sizes. Subsequent post hoc contrasts were computed with adjusted alpha-level (Bonferroni). Lastly, Pearson’s correlations were performed among self-report data, and between electrophysiological measures and self-report data to test the directed hypotheses that bulimic tendencies (fear of weight gain, binge-eating, purging) are associated with enhanced appetite and higher arousal as well as higher amplitudes of late positivity during attempts of down-regulation. P-values for exploratory correlations were Bonferroni-corrected.

3. Results

3.1. EDI subscales

Mean scores and standard deviations for the three subscales are presented in Table 1. We compared the scores of our sample with the scores of the construction sample of the questionnaire (Diehl & Staufenbiel, 1994) consisting of 382 healthy female students by means of between-samples t-tests. There were no significant group differences. Thus, the scores of our sample were in the non-clinical range.

3.2. Subjective ratings

The subjective ratings are displayed in Table 2. Significant condition effects were obtained for ratings of valence ($F(3,96) = 33.60$, $p < .001$, $\varepsilon = .71$, $\eta^2_p = .51$), arousal ($F(3,96) = 13.03$, $p < .001$, $\eta^2_p = .52$) and appetite ($F(3,96) = 75.71$, $p < .001$, $\eta^2_p = .70$). The affective...
state during Increase Food was rated as more pleasant (higher valence) and more arousing than during all the other conditions (all ps < .001), whereas during Decrease Food it was rated as less pleasant (p < .001), but not less arousing than during the Watch Food condition. Significantly higher valence and arousal ratings were assigned to the Watch Food than to the Watch Neutral condition (all ps < .001). During Increase Food, the experienced appetite was significantly greater than in all the other conditions (all ps < .001). During Decrease Food, the appetite did not differ from the Watch Food condition. Increase and Decrease Food received higher appetite ratings than the Watch Neutral condition (all ps < .001).

The instruction to decrease experienced appetite was rated as requiring significantly more effort than to increase it (F(1,32) = 3.61, p = .001).

### 3.3. ERP data

#### 3.3.1. P300

The ANOVA revealed significant main effects for condition (F(3,96) = 27.36, p < .001, $\eta^2_p = .42$) and region (F(1,32) = 203.42, p < .001, $\eta^2_p = .86$), but not for hemisphere (F(1,32) = 2.32, p = .137, $\eta^2_p = .07$). There were significant interactions for condition x region (F(3,96) = 8.19, p < .001, $\eta^2_p = .20$), condition x hemisphere (F(3,96) = 3.21, p = .026, $\eta^2_p = .09$), region x hemisphere (F(1,32) = 22.91, p < .001, $\eta^2_p = .42$) and condition x region x hemisphere (F(3,96) = 2.84, p = .042, $\eta^2_p = .08$).

Post hoc t-tests revealed that in both left and right fronto-central and centro-parietal regions the P300 amplitude was significantly larger in all Food conditions than in the Neutral condition (all ps < .001). In the left fronto-central region P300 amplitudes were significantly larger during Decrease Food than during Watch Food (p = .019). Moreover, in the left centro-parietal region P300 amplitudes were significantly larger during Increase Food than during Watch Food (p = .008), and in the right centro-parietal region they were larger during Increase Food than during Decrease Food and Watch Food (ps < .004). Overall, the P300 component was larger in the centro-parietal region than in the fronto-central region.

#### 3.3.2. LPP1 (500–1000 ms)

The ANOVA revealed significant main effects of condition (F(3,96) = 22.54, p < .001, $\eta^2_p = .41$) and region (F(1,32) = 83.49, p < .001, $\eta^2_p = .72$), but not for hemisphere (F(1,32) = 0.49, p = .490, $\eta^2_p = .02$). There were significant interactions for condition x region (F(3,96) = 4.29, p = .007, $\eta^2_p = .12$), condition x hemisphere (F(3,96) = 4.11, p = .009, $\eta^2_p = .11$) and region x hemisphere (F(1,32) = 8.18, p = .007, $\eta^2_p = .20$).

Post hoc t-tests showed that in both regions and hemispheres LPP1 amplitudes were significantly larger in all Food conditions than in the Neutral condition (all ps < .013). Moreover, LPP1 amplitudes were significantly larger in the Increase Food than in the Decrease Food and Watch Food condition (ps < .034). Overall, the LPP1 was larger in the centro-parietal relative to the fronto-central region.

#### 3.3.3. LPP2 (1000–1500 ms)

The ANOVA revealed significant main effects for condition (F(3,96) = 7.60, p = .001, $\eta^2_p = .19$) and region (F(1,32) = 9.50, p = .004, $\eta^2_p = .23$), but not for hemisphere (F(1,32) = 0.01, p = .947, $\eta^2_p = .01$). There were significant interactions for condition x region (F(3,96) = 14.51, p < .001, $\eta^2_p = .31$) and condition x hemisphere (F(3,96) = 8.36, p < .001, $\eta^2_p = .21$).

Post hoc t-tests showed that in the left fronto-central region the LPP2 amplitude was significantly larger in the Increase Food than in the Watch Neutral condition (p < .017), whereas in the right fronto-central region it was larger in the Increase Food than in the Decrease Food and also the Watch Neutral condition (ps < .004). In both left and right centro-parietal regions the LPP2 was larger during Increase Food than during Decrease Food and Watch Neutral (ps < .029), and during Watch Food than during Watch Neutral (ps < .001). Moreover, in the centro-parietal region the LPP2 was found to be larger in the right than left hemisphere during Increase Food (p = .010) only. Overall, the LPP2 was larger in the centro-parietal compared to the fronto-central region.

### 3.4. Correlational analyses

The scores on the EDI scales (‘fear of weight gain’, ‘binge-eating’ and ‘purging’) were positively correlated with the experienced arousal and appetite in the Decrease Food condition (see Table 3). When applying Bonferroni correction, for the Increase condition ratings of arousal were positively correlated with fear of weight gain and binge-eating.

Also, as hypothesized, there were positive correlations between the EDI subscales and ERP amplitudes in the Decrease Food condition (see Table 4). We observed no statistically significant correlations between ratings and ERPs for the Increase Food and Watch Food conditions, when applying Bonferroni corrections. Interestingly, the BMI showed no association with ERP amplitudes.

### Table 1

Comparison of means (M) and standard deviations (SD) of Eating Disorder Inventory (EDI) scores between the current sample and the EDI construction sample (Diehl & Staufenbiel, 1994).

<table>
<thead>
<tr>
<th>EDI subscale</th>
<th>Current sample n = 33</th>
<th>Construction sample n = 382</th>
<th>Between samples t-test df = 413</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>T</td>
</tr>
<tr>
<td>Fear of weight gain</td>
<td>7.2 (6.0)</td>
<td>9.5 (8.0)</td>
<td>1.61</td>
</tr>
<tr>
<td>Binge-eating</td>
<td>6.6 (6.3)</td>
<td>4.5 (7.2)</td>
<td>1.62</td>
</tr>
<tr>
<td>Purging</td>
<td>1.8 (2.4)</td>
<td>1.9 (5.0)</td>
<td>0.11</td>
</tr>
</tbody>
</table>

### Table 2

Experienced valence, arousal, appetite, and effort (means, M, and standard deviations, SD) during the different conditions.

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Conditions</th>
<th>Increase Food M (SD)</th>
<th>Decrease Food M (SD)</th>
<th>Watch Food M (SD)</th>
<th>Watch Neutral M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valence</td>
<td></td>
<td>7.02 (1.02)</td>
<td>5.53 (1.37)</td>
<td>6.35 (1.08)</td>
<td>4.94 (0.87)</td>
</tr>
<tr>
<td>Arousal</td>
<td></td>
<td>5.11 (1.96)</td>
<td>4.41 (1.85)</td>
<td>4.28 (1.89)</td>
<td>2.97 (1.42)</td>
</tr>
<tr>
<td>Appetite</td>
<td></td>
<td>6.73 (1.44)</td>
<td>4.77 (2.03)</td>
<td>5.02 (1.82)</td>
<td>2.07 (1.24)</td>
</tr>
<tr>
<td>Effort</td>
<td></td>
<td>3.19 (1.51)</td>
<td>4.53 (2.00)</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
Table 3  
Pearson's correlations between subjective experience during picture viewing in the Increase Food and Decrease Food conditions and scores on the Eating Disorder Inventory (EDI).

<table>
<thead>
<tr>
<th>EDI subscale</th>
<th>Increase Food</th>
<th>Decrease Food</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Appetite</td>
<td>Arousal</td>
</tr>
<tr>
<td>Fear of weight gain</td>
<td>.67</td>
<td>.36</td>
</tr>
<tr>
<td>Binge-eating</td>
<td>.60</td>
<td>.46</td>
</tr>
<tr>
<td>Purging</td>
<td>.34</td>
<td>.53</td>
</tr>
</tbody>
</table>

Note:  
* p < .05,  ** p < .01.

Table 4  
Pearson's correlations between ERP amplitudes in the Decrease Food condition and scores on fear of weight gain, binge eating, and purging subscales of the Eating Disorder Inventory (EDI).

<table>
<thead>
<tr>
<th>Region</th>
<th>Left FC</th>
<th>Right FC</th>
<th>Left CP</th>
<th>Right CP</th>
</tr>
</thead>
<tbody>
<tr>
<td>P300 Fear of weight gain</td>
<td>.29</td>
<td>.34</td>
<td>.30</td>
<td></td>
</tr>
<tr>
<td>Binge eating</td>
<td>.43**</td>
<td>.40**</td>
<td>.42**</td>
<td></td>
</tr>
<tr>
<td>Purging</td>
<td>.45**</td>
<td>.31**</td>
<td>.47**</td>
<td>.37**</td>
</tr>
<tr>
<td>LPP Fear of weight gain</td>
<td>.44**</td>
<td>.41**</td>
<td>.50**</td>
<td>.41**</td>
</tr>
<tr>
<td>LPP Binge eating</td>
<td>.35**</td>
<td>.37**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPP Purging</td>
<td>.35**</td>
<td>.47**</td>
<td>.34</td>
<td></td>
</tr>
</tbody>
</table>

Note: FC = Fronto-central; CP = Centro-parietal; LPP = Late positive potential; LPP1 = 500–1000 ms; LPP2 = 1000–1500 ms.  
* p < .05,  ** p < .01.

4. Discussion

This ERP study focused on reappraisal effects during the exposure to food cues in healthy, normal-weight women. In line with earlier studies (Nijs et al., 2010; Stockburger et al., 2008, 2009) we demonstrated that pictures depicting high-caloric food elicited greater P300 and LPP amplitudes compared to non-food pictures. This expected effect could be observed across all instruction conditions (Watch, Decrease, Increase) and can be interpreted in the framework of motivated attention (Bradley et al., 2003). Food stimuli are survival-relevant from a bioevolutionary standpoint and therefore require more attention and processing resources than affectively neutral stimuli.

The instruction to increase or decrease the affect to food stimuli enhanced P300 amplitudes relative to an instruction to passively view the pictures. The association with a specific task (to increase or decrease affect) turned food stimuli to targets, increased their task relevance and hence amplified the P300. This has previously been reported by Weinberg et al. (2012), who were able to show that an early portion of the LPP, which according to the authors resembles the P300, was sensitive to the target status of stimuli.

More importantly, we were interested in specific ERP effects associated with the applied reappraisal strategies. In contrast to an earlier study (Krompinger et al., 2008) that found no ERP changes during up-regulation of positive affect, in the present study amplitudes of the P300 were higher at centro-parietal sites during the Increase Food condition compared to passive viewing. This change was accompanied by increased ratings of positive valence, arousal, and appetite experienced during the viewing of the food pictures. When asked for the difficulty level to apply this specific reappraisal strategy, the women had indicated that less effort was needed compared to the Decrease condition. Consequently, it seems to be easier to experience food cues in a more positive way than to reduce the appetitive value. This could be seen in the affective ratings for arousal and appetite, which did not differ between the Watch and the Decrease condition. In contrast, the valence ratings were reduced during negative reappraisal. Thus, telling yourself that a food item is not suitable for consumption (e.g., by telling yourself that it is not real) was not an effective way to change the motivational value of the stimulus. The ‘wanting’ of the food item as indicated by the experienced appetite did not change in the intended direction.

The results for the LPP components were similar to the P300 findings. An augmented LPP was detected during positive reappraisal. The successful realization of the Increase instruction could be seen up to 1500 ms after picture onset. In contrast to our predictions and also in contrast to earlier ERP studies on down-regulation (Hajcak & Nieuwenhuis, 2006; Moser et al., 2006, 2010), the Decrease and the Watch condition did not differ in amplitudes. This indicates that increased attention and positive valence attribution to the food items were maintained. Thus, the attempt to decrease the motivational significance failed again. However, it has to be noted that the aforementioned studies instructed to down-regulate negative emotional responses, while our participants were requested to dampen appetitive affect.

We used a correlational approach in order to determine whether bulimic tendencies were associated with neural indicators of food-related reappraisal. As hypothesized, women who had obtained higher scores on the Eating Disorder Inventory subscales ‘fear of weight gain’, ‘binge eating’, and ‘purging’ gave higher arousal and appetite ratings for food pictures in the Decrease condition. Moreover, the P300 and LPP amplitudes for the Decrease condition were positively correlated with these EDI scales. Obviously, women with bulimic tendencies had more problems to down-regulate their appetite than women with no such tendencies. It has to be noted that we studied a sample of women who did not suffer from clinically relevant eating disorders. Nevertheless, already self-reported non-clinical forms of bulimic behaviors (especially purging) showed an association with altered regulation capacities of food value and associated brain activation. Therefore, it seems promising to adopt a prospective-longitudinal approach in a future study in order to investigate if the observed ERP effects could be used as predictors for the manifestation of a bulimia nervosa.

On the contrary, body weight showed no association with regulation indicators. This might be due to the fact that the BMI is a relatively simplistic proxy of eating behaviors, and thus lacks sensitivity within this context. Nevertheless, previous studies found correlations between food-related attention (discriminatory abilities regarding food and non-food items) and the BMI (Nummenmaa et al., 2011). Food detection however differs from the process of regulation the appetitive value of food.

Some limitations of the current study should be noted: Firstly, we only used screening questions to check for mental disorders. This approach lacks sensitivity, which could be improved by a structured clinical interview. Secondly, we relied on our participants’ self-report that they adhered to the overnight fast. In future studies this should explicitly be checked (e.g., by means of a blood-glucose-test). Moreover, the general emotion regulation capacity of the participants had not been assessed. This however is needed to determine the specificity of the observed ERP effects. Also, the investigation of other types of altered eating behavior (e.g., restraint eating) will help to pinpoint particular ERP components associated with deficient regulation of food motivation.

5. Conclusion

There is a general attentional bias for food cues indexed by the P300 and the LPP. This bias can easily be enhanced but is difficult to reduce. Bulimic tendencies (purging, binge-eating, fear of
weight-gain) are correlated with difficulties in decreasing the appetitive value of food, which is mirrored by the augmentation of late positive potentials.

References


