

Vegetarianism and food perception. Selective visual attention to meat pictures

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Introduction

The domain of food is a primary source of affect. Powerful mechanisms shape affective responding towards food stimuli according to nutritional needs of the organism (e.g., sweet preference, taste aversion; Rozin & Vollmecke, 1986). However, in humans, ideational reasoning provide further means determining affective responding, potentially overriding the pleasure based on the flavor of selected food items (Martins & Pliner, 2005; Rozin, Markwith, & Stoess, 1997). For instance, meat products may elicit a strong dislike and even disgust due to moral (e.g., linking meat consumption to cruelty, environmental degradation and political concerns) and health aspects (Allen, Wilson, Ng, & Dunne, 2000; Amato & Partridge, 1989; Fessler, Arguello, Mekdara, & Macias, 2003; Kenyon & Barker, 1998). Thus, vegetarianism provides a model system to explore the effects of a hedonic shift from liking to dislike towards specific food items based on ideational reasoning.

The affect system has pervasive effects on various psychological processes. The present study focused on the affective guidance of selective attention processes. Such a mechanism assures that significant stimuli automatically gain focused attention facilitating appropriate approach or avoidance behaviors (Lang, Bradley, &

Cuthbert, 1997; Öhman, Flykt, & Lundqvist, 2000). Here, using a passive viewing task, we examined whether vegetarians' negative affect towards meat turns corresponding visual stimuli into efficient attention catchers. Brain potentials enable one to measure the attention capture of affective stimuli at the level of initial stimulus perception. Previous studies revealed that the late positive potential (LPP), which occurs between 300 and 700 ms after stimulus onset, is enlarged when viewing unpleasant (e.g., mutilations, threat) and pleasant (erotic scenes, adventures) compared to neutral (household objects, neutral faces) pictures (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Schupp, Flaisch, Stockburger, & Junghöfer, 2006). Accordingly, the heightened affective salience of meat stimuli in vegetarians was expected to increase selective attention processes as indexed by the LPP. Furthermore, this effect was predicted to be specific to meat (i.e. not apparent for comparable non meat pictures), because meat is the distinct food category rejected by vegetarians. Previous research suggests that enlarged LPP amplitudes to significant stimuli reflect an implicit process (Ito & Cacioppo, 2000). In order to explore this issue, we included a condition in which participants performed an explicit attention task in which target stimuli were defined by an additional food category (desserts). It was hypothesized that vegetarians would show enhanced LPP amplitudes to meat pictures even when both meat and vegetable pictures represent non target stimuli, thus supporting the idea that enlarged LPP amplitudes reflect an implicit process.

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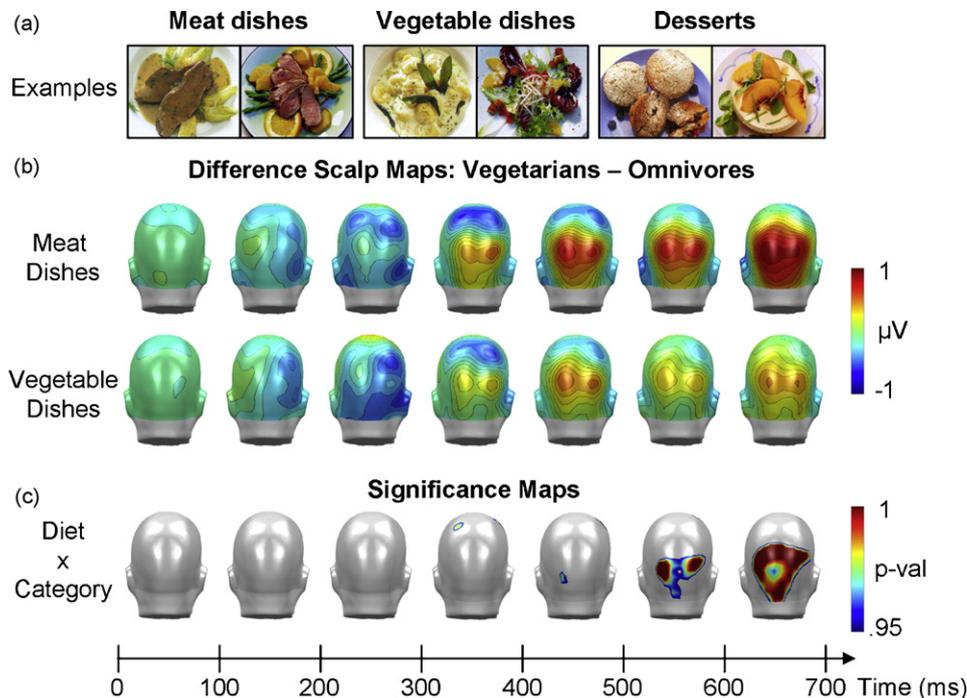


Fig. 1. (a) Examples of the food pictures showing meat and vegetable dishes, and desserts. (b) Interaction of diet and picture category. Differences (in 100 ms steps) in the surface scalp maps between vegetarians and omnivores viewing pictures of meat dishes and vegetable dishes averaged across the two experimental conditions. (c) Mapping of the areas showing a significant interaction (back view of a model head).

Methods

Participants

Based on their eating habits, 24 participants (12 females; mean age = 24, range 19–31) were selected out of 38 students from the University of Greifswald. Participants who reported that they do not consume any meat products were classified as vegetarians ($N = 12$; 5 females) and participants reporting no constraints with respect to the consumption of meat were classified as omnivores ($N = 12$; 7 females). The mean body mass index was 22.4 ($S.D. = 3.0$) and did not differ between groups.

Vegetarianism can be related to restrictive forms of eating disorders (Bas, Karabudak, & Kiziltan, 2005; Martins, Pliner, & O'Connor, 1999) or a desire for thinness, especially in young women (Worsley & Skrzypiec, 1998). Accordingly, screening questions related to eating disorders (anorexia, bulimia) and binge eating periods from the diagnostic interview for mental disorders (DIPS; Margraf, Schneider, & Ehlers, 1994) served to exclude volunteers with eating disorders from participation. Furthermore, the German adaptation of the Restraint Scale (FEV) served to exclude restrained eaters (Heatherston, Herman, Polivy, King, & McGree, 1988; Pudel & Westenhöfer, 1989). In the final sample, vegetarians ($M = 2.5$, $S.D. = 1.6$) and omnivores ($M = 2.8$, $S.D. = 2.1$) scored equally low on the FEV Restraint scale (range: 0–21).

Vegetarians were asked to report how, when, and why they came to avoid meat (Rozin et al., 1997). They had followed their diet for an average of 8 years (range: 4–15 years) and the majority reported moral reasons for choosing a vegetarian diet, followed by disgust, taste and health motives.

All participants received 15 Euro for participation. In addition, they could earn 2.5 Euro depending on their performance in the explicit counting task.

Stimulus materials

Food pictures showed meat dishes ($N = 100$), vegetable dishes ($N = 100$) and desserts ($N = 100$) taken from commercially available cooking books (Fig. 1a). The meat and vegetable pictures showed principal meals and were matched with respect to amount, form, and colors of the displayed items. The dessert pictures showed cakes, fruits, and sweets.

Procedure

The 300 food pictures were presented in a pseudo randomized order with no more than two repetitions of the same category. Pictures were displayed for 1000 ms and variable inter trial intervals (1750–2250 ms). Each participant received his/her own order of picture presentation. In the first experimental condition, participants were instructed to passively view the pictures (passive viewing). This was followed by an active task condition in which participants saw the picture set again and were asked to silently count the dessert pictures (explicit task). At five interspersed breaks, they had to mention their count. Finally, they had to rate each of the depicted food on a 3 point hedonic rating scale with “do like it a lot” [1], “neither/nor” [0] or “do not like it at all” [−1].

EEG recording

Brain and ocular scalp potential fields were measured with a 129 lead geodesic sensor net (EGI: Electrical Geodesics, Inc., Eugene, OR), on line bandpass filtered from 0.01 to 100 Hz, and sampled at 250 Hz using Netstation software and EGI amplifiers. Electrode impedance was kept below 30 $k\Omega$, as recommended for this type of electroencephalogram (EEG) amplifier. Data were recorded continuously with the vertex sensor as reference. Data

editing and artifact rejection were based on the statistical control of artifacts, specifically tailored for the analyses of dense sensor ERP recordings (Junghöfer, Elbert, Tucker, & Rockstroh, 2000). The data were baseline corrected and converted to an average reference. Separate average waveforms were calculated for the six experimental cells (three food categories by two task conditions), and for each sensor and participant.

Data analysis

Processing of food pictures

For statistical analysis, single sensor waveform and mean area scoring were used in concert. In single sensor waveform analyses, repeated measure analyses of variance (ANOVAs) containing the within subjects factors Food Category (meat vs. vegetable dishes) and Task (passive viewing vs. explicit task) and the between subjects factor Diet Group (vegetarians vs. omnivores) were calculated for each time point after picture onset separately for each individual sensor (Schupp, Junghöfer, Weike, & Hamm, 2003). To effectively prevent spurious findings, significant effects were only considered meaningful, when the effects were observed for at least eight continuous data points (32 ms) and two neighboring sensors (cf., Sabbagh & Taylor, 2000). Results revealed a significant interaction of Food Category and Diet Group in the time interval from 500 to 700 ms over posterior sensor sites.¹ To further explore these effects, mean amplitudes from representative posterior sensor clusters identified by both visual inspection and waveform analyses were averaged (EGI sensor numbers of the left cluster: 59, 60, 65, 66, 67, 71, 72; right cluster: 77, 78, 84, 85, 86, 91, 92). As initial data analyses revealed similar effects for left and right sensor groups, the factor Laterality was not further considered in the main analyses for brevity of result presentation. Data were entered into a three factorial ANOVA including the factors Diet Group, Food Category, and Task.

Explicit attention task

The primary aim of the counting task was to examine the hypothesis that increased attention to meat pictures in vegetarians reflects an implicit process. A possible concern is that the experimental groups differ in their task performance or compliance regarding the explicit attention task. To assure comparable task performance in vegetarians and omnivores, a first analysis examined the counting task. An overall accuracy score was obtained by subtracting the sum of the deviations from the correct target count across the five times participants indicated their count, converted to a percentage score. Vegetarians and omnivores showed a high and comparable performance in the counting task with $M = 97.1\%$ ($S.D. = 2.0$) and $M = 97.7\%$ accuracy ($S.D. = 1.4$), respectively, $t(22) < 1$, ns. In addition, dessert picture processing is associated in the explicit task condition with a pronounced target P3 in the ERP waveform (Johnson, 1988). Accordingly, in a further control analysis, the P3 to dessert pictures was scored as mean ERP activity from 400 to 600 ms in a centro parietal sensor cluster and submitted to a repeated measures ANOVA containing the between factor Diet Group and the within factor Task (passive viewing vs. explicit task). Participants showed the target P3 effect of enhanced P3 amplitudes in the explicit compared to the passive viewing task condition (Task $F_{1,22} = 91.5$, $p < 0.0001$). Of most interest, this effect was similarly pronounced in both groups (Task \times Diet Group $F_{1,22} < 1$).

¹ In this analysis, dessert pictures were excluded because of their different status in passive viewing and the explicit attention task. Control analysis including all three food categories confirmed a significant interaction of Food Category \times Diet Group, $F_{2,44} = 3.6$; $p < 0.5$ and the absence of group differences for dessert pictures, $F_{1,22} = 1.8$; ns.

Results

Stimulus ratings

Vegetarians almost exclusively evaluated meat dishes as negative, resulting in highly significant different hedonic ratings between vegetarians and omnivores, $\chi^2(2, 2400) = 1293.9$, $p < 0.001$. Compared to the prominent difference in evaluating meat dishes, only small albeit statistically significant group differences were found regarding vegetable dishes and desserts. Vegetarians rated vegetable dishes, $\chi^2(2, 2400) = 20.0$, $p < 0.05$, and desserts, $\chi^2(2, 2400) = 100.0$, $p < 0.05$, more positively than omnivores.

Processing of food pictures: ERPs to meat vs. vegetables dishes

As illustrated in Fig. 1b, meat pictures elicited enlarged LPPs over posterior regions in vegetarians compared to omnivores. In contrast, group differences of LPPs were small when processing vegetable dishes. These findings were supported by single sensor waveform analyses revealing a significant interaction of Food Category and Diet Group in the time window from 500 to 700 ms over parietal and occipital sensor regions (Fig. 1c). In addition, ANOVA analyses of mean areas scores of left and right posterior sensor clusters supported the hypothesis of selective meat processing in vegetarians; Food Category \times Diet Group: $F_{1,22} = 7.1$, $p < 0.05$. Contrasting both diet groups, meat pictures elicited a significantly enlarged LPP in vegetarians compared to omnivores ($F_{1,22} = 5.3$, $p < 0.05$), while LPP amplitudes to vegetable dishes were not significantly different between vegetarians and omnivores ($F_{1,22} = 1.4$, ns). Considering each diet group separately, vegetarians showed a significantly enlarged LPP to meat ($M = 1.26 \mu V$) compared to vegetable dishes ($M = 0.74 \mu V$) ($F_{1,11} = 13.4$, $p < 0.005$). In contrast, omnivores revealed similar LPP amplitudes to meat ($M = 0.30 \mu V$) and vegetable dishes ($M = 0.24$) ($F_{1,11} = 0.6$, ns).

Remarkably, the interaction of Food Category and Diet Group was not further qualified by the factor Task (three way interaction: $F_{1,22} = 1.6$, ns). Separate examination of the passive viewing and explicit task condition confirmed enlarged LPP amplitudes in vegetarians viewing meat dishes compared to vegetable dishes in both task conditions ($\Delta = 0.41$ and $0.64 \mu V$; $F_{1,11} = 13.2$ and 11.3 , $p < 0.005$, respectively) while no significant difference between meat and vegetable dishes was observed for omnivores ($\Delta = 0.15$ and $-0.01 \mu V$; $F_{s1,11} < 1.5$, ns).

Discussion

Vegetarians evince a hedonic shift towards meat stimuli based on ideational reasoning, predominantly driven by moral and health concerns (Rozin et al., 1997). The present study explored the hypothesis that increased salience of meat in vegetarians turns corresponding food stimuli into efficient attention catchers. The LPP as non obtrusive brain potential component was measured, which has been shown to reveal a heightened state of selective attention when viewing affective pictures (Nieuwenhuis, Aston Jones, & Cohen, 2005; Schupp et al., 2006). Consistent with the hypothesis, meat pictures elicited enlarged LPP amplitudes in vegetarians compared to omnivores. This finding was specific to meat stimuli as brain potentials to comparable pictures of vegetable dishes did not differ significantly between vegetarians and omnivores. These findings support the idea that the attention capture of food is not only related to biological processes of food consumption but also shaped by the affective salience associated with ideational reasoning and symbolic meaning (Rozin, 1996).

The explicit attention task condition provides further insight into the nature of the attention capture of affect laden food cues. While participants were asked to count the 'desserts', meat as well as non meat principle meals were non target stimuli. Consistent with the assumption that the attention capture of meat stimuli in vegetarians reflects an obligatory process, the effect of enlarged LPP amplitudes to meat stimuli in vegetarians was fully maintained in the explicit task condition. Moreover, as behavioral and electrophysiological indices (target P3 effect) were highly similar across groups, this result rules out different task engagement as alternative explanation. Taken together, these findings suggest that the attention capture of meat pictures in vegetarians is due to their implicit stimulus relevance (Ito & Cacioppo, 2000), which impacts the encoding even if the focus of explicit attention is directed to a different stimulus category.

Providing first evidence from the food domain, these findings underscore the notion to consider information processing at the level of distinct processing stages such as stimulus evaluation and behavioral responding (Cacioppo, Berntson, & Gardner, 1999; Luck, Woodman, & Vogel, 2000). Meat pictures not only elicit a strong avoidance predisposition in vegetarians, as revealed by subjective self reports, they are also highly efficient in recruiting selective visual attention during encoding, as indexed by the LPP. In the case of vegetarianism, increased attention to meat may foster attitude consistent behaviors by pitting moral reasoning (e.g., treatment of animals or long term health risks) higher than biological factors (flavor or nutritional value). The presentation of low and high caloric food items provides a further manipulation of the affective salience and symbolic meaning of food cues. Functional magnetic resonance imaging studies revealed reliable differences in the activation of perceptual and reward related brain regions when comparing high and low caloric food pictures (Killgore et al., 2003). These findings may have broader implications regarding the power of affect laden food cues to capture attentional resources. For instance, ambivalent and affect laden attitudes towards palatable food, common in restrained eating, dieting, and eating disorders, may increase implicit attention capture potentially opposing self control efforts (Mauler, Hamm, Weike, & Tuschen Caffier, 2006).

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