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Frontal late positivity in dental phobia: A study on gender differences

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ABSTRACT

Although dental phobia afflicts men and women, gender differences in neural correlates of this disorder have not been investigated thus far. We recorded event-related potential (ERPs) in 30 individuals with dental phobia (15 women, 15 men with comparable disorder severity) and 30 nonphobic controls (15 women, 15 men) while they passively viewed pictures depicting dental treatment, generally fear-eliciting, disgust-eliciting and neutral contents.

Male and female individuals with dental phobia as compared with controls displayed an enlarged centro-parietal late positivity (300–1500 ms). Gender difference concerned prefrontal ERPs. Only men with dentophobia showed an enhanced positivity towards the phobic relative to the neutral pictures in the time window between 300 and 1500 ms. Such a differentiation was absent in the other groups (male controls, female phobics, female controls). This finding indicates a gender-dependent recruitment of frontal attention networks in dental phobia and might reflect that male and female sufferers of dentophobia differ with regard to controlled attention focusing and cognitive avoidance during exposure.

1. Introduction

Dental phobia is a common type of specific phobia, which affects approximately 2–4% of the general population (e.g. Oosterink et al., 2009). The disorder is characterized by extreme and uncontrollable fear of dentistry and pronounced avoidance of seeking dental care. In terms of dental health and overall well-being, the symptoms can have serious ramifications (Armfield, 2008).

Dental phobia has a less skewed gender distribution than other types of specific phobia; e.g. Oosterink et al. (2009) reported a prevalence of 4.6% in females compared to 2.7% in males. Despite the considerable amount of male and female individuals afflicted by this disorder, gender differences in dental-phobic symptoms and associated problems have hardly been investigated. One exception is a study by Sartory et al. (2006) who demonstrated that female and male individuals with dental phobia were comparable in many clinical features (e.g. dental pain, negative emotions related to dental treatment), but differed in the displayed avoidance behavior and the perceived internal control during the treatment.

The majority of studies on gender effects focused on dental fear instead of phobia. Several studies (e.g. Eli et al., 2000; Heft et al., 2007) found that men reported lower levels of dental anxiety than women, although they expected more pain. After the completion of the treatment, women remembered more pain and other negative experiences (Eli et al., 2000; Locker et al., 1996). In contrast, Settineri et al. (2005) observed no gender differences in global dental anxiety; only specific fears in relation to the use of dental instruments and the tilted-back position of the chair differed between the two groups. Such gender effects might be a result of a lower perceived capability of control in women relative to men afflicted with dental fears (Liddell and Locker, 1997).

Besides little knowledge about gender differences in dental phobia, the neuronal basis of this disorder is also poorly understood. There is only one published study on electrocortical correlates of dental phobia during symptom provocation (Leutgeb et al., 2011). This investigation with exclusively female participants observed that phobics relative to controls showed an enhanced late positivity (300–700 ms) when confronted with pictures displaying dental treatment. This enhancement was most pronounced across parietal electrode sites and was interpreted to reflect motivated attention. Similar ERP effects have been reported in numerous studies on animal phobias (e.g. Leutgeb et al., 2009; Michalowski et al., 2009; Miltner et al., 2005; Muehlberger et al., 2006; Schienle et al., 2008). The observed increased parietal late positivity in phobic patients was understood as an indicator of automatic allocation of attentional resources towards the phobic object.

Late positivity changes in spider phobics were observed in a study on exposure therapy by Leutgeb et al. (2009). After successful treatment the patients displayed a fronto-central LPP enhancement as compared with the LPP before therapy. This treatment effect was

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discussed in terms of reduced attentional avoidance and increased control experience.

Interestingly, ERP findings on blood-injection-injury (BII) phobia are less clear. Buodo et al. (2006) found that blood phobics and controls responded to mutilation pictures with comparable parietal P300 and LPP amplitudes, suggesting that blood phobics did not assign enhanced attentional resources to the phobic stimulus. In a subsequent study of the group (Buodo et al., 2010) participants were simultaneously presented with disorder-relevant and-irrelevant pictures. BII phobics displayed an increased N2pc which is an indicator of an early visuospatial attentional bias. Finally, in a study by Sarlo et al. (2011) blood phobics displayed an enlarged N100 and a reduced parietal and central LPP (600–800 ms) towards mutilation pictures relative to controls. This pattern might reflect a processing bias involving early selective encoding and late cognitive avoidance. As in all previous investigations, only females were studied.

The main objective of the present investigation was therefore to compare affective and ERP responses (N100, N200, P100, P300 and LPP) between males and females suffering from dentophobia when exposed to disorder-relevant material. Based on previous findings (Sartory et al., 2006; Liddell and Locker, 1997; Leutgeb et al., 2009; Sarlo et al., 2011) we expected that relative to male phobics female phobics would display a reduced fronto-central late positivity during symptom provocation as they experience less cognitive control and show more avoidance behavior.

2. Materials and methods

2.1. Participants

Thirty right-handed and medication-naive individuals suffering from dental phobia (15 males, 15 females with comparable disorder severity) and thirty non-phobic controls (15 males, 15 females) participated in the study. They were recruited via an article in a local newspaper and at the dental clinic of the Medical University of Graz. Dental phobia diagnoses according to DSM-IV-TR (American Psychiatric Association, 2000) were obtained by a board-certified clinical psychologist. Individuals with dental phobia who suffered from any other mental disorder except dental phobia were excluded. Control participants did not suffer from any mental disorder. The groups did not differ from each other with respect to age ($F_{3,56} = 0.24$, $p = .63$; *M* (SD) in years: male phobics = 32.47 (8.50); male controls = 27.33 (5.54); female phobics = 28.20 (7.07); female controls = 24.80 (5.93)). All participants gave written informed consent after the nature of the study had been explained to them. The study was approved by the ethics committee of the University of Graz. If interested, the phobic participants were referred to psychotherapy.

2.2. Material

Interviews and questionnaires. We used a standardized clinical interview (Mini-DIPS: Margraf, 1994) with additional questions (e.g. onset of disorder, most feared aspects of the phobic situation) to obtain a clinical diagnosis. Moreover, the participants completed the Dental Anxiety Scale (DAS; Corah, 1969), the Dental Cognitions Questionnaire (DCQ, de Jongh et al., 1995), the Beck Depression Inventory (BDI; Hautzinger et al., 1993), the State Trait Anxiety Inventory (STAI; Laux et al., 1981) and the Questionnaire for the Assessment of Disgust Sensitivity (QADS; Schienle et al., 2002b). All of the self-report instruments are characterized by sufficient reliability indices (all Cronbach's alpha > .85). The DAS consists of four questions targeting experienced anxiety during anticipated and actual dental treatment. A cut-off score of 13 points was used for the inclusion in the phobic group (≥13). The DCQ describes 38 negative cognitions (e.g. *I can't control myself*; *treatments often fail*) about dental treatment. The STAI was used to assess trait anxiety. Possible scores range from 20 to 80 with higher scores being indicative of increased anxiety. The BDI is a 21-item inventory indexing depression intensity with a score range of 0–63. The QADS asks individuals to rate the experienced disgust intensity for a total of 37 situations on 4-point scales.

Pictures. The EEG paradigm included 120 pictures representing four different emotional categories: 'phobia', 'fear', 'disgust' and 'neutral'. Pictures were partly selected from the International Affective Picture System (IAPS; Lang et al., 1999) and from two other sets (disgusting contents (Schienle et al., 2002a); dental surgery (Leutgeb et al., 2011). The phobia-related stimuli depicted scenes of dental treatment. Disgust-relevant pictures[1] represented different domains like 'repulsive animals' and 'poor hygiene'. Fear-related pictures[2] showed predators (e.g. shark, lion) and attacks by humans (e.g. with knives, pistols), whereas neutral pictures[3] consisted of household articles. All pictures had a resolution of 800 × 600px.

2.3. Procedure

Each participant underwent two experimental sessions. In the first diagnostic session each participant completed the standardized clinical interview and the questionnaires.

For the subsequent session (approximately one week later), male and female phobics had been matched according to their disorder severity based on the scores of the dental anxiety scales and the judgment of the clinical psychologist. The participants were presented with pictures representing four different emotional categories ('phobia', 'fear', 'disgust', 'neutral') on a computer screen (distance: approximately 120 cm). During the exposure the electroencephalogram (EEG) was recorded. The pictures were shown in random order for 6000 ms each. The inter-stimulus intervals varied between 8000 and 12000 ms. After the experiment, participants gave affective ratings by means of the Self-Assessment Manikin (SAM; Bradley and Lang, 1994) for valence and arousal, and by means of two Likert scales for experienced disgust and fear (all ranges 1–9, with '9' indicating that the subject felt very positive, aroused, disgusted and anxious). For this purpose the rating scales as well as the pictures were presented as paper-and-pencil versions (with no time restriction). Mean judgments were obtained for all pictures of each condition. The mean affective ratings (*M*, SD) for the four picture categories were as follows: valence ratings: fear (4.38, 1.74), disgust (3.00, 1.52), phobia (4.37, 2.16), neutral (7.02, 1.72); arousal ratings: fear (3.98, 1.98), disgust (4.85, 2.10), phobia (4.25, 2.56), neutral (1.33, 0.77).

2.4. EEG

Apparatus. The EEG was recorded with a Brain Amp 32 AC system (Brain Products, Gilching, Germany) and analyzed with the Brain Vision Analyzer (2.0, Brain Products, Gilching, Germany).

Recording. We recorded with an Easy-Cap electrode system (Hersching, Germany) from 21 sites (Fp1, Fp2, F3, F4, F7, F8, C3, C4, T7, T8, P3, P4, P7, P8, O1, O2, Fz, Cz, Pz) including the mastoids (Tp9, Tp10). All sites were referenced to FCz. A bipolar horizontal electrooculogram (EOG) was recorded from the epicanthus of each eye, and a bipolar vertical EOG was recorded from the supra- and infra-orbital position of the right eye using Ag/AgCl electrodes. Prior to the placement of the electrodes, the sites on the participants' scalp and face were cleaned with alcohol and gently abraded. All impedances of the EEG electrodes were kept below 5 kΩ. Data were sampled at 2500 Hz with a bandpass filter set to 0.016–1000 Hz (full amplifier range).

Data reduction. EEG data were down-sampled to 250 Hz. Independent component analysis (ICA) was computed on all EEG channels 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, lateral frontal maxima with different polarity for horizontal saccades). In addition, identified components were compared to EOG channels. Corrected data were compared with raw EEG in order to assure that this approach was sufficient. Afterwards, the EEG was referenced to linked mastoids (Tp9, Tp10). EEG data were segmented into epochs of 1700 ms starting 200 ms before the onset of the stimulus. Subsequently, segments were visually inspected to discard remaining artifacts. After artifact correction remaining trials (out of 30) were on average (*M*, SD) 28.85 (1.74) for neutral, 28.72 (2.17) for disgust, 28.85 (1.89) for fear, and 28.20 (2.90) trials for the phobic condition. Finally the corrected data were low-pass filtered (20 Hz, 24 dB/octave).

ERP components. Epochs were averaged and corrected to a 200 ms pre-stimulus baseline separately for each condition. Magnitudes of the ERP components were extracted via average amplitudes for the time windows P300 (300-450 ms), the early LPP (550–770 ms) and the late LPP (800–1500 ms). The late positivity windows had been selected based on previous studies on symptom provocation in animal phobia and dental phobia (e.g. Leutgeb et al., 2009, 2011; Schienle et al., 2008). This selection had been confirmed by visual inspection. Additionally, earlier components such as the P100 (80–140 ms), the N100 (145–195 ms), and the N200 (180–320 ms) were extracted and compared between the phobia and the control group. These components had been identified as indicators of attentional bias in BII phobia (Buodo et al., 2010). Since we observed no statistically significant symptom provocation effects for the P100, N100 and N200 the results are not reported.

2.5. Statistical analyses

Affective ratings (experienced valence, arousal, fear, and disgust) were submitted to three-way ANOVAs with the factors *GROUP* (phobia and control), *GENDER*

[1] IAPS picture numbers (Lang et al., 1999) disgust: 0034, 9008, 9140, 9320.

[2] Fear: 1300, 1302, 1303, 1321, 1930, 1931, 3530, 5940_1, 5972, 6211, 6212, 6230, 6250_2, 6312, 6350, 6370, 6510, 6540, 6940, 9600, 9910, 9921.

[3] Neutral: 2880, 7000, 7009, 7010, 7030, 7034, 7050, 7080, 7100, 7157, 7185, 7190, 7205, 7211, 7830; all other pictures were taken from our own picture sets.