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Exposure therapy leads to enhanced late frontal positivity in 8- to 13-year-old spider phobic girls

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ABSTRACT

Neurobiological studies have demonstrated that psychotherapy is able to alter brain function in adults, however little exists on this topic with respect to children. This waiting-list controlled investigation focused on therapy-related changes of the P300 and the late positive potential (LPP) in 8- to 13-year-old spider phobic girls. Thirty-two patients were presented with phobia-relevant, generally disgust-inducing, fear-inducing, and affectively neutral pictures while an electroencephalogram was recorded. Participants received one session of up to 4 h of cognitive-behavioral exposure therapy. Treated children showed enhanced amplitudes of the LPP at frontal sites in response to spider pictures. This result is interpreted to reflect an improvement in controlled attentional engagement and is in line with already existing data for adult females. Moreover, the girls showed a therapy-specific reduction in overall disgust proneness, as well as in experienced arousal and disgust when viewing disgust pictures. Thus, exposure therapy seems to have broad effects in children.

1. Introduction

In the last years, there is increasing interest in neurobiological changes due to psychotherapy of specific phobia (for reviews, see Beauregard, 2009; Porto et al., 2009). Some research on correlates of cognitive-behavioral therapy (CBT) in spider phobia has been done with functional magnetic resonance imaging (fMRI, e.g., Schienle et al., 2007, 2009; Straube et al., 2006) using spider pictures for symptom provocation. The therapy-effect in the study by Straube et al. (2006) consisted of a reduction of hyperactivation in the anterior ventral insula reflecting a habituation of the somatic fear response. In contrast, Schienle et al. (2007) found enhanced activation in a large prefrontal area (i.e., the medial orbitofrontal cortex extending to the anterior cingulate cortex) after CBT, which was maintained in a 6-month follow-up session (Schienle et al., 2009). The effect was interpreted as a correlate of successful cognitive restructuring, mainly reflecting the relearning of stimulus-reinforcement associations and improvements in emotion regulation.

Superior to fMRI, the high temporal resolution of event-related potentials (ERPs) makes them a very promising tool to study neural responses toward phobic stimuli. There are two relevant ERP positivities within this context that are maximal at parietal recording sites. The P300 peaks between 300 and 500 ms following picture onset. The late positive potential (LPP) is a more sustained deflection, starting around 500 ms, which can be observed up to 6 s after picture onset (Pastor et al., 2008). The LPP tends to become more frontally distributed over time (Foti et al., 2009; Foti and Hajcak, 2008). Both components have repeatedly been shown to reflect increased attention toward motivationally relevant stimuli. Whereas the P300 has been linked to automatic attention processes, the LPP can be utilized as a measure of controlled attention and emotion regulation (for a review see Olofsson et al., 2008).

There are a handful of studies exploring effects of symptom provocation in spider phobics relative to healthy controls during passive picture viewing in adults (Michalowski et al., 2009; Miltner et al., 2005; Mühlberger et al., 2006; Schienle et al., 2008; Leutgeb et al., 2009) and children (Leutgeb et al., 2010). These studies consistently showed enhanced amplitudes of the P300 (combined for all studies: 280–520 ms) and early time frames of the LPP (combined for all studies: 428–800 ms) in phobics relative to controls during exposure. Results might be interpreted as effects of relatively fast and reflexive motivated attention. The ERP enhancement was specific for the spider condition and was not observed for other disorder-irrelevant emotion categories (e.g., fear, disgust; Schienle et al., 2008; Leutgeb et al., 2009, 2010).

In contrast to effects of symptom provocation, changes in ERPs after psychotherapy have hardly been investigated. A single published study by Leutgeb et al. (2009) reported a statistically

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significant change in late positivity in treated spider phobic adult females. Relative to a waiting-list group the treated patients showed enhanced amplitudes in response to spider pictures at fronto-central sites in a very late time window of the LPP from 800 to 1500 ms. The effect was specific for the disorder-relevant material as there were no changes in response to other picture categories (fear, disgust, neutral). Data were interpreted to reflect improved control of attentional direction during confrontation with spiders. This interpretation is in line with already existing studies showing that the voluntarily direction of attention is able to enhance the amplitude of late LPP amplitudes (Dunning and Hajcak, 2009; Ferrari et al., 2008; Hajcak et al., 2009; Keil et al., 2005; Schupp et al., 2007). Leutgeb et al. (2009) found no therapy-related changes of the P300 or the early LPP in spider phobic women. Consequently, it seems rather difficult to change these fast, automatic attentional processes in spider phobics by means of psychotherapy.

To our knowledge, there are no published ERP studies on therapy effects with spider phobic children. Generally, there is evidence that ERP latencies grow shorter with child development, indicating higher processing speed. However, studies showed that late positive components are similar in adults and children. The P300 is present even in early childhood, although latencies are longer and amplitudes are higher reflecting lower processing efficiency (for a review, see Fox et al., 2006).

Spider phobic patients experience extreme feelings of fear when confronted with spiders. However, they also report strong feelings of disgust for spiders. It has repeatedly been argued that specific phobia might be disgust-based rather than fear-based (for a review, see Olatunji et al., 2010). In line with this, several studies with spider phobics have hypothesized a role of overall disgust proneness in the etiology and maintenance of the disorderin adults (e.g., Tolin et al., 1997) and children (Muris et al., 2008a). In a study by De Jong et al. (2002) spider phobic women displayed heightened overall disgust proneness and a strong disgust response when exposed to disorder-irrelevant disgust elicitors. Muris et al. (2008a) reported significant correlations between symptoms of spider phobia and dispositional disgust in 9- to 13-year-old children. Additionally, De Jong et al. (1997) showed that 9- to 14-year-old spider phobic girls displayed an elevated overall disgust proneness. In a previous study we were also able to show heightened overall disgust-proneness in spider phobic children relative to controls (Leutgeb et al., 2010) which was accompanied by heightened average facial electromyographic activity of the levator labii and the corrugator supercilii in response to spider and disgust pictures. However, there are also studies that failed to find an overall heightened disgust proneness in adult spider phobics (Leutgeb et al., 2009; Schienle et al., 2008). In a recent study by Muris et al. (2008b) children, who had received disgust-related information about unknown animals, not only experienced a higher level of disgust but also displayed an increase in fear beliefs related to these animals. The authors concluded that there is an increased risk to develop fear for a stimulus that evokes disgust. De Jong and Muris (2002) reached a similar conclusion, as they found that the possibility of making involuntarily contact with a disgusting stimulus (i.e., the spider) is the essence of spider phobia in 10- to 14-year-old girls.

The present study is an effort to examine therapy-related changes in electrocortical correlates of spider phobic children. Patients passively viewed pictures (showing spiders, fear inducing, disgust inducing and neutral contents) while the EEG was recorded before and after exposure therapy. The therapy group was compared to a waiting-list group. We expected a reduction in phobic symptoms and in experienced fear, arousal and disgust as well as a rise in experienced positive affect during exposure in the therapy group relative to a waiting-list group. Moreover, we expected a therapy-induced enhancement of the fronto-central LPP specifically to spider pictures. Additionally, we were interested if CBT also has an impact on overall disgust proneness and trait anxiety.

2. Methods

2.1. Participants

Thirty-two right-handed and non-medicated girls aged from 8 to 13 years participated in the current investigation. Female participants were chosen because of the higher prevalence of spider phobia in females as compared to males (Essau et al., 2000; Fredrikson et al., 1996). All girls suffered from spider phobia (DSM-IV-TR: 300.29). Participants were randomly assigned to either a therapy group ($N = 15$) or a waiting-list group ($N = 17$). The two groups were comparable with respect to age (M (SD): therapy group = 137.5 (15.5) months; waiting-list group = 132.9 (16.9) months). Children were recruited via articles in local newspapers. After the nature of the study had been explained to them, all girls and their caregivers gave written informed consent. Diagnoses were made by a board-certified clinical psychologist. The study was approved by a local ethic committee. Participants received exposure therapy for free and were compensated with 15 € for their participation.

2.2. Procedure

A diagnostic session, consisting of a standardized clinical interview for children (Unnewehr et al., 1995) and an interview checking diagnostic criteria of spider phobia according to the DSM IV-TR (APA, 2000), was conducted at the beginning of the investigation. Additionally, children filled out the spider Phobia Questionnaire for Children (SPQ-C, Kindt et al., 1996), a child-adapted version of the Questionnaire for the Assessment of Disgust Proneness (QADS, Schienle et al., 2002) and the trait-scale of the State-Trait Anxiety Inventory for Children (STAI-C, Spielberger et al., 1973). Furthermore, children underwent a behavior avoidance test (BAT). A spider (*Tegenaria atrica*, approximately 3 cm in size) was put in a transparent case and placed on a table 5 m from the participant who was then instructed to approach the box, open it and take the spider on her hand. Participants who opened the box were excluded from the study. Subsequently, a diagnostic session with the caregiver, consisting of a clinical interview (Unnewehr et al., 1995; parent version) and an interview checking diagnostic criteria of spider phobia according to the DSM IV-TR (APA, 2000), was conducted. Diagnoses were determined on basis of child and parent reports according to the DSM IV-TR (APA, 2000) criteria. Patients who suffered from any other mental disorder than spider phobia were excluded from the sample.

One week later children were exposed to a total of 130 pictures during EEG recording. Pictures represented four different categories: 'spider', 'neutral', 'disgust' (e.g., snails, dirty toilet), and 'fear' (showing predators). Pictures were selected from the International Affective Picture System (IAPS, Lang et al., 1999) and a second picture set (Schienle et al., 2005; Leutgeb et al., 2010)[1]. Per category thirty pictures were shown. Additionally, 10 positive 'motivators' (e.g., bunnies, kittens) were used to make children feel more comfortable during picture presentation. 'Negative' pictures ('fear', 'disgust') were chosen to be appropriate for children (e.g., no mutilation or violence pictures). Pictures were shown in a random order for 6 s each. Interstimulus intervals varied between 4 and 8 s. Children were instructed to sit as still as possible and to passively watch the pictures. Immediately after the experiment, children rated their impression of the pictures by means of the Self-Assessment Manikin (SAM; Bradley and Lang, 1994) for 'valence' and 'arousal', and on two nine-point Likert scales on the dimensions 'fear' and 'disgust' (range 1–9, with '9' indicating that the subject felt very positive, aroused, anxious or disgusted).

One week later children of the therapy group received a single session of Cognitive Behavioral Therapy (CBT) according to Öst (1989), which lasted for a maximum of 4 h. The therapy consisted of detailed psychoeducation about fear and spiders, and exposure in vivo with participant modeling and cognitive restructuring. Therapy was conducted by a board-certified clinical psychologist. One week after therapy, a second EEG-session with subsequent SAM rating was conducted. Additionally, children filled out the SPQ-C (Kindt et al., 1996), the child-adapted version of the QADS (Schienle et al., 2002) and the STAI-C (Spielberger et al., 1973). Children of the waiting-list group received CBT after the second EEG-session.

2.3. Electroencephalographic recording and raw data analysis

The EEG was recorded with a Brain Amp 32 system (Brain Products, Gilching) and an Easy-Cap electrode system (Falk Minow Services, Munich) from 21 sites (Fp1, Fp2, F3, F4, F7, F8, C3, C4, T7, T8, P3, P4, P7, P8, O1, O2, Fz, Cz, Pz, Tp9, Tp10). All sites

[1] The numbers of the IAPS pictures (Lang et al., 1999) used were the following: neutral (7000, 7009, 7010, 7034, 7050, 7080, 7100, 7140, 7170, 7175, 7190, 7205, 7211), fear (0015, 1114, 1930), disgust (0018, 0019, 0020, 0021, 0022, 0025, 0026, 0027, 0028, 0031, 0032, 1274, 1275, 9008,9300, 9301, 9320), positive motivators (1440, 1463, 1750, 1999, 2071, 2311, 2387, 7340, 7410, 7460). Seventeen neutral, 24 disgust, 27 fear and all spider pictures were taken from validated picture sets of the authors (Schienle et al., 2005; Leutgeb et al., 2010).