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Psychophysiology of spider phobia in 8- to 12-year-old girls

Verena Leutgeb*, Axel Schäfer, Angelika Köchel, Wilfried Scharmüller, Anne Schienle

University of Graz, Department of Clinical Psychology, Austria

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ABSTRACT

The present investigation focused on late event-related potentials (ERPs) and facial electromyographic (EMG) activity in response to symptom provocation in 8- to 12-year-old spider phobic girls and compared results to those in non-fearful controls. Fourteen patients and 14 controls were presented with phobia-relevant, generally fear-inducing, disgust-inducing and affectively neutral pictures in an EEG/EMG session. ERPs were extracted in the time-windows 340–500 ms (P300) and 550–770 ms (late positive potential, LPP). Relative to controls, phobics showed enhanced amplitudes of P300 and LPP in response to spider pictures. This result is interpreted to reflect motivated attention to emotionally salient stimuli. Moreover, phobics showed enhanced average facial EMG activity of the levator labii and the corrugator supercilii in response to spider pictures, reflecting the negative valence and disgust relevance of spiders. Additionally, spider phobic girls relative to controls showed higher overall disgust proneness and heightened average facial EMG activity in both muscle regions in response to disgust stimuli, possibly revealing a disgust-based origin of spider phobia in children. These aspects should be considered in psychotherapeutic treatment of childhood spider phobia.

1. Introduction

With a 3-month prevalence rate of 4.6% anxiety disorders are the most frequent psychiatric disorders in 9- to 10-year-old children (Costello et al., 2003). There are several epidemiologic studies reporting prevalence rates of specific phobia in children from 2.6 to 9.1%, with an average of 5% across studies (Ollendick et al., 2002). Girls are more likely to develop spider phobia than boys (Federer et al., 2000; Muris et al., 1999). According to DSM IV-TR (APA, 2000) diagnostic criteria of spider phobia include an intense fear reaction when exposed to spiders, anxious anticipation and pronounced avoidance behavior. In contrast to adults, children do not always realize that their fear is excessive or unreasonable.

Specific phobias show the earliest onset among anxiety disorders and studies with children report an onset of spider phobia in early childhood (Becker et al., 2007). However, in most cases of spider phobia, children are "supported" by parents, who remove spiders if children panic at their sight. Therefore, avoidance behavior does not lead to severe restrictions in daily routines and interference with the patients' normal functioning as this is often the case in adults. Consequently, spider phobic children are very seldom transferred to psychotherapy, even though they experience intense distress during confrontation with spiders or even anticipation of possible contact. In contrast to the view that childhood anxiety is a passing phenomenon in most cases (Craske, 1997) there is considerable evidence that childhood anxiety disorders often have a chronic course (Keller et al., 1992; Last et al., 1996). In this sense, it seems quite reasonable to investigate the psychopathology of spider phobia in children (Muris, 2006) to provide a basis for future studies on therapeutic interventions.

Event-related potentials (ERPs) are a very promising tool to investigate the attentional reaction towards phobic stimuli aside from self-report data. Very consistently, such studies have reported enhanced amplitudes of the P300 and the late positive potential (LPP) for spider phobic adults relative to non-phobic controls when presented with spider pictures (e.g., Kolassa et al., 2005; Leutgeb et al., 2009; Miltner et al., 2005; Mühlberger et al., 2006; Schienle et al., 2008). The enhancement of P300 and LPP amplitudes, however, is not phobia-specific: for adults, it has repeatedly been shown, that the presentation of emotionally salient (both pleasant and unpleasant) pictures relative to neutral pictures elicits enlarged amplitudes of the P300 and the LPP (e.g., Cuthbert et al., 2000; Keil et al., 2002; Schupp et al., 2000). This finding has been interpreted in line with the theory of motivated attention (Lang et al., 1997) stating that emotionally significant stimuli automatically draw attention (for a review see Olofsson et al., 2008). Moreover, some studies investigated earlier ERPs (P100, N170) in phobics and healthy controls (Kolassa et al., 2006, 2007). The P100 was found to be enhanced in response to spider pictures in spider and social phobics compared to controls, which was interpreted to reflect cortical hypervigilance

* Corresponding author at: University of Graz, Clinical Psychology, Universitätsplatz 2/III, A – 8010 Graz, Styria, Austria. Tel.: +43 316 380 8507; fax: +43 316 380 9808.
E-mail address: verena.leutgeb@uni-graz.at (V. Leutgeb).

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for incoming stimuli. Moreover, the N170 was found to be increased in response to spider pictures in spider and social phobics as well as in healthy controls, which was interpreted to possibly reflect a general advantage for fear-relevant compared to neutral stimuli.

Although event-related potentials such as the P300 and the LPP have been extensively studied in adults in either normal controls or spider phobic subjects, there are only few studies in children. Therefore, it remains unresolved if late ERP components in children can be compared to those in adults. However, in a recent investigation with 5- to 8-year-old children, Hajcak and Dennis (2009) reported enhanced late positivity following the presentation of unpleasant or pleasant pictures relative to neutral pictures, which was very similar to the LPP in adults. Publications on late ERPs in spider phobic children are lacking and the present study is an effort to examine whether spider phobic children, like adults, display a modulation of late ERPs to Spider compared to Neutral pictures.

It has repeatedly been argued that many specific phobias might be disgust-based rather than fear-based (e.g., Power and Dalgleish, 2008). Recently, Gerdes et al. (2009) showed that spiders elicit significantly greater disgust and fear than other arthropods (e.g., bees or wasps). According to Davey (1994) the disgust-evoking status of spiders might have a cultural rather than a biological origin, as for a long time spiders have been associated with disease and contamination. The typical facial expression of disgust is the nose wrinkle and the retraction of the upper lip (Ekman, 1971). According to several studies (Schienle et al., 2001; Stark et al., 2005; Vrana, 1993) the electromyographic (EMG) activity of the levator labii can be used as an index specific for disgust. De Jong et al. (2002) showed that spider pictures elicited a strong disgust response in addition to fear in spider phobic women, as indicated by self-report and enhanced levator labii muscle activity. The authors further reported enhanced activity of the corrugator supercilii (the "frowning") muscle. Enhanced corrugator muscle activity has repeatedly been shown to reflect experienced valence, with more activity during exposure to unpleasant stimuli than during exposure to pleasant stimuli (e.g., Bradley and Lang, 2000). In a recent study, Armstrong et al. (2007) revealed that the facial EMG is a valuable tool to discriminate between pleasant and unpleasant stimuli in children. Disgust-like facial expressions are displayed by newborns to salty, sour and bitter tastes (Rosenstein and Oster, 1988). This innate distaste response is a precursor of the disgust emotion that most likely develops between the age of 4 and 8 years (Rozin et al., 1985, 2000; Rozin and Fallon, 1987). Therefore, it makes sense to study facial expression of disgust in children, especially in a psychopathological context. To our knowledge there are no published studies on facial EMG activity in spider phobic children.

In addition to the enhanced disgust-evoking status of spiders *per se* in spider phobics, several studies with adults have hypothesized a role of overall disgust proneness in the etiology and maintenance of the disorder (e.g., Tolin et al., 1997). In the above-mentioned study by De Jong et al. (2002) spider phobic women also displayed heightened overall disgust sensitivity and a strong disgust response if exposed to disorder-irrelevant disgust elicitors. However, in previous studies of our research group we found no overall heightened disgust proneness in spider phobic females (Leutgeb et al., 2009; Schienle et al., 2008). In children, there are data supporting the view that habitual disgust might be an important factor for the development and maintenance of spider phobia: De Jong et al. (1997) showed, that 9- to 14-year-old spider phobic girls did not only consider spiders *per se* as more disgusting than non-phobic controls, but did also display a higher overall disgust proneness. In a recent study by Muris et al. (2008a) 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 (the spider) is the essence of spider phobia in 10- to 14-year-old girls. Moreover, Muris et al. (2008b) reported significant correlations between symptoms of spider phobia and dispositional disgust in 9- to 13-year-old non-clinical children.

The present study was designed to study ERPs and facial EMG activity in response to spider, fear-relevant, disgust-relevant and neutral pictures in spider phobic girls and non-fearful controls. For spider phobics, we expected enhanced amplitudes of the P300 and the LPP in response to Spider pictures relative to Neutral pictures. Additionally, we expected enhanced EMG activity of the levator labii and the corrugator supercilii for spider phobics in response to Spider pictures relative to Neutral pictures. Moreover, we expected spider phobic girls to report enhanced overall disgust proneness. The present study is the first to investigate ERPs and facial EMG activity in spider phobic children.

2. Methods

2.1. Participants

Twenty-eight right-handed and non-medicated girls aged from 8 to 12 years participated in the current study. In line with earlier studies (Kolassa et al., 2005; Leutgeb et al., 2009; Schienle et al., 2008) two extreme groups in their extent of fearfulness towards spiders were chosen for the current study. Fourteen girls suffered from spider phobia (DSM-IV-TR: 300.29) and were referred to cognitive behavioral treatment if interested, whereas 14 control girls did not suffer from any mental disorder and received 30 € for their participation. Children were recruited via articles in local newspapers. It was asked for 'children experiencing intense fear and distress when confronted with spiders' and for 'children without fear of spiders'. It was ensured that the control sample did not include subclinical spider phobics, therefore participants were only included in the sample if they were able to let a living spider walk around on their hand. Diagnoses were made by a board-certified clinical psychologist. Both groups were comparable with respect to age (*M* (*SD*): phobics = 130.1 (14.7) months; controls = 125.9 (16.5) months). All participants and their caregivers gave written informed consent after the nature of the study had been explained to them. The study was approved by a local ethic committee.

2.2. Procedure

First, the girls underwent a diagnostic session consisting of a clinical interview (Unnewehr et al., 1995; 'Diagnostisches Interview bei Psychischen Störungen', DIPS, child version) and a detailed interview checking diagnostic criteria of spider phobia according to the DSM IV-TR (APA, 2000). 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). Finally, children underwent a behavior avoidance test (BAT). A spider (*Tegenaria atrica*, approximately 3 cm) was put in a transparent case and placed on a table 5 m from the participant who was then instructed to approach the box. The children received scores (range 0–12) according to their approach behavior (0 points = no movement, 12 points = removing the spider from the box and holding it in their hands for 20 s). Subsequently, a diagnostic session with the caregiver, which consisted of a clinical interview (Unnewehr et al., 1995; parent version), was conducted. Diagnoses were determined on basis of child vs. parent reports. For diagnosing spider phobia the DSM IV-TR criteria had to be met, and there were cutoff scores for the SPQ (at least 15 points) and the BAT (not more than 7 points, which means that they did not open the spider's box). Patients who suffered from any other mental disorder than spider phobia were excluded. Control group participants who suffered from any mental disorder were excluded. Controls had to be able to hold the spider in their hands for 20 s or more without feelings of fear.

In an experimental session children were exposed to a total of 130 pictures during EEG/EMG recording. The slides represented four different emotional categories: 'Spider' pictures depicted spiders in different environments, 'Fear' pictures depicted predators (e.g., shark, lion), 'Disgust' pictures represented different domains like 'repulsive animals' (e.g., maggots) or 'poor hygiene' (e.g., dirty toilet) and 'Neutral' pictures depicted household articles, or geometric figures. Pictures were selected from the International Affective Picture System (IAPS, Lang et al., 1999) and a second picture set (Schienle et al., 2005). Thirty pictures were shown per category. Additionally, 10 positive 'Motivators' were presented to make children feel more comfortable (e.g., bunnies, kittens). 'Negative' pictures ('Fear', 'Disgust') were chosen to be appropriate for children (e.g., no mutilation or violence pictures were included). Pictures were shown in a random order for 6 s each. Inter-stimulus inter-