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Facial emotion processing in pediatric social anxiety disorder: Relevance of situational context

Daniela Schwab*, Anne Schienle*

University of Graz, Institute of Psychology, Department of Clinical Psychology, Universitätsplatz 2/III, A-8010 Graz, Austria

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ABSTRACT

Social anxiety disorder (SAD) typically begins in childhood. Previous research has demonstrated that adult patients respond with elevated late positivity (LP) to negative facial expressions. In the present study on pediatric SAD, we investigated responses to negative facial expressions and the role of social context information. Fifteen children with SAD and 15 non-anxious controls were first presented with images of negative facial expressions with masked backgrounds. Following this, the complete images which included context information, were shown. The negative expressions were either a result of an emotion-relevant (e.g., social exclusion) or emotion-irrelevant elicitor (e.g., weight lifting). Relative to controls, the clinical group showed elevated parietal LP during face processing with and without context information. Both groups differed in their frontal LP depending on the type of context. In SAD patients, frontal LP was lower in emotion-relevant than emotion-irrelevant contexts. We conclude that SAD patients direct more automatic attention towards negative facial expressions (parietal effect) and are less capable in integrating affective context information (frontal effect).

1. Introduction

Social anxiety disorder (SAD) is a common mental disorder which in most cases manifests at an early age. About 75% of the patients develop symptoms between eight and 15 years of age (American Psychiatric Association, 2013; Stein & Stein, 2008). SAD is characterized by the intense fear of becoming embarrassed in one or more social situations. These may include playing with other kids, reading in class, taking exams, speaking to authority figures, and performing in front of others (American Psychiatric Association, 2013; Stein & Stein, 2008). The fear and associated avoidance behavior have negative consequences, such as poorer academic performance and an elevated rate of school dropout (Rao et al., 2007). The disorder persists without treatment (American Psychiatric Association, 2013; Beesdo, Knappe, & Pine, 2009; Stein & Stein, 2008). Therefore, an early diagnosis and identification of relevant psychopathological factors for this disorder are crucial.

One of these factors relates to altered affective face processing, which has been repeatedly identified in adult SAD patients. They show an elevated sensitivity for negative expressions such as anger and disgust, which signal disapproval and rejection (Staugaard, 2010). In the same vein, (socially) anxious children are more sensitive to facial displays of negative emotions (Stirling, Eley, & Clark, 2006; Waters, Henry, Mogg, Bradley, & Pine, 2010; Waters, Mogg, Bradley, & Pine, 2011).

In order to decode the emotional state of other individuals, it is a helpful strategy to focus on their facial expressions. However, information about the situational context is also very important to correctly interpret others' feelings. For example, a negative facial expression may indeed mirror a negative feeling state, or in the context of physical exercise, simply indicate muscle tension or exhaustion. Importantly, the core symptom of SAD is the expectation of being negatively evaluated by others; as a result, facial information is only processed in a self-referential mode. This implies that a display is always interpreted as a manifestation of disapproval (Staugaard, 2010). Therefore, considering the possibility that negative facial expressions can also be independent of emotion-relevant elicitors might be a helpful strategy in helping to overcome social anxiety.

It is surprising that thus far, the ability of SAD patients to integrate context information during facial expression processing has not been investigated; merely, the responses to 'faces only' have been studied.

In ERP research, both early and late components (e.g. P100, N170, late positivity) relating to affective faces have been analyzed for adults as well as for children. The P100 is a positive deflection peaking around 100 ms after stimulus onset. It is associated with attention-modulated processing of faces (e.g., Luck, 2005). The P100 to negative facial expressions is enhanced in SAD patients in comparison to healthy

* Corresponding authors.
E-mail addresses: daniela.schwab@uni-graz.at (D. Schwab), anne.schienle@uni-graz.at (A. Schienle).

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controls reflecting hypervigilance (Kolassa et al., 2009; Kolassa, Kolassa, Musial, & Miltner, 2007; Mühlberger et al., 2009; Müller et al., 2009; Rossignol, Campanella et al., 2012; Rossignol, Philippot, Bissot, Rigoulot, & Campanella, 2012).

The N170 is a negative deflection peaking around 170 ms after stimulus onset and mirrors categorization and identification of facial stimuli (Luck & Kappenman, 2012). Because of its face-specificity, the N170 has been investigated in most EEG studies on emotional face processing in SAD patients. The findings are heterogeneous. Müller et al. (2009) found smaller N170 amplitudes to facial expressions in SAD patients indicating avoidance or disruption of face processing. Contrary, Kolassa and Miltner (2006) observed a positive association between the N170 amplitude to angry faces and SAD symptom severity reflecting a more intense processing style of disorder relevant stimuli. However, most studies did not find N170 effects moderated by social anxiety (e.g. Kolassa et al., 2007, 2009; Rossignol, Campanella et al., 2012; Rossignol, Fisch, Maurage, Joassin, & Philippot, 2013). Therefore, the existing evidence rather points to unimpaired structural encoding of facial stimuli in SAD (see e.g., Peschard, Philippot, Joassin, & Rossignol, 2013).

The late positivity (LP) increases between 300 to 500 ms after stimulus onset and can outlast stimulus offset (for review see Hajcak, MacNamara, & Olvet, 2010). There are several lines of evidence that frontal and parietal LP reflect different modes of emotion processing and originate from different neuronal sources (Foti, Hajcak, & Dien, 2009; Hajcak, Weinberg, MacNamara, & Foti, 2012). In general, emotion perception and regulation are attention-driven functions which involve bottom-up as well as top-down processes (Ochsner et al., 2009). Enhanced parietal LP has been interpreted to reflect increased visual attention allocation to emotional stimuli (Hajcak et al., 2010; Schupp, Flaisch, Stockburger, & Junghöfer, 2006), whereas enhanced frontal LP mirrors evaluative and reflective/integrative processing (Cunningham, Espinet, DeYoung, & Zelazo, 2005). Socially anxious adults showed enlarged parietal LP to negative facial expressions (e.g. Moser, Huppert, Duval, & Simons, 2008).

ERPs to threatening faces are also amplified in anxious children (Hum, Manassis, & Lewis, 2013; Kujawa, MacNamara, Fitzgerald, Monk, & Phan, 2015). Kujawa et al. (2015) observed heightened parietal LP to angry and fearful faces in children with various anxiety disorders, especially in those with social anxiety symptoms.

For the present ERP study, we had two major aims. Firstly, we wanted to investigate the processing of negative facial expressions in pediatric SAD. Secondly, we were interested in whether anxious and non-anxious children process context information differently when presented with faces. We exposed children to negative facial expressions, first without visual context information ('face only' with masked background), and subsequently with context (unmasked background). The context information either indicated an emotion-relevant elicitor for the facial expression (e.g. disappointment because of social exclusion), or consisted of an emotion-irrelevant background (e.g. crying during onion cutting). Before the context was unmasked, participants had to guess whether the face would occur in an emotion-relevant or emotion-irrelevant situation.

We hypothesized that, relative to controls, SAD patients would show higher parietal ERP amplitudes when presented with faces only (Hum et al., 2013; Kolassa & Miltner, 2006; Kujawa et al., 2015; Moser et al., 2008; Mühlberger et al., 2009). Further, based on their biased social expectations, they should also anticipate more emotion-relevant contexts (Foa, Franklin, Perry, & Herbert, 1996; Gilboa-Schechtman, Franklin, & Foa, 2000; Taylor & Wald, 2003). Regarding the integration of context information, different outcomes were possible. SAD patients might focus on the negative facial expression and neglect additional visual cues, whereas non-anxious controls should be able to perform the integration of this information (Bögels & Mansell, 2004; Mogg & Bradley, 1998). If this is the case, then parietal ERPs should not differ in patients between the two context conditions (Dennis & Hajcak, 2009). On the other hand, SAD patients might have problems in integrating context information, especially when it is emotion-relevant, which would selectively reduce their ERPs in this condition. This integration process is very likely based upon frontal instead of parietal cortical networks. Previous studies on children (DeCicco, Solomon, & Dennis, 2012; Solomon, DeCicco, & Dennis, 2012) have already demonstrated that the processing of affective scenes leads to changes in both parietal as well as frontal LP.

2. Materials and methods

2.1. Participants

We investigated 15 children with SAD (11 girls, 4 boys) and 15 non-anxious controls (13 girls, 2 boys) aged 7–13 years. Prior to the EEG recording, all participants were screened with the German version of the Social Anxiety Scale for Children (Melfsen, 1998). The SASC-R-D assesses SAD symptoms with two subscales: *fear of negative evaluation* (FNE; e.g. "I worry about being teased") and *social avoidance and distress* (SAD; e.g. "I feel shy around children I don't know"). Children of the SAD group had elevated scores in one of the two subscales of the SASC-R-D (above 75th percentile). We assured the SAD diagnosis with a structured clinical interview for children and parents (Unnewehr, Schneider, & Margraf, 1994) conducted by a board-certified clinical psychologist. Children of the SAD group did not have any comorbid disorders and did not undergo any kind of treatment for their symptoms. Children of the control group were characterized by low scores in both subscales of the SASC-R-D. The structured clinical interview indicated no past or present mental disorders for them.

The two groups did not differ in gender ratio ($\chi 2(2) = 0.83$, $p = 0.36$; patients: 77.33% female, 26.67% male; controls: 86.67% female, 13.33% male), mean age ($t(28) = -0.66$, $p = 0.52$; patients: $M = 9.60$ years, $SD = 1.55$; controls: $M = 9.20$ years, $SD = 1.78$), or years of education ($t(28) = -0.84$, $p = 0.41$; patients: $M = 4.27$ years, $SD = 1.53$; controls: $M = 3.73$ years, $SD = 1.91$).

All children and their parents were carefully instructed and gave written informed consent. The study had been approved by the ethics committee of the University of Graz. Due to technical problems during data recording, rating data of two participants was not available for analysis.

2.2. Procedure

Participants were recruited through the psychological outpatient clinic of the University and by media advertisements. After the diagnostic session (SASC-R-D, clinical interview), the children participated in the EEG session, during which they were presented with a total of 120 pictures. Each trial started with the presentation of a fixation cross (duration: 500–1500 ms). Then, a negative facial expression was shown without any visual context information (60 pictures with 'faces only'; the background had been covered by a black rectangle) for 1500 ms. Subsequently, two thumbs were presented on the computer screen, one pointing up (indicating anticipation of an emotion-irrelevant context), and one pointing down (indicating anticipation of an emotion-relevant context). Participants had to guess whether an emotion-relevant stimulus or an emotion-irrelevant context would explain the facial expression. They had to press a corresponding button within 4000 ms (guessing task). After another fixation period (duration: 500–1500 ms), the picture including the context information was presented for 1500 ms (60 pictures with complete scenes). In 30 pictures, the negative facial expressions were shown because of an emotion-relevant elicitor (e.g. a girl is disappointed when she realizes that other girls are bad-mouthing about her; a couple is fighting, see Fig. 1A). The other 30 pictures depicted negative expressions in emotion-irrelevant contexts (e.g. cutting onions, blowing up a balloon, lifting a weight, looking into a blowing hair dryer; see also Fig. 1B).