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The impact of high trait social anxiety on neural processing of facial emotion expressions in females

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ABSTRACT

A cognitive model of social anxiety predicts that an early attentional bias leads to greater cognitive processing of social threat signals, whereas the vigilance-avoidance model predicts there will be subsequent reduction in cognitive processing. This study tests these models by examining neural responses to social threat stimuli using Event-related potentials (ERP). 19 women with high trait social anxiety and 19 women with low trait social anxiety viewed emotional expressions (angry, disgusted, happy and neutral) in a passive viewing task whilst ERP responses were recorded. The HSA group revealed greater automatic attention, or hypervigilance, to all facial expressions, as indexed by greater N1 amplitude compared to the LSA group. They also showed greater sustained attention and elaborative processing of all facial expressions, indexed by significantly increased P2 and P3 amplitudes compared to the LSA group. These results support cognitive models of social anxiety, but are not consistent with predictions of the vigilance-avoidance model.

1. Introduction

Social anxiety is characterized by an avoidance of social situations and a fear of negative evaluation which leads to perception of social threat (including in relation to ambiguous social signals such as neutral facial expression), significant impairments in social relationships and functioning. The interpretation of facial expressions is particularly relevant in social anxiety since the human face is central to social cognition and communicates a vast amount of information (Calder & Young, 2005). Given that facial expressions show universally recognizable emotions (Ekman & Friesen, 1976), this makes them powerful stimuli for investigating social aspects of emotional processing.

Several cognitive models of social anxiety highlight an important role of cognitive biases in maintaining social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997). Most models predict an early automatic hypervigilance to social threat cues but they diverge in their predictions of later cognitive processing. Clark and Wells (1995) predict that attentional resources are directed internally as part of self-focused attention with a concomitant reduction in attention to external social threat cues, whereas Rapee & Heimberg (1997) propose that attention is simultaneously directed internally with self-focused attention and to external social threat cues. Further models propose that following initial hypervigilance, there is difficulty disengaging from threat leading to sustained attentional processing (Amir, Elias, Klumpp, & Przeworski, 2003; Buckner, Maner, & Schmidt, 2010). In contrast, the vigilance-avoidance model (Mogg, Mathews, & Weinman, 1987; Mogg & Bradley, 1998; Williams, Watts, Macleod, & Mathews, 1997) proposes that following this initial hypervigilance, individuals with social anxiety avoid further processing of social threat stimuli, leading to reduced later cognitive processing of social threat stimuli.

Empirical evidence for models of social anxiety is variable in behavioural studies using dot-probe designs (Chen, Ehlers, Clark, & Mansell, 2002; Mogg & Bradley, 2002), and in eye movement studies (Buckner et al., 2010; Horley, Williams, Gonsalvez, & Gordon, 2003; Mogg, Garner, & Bradley, 2007; Wieser, Pauli, Alpers, & Muhlberger, 2009). Dot-probe methodology is unable to examine temporal processes involved in social anxiety, and eye movements are not sensitive to covert shifts in attention. Event-related potentials (ERP) are high temporal resolution methods which reveal covert and overt attentional processes. ERPs have been widely used to examine processing of emotional faces in social anxiety. ERP studies of emotional face expressions have revealed

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increased amplitudes of early ERP components suggesting an early attentional bias of threat-related emotional faces (Ashley, Vuillemier, & Swick, 2004; Eimer & Holmes, 2002; Williams, Palmer, Liddell, Song, & Gordon, 2006) and emotional facial expressions have been found to modulate later cortical processing (300–900 ms) suggesting later emotional elaboration processes (Eimer & Holmes, 2002; Schupp, Junghofer, Weike, & Hamm, 2004; Williams et al., 2006).

ERP studies in both clinical social anxiety groups and nonclinical participants with high trait social anxiety have consistently reported increased P1 amplitudes over temporal-occipital regions to facial expressions (Kolassa & Miltner, 2006; Muhlberger, Wieser, Hermann, Weyer, Troger, & Pauli, 2009; Peschard Philipott, Joassin, & Rossignol, 2013; Rossignol et al., 2012; Rossignol, Campanella, Bissot, & Philipott., 2013; Wieser, Pauli, Riecherts, & Muhlberger, 2010). Interestingly, most studies report a generalized increase in P1 amplitude to all facial expressions in social anxiety rather than a specific increase to socially threatening expressions (Peschard et al., 2013; Rossignol et al., 2012; Rossignol et al., 2013; Wieser et al., 2010). P1 amplitude is generated in extrastriate visual cortex (Allison, Puce, Spencer, & McCarthy, 1999), and is thought to reflect increased automatic visual and initial attentional processing. Some studies have reported increased P1 amplitudes to non-social control tasks, suggesting this elevated P1 amplitude in social anxiety reflects a generalized enhancement of visual attentional processing to all stimuli, not just social stimuli (Peschard et al., 2013).

ERP studies have typically reported inconsistent findings in relation to later emotional processing and social anxiety. N170 at temporo-occipital sites is a face-processing waveform that reflects structural encoding of facial configurations (Eimer, 2000). Some studies have reported increased N170 amplitudes to fearful and angry faces in patients with social anxiety compared to spider phobics (Kolassa & Miltner, 2006) or controls (Wieser et al., 2010), but others conducted in non-clinical groups with high trait social anxietyhave found no differences in N170 amplitudes (Kolassa et al., 2009; Mühlberger et al., 2009; Peschard et al., 2013; Rossignol, Anselme, Vermeulen, Philipot, & Campanella, 2007; Rossignol et al., 2012). This may suggest that subclinical levels of social anxiety do not impact on cortical processing associated with structural face encoding (Peschard et al., 2013).

Other ERP studies have examined the P2 component at parietal sites, which reflects sustained perceptual processing (Schupp et al., 2004) and activation and direction of further attentional processing (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007). These studies reveal further inconsistencies, with some studies reporting increased P2 amplitude to all faces (Rossignol et al., 2012), others reporting a specific increase in P2 amplitude to social threat faces (Rossignol et al., 2013; Van Peer, Spinhoven, & Roelofs, 2010) and others failing to find an effect of social anxiety on P2 (Kolassa & Miltner, 2006; Kolassa et al., 2009). Social anxiety is characterized by fear of negative evaluation, thus examining face processing in studies which have classified social anxiety groups according to fear of negative evaluation is of particular importance. In this light, ERP studies classifying groups according to brief fear of negative evaluation have reported increased general P1 and increased P2 specifically to social threat (Rossignol et al., 2013).

Finally, some ERP studies have examined late parietal components P3 or the late positive potential (LPP) thought to reflect longer term emotional evaluation processes. Whilst some studies reported increased amplitudes of the late positive potential (LPP: Moser, Huppert, Duval, & Simon, 2008; Mühlberger et al., 2009), others have reported no differences in LPP amplitudes (Rossignol et al., 2007; Wieser et al., 2010). Interestingly, a recent study manipulated the context (negative self-relevant, positive self-relevant) with a verbal cue prior to exposure to a neutral facial expression and found that individuals with high social anxiety had greater LPP amplitudes to neutral images following a negative self-relevant context, whereas individuals with low social anxiety displayed greater LPP amplitude following a positive self-relevant context cue (Wieser & Moscovitch, 2015). Therefore, it remains unclear whether there is a specific increase to negative, socially-relevant stimuli in later components (P3/LPP) in high social anxiety. These inconsistencies may relate to methodological variations, as several tasks employed additional cognitive processes (flanker task: Moser et al., 2008); or employed blended angry and disgust facial expressions (Rossignol et al., 2007). ERP studies employing passive viewing tasks (without additional cognitive processes) and employing a range of emotional facial expressions are required to further investigate this issue.

A recent study utilized steady state visual evoked potentials (ssVEP) to assess whether individual with social anxiety had greater sustained visual processing over several seconds following viewing face stimuli (McTeague, Shumen, Wieser, Lang, & Keil, 2011). This study found that individuals with high social anxiety had greater ssVEPs which were generated predominantly from medial occipital cortex and bilateral occipital poles (McTeague et al., 2011). This effect was generalized, with greater ssVEPS found to all facial emotion expressions across a 3500 ms time-window.

To date, the most consistent finding in social anxiety is of greater initial hypervigilance indexed by P1 over occipital regions, which appears generalized to all facial expressions. Recent attentional network theory proposes that key attentional networks exist in frontal and parietal cortical regions (Petersen & Posner, 2012), and that frontal eye field regions are specifically involved in the initial orienting of attention (Petersen & Posner, 2012), thus it is important to examine whether there is generalized early hypervigilance in these frontal networks in social anxiety. The current study will compare high and low social anxiety groups on the N1component, which reflects early automatic orienting and selective attention in frontal cortical regions. Further, extending the work of McTeague et al. (2011) who found evidence of sustained longer-term cortical processing of faces localized to occipital and extrastriate visual regions, the current study will examine whether there is evidence of sustained attentional processing in parietal attention networks by comparing high and low social anxiety groups on consecutive ERP components (P2, P3 and LPP) at parietal sites. It is unclear whether these later components will reflect a specific increase to social threat stimuli, therefore this study will compare ERP responses to angry, fearful, happy and neutral facial expressions.

Therefore, the aim of this study is to examine the impact of trait social anxiety on early and late ERP components to facial emotion expressions (Angry, Disgust, Happy, Neutral). In accordance with previous literature, it is predicted that the high social anxiety group (HSA) will display an early attention bias towards all emotional faces, reflected in increased N1 amplitude compared to the low social anxiety (LSA) group. If the cognitive model is correct, it is predicted there will be increased P2, P3 and LPP amplitudes to angry and disgust faces in the HSA compared to LSA group, but if the vigilance-avoidance model is correct, it is predicted there will be significantly lower LPP and P3 amplitudes to angry and disgust faces in the HSA compared to LSA group.

2. Methods

2.1. Participants

Forty female psychology undergraduate students with normal or corrected to normal vision were recruited for the study in return for course credit. Given noted sex differences in emotional ERP responses (Gardener, Carr, Macgregor, & Felmingham, 2013; Lithari