Hyperscanning and avoidance in social anxiety disorder: The visual scanpath during public speaking

Nigel Teik Ming Chen [a,b], Laurenn Maree Thomas [c], Patrick Joseph Fraser Clarke [b], Ian Bernard Hickie [a], Adam John Guastella [a,*]

[a] Brain & Mind Research Institute, University of Sydney, 100 Mallett St, Camperdown, NSW 2050, Australia
[b] Centre for the Advancement of Research on Emotion, School of Psychology, University of Western Australia, 35 Stirling Hwy, Crawley, WA 6009, Australia
[c] School of Social Sciences and Psychology, University of Western Sydney, Locked Bag 1797, Penrith, NSW 2751, Australia

ARTICLE INFO

ABSTRACT

Social anxiety disorder (SAD) is a debilitating mental illness which is thought to be maintained in part by the aberrant attentional processing of socially relevant information. Critically however, research has not assessed whether such aberrant attentional processing occurs during social-evaluative contexts characteristically feared in SAD. The current study presents a novel approach for the assessment of the visuocognitive biases operating in SAD during a social-evaluative stressor. For this task, clinically socially anxious participants and controls were required to give a brief impromptu speech in front of a pre-recorded audience who intermittently displayed socially positive or threatening gestures. Participant gaze at the audience display was recorded throughout the speech. Socially anxious participants exhibited a significantly longer visual scanpath, relative to controls. In addition, socially anxious participants spent relatively longer time fixating at the non-social regions in between and around the confederates. The findings of the present study suggest that SAD is associated with hyperscanning and the attentional avoidance of social stimuli.

© 2014 Elsevier Ireland Ltd. All rights reserved.

1. Introduction

Social anxiety disorder (SAD) is a relatively common and debilitating psychiatric disorder characterized by an excessive fear of negative social evaluation, with an estimated lifetime prevalence of 12.1% (Kessler et al., 2005). Cognitive accounts suggest that SAD is maintained by biases in information processing (Williams et al., 1997; Mogg and Bradley, 1998). It has been suggested that the fear of negative evaluation in SAD may be reflected in an excessive vigilance for threat cues in the environment which may confirm such a fear (Beck et al., 1985; Beck and Clark, 1997). While a large body of research has confirmed that social anxiety is associated with an attentional bias to threat (cf. Bar-Haim et al., 2007), several studies have also observed that socially anxious individuals may avoid such information (Mansell et al., 1999; Chen et al., 2002; Stirling et al., 2006). A two-stage vigilance–avoidance model of attentional bias has been proposed to integrate these findings (Mogg et al., 1997; Amir et al., 1998). According to this model, socially anxious individuals are posited to be initially vigilant for threat, but subsequently avoid such information in an attempt to alleviate anxious symptoms.

Previous attentional bias research has typically employed reaction time based assessments, such as the dot probe task (MacLeod et al., 1986). In a typical task, threat–neutral stimulus pairs are briefly presented, and then replaced by a probe appearing in the location vacated by one of the two stimuli. Socially anxious individuals have been found to be faster to respond to probes appearing in threat, relative to neutral, locations, which is taken to reflect an attentional bias to threat (Asmundson and Stein, 1994; Musa et al., 2003).

While such reaction time based tasks have been useful in establishing the presence of attentional bias in SAD, they offer limited flexibility in the assessment of the more dynamic patterns of attention. Gaze-based measures of attentional bias have been increasingly utilized, as eye tracking may provide a relatively direct measure of visual attention in real time (Duchowski, 2002). While probe tasks typically index biases in covert attention, eye tracking provides a measure of foveal vision, providing an assessment of biases in overt attention (Armstrong and Olatunji, 2012). Recent attentional bias research, incorporating gaze-based measures, has demonstrated that anxious individuals have a greater propensity, or are faster, to initially orient gaze towards threat stimuli (Mogg et al., 2000; Calvo and Avero, 2005; Garner et al., 2006; Armstrong and Olatunji, 2012),

---

consistent with the notion that social anxiety is associated with an attentional bias to threat.

Previous studies have additionally assessed the total fixation time towards socially relevant stimuli in order to examine the preferences in selective attention over time. Clinically socially anxious individuals, in comparison to controls, have shown reduced total fixation time to emotional social stimuli (Chen et al., 2012; Weeks et al., 2013). Anxious non-clinical individuals have exhibited similar total fixation time reductions towards threat (Rohner, 2002; Calvo and Avero, 2005). The findings suggest that SAD may be associated with the attentional avoidance of emotional social stimuli, when considering the overall attentional preference for a given period of stimulus presentation.

While the aforementioned research demonstrates the biased attentional processing with regard to emotional stimuli, it is further possible that SAD may be associated with a general aberration of the visual scanpath. The visual scanpath is the trace of eye movements made while viewing a complex stimulus, and consists of a sequence of fixations and saccades. While several processes influence the visual scanpath, it may essentially be taken to reflect the manner in which information is attended to, reappraised and integrated (Toh et al., 2011). Hyperscanning for instance, which is the extensive and potentially excessive monitoring of visual information in the environment, has been suggested to reflect a vigilant strategy (Green et al., 2003; Horley et al., 2003). In terms of fixations and saccades, hyperscanning may be reflected by saccades of greater amplitude, and attenuated fixations with regard to duration and quantity, which subsequently may result in a longer scanpath length. Consistent with this notion, clinically socially anxious individuals, in comparison to controls, have exhibited longer scanpaths and reduced fixation duration while viewing emotional faces (Horley et al., 2003, 2004). Similarly, the scanning of threatening faces has been associated with a greater mean spatial distance between consecutive fixations (Green et al., 2003).

While existing research has incorporated gaze-based measures in order to assess the biased attentional processes in SAD, minimal research has been conducted to assess whether attentional avoidance and hyperscanning operate in SAD during conditions of social-evaluative stress. Given that such conditions are characteristically feared in SAD, it is imperative to ascertain whether the attentional biases observed during controlled laboratory experiments indeed occur during practically relevant social-evaluative tasks. The speech task has commonly been used in social anxiety research, as it necessitates social performance and exposes the participant to potential negative social evaluation. Socially anxious individuals have been found to give negative self-appraisals of their speech performance, experience heightened distress, and also exhibit greater startle reactivity in response to the speech task (Rapee and Lim, 1992; Cornwell et al., 2006, 2011). We have recently shown that the implementation of eye tracking during a speech task may yield crucial insights into the attentional processes which occur during conditions of social-evaluative stress (Alvares et al., 2012; Lowe et al., 2012). In this task, broadly referred to as the Sydney Eye Movement and Speech Assessment (SEMSA), participants give a brief speech in front of a pre-recorded audience of confederates, who intermittently display positive and threatening social gestures, while eye gaze is recorded. The audience display presented during the SEMSA may provide a useful socially relevant stimulus to examine visual attention. However, this assessment has yet to be applied to SAD-related attentional anomaly.

Hence, the present study sought to determine whether aberrant attentional processing is associated with SAD while processing dynamic social information during a practically relevant task. In light of previous research, it was predicted that clinically socially anxious individuals, relative to controls, would exhibit hyperscanning of the audience display, indicated by an increased scan length during the speech. To further examine the component factors which contribute to the visual scanpath, we additionally considered the

mean distance between consecutive fixations (MDBF), total fixation count and the mean fixation duration. It was anticipated that if SAD was associated with a longer scan length, such hyperscanning may further be associated with a greater MDBF, reduced total fixation count, or shortened mean fixation duration. We additionally assessed the relative distribution of attention towards the audience display. If SAD is associated with the avoidance of sustaining attention towards social stimuli throughout the speech, reduced total fixation time toward social display regions and greater total fixation time at the remaining non-social regions of the audience display are expected.

2. Method

2.1. Participants

Clinical participants were initially recruited from the Brain & Mind Research Institute, as part of a cognitive behavioural group therapy programme. In order to control for potential age-related influences on visual scanning (e.g. Sullivan et al., 2007), participants aged 35 years and under were selected for the present study. Twenty-two clinical participants (seven females) were included. All clinical participants met DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria for SAD, based on the Anxiety Disorder Interview Schedule for Adults (ADIS-IV; Brown et al., 1994). Exclusion criteria included a primary diagnosis of a psychotic disorder, current suicidal ideation, or comorbid Axis II disorders. Clinical participants were not excluded based on Axis I comorbidity ($n = 11$), as this is typical of community-based clinical samples (Kroenke et al., 2007; Clarke et al., 2012a, 2012b). 35.29% met criteria for another anxiety disorder, 29.41% with a mood disorder, and 5.88% with a substance dependence disorder. 47.06% were currently taking between one and three psychotropic medications (combinations of antidepressants, antipsychotics, and mood stabilizer medications). 64.71% of the clinical participants had either completed or were currently engaged in tertiary level education, 23.53% had completed secondary education, and 11.76% did not provide education information. Nineteen (eight females) control participants were recruited from the University of Sydney. Controls were included if they did not report a history of mental illness, and were reimbursed $20 for their time. Mean participant age was 24.49 (S.D.=4.24). All participants had correct or corrected-to-normal vision.

All participants provided informed written consent, and were fully debriefed following the experiment. Data collected from participants were de-identified. This research was conducted in accordance with the principles expressed in the Declaration of Helsinki, and ethical approval was granted by the Human Research Ethics Committee, University of Sydney.

2.2. Materials

2.2.1. Questionnaire measures

Participants were administered the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987) to assess social anxiety symptoms. The LSAS yields four subscales reflecting an individual's fear and avoidance across performance situations and social interactions. A global social anxiety score may further be obtained by summing the four subscales. Participants additionally completed the Depression Anxiety Stress Scale (DASS-21; Lovibond and Lovibond, 1995) to provide a further measure of depression, anxiety and stress, rated their subjective distress on a 100-point Subjective Units of Distress Scale (SUDS) immediately before and after their speech.

2.2.2. Audience display

The audience display was presented on a large 152 cm 16:9 plasma television, and consisted of 16 individually filmed confederates, presented in a four by four array, illustrated in Fig. 1. The 16 array cells were presented in front of a black background. Each cell contained one centred confederate face presented in colour, surrounded by a light grey backdrop. Each cell measured 23.3 cm by 17.5 cm. Each confederate occupied approximately 35% of their respective cell. The edges of adjacent cells were separated horizontally by 2.8 cm and vertically by 1.9 cm. The centres of adjacent faces were separated horizontally by 26.1 cm and vertically by 19.4 cm, subtending at 6.0° and 4.5° visual angle (VA) respectively.

The audience consisted of eight male and eight female confederates. Four confederates displayed positive social gestures, four confederates displayed threatening social gestures, and eight confederates remained neutral. Positive social gestures included a smile, a smile with a nod, or a serious nod in agreement. Threatening social gestures included a disgust expression, a disagreeing shake of the head, or a sigh of boredom. Arrangement of the emotional confederates was partially derived from a Latin square design, such that one positive and one threat confederate was presented on each row and on each column of the array. Positive, threat and neutral confederates were balanced for gender. Additionally, two counter-balanced versions of the audience display were created, in which emotional confederates were switched for valence across versions. The initial 50 s of presentation consisted of all confederates displaying