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Social anxiety and threat-related interpretation of dynamic facial expressions: Sensitivity and response bias

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ABSTRACT

Facial expressions can convey disapproval or rejection, which is highly relevant information for socially anxious observers. We investigated how social anxiety biases the interpretation of ambiguous expressions towards threat. Undergraduates with clinical levels of social anxiety and non-anxious controls were presented with 1-s video-clips displaying facial happiness, anger, fear, sadness, disgust, and surprise, at various levels of emotional intensity, or neutral expressions. Participants categorized the expressions. Social anxiety was associated with enhanced detection of anger and disgust at low intensity levels, relative to non-anxious controls. Also, social anxiety was related to a higher probability of interpreting emotionally "neutral" faces as angry. *A′* sensitivity was affected, with no effects on *B″* response criterion. Socially anxious individuals are likely to perceive hostility, disapproval, or dislike in ambiguous facial expressions (with low intensity signals of anger/disgust, or "neutrality"). The effect involves an interpretative bias that occurs during expression encoding and is not contaminated by response biases.

1. Introduction

The core feature of social anxiety and social phobia is a persistent and excessive fear of being evaluated by other people, and the avoidance of situations involving scrutiny and possible negative evaluation (American Psychiatric Association, 2013). Such symptoms have been attributed to biased threat-related interpretations of ambiguous social cues (Heimberg, Brozovich, & Rapee, 2014; Hofmann, 2007). Socially anxious individuals would be prone to judge social stimuli as threatening, which would maintain and increase social fear and avoidance. There is indeed evidence that descriptions of ambiguous social scenarios are interpreted by socially anxious individuals in a more negative, or a less positive, manner than by non-anxious ones (see Mobini, Reynolds, & Mackintosh, 2013; Morrison & Heimberg, 2013).

In social interaction, facial expressions are a major source of information about the feelings and intentions of other people, such as the liking and approval expressed by happy faces or the hostility and disapproval of angry faces. Accordingly, given the nature of social anxiety, and that facial expressions in social settings are frequently ambiguous (Calvo, Gutiérrez-García, Fernández-Martín, & Nummenmaa, 2014; Krumhuber & Scherer, 2011), we can predict—and aim to investigate—that (a) social anxiety will bias interpretative processes by facilitating the recognition of threat-related expressions that convey hostility and rejection, i.e., anger and disgust, (b) differences between socially anxious and non-anxious individuals will appear especially for low expressive intensities, when expressions become more ambiguous, and (c) social anxiety will be related to a higher probability of threat-related interpretations of "neutral" (not explicitly emotional) faces.

Prior research has, however, yielded inconsistent findings (see Morrison & Heimberg, 2013; Staugaard, 2010). Social anxiety is not generally associated with explicit recognition performance in/accuracy for basic and prototypical expressions (e.g., anger, sadness, etc.), and there is only limited evidence that socially anxious individuals tend to interpret ambiguous—morphed or blended—expressions in a more negative way (as angry: Bell et al., 2011; Yoon, Yang, Chong, & Oh, 2014; or contemptuous: Heuer, Lange, Isaac, Rinck, & Becker, 2010) or in a less benign fashion (as less happy: Gutiérrez-García & Calvo, 2014), relative to non-anxious individuals. But, even for ambiguous expressions, there have been failures to find any difference as a function of social anxiety (Button, Lewis, Penton-Voak, & Munafò, 2013) and social phobia (Jusyte & Schönenberg, 2014).

We aim to extend prior research by increasing the ecological validity of stimuli and sensitivity of measures. First, in most prior studies, photographic faces with static expressions were presented. Yet, facial behavior in daily life is typically dynamic. Two studies have used a task that approximates the dynamic nature of facial expressions in the real world, by displaying morphed faces that unfolded gradually from neutral to full emotion. Joormann and Gotlib (2006) reported that

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individuals with social phobia needed less expression unfolding to identify anger than depressed or healthy controls did. Heuer et al. (2010) found that socially anxious individuals misinterpreted disgust as contempt (an emotion related to social rejection). Dynamic displays may thus be appropriate for investigating interpretative bias. In line with this approach, we used dynamic morphing, but tried to mimic natural movement more closely (see Hoffmann, Traue, Bachmayr, & Kessler, 2010). Instead of morphing a face from neutral to emotional at a rate of 500 ms (Joormann & Gotlib, 2006) or 1 s (Heuer et al., 2010) per frame, we used a 30-frame per s unfolding rate.

Second, in prior studies, recognition performance was generally measured only in terms of "correct" responses. Instead, two recent studies (Langner, Becker, Rinck, & van Knippenberg, 2015; Yoon et al., 2014) applied Signal Detection Theory (SDT) to obtain discrimination measures, and separate perceptual sensitivity from response criterion. This serves to determine whether anxious individuals are better at detecting threat in truly threat-related expressions (high sensitivity to anger), or they are simply more likely to respond that all faces look threatening, regardless of the actual emotion (a more lenient response criterion for anger). Yoon et al. (2014) reported that social anxiety was related to both greater sensitivity to mild angry expressions and a response bias towards labelling other expressions as angry, but Langner et al. (2015) found no effects, thus results were discrepant. It must, nevertheless, be noted that a limited number of expressions were investigated (neutral, angry, and happy: Yoon et al., 2014; or neutral and angry: Langner et al., 2015), which were presented in static format. We extended this approach by applying SDT measures to all six basic emotions (angry, fearful, sad, disgusted, surprised, and fearful) in dynamic format.

Given that dynamic (relative to static) displays are beneficial for facial affect identification particularly for subtle expressions (Krumhuber, Kappas, & Manstead, 2013), we reduced their intensity (see Bell et al., 2011; Button et al., 2013). In addition to the 0% neutral face baseline, we generated dynamic morphs of facial emotions with intensities of 25%, 50%, and 75% (relative to each 100% full-blown emotion). In a categorization task, 1-s video-clips were presented, and participants selected one of six response options (the six basic emotions). In addition to hits and false alarms, indices of A' sensitivity and B'' response criterion were computed, as well as type of emotional confusions from neutral faces. If there is a threat-related interpretative bias in social anxiety during expression encoding, social anxiety should be associated with (a) high A' scores for expressions conveying hostility and rejection, i.e., anger and disgust, (b) low recognition thresholds, i.e., at low expressive intensities, and (c) a high probability of confusions of neutral faces as angry or disgusted. If the tendency to endorse negative interpretations occurs for all expressions or the B'' criterion is affected, then a response—rather than a genuine encoding—bias will be involved.

2. Methods

2.1. Participants and social anxiety measures

Forty-eight psychology undergraduates (mean age: 21.6 years; range: 19–25) took part in the experiment after informed consent. They were selected from a pool of 213 students on the basis of their convergent high or low scores on the Social Interaction Anxiety Scale (SIAS) and the Social Phobia Scale (SPS; Mattick & Clarke, 1998; see Gomez, 2016, for short forms of these scales). The used Spanish versions have been validated in large undergraduate samples (Olivares, García-López, & Hidalgo, 2001). Each questionnaire is a 20-item measure with a Likert-type scale ranging from 0 (not at all characteristic of me) to 4 (extremely characteristic). Sample items: "I have difficulty making eye-contact with others" (SIAS); or "I can get tense when I speak in front of other people" (SPS). These scales were administered in various classrooms to groups of students, with anonymous codes.

Twenty-four participants (16 female) with the highest (SIAS: $M = 47.79$; $SD = 8.56$; SPS: $M = 33.54$; $SD = 6.65$) scores, and another 24 (16 female) with the lowest scores (SIAS: $M = 13.67$; $SD = 3.41$; SPS: $M = 10.83$; $SD = 3.07$), were selected for the experiment. For the social anxiety group, we used the following clinical cut-off scores: ≥34 on the SIAS and ≥24 on the SPS (see Brown et al., 1997; Jusyte & Schönenberg, 2014; Weeks et al., 2005). The anxious and the non-anxious groups had the same female/male proportion and age. The study was approved by the local ethics committee and was conducted in accordance with the Declaration of Helsinki.

2.2. Facial expression stimuli

We used 1-s video-clips as stimuli (see Supplemental materials). To build them, we first selected digitized color photographs of prototypical neutral, happy, angry, fearful, sad, disgusted, and surprised faces of 24 posers (12 females; 12 males) from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist, Flykt, & Öhman, 1998; Calvo & Lundqvist, 2008).

Second, these face stimuli were subjected to morphing by means of FantaMorph© software (Abrosoft). For each expression of each poser, we created a sequence of 100 frames progressively increasing emotional intensity, based on two images: a neutral face as the first frame, and a full-blown emotional face (happy, etc.) as the final frame. We then selected frames no. 1 (neutral), 25, 50, and 75, which represented, respectively, the 0, 25, 50, and 75% intensities. The full-blown, 100% intensity level was not used because prior research has generally shown no recognition differences as a function of social anxiety for prototypical expressions (Staugaard, 2010). Fig. 1 shows examples of the different intensity levels.

Third, dynamic versions of these expressions were created with FantaMorph©. Video-clips involved a smooth continuum between the neutral and each emotional expression at 30 frames per second. Facial expressions unfolded until the corresponding maximal target intensity (i.e., 25, 50, or 75%). The unfolding sequence developed for 900 ms after stimulus onset, and the last frame was frozen for 100 ms. This morphing rate was used to simulate natural average unfolding speed of emotional facial expressions (Hoffmann et al., 2010). In the 0% intensity condition, a still image of a neutral face was displayed for 1 s.

2.3. Procedure

Each participant was presented with 144 video-clips of emotional expressions (24 models × 6 emotions × 1 intensity level for each emotion) plus 24 photographs of neutral expressions (i.e., the 0% intensity condition). To avoid habituation, a participant was presented with each poser only once displaying each of the six emotions, each time with a different intensity. The face stimuli were shown on a computer screen in three blocks, by means of E-Prime 2.0. Trial order was randomized. Participants were asked to indicate which emotion was displayed on each trial by pressing one key out of six. The six basic emotional expressions were explicitly identified in advance. Participants were informed that some faces displayed low-intensity emotions, but not that some of them were neutral. This way, we forced observers to detect subtle expressions—which was particularly relevant for the low-intensity and the neutral conditions—and thus bias their interpretation.

The sequence of events on each trial is shown in Fig. 2. After an initial 500-ms fixation cross, a photograph of a neutral expression appeared for 1 s or a video-clip unfolded for 900 ms plus a 100-ms still final frame. The face subtended 10.5 (height) × 8.0 (width) cm. Following the face offset, there was a 300-ms blank interval before a response screen appeared, with six boxes shown horizontally. Each box was associated to a number and a verbal label (e.g., 4: disgust; 5: happiness, etc.). The assignment of emotions to numbers/locations was counterbalanced