"Fear guides the eyes of the beholder": Assessing gaze avoidance in social anxiety disorder via covert eye tracking of dynamic social stimuli[★]

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ABSTRACT

Gaze avoidance is an important feature of social anxiety disorder (SAD) and may serve as a biobehavioral marker of SAD. The purpose of the present study was to replicate and extend findings on gaze avoidance in SAD via eye tracking during a computerized social simulation. Patients with SAD ($n = 27$) and a (sub)sample of demographically-matched healthy controls (HC; $n = 22$) completed a computerized, dynamic social simulation task involving video clips of actors giving positive and negative social feedback to the participant. All participants were unknowingly eye tracked during the simulation, and post-study consent was obtained to examine responses. Consistent with the *bivalent fear of evaluation (BFOE) model* of social anxiety, fear of positive evaluation related systematically to state anxiety in response to positive social feedback, and fear of negative evaluation related systematically to state anxiety in response to negative social feedback. Moreover, compared to HCs, SAD patients exhibited significantly greater global gaze avoidance in response to both the positive and negative video clips. Our results provide strong additional support for gaze avoidance as a biobehavioral marker of SAD, as well as additional support for the BFOE model. Implications for the assessment and treatment of SAD are discussed.

1. Introduction

Social anxiety disorder (SAD; social phobia) is characterized by excessive fear of social or performance situations and is the fourth most common mental disorder, with an estimated lifetime prevalence rate of 12.1% (Kessler et al., 2005). Patients seeking treatment for SAD report impairment across numerous life domains (Schneier et al., 1994; Stein, McQuaid, Laffaye, & McCahill, 1999). Moreover, SAD is highly comorbid with other debilitating disorders, including depression and substance use disorders (Kessler, Stang, Wittchen, Stein, & Walters, 1999; Schneier et al., 1994).

The link between social anxiety-related symptoms (e.g., fears of evaluation) and submissive behaviors in general has been supported by a number of studies (e.g., see Galili, Amir, & Gilboa-Schechtman, 2013; Gilboa-Schechtman, Galili, Sahar, & Amir, 2014; Weeks, Heimberg, & Heuer, 2011; Weeks, Rodebaugh, Heimberg, Norton, & Jakatdar, 2009).

Eye gaze in particular is considered a threat signal in humans and animals (e.g., see Ellsworth, Carlsmith, & Hensen, 1972; Gilbert, 2001). In parallel, gaze *avoidance* serves as a submissive signal (Gilbert, 2001; Horley, Williams, Gonsalvez, & Gordon, 2004) in that avoiding gaze signals one's lower social status and sense of threat. Similar to non-human primates (de Waal, 1988), humans can appease others with submissive nonverbal displays which include eye gaze avoidance (Ellyson & Dovidio, 1985; Kaminer & Stein, 2005).

Eye tracking is an objective measure that can be used to determine the direction of an individual's gaze in real time. Previous studies have utilized eye tracking to examine "eye contact" tendencies of socially anxious individuals with experimental stimuli, and results have highlighted gaze avoidance as a biobehavioral indicator of SAD. For example, a model which has informed eye tracking research with respect to social anxiety (Weeks, Howell, & Goldin, 2013) is the *bivalent fear of evaluation* (BFOE) model (Weeks & Howell, 2012, 2014). According to

the BFOE model, fear of evaluation in general, including fear of positive evaluation (FPE) as well as fear of negative evaluation (FNE), is important in social anxiety (e.g., see Weeks, Heimberg, & Rodebaugh, 2008). FPE consists of dread that others may evaluate one positively—resulting in increased attention and potential reprisal from perceived socially dominant others (see Reichenberger & Blechert, 2018, for a review). In contrast, FNE pertains to the sense of dread associated with being evaluated unfavorably, and social anxiety pertains to affective reactions to social situations. FPE, FNE, and social anxiety have all been shown to relate strongly and positively to one another. Moreover, FPE and FNE account for unique variance in social anxiety symptom severity (e.g., see Fergus et al., 2009; Weeks, Heimberg, Rodebaugh, 2008; Weeks, Heimberg, Rodebaugh, & Norton, 2008). Essentially, the BFOE model suggests that these two fears cause socially anxious individuals to feel compelled to be as inconspicuous as possible at all times within feared social situations (e.g., see Weeks & Howell, 2014).

1.1. Convergence between BFOE model and eye tracking findings

Given the focus of the present study upon *eye contact*, previous findings involving *attention to faces* in general (e.g., utilizing dot-probe tasks, or eye tracking pertaining to *faces in general* rather than eye regions specifically) are beyond the scope of this paper, and so will not be reviewed here. Given the above, and relevant to the foci of the BFOE model upon distinct valences of socio-evaluative cues, four studies have specifically examined social anxiety and gaze avoidance in response to positive and negative social stimuli (in contrast to either attention to faces in general or gaze tendencies in response to only neutral facial images). Two of these studies included treatment-seeking adults diagnosed with SAD and demographically-matched healthy controls who viewed still-images of happy, angry or sad, and/or neutral faces for a period 10 s (Horley, Williams, Gonsalvez, & Gordon, 2003, 2004). Convergent findings across the studies by Horley et al. (2003, 2004) showed that SAD patients exhibited fewer total fixations in the eye regions of the *negative* facial photographs in comparison to healthy control participants (Horley et al., 2003, 2004). In addition, consistent with the BFOE model, SAD symptom severity related negatively to both number of fixations and fixation duration in eye regions for happy facial images (Horley et al., 2004). Thus, patients with more severe social anxiety symptoms avoided gaze in response to positive as well as negative facial images.

Weeks et al. (2013) found that SAD patients (a mixed sample with regard to generalized and non-generalized subtypes, per *Diagnostic and Statistical Manual of Mental Disorders* criteria (American Psychiatric Association, 1994)) exhibited gaze avoidance in response to dynamic and emotionally valenced social stimuli *in general,* including both positive (e.g., happy, approving) and negative (e.g., angry, disapproving) stimuli. Furthermore, FPE was found to relate systematically to state anxiety in response to the positive social simulations, and FNE was found to relate systematically to state anxiety in response to the negative social simulations. Thus, in line with the above finding of Horley et al. (2004) that SAD symptom severity was associated with decreased gaze towards positive stimuli, the findings of Weeks et al. (2013) provided direct support for the premise that both positive and negative social cues are threatening to SAD patients (e.g., see Weeks, Jakatdar, & Heimberg, 2010). Moreover, these findings have been replicated in adolescents with SAD versus healthy controls when using static happy, neutral, and angry faces (Keil et al., 2018), in that adolescents with SAD held shorter first fixation durations in eye regions *across facial valences* in comparison to healthy controls. Thus, gaze avoidance may be a developmentally stable feature of fear of evaluation in SAD.

1.2. Present study

The goal of the present study was to replicate and extend findings on SAD-related gaze avoidance. Individuals who met criteria for a

principal diagnosis of SAD (generalized subtype, per DSM-IV criteria (APA, 1994)) and demographically-matched healthy control (HC) participants were asked to view twenty-six 12 s dynamic videos of actors delivering either positive (13 videos) or negative (13 videos) statements (concordant with emotional expressions), as if "to the participant". All participants were unknowingly eye tracked during the experiment (post-study consent was obtained to examine responses; see **Procedures**), and were asked to provide state anxiety ratings in response to each of the videos.

We tested four hypotheses. (**Hypothesis 1**) [1a] SAD patients would endorse elevated state anxiety relative to HCs in response to social interaction video stimuli involving receipt of [i] positive and [ii] negative feedback; [1b] state anxiety in response to the distinctly valenced social simulation task videos would relate positively to fear of the respective valence of evaluation (i.e., state anxiety experienced in response to positive videos would relate positively and uniquely to FPE, whereas responses to negative videos would relate positively and uniquely to FNE); (**Hypotheses 2-4**) with regard to gazing at the eyes of the actors in both the positive and negative social stimuli, SAD patients would exhibit increased gaze avoidance *overall* in comparison to the healthy controls, as indexed by [2] *total time* holding eye contact (i.e., gazing within designated eye regions); [3] total number of eye *fixations*; and [4] total *fixation durations*.

2. Methods

2.1. Participants

Participants were 27 SAD patients and 22 HCs who were demographically-matched to a subset ($n = 22$) of the SAD patients on age, sex, and racial/ethnic background. No eligible matched HCs were able to be recruited for 5 of the eligible SAD patients. These 5 unmatched SAD patients were retained to maximize the external validity of the obtained effects. When excluding the 5 unmatched SAD patients, results were substantively identical to results obtained from the full sample ($N = 49$).

Three participants who would have otherwise been viable for inclusion in the present study were excluded on an a priori basis (i.e., had these participants been retained, $N = 52$). Two of these participants exhibited response biases on the primary study self-report measures, suggesting invalid response sets.[4] The third of these participants was excluded because the eye tracking component of the study was unwittingly revealed to this participant prior to initiating the study procedures.

Participants were recruited via fliers posted throughout the community at large (see below for inclusionary/exclusionary criteria). All participants received $25 for their participation. Exclusion criteria included: qualifying for a principal or co-principal diagnosis of any anxiety disorder (other than SAD, in the case of the SAD patient group) or a mood disorder; qualifying for a diagnosis of any psychotic disorder or substance use disorder; or acute suicidal ideation. For HC participants, individuals were excluded if there was evidence of any Axis I disorder (APA, 1994). Furthermore, inclusionary criteria for the patient sample included a principal diagnosis of SAD of the generalized subtype (per DSM-IV criteria; APA, 1994). See Table 1 for demographics of the study sample.

The SAD and HC samples were statistically equivalent on the basis of sex, $\chi2 (1) = 0.02$, $p = .89$, age, $F (1, 47) = 3.58$, $p = .06$, and ethnicity, $\chi2 (3) = 1.79$, $p = .62$. Given that our SAD and HC samples were demographically-matched (and, even upon including 5

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[4] These participants ($n = 2$) provided the same response across straightforward and reverse-scored items for these measures, indicating an *acquiescent response set* [see, e.g., Weeks et al., 2005; Weeks, Heimberg, Rodebaugh, 2008, for additional details]).

Table 1
Descriptive statistics for social anxiety disorder patients and healthy control participants on demographic variables.

	SAD patients (55.1%; n = 27)				Healthy controls (44.9%; n = 22)			
	n	%	M	SD	n	%	M	SD
Sex								
Women	16	59.3			13	59.1		
Men	11	40.7			9	40.9		
Age			25.04	9.40			21.04	4.18
Ethnicity								
Caucasian	25	92.6			20	90.9		
Non- Caucasian	2	7.4			2	9.1		

Notes: SAD = social anxiety disorder; SAD patients and healthy controls were statistically equivalent on all demographic variables, all *ps* > .05.

unmatched SAD patients, demographically-equivalent), these sub-samples were pooled for relevant analyses to prevent range restriction.

The majority of participants in the overall study sample were women (59.2%), with a mean age of 23.21 years (SD = 7.70). The majority of participants in the overall study sample were Caucasian (87.8%); 6.0% were Hispanic/Latino; 3.1% were African American; and 3.1% were Native Hawaiian/Pacific Islander.

2.2. Measures

All participants completed the following measures:

2.2.1. Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV-L; DiNardo, Brown, & Barlow, 1994)

The ADIS-IV-L provides probes and questions that assist in assigning DSM-IV diagnoses for a subset of psychiatric disorders. All participants in the present study completed the full ADIS-IV-L. All interviewers in the present study satisfied training criteria outlined by Brown, DiNardo, Lehman, and Campbell (2001). The ADIS-IV-L exhibits strong reliability for the assessment of SAD (Brown et al., 2001). Furthermore, in order to assess the inter-rater reliability of the ADIS-IV-L within the present study, 22.2% of the interviews of the SAD patients were reviewed by a second rater (who had satisfied ADIS-IV-L training criteria); the raters derived independent diagnoses, and 100% agreement with the original principal diagnosis of SAD was obtained (K = 1.0).

2.2.2. Fear of Positive Evaluation Scale (FPES; Weeks, Heimberg, Rodebaugh, 2008)

The 10-item FPES uses a 10-point Likert-type rating scale, ranging from 0 (*not at all true*) to 9 (*very true*). The FPES has demonstrated strong reliability, construct validity, and factorial validity in both undergraduate (Weeks, Heimberg, Rodebaugh, 2008) and clinical (Fergus et al., 2009; Weeks, Heimberg, Rodebaugh, Goldin, & Gross, 2012) samples. The FPES demonstrated good internal consistency in the present sample (α = .87).

2.2.3. Brief Fear of Negative Evaluation Scale-Straightforward Items (BFNE-S: Rodebaugh et al., 2004; Weeks et al., 2005)

The BFNE (Leary, 1983) is a 12-item self-report measure of fear and distress related to negative evaluation from others. Consistent with recommendations by Rodebaugh et al. and Weeks et al., we utilized only the 8 straightforward (-S) BFNE items to calculate the total score. The BFNE-S has demonstrated excellent internal consistency (all α's > .92), factorial validity, and construct validity in undergraduate (Rodebaugh et al., 2004) and clinical (Weeks et al., 2005) samples. The BFNE-S demonstrated excellent internal consistency in the present sample (α = .97).

2.2.4. State social anxiety ratings

Participants reported their state anxiety on a 100-point Subjective Units of Discomfort Scale (SUDS) in response to each video stimulus.

3. Procedures

All potential participants were recruited via fliers posted throughout the community at large surrounding Ohio University. Interested callers were administered screening questions for anxiety and mood disorders and the Mini-Social Phobia Inventory (Mini-SPIN; Connor, Kobak, Churchill, Katzelnick, & Davidson, 2001) over the telephone. The Mini-SPIN yields an empirically-replicated cutoff score indicating probable diagnosis of SAD (Connor et al., 2001; Weeks, Spokas, & Heimberg, 2007). Potential SAD participants who exceeded the cutoff score on the Mini-SPIN and who rated SAD symptoms as their primary psychological concern were invited to complete the proposed study. Healthy control participants were recruited in a separate, concurrent wave. Specifically, HC participants: did not exceed the cutoff score on the Mini-SPIN, responded negatively to screening questions pertaining to any current Axis I disorders (APA, 1994), and were demographically-matched (on the basis of age, sex, and racial/ethnic background) to the recruited SAD patients.

Following completion of all study procedures, participants completed an exit interview in which awareness of the eye tracking procedures was formally assessed (95.9% of participants were unaware that eye tracking had occurred; see **Preliminary Considerations and Analyses** section for additional details). Participants were then debriefed, the rationale for the study and the element of deception (i.e., that eye tracking was conducted without participants' advanced knowledge) were explained, and post-study consent to analyze the participants' eye tracking data was obtained.

4. Eye tracking system

All participants were eye tracked using a D6 high-speed eye tracking system (spatial error between actual gaze position and computed gaze position < 1°; 120 Hz sampling rate; Applied Science Laboratories, 2008). The D6 system is equipped with a *head tracker*, which obviates the need for a chin-strap/head gear. Participants were seated in a chair located in front of the display monitor, such that their eyes were located a standardized 24 in. from the monitor (i.e., the optimal distance for maximizing accuracy of the D6 system; ASL, 2008).

Eye tracking data were analyzed using a variety of indices to operationalize "eye contact" (i.e., degree of eye gaze): (a) *total amount of time that "eye contact" was held* with actors in the experimental stimuli, including both fixed gaze and "scanning"; (b) number of *fixations* (i.e., gaze within a 1- degree visual angle for > 200 ms); and (c) *duration of fixations* (i.e., amount of time participants held eye contact consistently in any given instance; ASL, 2008).

5. Social Evaluation Task-Modified (SET-M; Weeks et al., 2013)

All participants were asked to view a series of 26 video clips, each 12 s in duration. Thirteen of the clips were designed to simulate the delivery of positive social feedback (e.g., *You're an interesting person*),
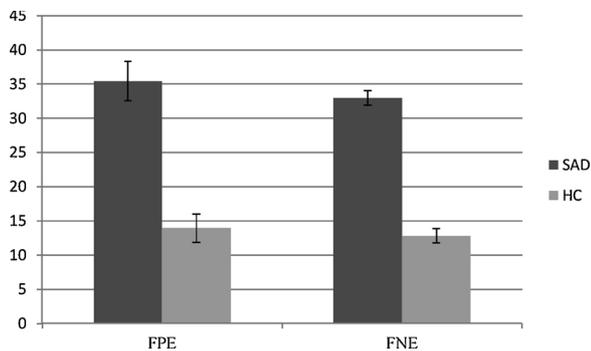
Fig. 1. Trait levels of fears of positive and negative evaluation, plotted separately for patients with social anxiety disorder and healthy control participants. *Notes:* SAD = social anxiety disorder; HC = healthy control participants; FPE = fear of positive evaluation; FNE = fear of negative evaluation. FPE and FNE values are not equivalent in scale.

with the remaining 13 clips designed to simulate the delivery of negative social feedback (e.g., *You're a boring person*). The order of the presentation of the videos as viewed by the participants was randomized. The SET-M represents a select subset of videos from the original SET, which was created for a related study (e.g., see Goldin et al., 2014). There were a total of 8 actors in the video clips (50% men; of varying ages [˜20 to ˜50 years of age] and racial/ethnic backgrounds), and each actor delivered positive and negative statements.

The SET-M videos were separated by black "buffer" slides, and immediately following each video, participants were asked for their state anxiety (i.e., SUDS ratings) in response to each video.

Prior to completing the SET-M task, the eye tracking system was calibrated for each participant using a 9-point calibration method. Regarding the fact that participants were eye tracked without their advanced knowledge in the present study, the calibration procedure was introduced to participants as a method for "orienting the attention of all participants to the screen in a standardized way". Eye tracking equipment was visible to participants, located below the display monitor in plain view. This equipment was not discussed with the participants in any way. Experiment coordinators read the below procedural script verbatim to every participant in order to provide a credible rationale for the calibration procedures which did not reveal that participants would be eye tracked.

> With studies like this one that involve perceptual processing, it has been found to be helpful to orient your visual attention in a very specific way, as this will prime the manner in which you attend to the videos we will be showing you. Specifically, I am going to present some dots on the screen and ask you to look at them in a specific order. This will orient you visually to the simulation, and prepare you for the task.

Moreover, in the event that satisfactory calibration data were not obtained on the first attempt, the calibration task was repeated, with experiment coordinators reading the below procedural script verbatim in order to provide a credible rationale for repeating the procedures.

> Okay, great. But, the number of times that we have each participant go through this priming task is randomly determined prior to the beginning of the study, so I'm going to ask you to repeat it. Are you ready?

Eye tracking did not commence until satisfactory calibration data were obtained.

6. Eye tracking analyses

All eye tracking analyses were performed using GazeTracker 8.0 (Eye Response Technologies, 2005). Dynamic regions of interest (ROIs)

were programmed via visual interface with the video stimuli, with each ROI located precisely around each eye region of the actors throughout the videos (i.e., ROIs were programmed to encompass the sclera [with the pupil and iris nested within this zone range] and to exclude all regions outside of the sclera [i.e., eyelids, eyebrows, etc.] to the greatest extent possible). Thus, our method of programming ROIs allowed for the assessment of direct eye gaze. The ROIs surrounding the eyes of the actors in the SET-M videos equaled $1.504°^{2}$ of visual angle. As noted above, the accuracy of our eye tracking system is $< 1°$ – thus, for participants gazing at the center of our ROIs (i.e., making "eye contact" with the pupil), our calculated gaze locations fell well within the accuracy parameters of our system.

7. Results

7.1. Preliminary analyses

Of the 49 participants who were included in the present analyses, only 4.1% ($n = 2$ [SAD patient: $n = 1$; HC: $n = 1$]) reported suspicion that a goal of the study was to examine eye movement during an exit interview. Our results remained substantively identical upon excluding these 2 cases.

FPE and FNE were strongly and positively correlated ($r = .60$, $p < .001$). SAD patients endorsed greater levels of both FPE and FNE in comparison to the HC participants, $F (2, 46) = 99.84, p < .001$; both follow-up $Fs > 33.58$, both $ps < .001$, and these were both large effects, both Cohen's $ds > 1.67$. See Fig. 1.

7.2. Hypothesis 1

An ANOVA was employed to test Hypothesis 1a, which stated that SAD patients would endorse elevated state anxiety in response to both positive and negative social stimuli in comparison to HCs. SAD diagnostic status (i.e., SAD versus HC) was the fixed factor, and mean state anxiety ratings (i.e., SUDS scores), averaged across the respective valence of social stimuli (i.e., positive and negative), served as the dependent variables. There was a significant, large omnibus multivariate effect for SAD status, $F (2, 46) = 27.12, p < .001$, partial $\eta^2 = .53$.

Consistent with our hypothesis, follow-up between-subjects contrasts revealed that this effect was significant for both the positive, $F = 35.20, p < .001$, and negative, $F = 49.34, p < .001$, social stimuli, and these were both large effects, both Cohen's $ds > 1.69$. See Fig. 2.

Consistent with hypothesis, state anxiety ratings in response to the positive feedback stimuli related strongly and positively to FPE, $r = .64, p < .001$, and state anxiety ratings in response to the negative feedback stimuli related strongly and positively to FNE, $r = .70, p < .001$.

Indeed, the relationship between FPE and state anxiety ratings in response to the positive feedback stimuli remained robust even upon controlling for FNE, partial $r = .47, p = .001$, and the relationship between FNE and state anxiety ratings in response to the negative feedback stimuli remained robust even upon controlling for FPE, partial $r = .55, p < .001$. Moreover, regarding discriminant validity, the relationship between FPE and state anxiety ratings in response to the *negative* feedback stimuli upon controlling for FNE was statistically nonsignificant, partial $r = .25, p = .09$. Furthermore, the relationship between FNE and state anxiety ratings in response to the *positive* feedback stimuli upon controlling for FPE was markedly smaller, partial $r = .29, p = .047$, than the relationship between FPE and state anxiety ratings in response to the positive feedback upon controlling for FNE (see above).[5]

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[5] In response to a comment from an anonymous reviewer, as an integrity check, we also examined the bivariate relations between fears of evaluation and state anxiety ratings in response to the feedback stimuli in the clinical and
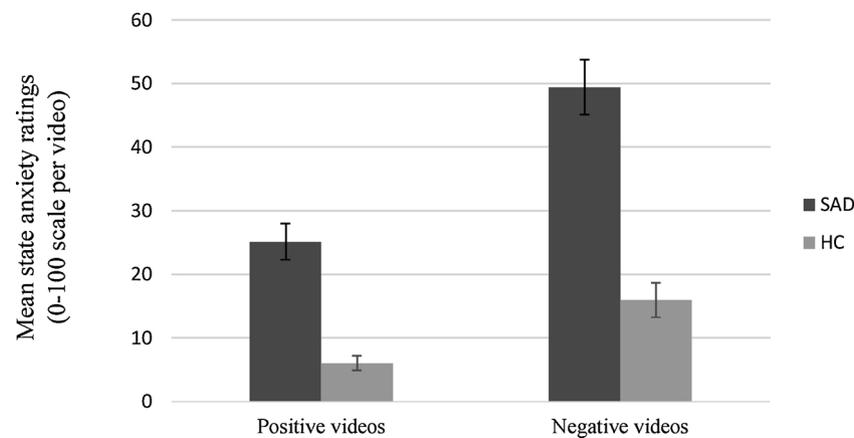
Fig. 2. Mean state anxiety ratings in response to video stimuli, plotted separately for SAD patients and healthy control participants, and separately for positive and negative video stimuli.
Notes: SAD = social aniety disorder patients; HC = healthy control participants.

7.3. Hypotheses 2–4

A series of 2 (SAD group: SAD versus HC) x 2 (emotional valence of video stimuli: positive versus negative) x 8 (1.5 s time blocks; see below for details) mixed repeated-measures ANOVAs was conducted to test Hypotheses 2 through 4, which stated that SAD would be associated with *decreased eye contact* throughout the SET-M task.[6] Eye tracking data were divided into eight 1.5 s blocks per 12 s video, for the repeated measures. SAD diagnostic status (i.e., SAD versus HC) served as the between-subjects factor, and mean values from the relevant eye tracking indices served as the dependent variables in the respective ANOVA. Significant group differences on each of the hypothesized eye tracking indices at all timepoints were expected.

7.3.1. Hypothesis 2: Total time holding eye contact

The between subjects (SAD) main effect was significant, F (2, 46) = 4.49, p = .017, partial $\eta 2$ = .17. The effects for time alone, and SAD group by timepoint interaction, were not significant, both ps > .05. Follow-up between-groups comparisons were performed, and a Bonferroni correction was applied to control for comparisons across positive and negative social feedback (p = .05/2 = .025). Positive SAD diagnostic status was associated with significantly less total time holding eye contact with the actors in both the positive, F (1, 47) = 8.71, p = .005, and negative, F (1, 47) = 6.23, p = .016, video clips. These were large and medium effects, partial η^2s = .16 and .12, respectively (see Fig. 3a).

(footnote continued)

control groups separately. State anxiety ratings in response to the positive feedback stimuli related significantly and positively to FPE in the clinical sample alone, r = .48, p = .01; this relationship was not significant in the control sample alone, r = .23, p = .25, but the effect was in the expected direction, and this nonsignificant effect is reasonably attributable to range restriction within a homogeneous sample of reduced size. The relationship between state anxiety ratings in response to the negative feedback stimuli and FNE was not statistically significant in the clinical sample alone, r = .27, p = .20, but the effect was in the expected direction, and is also reasonably attributable to range restriction within a homogeneous sample of reduced size. The relationship between state anxiety ratings in response to the negative feedback stimuli and FNE was significant in the control sample alone, r = .77, p < .001.

[6] Given that all values of the primary eye tracking indices obtained in the present study (i.e., total time holding eye contact, total number of fixations upon the eyes, and total durations of fixations upon the eyes) were very strongly intra-correlated for both the positive and negative video stimuli (mean r = .95, all ps < .001), a series of ANOVAs was employed rather than a single ANOVA due to multicollinearity concerns.

7.3.2. Hypothesis 3: Number of fixations on eyes

The between subjects (SAD) main effect was significant, F (2, 46) = 3.49, p = .039, partial η_2 = .13. The effects for time alone, and SAD by timepoint interaction, were not significant (both ps > .29). Follow-up between-groups comparisons were performed, and a Bonferroni correction was applied (p = .025 [see above]). Positive SAD status was associated with significantly fewer fixations upon the eyes of the actors in both the positive, F (1, 47) = 7.11, p = .011, and negative, F (1, 47) = 6.45, p = .015, video clips. These were both medium effects, partial η_2s = .13 and .12, respectively (see Fig. 3b).

7.3.3. Hypothesis 4: Fixation durations upon eyes

The between subjects (SAD) main effect was significant, F (2, 46) = 4.60, p = .015, partial η_2 = .17. The effects for time alone, and SAD by timepoint interaction, were not significant (both ps > .20). Follow-up between-groups comparisons were performed, and a Bonferroni correction was applied (p = .025 [see above]). Positive SAD status was associated with significantly briefer fixation durations upon the eyes of the actors in both the positive, F (1, 47) = 9.24, p = .004, and negative, F (1, 47) = 6.22, p = .016, video clips. These were large and medium effects, partial η_2s = .17 and .12, respectively (see Fig. 3c).

8. Discussion

The present study is only the second to assess: [1] SAD-related gaze avoidance via utilization of eye tracking without participants' advanced knowledge, [2] via utilization of *dynamic* (i.e., video; as opposed to still-image) social stimuli, and [3] within the context of the BFOE model of social anxiety (although see also Howell, Zibulsky, Srivastav, & Weeks, 2016 regarding [1] and [2]). Furthermore, the present study is the first to incorporate these elements with a sample including patients who qualified for a confirmed principal diagnosis of SAD of the generalized subtype, and a control sample of confirmed healthy control participants who were demographically- matched to (the majority of) the clinical sample. Analyses were conducted that served to replicate and extend previous findings involving gaze avoidance as a biobehavioral indicator of SAD per the BFOE model.

We found that, compared to healthy controls, SAD patients endorsed greater state anxiety in response to both positive and negative social feedback. This finding is consistent with prior research showing that FPE and FNE related significantly and similarly to state anxiety in anticipation of evaluative feedback (i.e., immediately after giving a speech; Weeks & Zoccola, 2015). In addition, follow-up analyses revealed that state anxiety ratings in response to the positive feedback stimuli related uniquely and positively to FPE, and state anxiety in
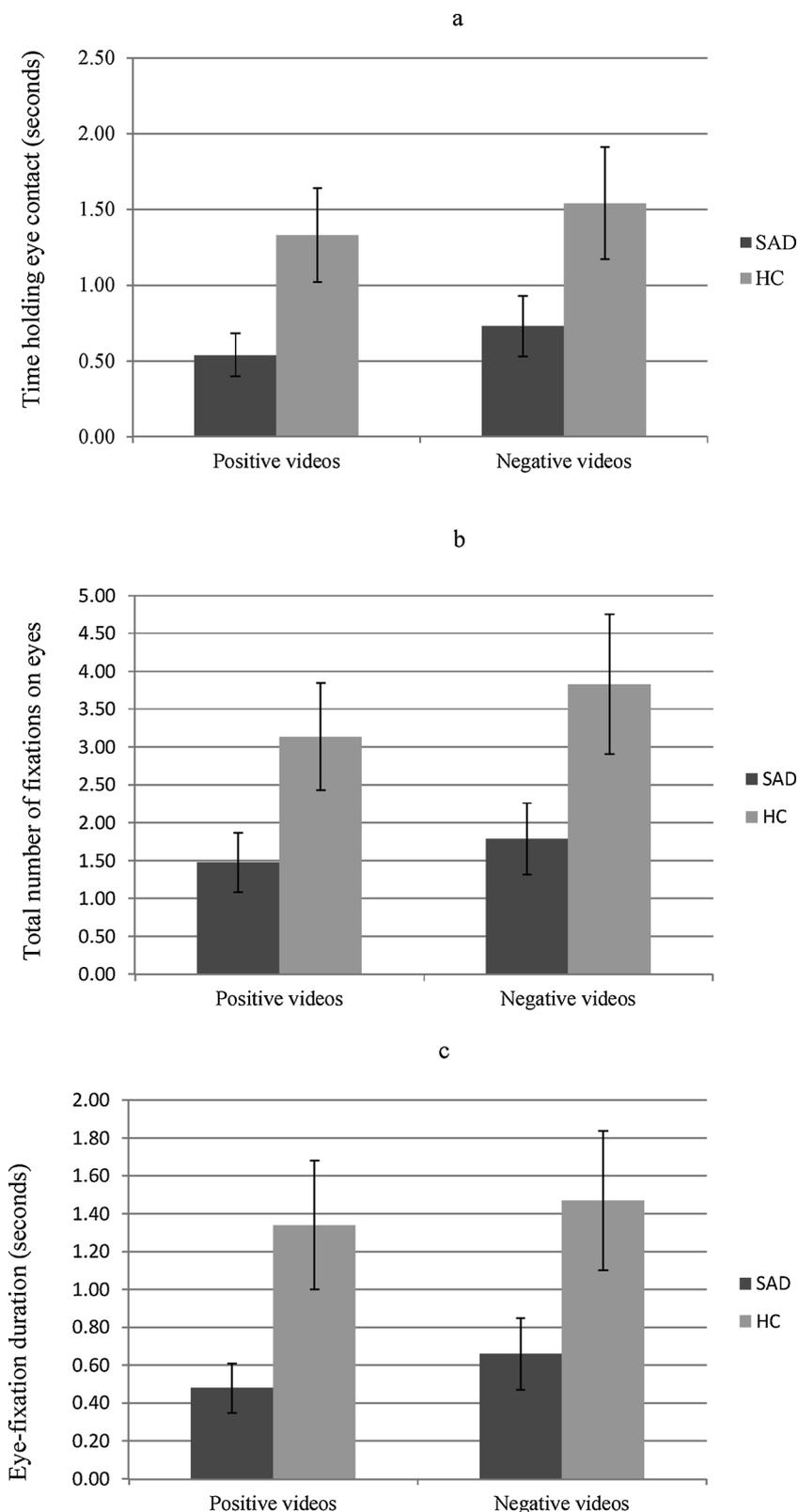
a

b

c

Fig. 3. Averaged eye tracking indices pertaining to eye contact with actors in the video stimuli, plotted separately for SAD patients and healthy control participants, and separately for positive and negative video stimuli.
Notes: SAD = social anxiety disorder patients; HC = healthy control participants.

response to the negative feedback stimuli related uniquely and positively to FNE, further highlighting that FPE and FNE are related but unique constructs. Second, a series of repeated-measures ANOVAs demonstrated that SAD was associated with globally decreased eye

contact with the actors in the video stimuli throughout the social simulation task, with regard to: total time holding eye contact, number of fixations upon the eyes, and fixation durations upon the eyes. Moreover, these effects were all significant for *both* the positive and negative

social stimuli. Repeated-measures analyses revealed no significant SAD group by timepoint interactions. Combined with the above findings, this indicates that individuals with SAD tend to consistently hold reduced eye contact with others in comparison to individuals without SAD – at least, for periods of 12 s—and across positive and negative feedback contexts.

Relevant to the BFOE model, specifically, our findings are consistent with previous findings demonstrating links among fears of both positive and negative evaluation and submissive behaviors in SAD (e.g., see Gilbert, 2014; Horley et al., 2004; Weeks, Heimberg, Rodebaugh et al., 2008; Weeks et al., 2009; Weeks et al., 2010; Weeks et al., 2011; Weeks, Lee et al., 2012; Weeks, Heimberg et al., 2012; Weeks et al., 2013; Weeks, Srivastav, Howell, & Menatti, 2016). Our present eye-tracking findings are also consistent with other psychophysiological data; for example, FPE has been shown to relate to increased cardiovascular threat responses during participants' presentations of their own best traits (see Weeks & Zoccola, 2015, 2016). Collectively, these multi-method findings provide strong support for the BFOE model of social anxiety and inform conceptualizations of what should be deemed "social threat". According to the BFOE model, fear of evaluation *in general* is important in social anxiety.

Our findings hold implications for the assessment of SAD. Eye tracking indices may hold merit as specialized treatment outcome indicators for SAD patients – this is an important area for future study. Future studies could also examine the utilization of eye tracking equipment to provide an objective index of gaze avoidance as a target behavior to be addressed in social skills training regimens, or its potential role as a safety behavior, with emphasis placed on maintaining eye contact while engaging in therapeutic exposures (i.e., to maximize the effectiveness of the exposure).

Several limitations to the present study warrant comments. First, our study did not include neutral social stimuli. Few studies have examined the relation between SAD and direct gaze avoidance in response to neutral faces in clinical samples, and these studies have yielded mixed findings. For example, in one study, no differences were found between SAD patients and healthy controls with regard to gaze avoidance in response to neutral faces (Horley et al., 2003). In a follow-up study, individuals with SAD tended to fixate more briefly than healthy controls upon the eyes of neutral faces (Horley et al., 2004), reflecting a single index of gaze avoidance. It will be important for future eye tracking studies which test the BFOE model to contrast gaze responses (or other biobehavioral and self-report measures) to positive and negative stimuli with neutral stimuli. This approach will help to clarify whether gaze avoidance occurs with any type of facial stimuli in SAD, or if there is something important about the polar *valence* of social information – be it positive or negative – as it relates to social threat from a psychoevolutionary framework (e.g., Gilbert, 2001). It bears noting that a recent study which did not involve eye tracking revealed hypothesized aversive emotional responses for positive and negative, *but not for neutral*, dynamic social stimuli, thereby entirely consistent with the BFOE model (Reichenberger, Wiggert, Wilhelm, Weeks, & Blechert, 2015) – however, whether or not these effects will extend to gaze tendencies remains an empirical question.

Furthermore, the participants in the present study were primarily young adults and Caucasian, and there is some (non-eye tracking-based) evidence that gaze tendencies may vary systematically across ethnic groups in at least some settings (e.g., see LaFrance & Mayo, 1978; Norton, Washington, Peters, & Hayes, 2010 for reviews on cultural aspects of nonverbal communication). Thus, replication of the present findings in additional samples with more diverse demographic characteristics is essential for establishing the generalizability of these results, which suggest that an implicitly measurable, objective, and biobehavioral measure of eye gaze, across positive and negative evaluative contexts, may serve as a biomarker for SAD.

Declarations of interest

None.

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