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Attentional control moderates the relationship between social anxiety and selective attentional responding to negative social information: evidence from objective measures of attentional processes

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Abstract

Cognitive theories of social anxiety implicate greater attention to negative social information in the development and maintenance of heightened social anxiety. Empirical evidence for this proposal, however, has been inconsistent. The aim of the current study was to examine the role of attentional control, which is one's ability to deploy attention to goal-relevant information as a potential moderator of the association between selective attentional responding to negative social information and social anxiety. Eighty-nine adults were recruited through Mechanical Turk platform and completed the Social Interaction Anxiety Scale as well as a novel paradigm designed to measure selective attentional responding to negative social information (angry faces) and attentional control. Attentional control was operationalised as the capacity to direct attention to the specified target stimuli. The results supported the hypothesis that attentional control plays this moderating role. Specifically, while participants with low levels of attentional control exhibited a positive association between social anxiety and selective attentional responding to negative social information, this association was eliminated among participants with high levels of attentional control. This finding may explain the heterogeneity of research findings in this area. Implications, limitations and directions for future research are discussed.

Keywords: Social anxiety; Selective attentional responding; Attentional control

1. Introduction

Cognitive models of social anxiety propose that people high in social anxiety vulnerability display greater attention to negative social information than people low in social anxiety vulnerability (Heimberg et al., 2010; Rapee & Heimberg, 1997). Consistent with this proposal, it has been found that people low in social anxiety vulnerability often exhibit attentional avoidance of negative social information, whereas people high in social anxiety vulnerability exhibit an attenuation, or even reversal, of this attentional avoidance of negative social information (Bar-Haim et al., 2007). However, not all studies have found evidence of such social anxiety-linked differences in attentional response to negative social information (e.g., Chen et al., 2012; Mansell et al., 2003). This inconsistency suggests the importance of identifying potential moderators of the association between social anxiety vulnerability and selective attentional responding to negative social information (Gorlin & Teachman, 2014; Taylor et al., 2016). The present study was designed to examine the potential role of attentional control as a candidate moderator.

A number of different approaches have been used to assess selective attentional responding to negative social information in social anxiety, but the most common is the attentional probe task (MacLeod et al., 1986). In this task, a pair of stimuli, comprising one socially negative member and one benign member, is briefly presented on each trial. Following stimulus pair offset, a probe appears in the location previously occupied by of one of the stimulus pair members. The participant must quickly discriminate the identity of this probe. An index of selective attentional responding to negative social information is obtained by computing relative speeding to discriminate probes appearing in the locus of the negative stimulus pair members compared to probes appearing in the locus of the benign stimulus pair members. Increasingly positive scores on this index reflect greater attentional vigilance for negative social information whereas increasingly negative scores reflect greater attentional

avoidance of such information. Using this approach, several studies have found evidence that people with high social anxiety vulnerability display greater attention to negative social information than do people low in social anxiety vulnerability (Klumpp & Amir, 2009; Stevens et al., 2009), but some studies have not found evidence of such social anxiety-linked difference in selective attention (e.g., Ononaiye et al., 2007).

To explain this inconsistency, it has been proposed that attentional control may moderate the relationship between elevated social anxiety vulnerability and selective attentional responding to negative information (Derryberry & Reed, 2002). Attentional control refers to the ability to strategically deploy attention toward goal-relevant information in the face of prepotent conflicting attentional demands (Sarapas et al., 2017). It has been hypothesized that the degree to which people high in social anxiety vulnerability display greater attention to negative social information than people low in social anxiety vulnerability, will be attenuated in those who exhibit higher levels of attentional control, as greater attentional control enables inhibition attention being selectively drawn towards negative social information (Derryberry & Reed, 2002).

While previous studies that have sought to test this hypothesis have yielded encouraging results, investigators have highlighted that these studies are compromised by methodological limitations, which undermine their capacity to adequately test this hypothesis. Specifically, they either have employed a self-report measure of attentional control, or have assessed selective attentional responding to negative social information in a suboptimal manner. For example, while Taylor et al. (2016) appropriately assessed selective attention using a probe detection task, they measured attentional control by asking participants to self-report their attentional control ability, using the Attentional Control Scale (Derryberry & Reed, 2002). Although participants' self-reported attentional control moderated the association between social anxiety vulnerability and selective attentional responding to

negative social information, there is evidence showing that the attentional control scale only captures people's subjective beliefs about their attentional control ability rather than their actual attentional control ability (Quigley et al., 2017). Gorlin and Teachman (2014) overcame this limitation by employing a performance-based measure of attentional control, but assessed selective attention using the emotional-Stroop approach, in which an index of selective attentional responding to negative social information is obtained by computing slowing to color name socially negative words compared to benign words. Although these researchers found that attentional control moderated the association between social anxiety vulnerability and selective attentional responding to negative social information, many investigators have pointed out that slowing to color name negative social information may not reflect greater attention towards such information, but may instead reflect general response freezing in the presence of negative information, or attentional avoidance of such information (Cisler & Koster, 2010).

The present study was designed to overcome these limitations by using an objective performance-based measure of attentional control, and by assessing selective attentional responding to negative social information using an attentional-probe task approach. Thus, participants completed an attentional assessment procedure in which some blocks of trials served to assess their selective attention to negative stimuli, and others instead assessed their level of attentional control. In the former blocks, pairs of faces were presented, one showing an angry emotional expression and the other a happy emotional expression. An index of selective attentional responding to negative social information was obtained by computing the degree to which participants were speeded to discriminate probes in the location of the angry face relative to probes in the location of the happy face. In blocks designed to assess attentional control, pairs of emotionally neutral faces were presented, one male and one female, and participants were instructed to allocate attention to the face of one specified

gender, which was where probes always appeared. An index of attentional control was obtained by computing the degree to which participants were speeded to discriminate probes in this known location (i.e. the location of the face of the specified gender) compared to their mean discrimination speed for probes when the location in which the probe would appear was unknown to them.

The hypothesis under test, that attentional control moderates the degree to which people high in social anxiety vulnerability display greater attention to negative social information than people low in social anxiety vulnerability, generates the prediction that the strength of the association between social anxiety vulnerability and selective attentional responding to negative social information will be significantly attenuated, or eliminated, in participants who exhibit greater attentional control.

2. Methods

2.1. Participants

Participants were 123 native English speakers who resided in the USA (84 male; Age, *M* = 38.58, *SD* = 10.98, range = 20-73 years). Participants were recruited via Amazon Mechanical Turk (MTurk; Litman, Robinson, & Abberbock, 2017). The distribution of highest educational attainment was 9.8% Master's degree, 53% Bachelor's degree, 3.3% trade school degree, and 34.9% high-school qualification.

2.2. Questionnaire Measures

2.2.1. Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998)

The SIAS is a 20-item self-report questionnaire measuring the degree to which participant report experiencing social anxiety symptoms. Scores range from 0-80, with higher scores indicating greater social anxiety vulnerability. The SIAS has shown good reliability and validity (Mattick & Clarke, 1998), and has been used in previous research investigating

the attentional basis of social anxiety vulnerability (Sposari & Rapee, 2007). For the current sample, internal consistency (Cronbach's alpha) was 0.95.

2.3. Attentional Assessment Task

The attentional assessment task was designed to assess variation in selective attentional responding to negative social information, and variation in attentional control. Across all trials, participants were presented with a pair of faces. 500 ms after this face pair onset, a probe appeared in the location of one of the two faces (overlaid on this face), and participants were required to discriminate the identity of this probe.

To assess selective attentional responding to negative social information, there were blocks of trials on which face pairs comprising the same person displaying an angry and a happy facial expression were presented, and participants were given no attentional instruction. An Index of Selective Attention to Negative Social Information was obtained by computing relative speeding to discriminate probes that appeared in the location of the angry face, compared to probes that appeared in the location of the happy face. A higher score on this index reflects greater selective attention towards negative social information.

To assess attentional control, there were blocks of trials on which face pairs comprising a male and female face, each displaying a neutral facial expression, were instead presented, and participants were instructed to always attend to one target member of the pair (identified on the basis of gender), as this is where the probe would appear. An index of attentional control was obtained by computing the degree to which participants were speeded to discriminate probes in the location of this target stimulus, relative to their average speed to discriminate probes on the former trials on which no attentional instruction was given. The mean latency to discriminate probes on the uninstructed trials served as a baseline to determine the degree to which participants were able to use the attentional instruction of the instructed blocks to successfully orient attention to the target location, relative to when they

did not know where the probe will appear. A higher score on this Attentional Control Index indicated greater attentional control.

A more detailed description of the attentional assessment task is provided in the supplementary material accompanying this manuscript.

2.4. Procedure

Participants were recruited to the study through advertisement on MTurk. Upon recruitment, participants provided informed consent before next completing the SIAS, a demographic questionnaire, and finally the attentional assessment task. The session took around 30 minutes to complete on average. Participants were compensated US$8 for participation.

3. Results

Thirty-two participants failed to reach the 85% accuracy criterion and were excluded from further analyses. Additionally, two participants were removed because their mean probe discrimination latencies were identified as outliers, using the 99% confidence interval, by falling more than 2.58 SDs from the mean of the sample (Goodhew et al., 2020). The final sample comprised 89 participants (60 males) with a mean age of 38.67 (*SD* = 11.19), and a mean SIAS score of 29.90 (*SD* = 17.34). Mean probe discrimination accuracy in this final sample was reassuring high at 93.9% (*SD* = 3.63). Before using correct probe discrimination latencies to compute the Index of Selective Attention to Negative Social Information and the Attentional Control Index, as described in the previous section, probe discrimination latencies less than 100 ms or falling more than 2.58 SDs above the participant's mean latency for that condition were removed (1.3% of all trials), in keeping with prior convention (Grafton et al., 2016).

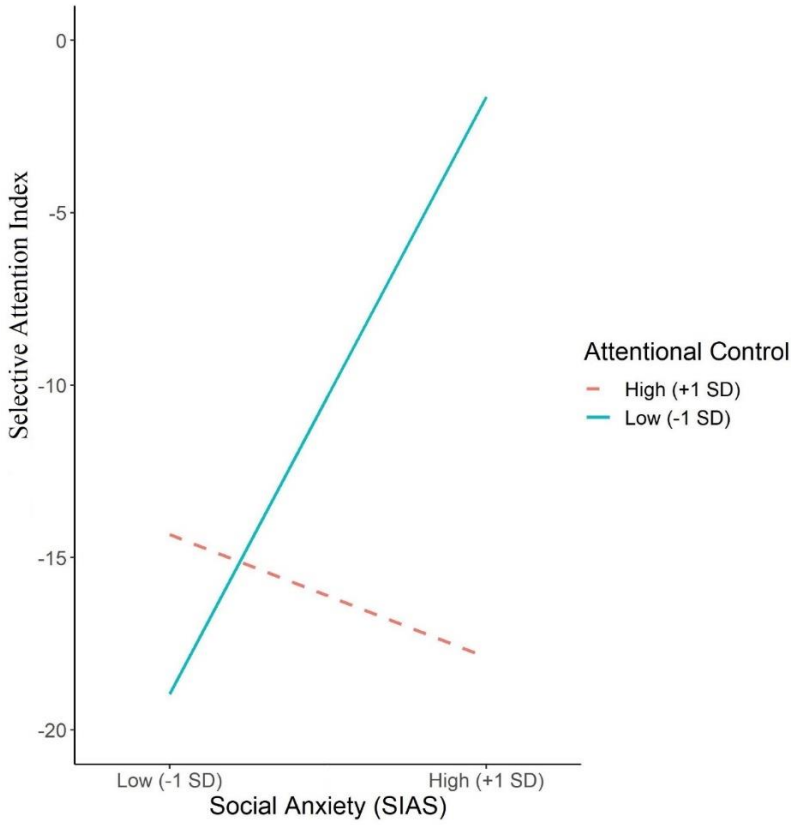
To test the prediction generated by the hypothesis under scrutiny, that the degree to which people high in social anxiety vulnerability display greater attention to negative social

information than people low in social anxiety vulnerability will be attenuated in people who exhibit higher levels of attentional control, a moderation analysis that involved attentional control as a continuous moderator was conducted, across all participants. Recommendations set out by Hayes and Preacher were followed, with bias-corrected bootstrapping (10,000 resamples) used to generate 95% confidence intervals (Hayes & Preacher, 2014). PROCESS model 1 was applied in which, Index of Selective Attention scores were entered as the dependent variable, SIAS scores as the predictor variable, and Attentional Control Index scores were entered as the moderator.

Two significant effects emerged from this analysis. Firstly, the SIAS scores significantly and positively predicted Index of Selective Attention scores (B = 0.96, 95% CI [0.23, 1.69], t = 2.60, p = 0.01), indicating that, in general, higher levels of social anxiety were associated with greater attentional bias to angry faces. Moreover, and of greatest relevance to the hypothesis under test, the analysis showed that Attentional Control Index scores did indeed significantly moderate the association between SIAS scores and Index of Selective Attention scores (B = -0.005, 95% CI [-0.010, -0.0005], t = -2.18, p = 0.031). The nature of this moderation is shown in Figure 1.

Figure 1

Moderation Effect of Attentional Control on Social Anxiety Vulnerability and Selective Attentional Responding to Negative Social Information.



As the figure shows, the moderation effect was consistent with the prediction generated by the hypothesis. Specifically, while the bootstrapping procedure revealed a significant positive association between SIAS scores and selective attention to negative social information index scores among participants with lower levels attentional control [B = 0.49, t = 2.76, p = 0.007], this association was eliminated among participants with higher levels of attentional control. Indeed, for these latter participants, the relationship between these two index scores was nominally negative, though non-significant[1] [B = -0.10, t = -0.57, p = 0.56].

[1] As heightened depression has been shown to be associated with elevated social anxiety (Adams et al., 2016), the analysis was repeated with participants' depression levels (BDI-II) covaried. The pattern of significance yielded by this analysis was the same with those above and is reported in supplementary material.

4. Discussion

The present study was designed to test the hypothesis that attentional control moderates the association between social anxiety vulnerability and selective attentional responding to negative social information. The results supported the hypothesis, by confirming that the magnitude of the association between social anxiety vulnerability and selective attentional responding to negative social information varied as a function of participants' attentional control. Specifically, in participants who exhibited relatively low attentional control, lower levels of social anxiety vulnerability were characterized by a tendency to attentionally avoid negative social information which was not demonstrated by participants with higher levels of social anxiety vulnerability. Thus, participants high in social anxiety vulnerability displayed greater relative attention to negative information than did those low in social anxiety vulnerability, but only when attentional control was relatively low.

It is appropriate to consider how poorer attentional control might result a stronger positive association between social anxiety vulnerability and selective attention to negative social information. One possibility is that, across all individuals, elevated social anxiety vulnerability serves to increase the degree to which negative social information automatically capture attention (Schultz & Heimberg, 2008), but strategic attentional control can be employed to eliminate the expression of such automatic attention to negative social information. Therefore, assuming sufficient ability to volitionally control attention, the association between social anxiety and selective attention to negative social information can be suppressed or eliminated, meaning that this association between social anxiety and selective attentional responding is disproportionately evident among individuals with an impoverished ability to control attention (Derryberry & Reed, 2002). In line with this account, Judah et al (2013) found that the positive association between elevated social

anxiety vulnerability and selective attentional responding to negative social information is more pronounced under conditions of high working memory load, which plausibly may attenuate participants' ability to deploy capacity-demanding attentional control strategies.

Given the common view that greater attention to negative social information causally contributes to elevated social anxiety (Schultz & Heimberg, 2008), it is also of interest to consider why our high socially anxious participants who demonstrated high attentional control exhibited this heightened anxiety, despite demonstrating no evidence of greater selective attention to negative social information on the present assessment task. One possibility is that social anxiety in people with high levels of attentional control is driven by factors other than attentional selectivity. Clearly, while greater attention to negative social information may make a potential contribution to elevated social anxiety, anxiety is undoubtedly multifactorial in aetiology, with many factors contributing to its development and maintenance such as maladaptive beliefs, learned behavioural avoidance and social skill deficits (Stein & Stein, 2008).

We also suggest replicating the current study using eye-tracking methodology, to enable continuous assessment of selective attentional responding to negative information. Eye-tracking methods could also be employed to yield alternative measures of attentional control, such as variation in speed to execute antisaccades to prepotent stimuli (e.g., Ranjbar et al., 2020). The findings yielded by such approaches would determine the robustness of the findings found in the current study. It would also be of interest to determine whether the presently observed moderation effect of our performance-based measure of attentional control, on the association between social anxiety and selective attentional responding to negative information, remains evident when attentional control is assessed using the self-report Attentional Control Scale (ACS; . If so, then this would challenge the idea expressed by some investigators that the ACS assesses only beliefs about attentional control rather than

genuine variation in attentional control (see Quigley et al., 2017). Of course, should it be the case that scores on the ACS do not moderate the association between social anxiety and selective attentional responding to negative information, it would not necessarily follow that this self-report scale does not assess meaningful variation in attentional control. However, it would indicate that the type of variation observed using performance-based measures of attentional may not be captured by this self-report instrument.

The present study was not designed to test hypotheses concerning attentional characteristics of clinical anxiety, and so it remains to be seen whether the effects observed in the present socially anxious sample remain evident in people with social anxiety disorder. The online delivery format of the present study means that it is readily amenable to deployment among individuals with clinical diagnoses of social anxiety. If future research serves to establish that the effects observed in the present study replicate when people with social anxiety disorder are examined, this would indicate that attentional control moderates the degree to which selective attentional responding is associated with elevated social anxiety in both clinical and no-clinical cohorts.

These limitations notwithstanding, the current study is the first to our knowledge that has tested the hypothesis that attentional control moderates the association between social anxiety and selective attentional response to negative social information using a task that employs an objective measure of attentional control, and the well-established probe approach to assess selective attentional response to negative social information. The findings confirm that attentional control does indeed moderate the association between selective attentional response and social anxiety, as predicted, which may explain previously heterogeneous findings in this field of research.

Data Availability Statement:

The data that support the findings of this study are openly available in the Open Science Framework at https://osf.io/eytjh/

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Supplementary Material

This supplementary material provides additional description of the attentional assessment task used in the methodology described in the manuscript.

1. Facial Images Stimuli

The face stimuli were taken from the FACES database (Ebner, Riediger, & Lindenberger, 2010); which is a standardized set of naturalistic faces of women and men each displaying a number of different emotional expressions. The faces used in the current study consisted of photos of 32 people (16 female) each showing an angry, happy, and neutral facial expression. Faces of four additional people (2 female) were used in practice trials. The face images were in portrait format with a grey background.

2. Attentional Assessment Task

To measure selective attentional responding to negative information, blocks of trials were required that enabled assessment of the degree to which participants attended to the angry face expression relative to a matched face showing a happy expression, when given no attentional instruction, by computing their relative speeding to discriminate probe stimuli presented in the location of the angry face (uninstructed blocks). To measure attentional control, blocks of trials were also needed in which participants were instructed to attend to one target member of a neutral face pair, identified based on gender (instructed blocks). An index of attentional control could then be calculated by computing the degree to which participants were faster to discriminate probes in the location of this target stimulus,

compared to their average speed to discriminate probes on uninstructed trials. In the following task description, the features common to all trials are described first, before outlining the unique characteristics of trials presented in uninstructed and instructed blocks.

2.1. Trial Structure Common to Both Types of Block

On each trial a pair of face images were presented simultaneously, one in the right side and one in the left side of the screen. Each face image measured 10 x 8 cm. The distance between the edges of images was 6 cm. After 500 ms, a probe appeared on one image and remained for 1000 ms. This probe was a visible boundary, sloping upward towards either the left or the right, and was created by lightening the right side of the image by 10% and darkening the left side of the image by 10%. Because the appearance of the probe makes a change on faces that automatically attracts attention, a boundary was simultaneously presented on the other face to prevent the automatic attraction of attention to probes, but this was vertically aligned with the centre of the image and so had no slope, as shown in Figure 1. Participants were required to indicate the direction of the sloping boundary, by pressing the left arrow key if this probe was sloping upward to the left, or the right arrow if this probe was sloping upward to the right. On each trial, the probe discrimination latency and accuracy were recorded. The next trial began immediately following the 1000ms probe exposure, regardless of whether a probe discrimination response had been made.

Figure 1

An Example of Probe Stimulus (left) and Vertical Boundary (right) on Two Neutral Faces

A total of 512 trials were presented over eight blocks, with each block comprising of 64 trials. There were four instructed blocks and four uninstructed blocks, which were presented in alternating order, with half of the participants starting with an uninstructed block and the other half starting with an instructed block. Within each block of 64 trials, every identity was presented an equal number of times, with each having been shown once before any were presented again. There was a 15-second rest break after each block.

2.2. Trial Structure Unique to Uninstructed Block

For the uninstructed block, each face pair comprised two photos of the same person, one showing an angry and the other a happy expression. On half of the trials, the angry face appeared in the left side of the screen and on the other half in the right side of the screen. The probe that was presented 500 ms later appeared with equal frequency on the angry and on the happy face. At the start of each uninstructed block, participants were informed that they could attend to faces however they chose to and were informed that the position of probes was random.

2.3. Trial Structure Unique to Instructed Block

For the instructed assessment block, in each trial the face pair comprised a male and female face, each showing a neutral expression. The male face appeared in the left and right sides of the screen with equal frequency. At the start of each instructed block, participants

were instructed to attend only to either male or female faces. They were also correctly informed that the probe only ever appeared in the locus of this target face. Each participant completed two instructed blocks with male faces as the target, and two instructed blocks with female faces as the target, with the order of these targets counterbalanced across participants.

2.4. Computing selective attention and attentional control indices

Our attentional indices were computed using probe discrimination latencies, which are meaningful only if participants demonstrate accurate discrimination, and so it was a requirement that participants display a minimum of 85% probe discrimination accuracy for inclusion in data analysis. Using their latencies to correctly discriminate probes, we calculated two attentional indices:

Index of Selective Attention to Negative Social Information: Using the latency to discriminate probes in the uninstructed blocks, an index of selective attention to angry faces was computed. This index expressed speeding to discriminate probes in the locus of angry faces, relative to probes in the locus of happy faces. To compute this index, the mean discrimination latency for probes in the locus of angry faces was subtracted from the mean discrimination latency for probes in the locus of happy faces. A higher score on this index reflects greater attention to negative information.

Attentional Control: Using latency to discriminate probes across all trials, an index of attentional control was computed. This index expressed speeding to discriminate the probes consistently presented in the locus of the target stimuli in instructed blocks, relative to probes in the uninstructed blocks. To compute this index, the mean discrimination latency for probes in instructed blocks was subtracted from the mean discrimination latency for probes in the uninstructed blocks. The mean latency to discriminate probes on the uninstructed trials was required to be used as a baseline to determine the degree to which participants were able to use the attentional instruction of the instructed blocks to successfully orient attention to the

target location, relative to when they did not know where the probe will appear. A higher score in this index indicates that participants were better able to orient attention toward the target stimuli on instructed blocks, and so reflects greater attentional control.

3. **Procedure**

The instructions for the attentional assessment task were delivered to the participant immediately prior to its commencement. These instructions emphasized that the participant should accurately discriminate the slope of each probe as swiftly as possible by pressing the appropriate response button. The participants then completed two practice instructed blocks and two practice uninstructed blocks, each comprising 32 trials. The practice blocks were delivered in the same alternating order as the blocks delivered in the attentional assessment task. Following the practice block the attentional assessment task was completed.

4. Examining the potential impact of depression on the moderation analysis outcome

As heightened depression has been shown to be associated with elevated social anxiety (Adams et al., 2016), the analysis was repeated with participants' depression levels (BDI-II) covaried. The pattern of effects yielded by this analysis was the same with those reported in the paper. The Attentional Control Index scores significantly moderated the association between SIAS scores and Index of Selective Attention scores (B = -0.005, 95% CI [-0.010, -0.0004], t = -2.13, p = 0.036). Specifically, a significant positive association was found between SIAS scores and selective attention to negative social information index scores among participants with lower levels attentional control [B = 0.45, t = 2.19, p = 0.03], this association was eliminated among participants with higher levels of attentional control. Indeed, for these latter participants, the relationship between these two index scores was nominally negative, though non-significant [B = -0.14, t = -0.73, p = 0.46]. Depression scores did not significantly predict the selective attention index scores [B = 0.11, t = 0.52, p = 0.60].