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Post-Evaluative Biases Toward Somatic Stimuli and Cardiovascular Responses in Social Anxiety

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Abstract Cognitive models of social anxiety emphasize the role of an attentional shift toward cues related to somatic state in social anxiety. We examined attentional biases to somatic cues and cardiovascular reactivity in response to a social evaluative task. Participants performed an impromptu speech during which they received standardized negative evaluative comments. Participants then completed a dot-probe task with social evaluative, somatic, and anger-related words. Blood pressure (BP) and heart rate (HR) were assessed in 1-minute intervals during baseline, the speech task, and the dot-probe task. Despite the fact that a high social anxiety group reported higher levels of anxiety, high and low social anxiety groups did not differ in their speech task-evoked BP or HR responses. Furthermore, the high social anxiety group, compared to the low social anxiety group, exhibited greater attentional biases to somatic words, suggesting greater attention directed toward information pertinent to somatic arousal.

Keywords Social anxiety · Somatic · Cardiovascular reactivity · Attentional bias · Social stress

Socially anxious individuals often report experiencing physical symptoms. Indeed, the diagnostic and statistical manual of mental disorders (DSM-IV; APA 1994) notes that “individuals with social phobia almost always experience symptoms of anxiety ... in the feared social situations (p. 412).” Along this

line, individuals diagnosed with social phobia endorsed experiencing a host of physical sensations to a greater degree than controls in social situations (Turner, Beidel, Dancu, and Stanley 1989). That socially anxious individuals report greater physical reactions to social stress has led to an assumption that socially anxious individuals experience greater levels of physiological activity than non-anxious individuals in social-evaluative contexts. However, careful inspection of available empirical data on task-induced physiological reactivity presents a complicated picture.

Although several studies have demonstrated that social anxiety is associated with greater cardiovascular reactivity (e.g., Feldman, Cohen, Hamrick, and Lepore 2004), there are ample data suggesting little distinction in cardiovascular reactivity to social stressors between socially anxious and non-anxious individuals (e.g., Baggett, Saab, and Carver 1996). For example, despite the fact that socially anxious individuals *self-reported* increased levels of physiological activation during a speech, they did not differ from their non-socially anxious counterparts on any of the 12 physiological measures at any of the assessment epochs (Mauss, Wilhelm, and Gross 2004). Similarly, compared to healthy controls, individuals diagnosed with generalized social phobia did not differ on any of the four physiological measures during any of the four tasks, including an interaction with a stranger (Edelmann and Baker 2002). Nonetheless, the social phobia group still *self-reported* higher levels of somatic sensations than the control group. Thus, socially anxious individuals seem to misperceive higher levels of arousal compared to controls. In a recent study (Gramer and Sprintschnik 2008), socially anxious individuals even exhibited *lower* blood pressure and heart rate reactivity compared to their less anxious counterparts. Although tenuous, extant data suggest dissonance between *self-reported* arousal and *objective* physiological parameters during socially stressful events.

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Cognitive models of social anxiety disorder posit that attention to cues related to one's somatic state in the context of social-evaluative threat plays an important role in the development, maintenance, and exacerbation of social anxiety symptoms (e.g., Clark and Wells 1995). In a study designed to test Clark and Wells' model, participants completed a dot-probe task, during which they were led to believe that they were presented with images of their own heart rate paired with a depiction of a sound wave (Pineles and Mineka 2005). Socially anxious individuals preferentially attended to images that they thought were of their heart rate than low socially anxious individuals, indicating that socially anxious individuals have exaggerated attentional biases to non-verbal somatic cues. Earlier, Mansell, Clark, and Ehlers (2003) examined attention to an external visual probe on some trials (superimposed on pictures of happy, angry, or neutral faces or household objects), versus a tactile probe applied to the fingers that participants were led to believe signaled changes in their heart rate and perspiration on other trials. Speech-anxious participants, compared to their non-anxious counterparts, responded more quickly to the tactile probe than to the visual probe, suggesting the presence of attentional biases for somatic cues among speech-anxious individuals.

Attentional biases to cues related to one's somatic state might account for the apparent and peculiar lack of concordance between self-reported affective responses and objectively assessed physiological parameters in socially anxious individuals (e.g., Mauss et al. 2004). As reviewed earlier, there is evidence for a misperception of physiological arousal in socially anxious individuals (e.g., Edelmann and Baker 2002). This misperception of physiological arousal might be due to socially anxious individuals' greater attention to somatically-relevant cues than their non-anxious counterparts. As a consequence, socially anxious individuals might become more aware of, or sensitive to, any increases in physiological arousal in social situations (Gerlach, Murlane, and Rist 2004). In other words, greater attention to somatic cues will increase the probability of perceiving or detecting any physiological changes, which, in turn, will possibly lead to more misinterpretations of somatic cues (Domschke, Stevens, Pfleiderer, and Gerlach 2010). Interpreting 'normal' somatic cues in a catastrophic manner could then lead to heightened anxiety in socially anxious individuals. In fact, indirect evidence supports this hypothesis. Socially anxious individuals reported greater increases in self-rated anxiety and/or evaluated their performance more negatively in response to false somatic feedback ostensibly indicating increased arousal (e.g., Wells and Papageorgiou 2001; Wild, Clark, Ehlers, and McManus 2008). Socially anxious individuals also were better at detecting their heartbeat compared to their less anxious counterparts, suggesting heightened somatic awareness in social anxiety (Stevens et al. 2011).

The current study was designed to investigate attentional biases toward somatic and affective cues, self-reported anxiety, and cardiovascular reactivity in socially anxious individuals in a social evaluative context. We are unaware of any published studies that have examined these facets concurrently; examining these facets within a study could enhance our understanding of the relations among these factors in social anxiety. This study aimed to examine whether social anxiety is indeed associated with heightened attentional biases to cues related to somatic arousal, even when they are not explicitly instructed to attend to such cues or a task does not require them to scan their bodies. Based on the Clark and Wells' (1995) model, we hypothesized that socially anxious participants would exhibit attentional biases toward somatic cues despite revealing no discernable differences in objective indicators of somatic state arousal. In addition to our central hypotheses, we also hypothesized for socially anxious individuals to exhibit attentional biases toward social anxiety related words.

Methods

Participants

Forty-two participants (21 women) participated in exchange for course credit. Mean age of the sample was 19.1 ($SD=1.16$). The sample was racially diverse: 54.8 % were Caucasian, 21.4 % Asian, 9.5 % Hispanic, 7.1 % African American, and 7.2 % choose not to indicate an ethnic/racial category.

Tasks

Speech Task Participants gave an impromptu speech during which they argued either for or against a 10 % increase in tuition at their undergraduate institution. They were told that the speech would be 5 min in duration and that it would be evaluated for clarity and quality of content by the experimenter. During the speech, the experimenter sat with a clipboard and appeared to be intently listening to and observing the participant. At 1 min, the experimenter interrupted the participant and asked, "why would you argue that?" At 1 min, 30-sec, the experimenter stated, "your speech is making no sense." At 2 min, 30-sec, the experimenter stated, "I still don't follow what you are saying." At 3 min, the experimenter stated, "you know what, that's enough." While piloting, we observed that a speech task without negative feedback failed to evoke reliable changes in anxiety. Thus, negative feedback was included to insure that the task led to increased anxiety.

Modified Dot-Probe Task Each trial started with a central fixation cross which was displayed for 500 ms. Next, word pairs were presented vertically in the middle of the screen for 500 ms and immediately followed by a probe (either one

asterisk or two asterisks). Three types of word pairs were used in this study: (a) angry versus neutral, (b) somatic versus neutral, and (c) social anxiety versus neutral. Stimuli for each emotion category were selected from a number of prior studies (e.g., Amir et al. 1996; Faunce, Mapledoram, and Job 2004; Keogh, Ellery, Hunt, and Hannent 2001) and were closely matched to neutral words (common household items) for their length and frequency of usage. The probe was presented in the former location of one of the stimuli, and participants' task was to indicate the identity of the probe (i.e., * vs. **) by pressing appropriate keys on the keyboard as soon as they could. The computer automatically recorded the RTs, which measured the time interval between the onset of the probe and participants' responses. The position of the word pairs and the probe were counterbalanced so that they appeared in either location with equal frequency. We used 24 neutral words and 24 emotional words (8 in each of the category). None of the words were repeated, and the order of presentation was randomly determined for each participant. Angry words were included as a control condition to assess the specificity of the biases in social anxiety. That is, we included angry words to rule out the possibility that socially anxious individuals exhibit biases to any negatively valenced words. We chose angry words, instead of other negative words (e.g., depression words), because negative feedback during speech could potentially activate anger-related feelings.

Measures

Social Phobia Scale (SPS) Considering the focus of the current study (i.e., attention to somatic cues), only the 13-item self-consciousness subscale of the Social Phobia Scale (SPS; Mattick and Clarke 1998) that taps a dispositional self-focus aspect of social anxiety was administered to assess participants' social anxiety levels. This subscale has strong internal consistency ($\alpha=.92$) and construct validity, and is more homogeneous in terms of factor structure than the full SPS (Zinbarg and Barlow 1996). In the current study, Cronbach's α was .85, and the participants' mean SPS scores was 15.38 (SD=8.75).

Self-Reported Affect Participants completed three affect ratings over the course of the study: at the beginning of the study, immediately following the speech, and after completing the dot-probe task. Participants rated their current mood state on several 11-point Likert scales ranging from *not at all* (0) to *extremely* (10), which have been used in previous research (e.g., Quartana et al. 2010; Yoon and Joormann 2012). The Likert scales included the items anxious, tense, and nervous, which were added to create a single composite measure of the levels of anxiety at each time point. Experimenter's comments during the speech performance could

provoke irritation. Thus, the items angry, irritated, and mad were added to create a single composite measure of the levels of annoyance at each time point.

Cardiovascular Parameters Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were measured with a Dinamap 1846 SX Monitor (Johnson & Johnson Medical Inc., New Jersey). This instrument assesses blood pressure using the oscillometric technique. BP and HR assessments were taken throughout at 60-second intervals. Mean SBP, DBP and HR variables were computed across measurements obtained during baseline, speech, and the dot-probe task.

Procedure

Upon arrival, participants were informed that the study was about the effects of stress on information processing and cardiovascular activity. Participants were tested individually after providing written informed consent. They were then seated upright in a comfortable chair, and an automated oscillometric blood pressure cuff was affixed over the brachial artery of the participant's non-dominant arm. Participants remained seated quietly for a 5-minute period, which served as a baseline, after which they provided affect ratings based on how they felt "right now." Participants were then given instructions for a dot-probe task and completed practice trials with word-pairs not used in the main trials (all of these trials were neutral-neutral word pairs). Next, participants were given instructions for and commenced the impromptu speech task. Following the speech task, participants provided affect ratings based on how they felt "during the speech." Participants then underwent the primary trials of the dot-probe task. Participants completed a questionnaire packet that included the SPS and other tasks that were not part of this study. At the end of the session, participants were fully debriefed about the procedure. All of the procedures were approved by the Institutional Review Board.

Data Reduction and Analytic Strategy

Mean SBP, DBP and HR variables were computed across measurements obtained during baseline, speech, and the dot-probe task. General linear Models (GLMs) which allow the continuous nature of the social anxiety measure to be preserved, thereby increasing power, were conducted to examine affective and cardiovascular responses to a stressor in socially anxious individuals. Likewise, a GLM was conducted to examine whether socially anxious individuals exhibited greater attentional biases to somatic (vs. social-evaluative) cues than their non-anxious counterparts. To illustrate the nature of any significant interaction effects or the main effects of social anxiety, participants whose SPS scores were in the top

or the bottom quartile were grouped into the high ($N=10$, SPS $M=28.1$, $SD=5.47$) or low ($N=10$, SPS $M=5.8$, $SD=1.81$) social anxiety (SA) groups. We then conducted appropriate t -tests. It is important to note that the patterns of results remained the same no matter how the two SA groups were formed (e.g., a median split, 1SD above and below the mean, etc.).

Results

Social Anxiety and Affective Responses

Table 1 presents zero-order correlations between social anxiety and all the other variables. As expected, a repeated measures Social Anxiety X Period GLM on the levels of self-reported anxiety yielded a significant main effect of social anxiety, $F(1,40)=18.14$, $p<.001$, $\eta_p^2=.31$. An interaction between social anxiety and period approached a traditional level of significance, $F(2,80)=2.55$, $p=.09$, $\eta_p^2=.06$, but the main effect of period was not significant, $F(2,80)=1.07$, $p=.35$, $\eta_p^2=.03$. As evident in Fig. 1, the high SA group reported higher levels of anxiety than the low SA group for all periods, for baseline, $t(18)=3.14$, $p=.006$, $d=1.41$; for speech, $t(18)=3.81$, $p=.001$, $d=1.71$; and for dot-probe task, $t(18)=2.68$, $p=.02$, $d=1.20$.

A Social Anxiety X Period repeated measures GLM on the levels of annoyance yielded a significant main effect of period, $F(2,80)=5.43$, $p=.006$, $\eta_p^2=.12$. However, neither the main effect of social anxiety, $F(1,40)=1.24$, $p=.27$, $\eta_p^2=.03$,

Table 1 Bivariate correlations between the scores on the Social Phobia Scale (SPS) and the other variables

	Social phobia scale
Anxiety-baseline	.52 ($p<.001$)
Anxiety-speech	.60 ($p<.001$)
Anxiety-dot-probe task	.42 ($p=.006$)
Anger-baseline	.17 (ns)
Anger-speech	.12 (ns)
Anger-dot-probe task	.20 (ns)
HR-baseline	.01 (ns)
SBP-baseline	-.03 (ns)
DBP-baseline	-.02 (ns)
HR-speech	-.02 (ns)
SBP- speech	.01 (ns)
DBP- speech	-.06 (ns)
HR-dot-probe task	-.03 (ns)
SBP-dot-probe task	-.01 (ns)
DBP-dot-probe task	-.15 (ns)
Bias-angry	-.07 (ns)
Bias-somatic	.29 ($p=.063$)
Bias-social	-.40 ($p=.010$)

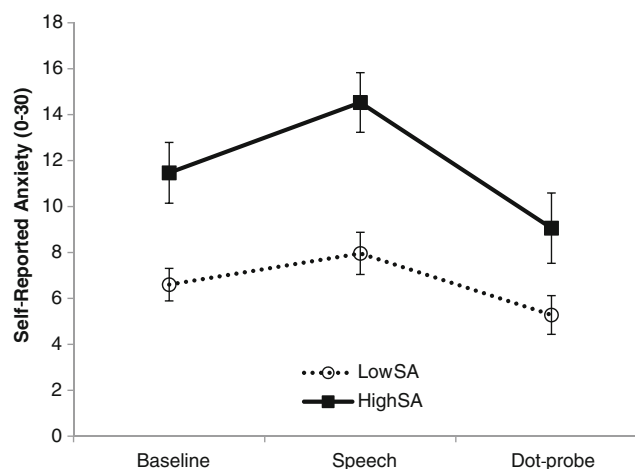


Fig. 1 Mean ratings of anxiety composite scores throughout the session. SA = social anxiety. Error bars represent standard errors

nor an interaction between social anxiety and period was significant, $F<1$. The results, thus, indicate that participants experienced increased annoyance in response to the feedback, and the two groups did not differ regarding the levels of annoyance they experienced. In contrast, the two groups did differ in their levels of anxiety. The overall pattern of results, thus, suggests that our manipulation had its intended effects.

Social Anxiety and Cardiovascular Responses

Mean SBP, DBP, and HR variables were computed across measurements obtained during baseline, speech, and the dot-probe task. We then conducted Social Anxiety X Period repeated measures GLMs for each cardiovascular measure. Analyses revealed significant main effects of period for all three measures: for SBP, $F(2,80)=7.96$, $p=.001$, $\eta_p^2=.17$, for DBP, $F(2,80)=18.67$, $p<.001$, $\eta_p^2=.38$, and for HR, $F(2,80)=18.67$, $p<.001$, $\eta_p^2=.32$. For all three measures, however, the interaction effects were not significant, all $F_s<1$, ns , indicating that the rate of changes in physiological measures over time did not differ as a function of social anxiety. Furthermore, for all three measures, the main effect of social anxiety was also not significant, all $F_s<1$, ns , which suggests that levels of social anxiety were not differentially associated with cardiovascular responses. Furthermore, absolute and relative (i.e., change scores from the baseline to speech) anxiety levels were not significantly correlated with any of the cardiovascular indices in the entire sample. The results remained non-significant when we conducted analyses separately for the high and the low SA groups. As evident in Fig. 2, follow-up paired t -tests revealed that participants exhibited increased levels of cardiovascular activation during the speech compared to the baseline, $t(41)=10.04$, $p<.001$, $d=1.02$ for HR; $t(41)=8.25$, $p<.001$, $d=0.86$ for SBP; and $t(41)=11.41$, $p<.001$, $d=1.63$ for DBP.

Social Anxiety and Attentional Biases

The mean percentages of data loss due to errors and outliers (i.e., greater than 2 SD) were 1.19 % and 1.44 %, respectively. To examine our hypothesis that socially anxious individuals exhibit greater bias toward somatic cues, bias scores for each participant were computed by comparing RTs when the probe appeared in the location of a non-neutral target word to RTs when the probe appeared in the location of a neutral word (MacLeod and Mathews 1988).¹ Positive values indicate an attentional bias toward non-neutral words. These bias scores were then subjected to a Social Anxiety x Bias Type GLM. There was a significant main effect of bias type, $F(2,80)=6.71$, $p=.002$, $\eta_p^2=.14$, which was qualified by a significant Social Anxiety x Bias Type interaction, $F(2,80)=6.53$, $p=.002$, $\eta_p^2=.14$. To better understand the nature of this interaction, we again examined two extreme groups. The high SA group ($M=-17.76$, $SD=53.07$) and the low SA group ($M=-10.64$, $SD=27.62$) did not differ in their bias scores for angry words, $t(18)=-0.38$, ns . Consistent with our hypothesis, the high SA group ($M=38.83$, $SD=35.40$) showed greater bias scores for somatic words than the low SA group ($M=7.8$, $SD=40.31$), $t(18)=1.83$, $p=.08$, $d=0.82$. The high SA group ($M=-28.1$, $SD=65.73$) showed less bias scores for social anxiety words than the low SA group ($M=40.60$, $SD=38.44$), $t(18)=-2.85$, $p=.01$, $d=-1.28$. Consistent with the hypothesis, the high SA group exhibited a significantly higher bias score for somatic words than social anxiety words, $F(1, 9)=7.83$, $p=.02$. In contrast, the bias score for somatic words was not significantly different from the bias score for social anxiety words in the low SA group, $F(1, 9)=3.92$, $p=.08$. Finally, we conducted separate t-tests to compare each group's bias scores with zero (0 = no bias). The high SA group's bias score for somatic words significantly differed from zero, $t(9)=3.47$, $p=.007$, and the low SA group's bias score for social anxiety words also significantly differed from zero, $t(9)=3.34$, $p=.009$. No other bias scores significantly differed from zero.

It could be argued that individuals who experience greater cardiovascular activity might pay more attention to their somatic symptoms. Bias scores for somatic words, however, were not correlated with any of the cardiovascular indices in the entire sample. Likewise, none of the correlations was significant when the analyses were conducted separately for the high and the low SA groups. Therefore, the argument that greater cardiovascular responses among socially anxious individuals might demand more attention to somatic stimuli seems an unlikely explanation for the pattern of the data we obtained.

¹ A Social Anxiety X Word Type X Word Location X Probe Location GLM with participants' raw RTs yielded a significant four-way interaction, $F(2, 80)=6.53$, $p=.002$, $\eta_p^2=.14$

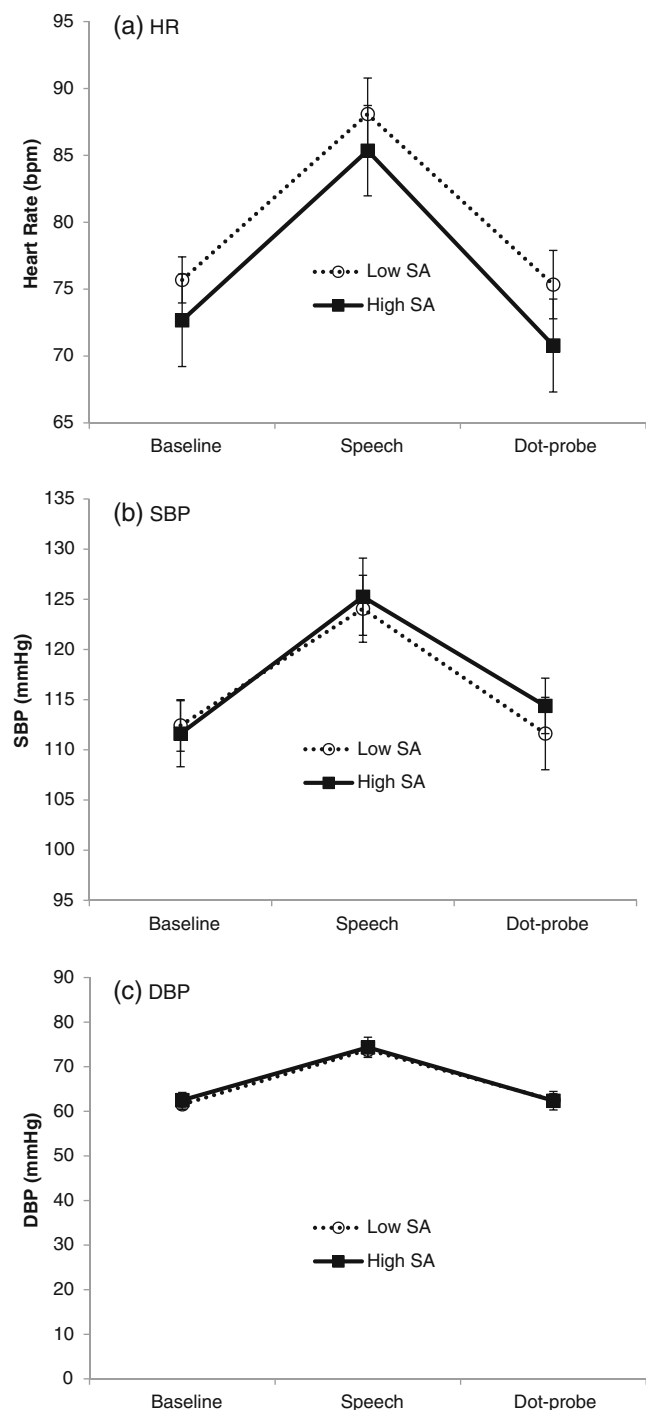


Fig. 2 Mean heart rate (HR; panel **a**), systolic blood pressure (SBP; panel **b**), and diastolic blood pressure (DBP; panel **c**). SA = social anxiety. Error bars represent standard errors

Discussion

The current study examined the relations among social anxiety, affective, and cardiovascular responses to a stressor, and attentional biases to somatic and social-evaluative stimuli. Regardless of their social anxiety level, participants

exhibited increased cardiovascular responses (relative to baseline) and self-reported anxiety during the stressor (i.e., receiving negative feedback while giving a speech). Importantly, despite reporting higher levels of anxiety, the high SA group did not differ from the low SA group in their cardiovascular responses. Further, participants' social anxiety levels were associated with different patterns of attentional biases, such that the high SA group paid more attention to somatically relevant stimuli, whereas the low SA group paid more attention to social anxiety related stimuli, immediately following a social evaluative stressor.

Although somewhat counter-intuitive, previous studies also demonstrated that physiological responses do not differ between high and low socially anxious individuals using analogue (e.g., Mauss et al. 2004) and clinical (Edelmann and Baker 2002) samples. More importantly, the current findings are consistent with cognitive models of social anxiety suggesting that socially anxious individuals shift their attention toward cues related to somatic states (Clark and Wells 1995). In the present investigation, following a social-evaluative task with negative performance feedback, socially anxious individuals exhibited greater attention to somatic cues. Considering that the high SA group's cardiovascular responses did not differ from the low SA group, it seems unlikely that the observed attentional biases to somatic cues were a consequence of increased arousal. Furthermore, attentional biases to somatic cues were not correlated with cardiovascular responses. Based on these findings, we contend that socially anxious individuals' heightened attention to somatic cues lead them to experience higher levels of anxiety compared to less anxious individuals, which is in line with the findings demonstrating increased interoceptive sensitivity in anxiety (see Domschke et al., 2010 for review).

Attentional biases to somatic cues may lead socially anxious individuals to be hypervigilant to even the slightest changes in arousal (e.g., Gerlach et al. 2004), which may lead them to report higher levels of physiological arousal despite exhibiting physiological activation that is similar to, or even less than, their non-anxious counterparts (e.g., Mauss et al. 2004). In addition, the shift in attention to somatic cues might set a foundation for socially anxious individuals to habitually misinterpret normal levels of arousal as signs of a threat (e.g., a potential source of embarrassment), thereby fostering greater anticipatory anxiety for future social interaction. Indeed, previous research (Norton, Cox, Hewitt, and McLeod 1997) has demonstrated that social anxiety is associated with high levels of anxiety sensitivity, a tendency to fear physical symptoms due to the beliefs that anxiety-related symptoms will lead to catastrophic outcomes (Reiss 1991; Reiss and McNally 1985). Socially anxious individuals' enhanced attention to somatic cues combined with their tendencies to interpret physical sensations as a potential source of social embarrassment (i.e., high anxiety sensitivity) might lead them to

experience greater anxiety in social evaluative situations. It will be important for future studies to examine whether anxiety sensitivity mediates the relation between attention to somatic cues and self-reported anxiety in socially anxious individuals.

Participants' social anxiety levels were inversely related to the degree to which they exhibited attentional biases toward social-evaluative words. It is important to note that our participants received objectively negative comments while delivering their speech. It is, thus, our speculation that individuals who would otherwise not show attentional biases toward social-evaluative words exhibited such biases in response to the negative feedback. Their attentional biases, thus, might reflect transient and reasonable increases in worry regarding their performance and evaluation. In addition, previous studies demonstrated that attentional (e.g., Amir et al. 1996; Buckner, DeWall, Schmidt, and Maner 2010) and interpretation biases (Yoon and Zinbarg 2008) for anxiety-specific stimuli (e.g., social-evaluative words for social anxiety) are suppressed in anxious individuals under threat. Taken together, it is possible that a focus on physiological responses in anticipation of, during, or following social stress is more critical to the propagation of social anxiety symptoms than any bias toward or away from social-evaluative cues. This, however, must be determined in future studies.

Some limitations are worth mentioning. Given our study's cross-sectional design, we cannot establish causal directions between attentional biases towards somatic cues and greater levels of anxiety in response to a social stressor. A manipulation of attentional focus would be the next interesting step. Another limitation is the timing in which assessment of attentional biases occurred. Arguably, it would be best to assess attentional biases while participants are giving a speech. It is, however, difficult, if not impossible, to assess participants' locus of attention while they perform a speech without diverting their attention and inadvertently make them focus on physical sensations (e.g., to monitor tactile probes ostensibly signaling internal physiological changes as in Mansell et al. 2003). Therefore, instead of assessing biases to objectively measured somatic activity, we examined biases to proximal semantic stimuli related to participants' somatic state. This methodological caveat tempers our conclusions to some degree. It, however, could be argued that our approach was a conservative test of Clark and Wells (1995)' model, given that socially anxious individuals still exhibited attentional biases even though we did not present internal signals per se (Pineles and Mineka 2005). We contend that our findings are credible given their consistency with previous research (e.g., Mansell et al. 2003; Pineles and Mineka 2005) and that the current study builds nicely upon the extant literature by investigating attentional biases and cardiovascular responses in one study.

Another limitation of the study is that we assessed only one type of bodily sensations (i.e., cardiovascular responses).

Some socially anxious individuals might be disturbed by other physiological sensations (e.g., blushing; Hofmann, Moscovitch, and Kim 2006). Therefore, it is recommended that future studies include a wider array of physiological responses, such as blushing, while also assessing attentional biases to varied stimulus categories of interest. Because we only administered 13-item subscale of the SPS, it is difficult to compare the levels of social anxiety in the current sample to participants in other studies. In addition, the Likert scale for affect, which has been used in previous research (e.g., Yoon and Joormann 2012), has not been formally validated. Finally, the findings are based on an analogue sample with a small sample size. Nonetheless, extant data do provide an empirical foundation for the integrative modeling of attentional biases, physiological activation, and self-reported affective experience in the context of social evaluation. Whether these patterns of arousal, affect, and attention emerge among individuals diagnosed with social anxiety will require future research.

To conclude, the current study implicates attentional biases to somatic cues in social anxiety. Socially anxious individuals did not report greater anxiety in evaluative situations because they experienced greater physiological arousal. Instead, it appears that they experienced greater anxiety as a consequence of greater attention given to cues related to somatic aspects of anxiety and a biased processing of normal physiological responses to social evaluation.

References

- Amir, N., McNally, R. J., Riemann, B. C., Burns, J., Lorenz, M., & Mullen, J. T. (1996). Suppression of the emotional Stroop effect by increased anxiety in patients with social phobia. *Behaviour Research and Therapy*, 34, 945–948.
- Baggett, H. L., Saab, P. G., & Carver, C. S. (1996). Appraisal, coping, task performance, and cardiovascular responses during the evaluated speaking task. *Personality and Social Psychology Bulletin*, 22, 483–494.
- Buckner, J. D., DeWall, C. N., Schmidt, N. B., & Maner, J. K. (2010). A tale of two threats: Social anxiety and attention to social threat as a function of social exclusion and non-exclusion threats. *Cognitive Therapy and Research*, 34, 449–455.
- Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, & F. R. Schneier (Eds.), *Social phobia: Diagnosis, assessment, and treatment* (pp. 69–93). New York: Guilford Press.
- Domschke, K., Stevens, S., Pfleiderer, B., & Gerlach, A. L. (2010). Interoceptive sensitivity in anxiety and anxiety disorders: An overview and integration of neurobiological findings. *Clinical Psychology Review*, 30, 1–11.
- Edelmann, R. J., & Baker, S. R. (2002). Self-reported and actual physiological responses in social phobia. *British Journal of Clinical Psychology*, 41, 1–14.
- Faunce, G. J., Mapledoram, P. K., & Job, R. F. S. (2004). Type A behavior pattern and attentional bias in relation to anger/hostility, achievement, and failure. *Personality and Individual Differences*, 36, 1975–1988.
- Feldman, P. J., Cohen, S., Hamrick, N., & Lepore, S. J. (2004). Psychological stress appraisal, emotion, and cardiovascular response in a public speaking task. *Psychology and Health*, 19(3), 353–368.
- Gerlach, A. L., Mourlane, D., & Rist, F. (2004). Public and private heart rate feedback in social phobia: A manipulation of anxiety visibility. *Cognitive Behaviour Therapy*, 33, 36–45.
- Gramer, M., & Sprintschnik, E. (2008). Social Anxiety and cardiovascular responses to an evaluative speaking task: The role of stressor anticipation. *Personality and Individual Differences*, 44, 371–381.
- Hofmann, S. G., Moscovitch, D. A., & Kim, H.-J. (2006). Autonomic correlates of social anxiety and embarrassment in shy and non-shy individuals. *Journal of Psychophysiology*, 61, 134–142.
- Keogh, E., Ellery, D., Hunt, C., & Hannent, I. (2001). Selective attentional bias for pain-related stimuli amongst pain fearful individuals. *Pain*, 91, 91–100.
- MacLeod, C., & Mathews, A. (1988). Anxiety and the allocation of attention to threat. *Quarterly Journal of Experimental Psychology*, 40A, 653–670.
- Mansell, W., Clark, D. M., & Ehlers, A. (2003). Internal versus external attention in social anxiety: an investigation using a novel paradigm. *Behaviour Research and Therapy*, 41, 555–572.
- Mattick, R. P., & Clarke, J. C. (1998). Development and validation of measures of social phobia scrutiny fear and social interaction anxiety. *Behaviour Research and Therapy*, 36, 455–470.
- Mauß, I. B., Wilhelm, F. H., & Gross, J. J. (2004). Is there less to social anxiety than meets the eye? Emotion experience, expression, and bodily responding. *Cognition and Emotion*, 18, 631–662.
- Norton, G. R., Cox, B. J., Hewitt, P. L., & McLeod, L. (1997). Personality factors associated with generalized and non-generalized social anxiety. *Personality and Individual Differences*, 22, 655–660.
- Pineles, S. L., & Mineka, S. (2005). Attentional biases to internal and external sources of potential threat in social anxiety. *Journal of Abnormal Psychology*, 114, 314–318.
- Quartana, P. J., Bounds, S., Yoon, K. L., & Burns, J. W. (2010). Anger suppression predicts pain, emotional and cardiovascular responses to cold pressor pain. *Annals of Behavioral Medicine*, 39, 211–221.
- Reiss, S. (1991). Expectancy model of fear, anxiety, and panic. *Clinical Psychology Review*, 11, 141–153.
- Reiss, S., & McNally, R. J. (1985). Expectancy model of fear. In S. Reiss & R. R. Bootzin (Eds.), *Theoretical issues in behavior therapy* (pp. 107–121). Mahwah: Lawrence Erlbaum Associates.
- Stevens, S., Gerlach, A. L., Cludius, B., Silkens, A., Craske, M. G., & Hermann, C. (2011). Heartbeat perception in social anxiety before and during speech anticipation. *Behaviour Research and Therapy*, 49, 138–143.
- Turner, S. M., Beidel, D. C., Dancu, C. V., & Stanley, M. A. (1989). An empirically derived inventory to measure social fears and anxiety: The Social Phobia and Anxiety Inventory. *Journal of Consulting and Clinical Psychology*, 1, 35–40.
- Wells, A., & Papageorgiou, C. (2001). Social phobic interoception: Effects of bodily information on anxiety, beliefs and self-processing. *Behaviour Research and Therapy*, 39, 1–11.
- Wild, J., Clark, D. M., Ehlers, A., & McManus, F. (2008). Perception of arousal in social anxiety: Effects of false feedback during a social interaction. *Journal of Behavior Therapy and Experimental Psychiatry*, 39, 102–116.
- Yoon, K. L., & Joormann, J. (2012). Stress reactivity in social anxiety disorder with and without comorbid depression. *Journal of Abnormal Psychology*, 121, 250–255.
- Yoon, K. L., & Zinbarg, R. E. (2008). Interpreting neutral faces as threatening is a default mode for socially anxious individuals. *Journal of Abnormal Psychology*, 117, 680–685.
- Zinbarg, R. E., & Barlow, D. H. (1996). Structure of anxiety and the anxiety disorders: A hierarchical model. *Journal of Abnormal Psychology*, 105, 181–193.