INTERPRETATION OF AND MEMORY FOR BODILY SENSATIONS DURING PUBLIC SPEAKING

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RUNNING HEAD: Memory for internal arousal

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Abstract

This study examined whether negative interpretations of bodily sensations result in a memory bias for such sensations under conditions of social evaluation. Undergraduate students (*N* = 77) were connected to equipment which they were told would measure their physiology and were trained on how to monitor their physiology via computer feedback as they gave a video-taped speech. Approximately half of participants (*n* = 41) were told that their physiological feedback provides important information about their performance, and those remaining (*n* = 36) were told that their physiological feedback is unrelated to their performance. Participants were subsequently given free recall and recognition tests for the computer feedback. Results suggest that believing physiological feedback is related to quality of performance resulted in enhanced memory for all information about bodily sensations. Furthermore, heightened social anxiety was associated with enhanced processing of stimuli associated with increasing physiology whereas lower social anxiety was associated with enhanced processing of stimuli associated with stable physiology when the belief that physiological feedback provides important information about performance is activated. Results are discussed in relation to cognitive behavioural models of social anxiety.

KEYWORDS: Self-focused attention; memory biases; interpretation biases; bodily sensations; social anxiety

Interpretation of and memory for bodily sensations during public speaking

1. Introduction

Self-focused attention refers to the process of directing attention towards internal information, such as thoughts, beliefs, and/or bodily sensations. According to Duval and Wicklund (1972) and Carver and Scheier (1981), directing attention towards the self serves to aid the individual in evaluating his/her behaviour. Fenigstein (1979) further distinguished between the tendency to attend towards aspects of the public self (e.g., how other people perceive oneself), referred to as public self-consciousness, and the tendency to attend towards private aspects of the self (e.g., personal thoughts feelings, and sensations), referred to as private self-consciousness.

Current cognitive models implicate self-focused attention in the maintenance of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997). In these models, individuals with social anxiety are proposed to form a mental representation of how they believe the audience perceives them. The bodily sensations that accompany anxiety are thought to play a particularly important role in the formation of this mental representation.

There is much evidence supporting these cognitive models. High levels of self-focused attention appear to result in stronger response to rejection (Fenigstein, 1979), and reduced memory accuracy for external social information (e.g., names, characteristics of a conversation partner) (Kimble, Hirt, & Arnold, 1985; Kimble & Zehr, 1982). Additionally, individuals with social anxiety disorder (SAD) have been found to score higher on measures of public self-consciousness (Hope & Heimberg, 1988; Jostes, Pook, & Florin, 1999; Lundh & Ost, 1996b; Saboonchi, Lundh, & Ost, 1999) and in some instances also on private self-consciousnesss (Hope, Rapee, Heimberg, & Dombeck, 1990; Jostes et al., 1999) compared to individuals without SAD. Furthermore, individuals with high levels of social anxiety have been found to preferentially attend to cues of internal arousal rather than cues of external social threat, whereas no such difference has been found for non-anxious individuals (Mansell, Clark, & Ehlers, 2003; Pineles & Mineka, 2005). Experimentally inducing self-focused attention in individuals with SAD results in enhanced concern over the impression they leave, increased social withdrawal (Alden, Teschuk, & Tee, 1992), and increased anxiety (Woody, 1996; Woody & Rodriguez, 2000). In contrast, instructions to attend externally during exposure have been found to result in greater reductions in within-situation anxiety and believability of feared consequences as compared to exposure alone among individuals with SAD (Wells & Papageorgiou, 1998).

Individuals with high levels of social anxiety also appear to also be more likely to interpret increased physiological response negatively. Arntz, Rauner, and van den Hout (1995) found that individuals with SAD are more likely to report an anxiety response to vignettes in which physiological symptoms of anxiety are apparent. In contrast, individuals without an anxiety disorder report an anxiety response only to vignettes in which actual danger is present. Roth, Antony, and Swinson (2001) found that individuals with SAD believe that others interpret observable symptoms of anxiety as being indicative of anxiety or a psychiatric condition and are less likely to interpret these symptoms as being a normal physical state compared to non-anxious participants. In another study, compared to non-anxious participants, individuals with SAD showed greater increases in anxiety and worry over their heart rate under conditions in which observers could hear the participant's heart rate compared to when only the participant could hear his/her heart rate (Gerlach, Mourlane, & Rist, 2004). These findings suggest that SAD concerns over physiological sensations may be related beliefs about the meaning of bodily sensations. Though, it should be noted that some studies have found that all individuals, regardless of the level of social anxiety exhibit increased anxiety and negative performance evaluation in response to false-feedback about increase arousal (Wild, Clark, Ehlers, & McManus, 2008).

This heightened awareness of internal physiological sensations may not be limited to just attentive and interpretation biases in social anxiety. In at least two studies, Hackmann and colleagues have found that most individuals with SAD report having recurrent images of social situations and that many of these images are linked to memories of early social events (Hackmann, Clark, & McManus, 2000). Importantly for this discussion, one of the main sensory modalities of these images and memories was bodily sensations, and several of the themes of these images and memories included fear of others noticing symptoms of anxiety, such as sweating or blushing (Hackmann et al., 2000; Hackmann, Surawy, & Clark., 1998).

Though memory biases for social threat information are predicted by cognitive models of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997), these studies assessing autobiographical memories of individuals with SAD (Hackmann et al., 2000; Hackmann et al., 1998) are among the few to find evidence for a memory bias for negative social evaluative information. Researchers have generally been unsuccessful in demonstrating that social anxiety is associated with a memory bias for social threat words (Cloitre, Cancienne, Heimberg, Holt, & Liebowitz, 1995; Foa, McNally, & Murdock, 1989; Rapee, McCallum, Melville, Ravenscroft, & Rodney, 1994), vignettes (Brendle & Wenzel, 2004; Wenzel, Finstrom, Jordan, & Brendle, 2005; Wenzel & Holt, 2002), or faces (Lundh & Ost, 1996a; Perez-Lopez & Woody, 2001).

One explanation as to why researchers have had difficulty detecting a memory bias in social anxiety may be due to the fact that attention is directed towards the self rather than towards external sources of threat. Studies assessing attention towards, and the meaning of, internal arousal (Clark et al., 2003; Artnz et al., 1994; Pineles & Mineka, 2005; Roth et al., 2001) suggest that one important source of threat may be internal information. What individuals with social anxiety may have a better memory for is the information that is the source of their self-focused attention: their thoughts, feelings, and bodily sensations. In fact, the few studies that have found evidence of a memory bias have found it for negative public self-referent information (e.g., thoughts about how other people perceive the self) (Mansell & Clark, 1999; O'Banion & Arkowitz, 1977; Smith, Ingram, & Brehm, 1983). To the best of our knowledge no study has yet to examine whether individuals with social anxiety also exhibit a memory bias for another source of self-focus, internal sensations of physiological arousal.

Using a false physiology feedback paradigm, this study examined whether attaching importance to the meaning of bodily sensations during a performance task would result in a memory bias for cues consistent with those bodily sensations. Participants were asked to give a speech while monitoring their physiological response on a computer monitor. Participants were subsequently asked to recall and recognize stimuli that were associated with increases, decreases, and stability in their physiological response during their speech. Half the participants were told that changes in their physiology were indicative of a poor performance; whereas the remaining participants were told that changes in their physiology were unrelated to their performance.

We hypothesized that interpreting changes in physiological arousal as being important would result in enhanced memory consistent with those beliefs (e.g., better memory stimuli associated with increasing and decreasing physiological changes). Because cognitive models of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997) and research (Mansell & Clark, 1999; Roth et al., 2001; Wells & Papageorgiou, 2001) suggest that such interpretations are common among individuals with social anxiety we also predicted that memory for stimuli indicative of changing and decreasing physiology would be most enhanced among the individuals with high social anxiety who were told that changes in their physiological arousal are important indicators of performance. That is, a three-way interaction between social anxiety, beliefs about the importance of physiological feedback, and type of feedback was predicted, such that the difference in memory for stimuli indicative of changing physiology between high and low socially anxious participants would vary as a factor of the degree to which they believed that changes in physiology were an important predictor of performance.

2. Method

2.1 Participants

Participants were 114 undergraduate students recruited from psychology classes at Concordia University, Montreal, Canada. Students received either $10, had their name entered in a draw for cash prizes or received partial credit towards their classes in exchange for participating. Half the participants were assigned to a high-importance condition (n = 57) and the remaining participants were assigned to a low-importance condition (n = 57) (see below for more information). Participants were excluded from the study if they did not attend both visits (n = 1), if they reported being diagnosed with panic disorder (n = 2), if they did not at all believe that the computer was measuring their physiology (n = 1), or if they indicated that they did not know the name for some of the images that they saw (n = 28) (see section *2.3* for a description of how the last two exclusionary criteria were assessed). One additional participant was excluded because they did not comply with instructions and 2 participants were also excluded due to experimenter error. Of the remaining participants, 42 were in the high-importance condition and 37 were in the low-importance condition.

To examine the relationship between social anxiety and memory for internal information participants were divided into high social anxiety (HSA; n = 39) and low social anxiety (LSA; n

= 40) groups based on a median split on the Social Phobia Scale (SPS; Mattick & Clarke, 1998). A median split, rather than the clinical cut off, was used as it enabled us to create groups of similar size for comparison purposes.[1]

A condition by social anxiety group ANOVA found no significant difference in age between participants in the two conditions, $F\ (1, 75) = 2.39$, $p = .13$, or the social anxiety groups, $F\ (1, 75) = 2.59$, $p = .11$, however the interaction between condition and social anxiety group approached significance, $F\ (1, 75) = 3.39$, $p = .07$, $\eta^2 = .04$. Analysis of outliers revealed two participants, ages 41 and 53 years, who were much older than other participants. Both participants were in the HSA low-importance group. After removing these two participants the interaction between condition and social anxiety group no longer approached significance, $F\ (1, 73) = 2.28$, $p = .14$. These participants were therefore eliminated from subsequent analyses. Of the remaining participants, there were no significant differences in distribution for sex, $\chi^2\ (3) = 2.56$, $p = .46$, or level of education, $\chi^2\ (9) = 12.52$, $p = .19$. Table 1 displays the average age of participants after removal of outliers, as well as the sex distribution and highest level of education attained. In the final sample analyzed in the high-importance condition 17 participants were in the HSA group and 22 were in the LSA group and in the low-importance condition 23 participants were in the HSA group and 15 were in the LSA group.

2.2 Measures

Social Phobia Scale (SPS) and *Social Interaction Anxiety Scale* (SIAS) (Mattick & Clarke, 1998). The SPS and SIAS are 20-item self-report questionnaires. The SPS assesses fear

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[1] Analyses were also run using Moderated Multiple Regression (MMR) which allows for the analyses of categorical and dimensional variables together. The disadvantage of MMR is that within participant variables (e.g., stimulus type [increasing, decreasing, stable]) cannot be entered into a single regression and thus separate regression must be calculated for each stimulus type for each memory measure (e.g., recognition and recall). As results did not significantly differ depending on whether social anxiety was analyzed categorically or dimensionally, we only report the categorical data here.

of being observed by others whereas the SIAS assesses social interaction anxiety. Scores greater than 24 on the SPS and greater than 34 on the SIAS are suggestive of SAD (Heimberg, Mueller, Holt, Hope, & Liebowitz, 1992). The scale has demonstrated excellent reliability and validity in a non-clinical sample (Osman, Gutierrez, Barrios, Kopper, & Chiros, 1998). The SPS was used to divide groups into high and low social anxiety because it assesses fears most relevant to the public speaking task in this experiment.

Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). The BDI-II is a 21-item self report questionnaire assessing symptoms of depression. Among non-clinical samples, it has demonstrated excellent reliability and validity (Carmody, 2005; Dozois, Dobson, & Ahnberg, 1998; Osman, Downs et al., 1997; Wiebe & Penley, 2005).

Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988). The BAI is a 21-item self report questionnaire assessing somatic and cognitive symptoms of anxiety. The scale has demonstrated excellent reliability and validity in non-clinical samples (Creamer, Foran, & Bell, 1995; Osman, Kopper, Barrios, Osman, & Wade, 1997).

State anxiety. At the beginning, just prior to, and just after giving the speech, participants were asked to rate how happy, angry, anxious, and depressed they were feeling using 100mm visual analog scales (VAS) anchored by “I do not feel at all X” at 0 and “I feel extremely X” at 100. The rating of anxiety was used as a measure of state anxiety. The remaining variables were simply filler items and therefore were not analyzed.

2.3 Integrity Check

Using 100mm VASs participants were asked “Did you believe that the computer was measuring your physiology?” Low scores indicate that they believed the computer was measuring their physiology and high scores indicate that they did not believe the computer was measuring their physiology.

To ensure that participants had conceptual knowledge of the image stimuli participants were asked at the end of the study if there were any images for which they did not know the name. Any participants who indicated that they did not know the name of some of the images was excluded from analyses because it was felt that absence of conceptual knowledge of image stimuli may adversely influence free recall and visual recognition of items.[2]

2.4 Image Stimuli

Stimuli were photographic images of animals, fruits and vegetables, and man-made objects that participants were told indicated that their physiology was increasing, decreasing, or stable. The meaning of each category was counterbalanced across participants (e.g., some participants were told that animal images indicate increasing physiology, whereas others were told that fruit or vegetable images indicate increasing physiology, and others were told that man-made object images indicate increasing physiology). Images were selected from Microsoft Office clip art and via searches on the internet. Stimuli were centered on the screen with a solid background. Images were 10 cm wide. Height varied depending on the photograph itself. Participants saw 20 images from each category; 5 images during the training phase, 10 images during the speech task; and 5 images as lures for the recognition test. Each image appeared on the screen for 5 seconds and was preceded by a 1 second blank screen.

2.5 Procedure

2.5.1 Physiology monitoring training.

[2] Analyses were rerun including participants who indicated that they did not know the name of all images. Though the pattern of results remained the same, some main effects and simple effects of the three-way interaction were reduced to the trend level. This appeared to result from the fact that participants who reported not knowing the names of some images substantially contributed to the level of variability within the sample.

The experiment took place in front of a computer. Participants were seated and then connected to equipment they were led to believe would be measuring their physiology. However, at no point in the study was their physiology measured. TD-142G vinyl disposable electrodes were attached to the inside of each elbow, and a Velcro electrode cuff was attached to the left index finger of each participants. Participants were told that these would measure fluctuations in heart rate and sweating respectively. A Panasonic video camera was mounted on top of the computer monitor, and a computer microphone was placed just to the left of the computer monitor. Participants were told that these would respectively measure awkward, abrupt movements and voice quality. Finally, a webcam was attached to the video camera. Participants were led to believe that it was an infra-red camera, which measured how much heat they were emitting, an indicator of blushing.

Participants were asked to give a video-taped speech, which they were led to believe would be evaluated by a psychologist at a later date. They were told that during the speech they would be provided with feedback from the computer on whether their physiology was increasing, decreasing or stable and were instructed on the type of feedback they would get for each type of physiological response. Participants then completed a practice trial to familiarize themselves with how to monitor their physiology. They were first asked to sit quietly for 30 seconds, then to jog on the spot for 30 seconds to increase physiology, and then to sit quietly for 30 seconds to decrease physiology. During each 30 second period participants were asked to observe the screen to see what happens when their physiology changes. For each practice trial participants saw 4 images that were consistent with the anticipated type of physiological response and to increase the believability of the task one image that was inconsistent with the anticipated type of physiological response.

2.5.2 Importance manipulation. Approximately half of participants were randomly assigned to a high-importance condition. They were told that if they give a successful speech, their physiology would remain fairly stable and therefore, they should expect to see mostly images indicative of stable physiology. The remaining participants were assigned to a low-importance condition, and were told that if they give a successful speech, their physiology would be likely to change but it does not reflect the quality of their performance, and therefore they should expect to see no particular pattern of images from the three categories on the screen.

2.5.3 *Speech.* Participants were then asked to choose a topic from a list of neutral topics (e.g, Discuss the pros and cons of downloading pirated music off the internet versus purchasing the real thing at the record store), and were given 3-minutes to prepare their speech.

At the end of 3-minutes to increase the impact of the importance manipulation the experimenter informed participants that the expert evaluating their speech would be given a copy of their physiological responses. Those in the high-importance condition were told that the expert would take this into account when evaluating their speech. Participants in the low-importance condition were told that the experimenter "couldn't imagine why the expert would use that information when evaluating their speech".

To enhance focus on the images on the computer monitor, the experimenter turned off the overhead light and turned on a desk lamp that was directed towards the participant. The experimenter then left the room while participants completed their 3-minute speech.

During the speech participants saw 30 images, 10 indicative of increasing, 10 of decreasing, and 10 of stable physiology. The order of the images was pseudo random to ensure that images from the same category would not appear more than twice in a row.

2.5.4 Distractor task. After completing the speech participants were taken to a separate room and given a 3-minute distractor task which consisted of completing a word search puzzle of names.

2.5.5 Free recall. Participants then returned to the room in which they gave the speech and were asked to write down as many of the images that they saw during their speech that they could remember. Participants were given 3-minutes to complete this task. At the end of 3-minutes the experimenter queried participants on any items that were unclear (e.g., If they wrote bear, the experimenter asked them to either say what kind of bear or to describe the bear to determine if they remembered seeing a polar bear).

2.5.6 *Recognition.* Participants were then were shown 30 images on the computer screen, 15 of which were ‘old’ images from the original speech (e.g., there were 5 each from the images associated with increasing, decreasing, and stable physiology) and 15 of which were ‘new’ images that they had not seen previously during the experiment. Participants were asked to indicate which pictures they had seen during the speech and which pictures were new. No more than two pictures in a row were from the same image category, and no more than two pictures in a row were both old or both new.

2.5.7 *Questionnaires.* After completing the recognition task, participants were then asked to complete a questionnaire package that included the questionnaires listed above.

2.6 Statistical Analyses

The percentages of correctly recalled items representing increasing, decreasing, and stable physiology were calculated. For recognition, the hit rate and false alarm rate were calculated for each stimulus type. Because hit and false alarm rates do not differentiate between sensitivity (e.g., the ability to distinguish between “old” and “new” items) and response bias (e.g., the tendency to respond “old” or “new”), signal detection theory (SDT) was used to tease apart these factors. *d′*, a measure of sensitivity, reflects the degree of overlap between signal (e.g. the distribution of responses to old items) and noise (e.g. the distribution of responses to new items) distributions, with less overlap reflecting greater sensitivity. It is expressed as standard deviation units between the means of the signal and noise distributions (MacMillan & Crellman, 2005; Stanislow & Todorov, 1999). There are a number of measures of response bias in SDT. Though, the likelihood ratio, β, is often reported (Stanislow & Todorov, 1999), research suggests that criterion *c* may be a better measure of response bias because it is less affected by changes in *d’* (MacMillan & Crellman, 2005; Stanislow & Todorov, 1999). Criterion *c* is the distance between the response criterion set by the participant and the neutral point where neither response is favored (e.g., the point in which the signal and noise distributions intersect) expressed in standard deviation units. *d′* and *c* were calculated on an excel spreadsheet using formulas described by Sorkin (1999). Because *d’* and *c* cannot be calculated when hit or false alarm rates are equal to either 1 or 0, an adjustment for such values must be made. The loglinear adjustment was employed as this adjustment has been shown to yield less biased results than more traditional adjustment methods (Miller, 1996).

3. Results

3.1 Social anxiety, Anxiety, and Depression

Table 1 also displays participants’ scores on the BAI, BDI-II, SPS, and SIAS. Group by condition ANOVAs demonstrate that there were no differences between conditions on the SPS, $F\ (1, 73) = .03$, $p = .87$, or SIAS, $F\ (1, 73) = .22$, $p = .64$. or the BDI-II, $F\ (1, 73) = 2.25$, $p = .14$, though there was a trend for participants in the low-importance condition to have higher scores the BAI, $F\ (1, 73) = 2.88$, $p = .09$, $\eta^2 = .04$. As expected, HSA participants scored significantly higher than did LSA participants on the SPS, F (1, 73) = 97.93, $p < .0001$, $\eta^2 = .57$, the SIAS, F (1, 73) = 46.80, $p < .0001$, $\eta^2 = .40$, the BDI-II, F (1, 73) = 4.00, $p = .05$, $\eta^2 = .05$, and the BAI, F (1, 73) = 6.05, $p = .02$, $\eta^2 = .08$. Unexpectedly, there was a significant condition by social anxiety group interaction on the BAI, F (1, 73) = 6.51, $p = .01$, $\eta^2 = .08$. Interactions were not significant for the BDI-II, F (1, 73) = .54, $p = .47$, SPS, F (1, 73) = .63, $p = .43$, or the SIAS F (1, 73) = 1.06, $p = .31$. LSA participants in the high-importance condition scoring significantly lower on the BAI than the other three groups.

3.2 Integrity Check

Group by condition ANOVAs were conducted for the integrity check question to assess the degree to which each group believed that their physiology was being monitored by the computer. There was no significant difference in the degree to which participants believed that their physiology was being monitored between conditions, F (1, 73) = 1.8, $p = .18$, or between social anxiety groups, F (1, 73) = .003, $p = .96$, nor was there an interaction between condition and social anxiety group, F (1, 73) = .10, $p = .76$. Participants generally indicated that they moderately believed that their physiology was being measured ($M = 37.17$, $SD = 28.67$).

3.3 State Anxiety

To establish that the performance task provoked anxiety, a 2 (high-importance vs low-importance) x 2 (HSA vs LSA) x 3 (baseline vs. pre-performance vs. post-performance) ANOVA was calculated with state anxiety as the dependent variable. State anxiety in HSA participants ($M = 47.69$, $SD = 24.31$) was significantly greater than state anxiety in LSA participants ($M = 31.37$, $SD = 26.57$), F (1, 73) = 15.28, $p < .0001$, $\eta^2 = .17$. There was also a significant main effect of time, F (2, 146) = 4.38, $p = .01$, $\eta^2 = .06$. Participants reported significantly more anxiety just prior to the speech, ($M = 46.41$, $SD = 25.57$) than at baseline ($M =$

39.22, *SD* = 24.60) or just after the speech (*M* = 39.63, *SD* = 26.58). There was no significant difference in state anxiety between the two conditions, F (1, 73) = .20, p = .66, n.s., nor were there any significant interactions, *F*s < 1.00. Thus, HSA participants were indeed more anxious than LSA participants, though increases in anxiety in response to the speech were not significantly different between the HSA and LSA groups.

3.4 Memory for Stimuli Associated with Physiological Response

As a result of unexpectedly lower BAI score in the high-importance LSA group, the BAI was entered as a covariate for subsequent analyses. The BDI-II was also entered as a covariate for subsequent analyses to account for the higher scores on this measure observed in the HSA compared to the LSA group. Mixed-factorial ANCOVAs with condition (high-importance vs. low-importance) and social anxiety group (HSA vs. LSA) as the between-participant factors, and stimulus type (increasing vs. decreasing vs. stable) as the within-participant factor were calculated for separately for each memory variable.

3.5 Free Recall

Free recall scores for each group and condition are displayed in Table 2. For recall, there was a significant main effect of condition, F (1, 71) = 4.52, p = .04, η^2 = .06. Table 2 demonstrates that participants in the high-importance condition recalled a significantly higher percentage of images than participants in the low-importance condition. None of the other main effects (e.g., for group and stimulus type) were significant nor were any of the interactions, *F*s < .87.

3.6 Recognition

Results for recognition are presented in Table 3. We first examined the hits and false alarm rates. For hit rate, the main effect of condition approached significance, F (1, 71) = 5.17, p

= .03, η^2 = .07. Participants in the high-importance condition had a higher hit rate than participants in the low-importance condition. None of the other main effects or interactions approached significance, *F*s < 1.91.

For false alarms, there was a significant main effect of condition, F (1, 71) = 4.67, p = .03, η^2 = .06. Participants in the high-importance condition made fewer false alarms than participants in the low-importance condition. There were no other significant main effects or interactions, *Fs* < 1.22.

d' was examined to determine if the differences observed for hits and false alarms were due to greater sensitivity in the high-importance condition. The main effect of condition was significant, F (1, 71) = 9.10, p = .004, η^2 = .11. Participants in the high-importance condition were more accurate overall than participants in the low-importance condition. None of the other main effects were significant, *F*s < 2.11, nor were any of the two-way interactions, *F*s < .56. However, the hypothesized condition x social anxiety group x stimulus type interaction nearly reached traditional levels of significance, F (2, 142) = 2.83, p = .06[3], η^2 = .04. Though within each condition HSA and LSA participants did not differ from each, pairwise comparisons of condition within each level of social anxiety did reveal that HSA and LSA participants responded differently to the high and low importance conditions. In the HSA group, participants in the high-importance condition were significantly more accurate than participants in the low-importance condition in recognizing increasing items, F (1, 71) = 4.90, p = .03, η^2 = .07, but not decreasing, F (1, 71) = 1.01, p = .32, or stable items, F (1, 71) = 2.14, p = .15. In contrast, in the LSA group, participants in the high-importance condition were significantly more accurate than

[3] Given that the three-way interaction between importance condition, social anxiety, and stimulus type, the main analysis of interest, was near but did not reach a traditional level of statistical significance, a *post-hoc* power analysis was conducted to determine if one explanation for the near significant finding for *d'* could be a lack of power in the statistical design. Power was revealed to be .55.

participants in the low-importance condition in recognizing stable items, F (1, 71) = 8.65, p = .004, η^2 = .11, and non-significantly more accurate in recognizing decreasing items, F (1, 71) = 2.64, p = .09, η^2 = .04, but not increasing items , F (1, 71) = .002, p = .96.

3.7 Response Bias

c was examined to determine if there were differences in response bias between the two conditions. Results for *c* are also presented in Table 3. None of the main effects or interactions were significant, *F*s < 1.67.

4. Discussion

This study examined whether self-focused attention coupled with a negative interpretation of bodily sensations would result in a memory bias for images representing those sensations. The relationship of these processes to social anxiety was also assessed. We predicted that individuals who interpreted changes in bodily sensations as being important to their performance would remember more stimuli associated with changes in physiology during a false feedback performance task compared to individuals who interpreted changes in bodily sensations benignly. We further anticipated that this memory bias would be amplified in individuals reporting high social anxiety.

Results were partially consistent with predictions. Individuals in the high-importance condition did not just remember more stimuli associated with changing physiology, but remembered more stimuli overall compared to individuals in the low-importance condition. This was apparent in both measures of recall and recognition accuracy. Importantly, this result could not be attributed to differences in response bias between the two conditions.

Though we anticipated that individuals in the high importance condition would remember stimuli associated specifically with changing physiology, we actually found that such an interpretation enhances memory for all stimuli. Unfortunately, because we did not test general memory ability, it is not possible to rule out the possibility that by chance, participants in the high-importance condition simply had better memory capabilities than participants in the low-importance condition. However, the random assignment of participants combined with the fact that participants in each condition did not significantly differ in level of education achieved makes the possibility of general memory differences unlikely. Furthermore, results cannot be adequately explained by differences in the degree to which participants believed the computer false feedback as there were no differences between the groups on our integrity check. Future investigators may wish to replicate this study to confirm that these factors did not in fact influence the findings.

The general enhancement of memory for information concerning one’s physiological response among participants in the high importance condition needs to be explained. Participants in the high importance condition were told that they should expect to see information consistent with stable physiology if they are giving a good speech. Information concerning what to expect regarding their physiological response should they give a good speech may not have primed them to attend to information about giving a poor speech but rather simply primed them to additional information that would be relevant to the self evaluation of their performance, in this case all information about their physiology.

Expectations concerning their performance, rather than expectations concerning their physiological response may have determined the type of information concerning their physiology to which they attended. The importance manipulation differentially influenced the accuracy with which different stimuli types were recognized depending on the participants’ level of social anxiety, though this finding only approached statistical significance. Among high social anxiety participants, holding the belief that one's physiology should be stable if giving a good speech resulted in greater recognition accuracy of stimuli associated with increases in physiological response compared holding the belief that one's physiology is unrelated to performance. In contrast, among low social anxiety participants, the belief that physiology should be stable if giving a good speech resulted in greater recognition accuracy of stimuli assoicated with stable and to some extent decreasing physiological response compared to the belief that physiological response is unrelated to performance.

One explanation for these findings is that individuals with high social anxiety tend to remember threat cues of threat whereas individuals with low social anxiety tend to remember cues of safety under social conditions. That is low socially anxious participants showed enhanced memory for cues that their performance is going well and that they are perhaps even relaxing (e.g., that their physiology was stable and possibly decreasing), whereas high socially anxious participants showed enhanced memory for cues that their performance is going poorly -- that their physiological response is not only changing, but increasing. The idea that low social anxiety is associated with enhanced processing of safety whereas high social anxiety is associated enhanced processing of threat or danger is consistent with studies demonstrating that individuals with social anxiety attend to negative social information and interpret ambiguous stimuli negatively, whereas individuals with low social anxiety attend to positive information and interpret ambiguous stimuli more positively (Breck & Smith, 1983; Constans, Penn, Ihen, & Hope, 1999; Gilboa-Schechtman, Franklin, & Foa, 2000; Perowne & Mansell, 2002; Veljaca & Rapee, 1998;).

Another explanation for these findings is that individuals with and without social anxiety have different self-regulatory strategies. Self-regulation theories suggest that different self-regulatory strategies can lead to different response behaviours (Carver & Scheier, 1998). Individuals may set a goal to achieve and work towards reducing the discrepancy between their current state and desired goal. Other individuals may set a standard to avoid and work at increasing the discrepancy between their current state and the standard to be avoided. Better memory for information concerning stable physiology may reflect discrepancy reducing strategies among low socially anxious participants, whereas better memory for information concerning increasing physiology may reflect discrepancy increasing strategies among high socially anxious participants. This interpretation is consistent with the idea that avoidance discrepancy strategies result in anxiety (Carver, Lawrence & Scheier, 1999) and consistent with cognitive models of social anxiety that propose that the core of social anxiety is a perceived discrepancy between standard s/he believes the audience has and perceived performance (Clark & Wells; Rapee & Heimberg, 1997).

These explanations, however, should be considered in light of two important factors. First, the three-way interaction was only a trend. Further analysis revealed that the power of the analysis was lower than traditionally accepted levels, suggesting that the sample size was most likely too small to detect the differences at appropriate levels of significance. Unfortunately due to the median split design it was difficult, if not impossible, to control the number of participants with high and low social anxiety in each importance condition. Secondly, differences between importance conditions within each social anxiety group were apparent only on the recognition memory task, whereas the differences in memory between the importance conditions was apparent on both recall and recognition. This is likely due to the fact that *d'* accounts for both hits and false alarms combined.

In addition to the limitations described above, it is important to note other limitations of this study. HSA participants scored significantly higher on the BDI-II. Though social anxiety and indeed most types of anxiety are often associated with greater depression, it would be beneficial to our understanding of memory in social anxiety to examine memory in a group of socially anxious participants who do not report elevated levels of depression, in order to be confident that differences observed between groups are due to social anxiety rather than depression. Unexpectedly, participants in the high-importance low social anxiety group had significantly lower BAI scores than participants in the other groups. We attempted to control for these differences statistically. Given these limitations, replication of findings, perhaps using a clinical sample, is warranted.

Despite these limitations, this is one of the first studies to attempt to assess memory for internal sensations using an ecologically valid paradigm. Memory for these internal sensations was assessed indirectly (e.g., via the type of image associated with each type of physiological information). Though assessing memory indirectly may have potentially reduced our power to detect such associations, we were still somewhat successful in detecting a memory bias. Some models of emotion processing that suggest people with anxiety show enhanced attention followed by avoidance of threat (Williams, Watts, MacLeod, & Mathews, 1997). In traditional tests of memory for threat information, individuals with high anxiety may not state that they recall or recognize threat material because of the strong desire to avoid this material, potentially reducing the ability of researchers to detect a memory bias. In fact, animal studies assessing fear memory often use avoidance as an indicator of memory and learning (Levine & Pizarro, 2004). By assessing memory for threat indirectly, anxious participants may be less likely to avoid target stimuli and therefore increase the ability of researchers to detect memory biases.

Should findings from this study be replicated in a clinical sample this will suggest that memory biases in SAD may be functionally related to other information processes biases associated with SAD. Specifically self-focused attention coupled with interpretations about the meaning of one's internal sensations may interact and result in enhanced memory for internal sensations of arousal. These memories may in turn contribute to negative images of the self (Hackmann et al., 2000; Hackmann et al., 1998). It may therefore be particularly important for cognitive behavioural therapists to focus on modifying beliefs about the self and reduce the degree of self-focused attention engaged in during social interactions. This is consistent with current cognitive-behavioural treatments for SAD (Clark et al., 2003) and may help to reduce memories for such biased sensations of arousal and help to update images of the self.

Acknowledgments

We would like to thank Oded Greemberg and Megan Wood for their help in data collection and entry, as well as the anonymous reviewers for their helpful comments. This research was supported by a doctoral scholarship awarded to the first author from the National Sciences and Engineering Research Council of Canada (NSERC) as well as by grant funding from NSERC awarded to the second author. Portions of this paper were presented at the 2006 conference of the Canadian Psychological Association.

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Table 1.

Demographic characteristics, social anxiety, general anxiety, and depression of participants

Condition		High Socially Anxiety		Low Social Anxiety	
		High-importance	Low-importance	High-importance	Low-importance
n		17	23	22	15
% Female		76	83	91	93
Level of education[a]					
% University		6	35	10	27
% Pre-university college		82	52	80	53
% Highschool		12	13	5	20
% Elementary school		0	0	5	0
Age	*M*	22.06	22.41	24.30	22.13
	SD	2.51	3.97	4.52	2.23
SPS[b]	*M*	22.65^{x}	21.15^{x}	6.00^{y}	6.93^{y}
	SD	8.29	9.24	3.21	3.79
SIAS[c]	*M*	22.82^{x}	26.70^{x}	15.43^{y}	14.00^{y}
	SD	12.94	9.44	10.31	9.85
BDI-II[d]	*M*	10.82^{x}	12.32^{x}	5.52^{y}	9.87^{y}
	SD	8.35	11.29	3.93	8.61
BAI[e]	*M*	16.18^{x}	14.64^{x}	7.13^{y}	14.80^{x}
	SD	10.99	7.51	4.24	8.14

Note. Means with differing subscripts are significantly different from each other at $p < .05$.

[a] Participants were asked to indicate their highest level of education attained. The large proportion of participants reporting having completed college is explained by the fact that residents of Quebec are required to attend college prior to starting university.

[b] Social Phobia Scale (Mattick & Clarke, 1998).

[c] Social Interaction Anxiety Scale (Mattick & Clarke, 1998).

[d] Beck Depression Inventory – II (Beck, Steer, & Brown, 1996).

[e] Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer,1988).

Table 2.

Percentage of correctly recalled stimuli associated with increasing, decreasing, and stable physiological response, after controlling for differences in age, depression and anxiety.[a]

		High Social Anxiety		Low Social Anxiety	
		High-importance	Low-importance	High-importance	Low-importance
Increasing	*M*	12.94[x]	10.00[y]	10.40[x]	10.67[y]
	SD	12.13	6.90	7.67	7.99
Decreasing	*M*	14.71[x]	10.91[y]	12.61[x]	7.33[y]
	SD	13.75	9.71	7.52	5.94
Stable	*M*	12.94[x]	9.55[y]	15.22[x]	9.33[y]
	SD	12.13	8.44	12.38	11.00

[a] Columns with differing superscripts indicate that there was a significant difference between those groups at $p < .05$.

Table 3

Percentage of hits, and false alarms during recognition for stimuli associated with increasing, decreasing and stable physiology. [a]

		High Social Anxiety		Low Social Anxiety	
		High-importance	Low-importance	High-importance^{x}	Low-importance^{y}
Hits					
Increasing	*M*	65.20^{x}	55.30^{y}	66.30^{x}	70.56^{y}
	SD	17.74	22.79	25.56	18.33
Decreasing	*M*	68.14^{x}	59.85^{y}	67.03^{x}	62.78^{y}
	SD	19.60	19.86	19.38	23.12
Stable	*M*	72.06^{x}	59.85^{y}	71.38^{x}	57.22^{y}
	SD	13.48	21.15	15.86	19.38
False Alarms					
Increasing	*M*	21.08^{x}	32.58^{y}	27.90^{x}	33.89^{y}
	SD	16.17	17.61	15.61	22.60
Decreasing	*M*	26.96^{x}	28.79^{y}	24.28^{x}	36.11^{y}
	SD	16.54	18.50	16.27	23.29
Stable	*M*	33.82^{x}	33.33^{y}	27.90^{x}	35.00^{y}
	SD	25.08	16.86	17.15	20.70
d′					
Increasing	*M*	1.38$^{x, z}$	.70^{y}	1.21^{x}	1.11^{y}
	SD	.86	.78	1.03	.93

Decreasing	*M*	1.26^{x}	.95^{y}	1.32$^{x, z†}$	.84^{y}
	SD	.85	.81	.83	.80
Stable	*M*	1.15^{x}	.81^{y}	1.33$^{x, z}$	.63^{y}
	SD	.70	.77	.70	.79
Criterion c					
Increasing	*M*	.24	.19	.07	-.09
	SD	.37	.49	.49	.49
Decreasing	*M*	.06	.18	.13	.02
	SD	.41	.45	.42	.58
Stable	*M*	-.08	.09	.02	.13
	SD	.57	.44	.44	.47

[a] Columns with differing superscripts indicate that there was a significant difference between those groups at $p < .05$. † indicates that the column with different superscript is different at $p < .10$.