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Memory Bias for Bodily Sensations in Social Anxiety

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ABSTRACT

Memory Biases for Bodily Sensations in Social Anxiety

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Cognitive models of social anxiety suggest that memory and attention towards threat are key factors in the maintenance of social anxiety. There is mounting evidence that individuals with social anxiety are engaged in self-focused attention, however there is little empirical evidence demonstrating that individuals with social anxiety exhibit memory biases for external threat information. Given that people with social anxiety tend to direct their attention towards internal aspects of the self, it may be that memorial biases are for internal cues of threat, such as bodily sensations, rather than external cues of threat. Two studies examined whether social anxiety is associated with a memory bias for cues associated with increased physiological arousal. In both studies, participants completed a performance task while monitoring what they believed was computer feedback about their bodily sensations; they were subsequently given free recall and recognition tests for the computer feedback. Study one examined whether individuals diagnosed with social anxiety disorder (SAD) exhibit a memory bias for their physiological response. Though there were no significant differences in memory for the computer feedback between SAD and control participants, among individuals with SAD only greater fear of bodily sensations was associated with better memory for the computer feedback. Study two extended the findings of study one by examining whether attaching greater importance to the meaning of bodily sensations enhances memory for those sensations. It was found that participants who were led to believe that bodily

sensations were important indicators of the quality of their performance showed enhanced memory for the computer feedback compared to participants who were provided with a neutral interpretation of bodily sensations. Furthermore, among participants told that bodily sensations are important in predicting their performance, those reporting high social anxiety remembered more information indicative of increased physiology, whereas those reporting low social anxiety remembered more information indicative of stable or decreasing physiology. Implications for our understanding of memory and anxiety, as well as specific cognitive-behavioural models of social anxiety are discussed in relation to the importance of considering individual differences in beliefs related to social situations.

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CONTRIBUTIONS OF AUTHORS

This Ph.D. consists of two manuscripts.

Study 1 (See Chapter 2)

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Study 2 (See Chapter 3)

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Relative Contributions

I proposed the overall research topic and focus of each study. For both studies I was the principal researcher responsible for the design for the studies, data collection, statistical analyses and interpretation of findings and manuscript preparation. Dr. Radomsky, the thesis supervisor, was available at all stages of research, particularly in research design and manuscript preparation, for consultation and feedback. Undergraduate students helped with data collection in both studies as part of undergraduate thesis and Psyc 311 projects. Ivana de Leo and Stella-Marie Paradisis helped with data collection in study 1. I was responsible for testing approximately 50% of participants in study 1. Additionally, I conducted 95% of the structured interviews given to participants in Study 1. The remaining 5% were administered by Stefanie Lavoie, an experienced research assistant. Oded Greemberg helped with data collection in study 2. I was responsible for testing approximately 50% of participants in study 2. For both studies I completed 100% of data analyses and manuscript preparation.

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Chapter 1

Introduction

Social anxiety is characterized by fear of one or more social situations in which embarrassment or humiliation may occur. Many individuals within the general population report having experienced at least one social fear during their lifetime (Wittchen & Fehm, 2003). Frequently reported feared social situations include public speaking, talking with other people, and eating or writing in public (Wittchen, Stein, & Kessler, 1999). To be diagnosed with social anxiety disorder (SAD) the fear must cause significant distress or interfere with daily functioning (American Psychiatric Association, 2000). The DSM-IV allows for the specification of generalized SAD, which is characterized by fear of most social situations. Researchers have also described a circumscribed or specific subtype, characterized by fear of one social situation, usually public speaking (Hook & Valentiner, 2002). The generalized subtype is associated with greater co-morbidity, earlier onset, and poorer treatment response (Hook & Valentiner, 2002) and is therefore considered more severe.

A diagnosis of SAD is associated with increased rates of unemployment, lower levels of education, and a higher likelihood to be single or divorced (Wittchen et al., 1999). A conservative estimate of the lifetime prevalence of SAD is at least 7% and the 12-month prevalence rate is 3 - 4% (Wittchen & Fehm, 2003). Social anxiety is one of the most commonly experienced types of anxiety in the general population. Because of the high prevalence of SAD, the frequency with which feared situations are encountered, and its effects on daily functioning it is also a very debilitating anxiety disorder.

Cognitive models of SAD have been developed to explain how fear in social situations is maintained across time despite the fact that individuals are frequently and repeatedly exposed to both feared social situations and corrective information (Clark & Wells, 1995; Rapee & Heimberg, 1997). Both models propose that individuals with SAD have excessively high standards for social performance, have doubts in their ability to meet these standards, and have overly negative expectations of the consequences of poor performance. Information processing biases including self-focused attention (e.g., the act of directing attention towards internal aspects of the self, such as thoughts, feeling, and bodily sensations), memory of past social experiences, and post-event processing of social events are presumed to maintain these beliefs. More specifically, when a feared social situation is encountered, the individual with SAD forms a mental image of how they believe they appear to the audience, which is then used as an indicator of their performance. According to Clark and Wells (1995), this mental image is formed by allocating attention towards interoceptive information and negative cognitions related to the self. Rapee and Heimberg (1997) suggest that interoceptive cues, external cues of social threat, and long-term memories of negative social events all play a role in developing this mental image. This attention towards the self not only has the negative effect of focusing attention upon symptoms of anxiety, but also reduces attention towards external, objective information about social performance. Clark and Wells (1995) also suggest that individuals with SAD are likely to engage in anticipatory rumination in response to a social situation. They often review what they think will happen and use recollections of past social events to develop these predictions; thus, when entering a social situation the individual with SAD is likely to already be in a self-focused negative

mood state. Furthermore, following a social situation, the individual is likely to repeatedly review the social situation in memory and retrieve other instances of perceived past failure according to Clark and Wells (1995). All three of these processes, anticipatory rumination, self-focused attention, and post-event processing, serve to confirm negative beliefs about others and the self.

Memory Biases in Social Anxiety

Both models described above imply that memory for social events is particularly important in the maintenance of social anxiety. Rapee and Heimberg (1997) suggest that long-term memories of social situations are used to develop the mental image of the self. Clark and Wells (1995) also suggest that during both the anticipatory and post-event processing memories of past social situations are likely to be recalled. It is therefore not surprising that several studies have examined whether social anxiety is associated with memory biases for negative social events.

Initial research exploring memory in social anxiety typically used social threat words as stimuli. In these experiments, participants high and low in social anxiety are given an incidental learning task that includes words classified as socially threatening (e.g., foolish, failure; Rapee, McCallum, Melville, Ravenscroft & Rodney, 1994) or neutral. After a brief delay following the encoding task, participants are asked to recall and/or recognize the words they had seen. Researchers hypothesized that socially anxious participants would remember more of the social threat words than participants reporting low levels of social anxiety. There have been several variations on this basic design, such as manipulating the level of social threat during which the material is encoding or retrieved (Breck & Smith, 1983; Mansell & Clark, 1999; O'Banion & Arkowitz, 1977;

Smith, Ingram, & Brehm, 1983), making the stimuli self-referent (Breck & Smith, 1983; Gotlib et al., 2004; Mansell & Clark, 1999; O'Banion & Arkowitz, 1977; Rapee et al., 1994; Sanz, 1996; Smith et al., 1983), and manipulating the valence of the material (Breck & Smith, 1983; Mansell & Clark, 1999; Sanz, 1996).

A considerable number of researchers have been unsuccessful in detecting memory biases in social anxiety using this paradigm for either explicit (Becker, Roth, Andrich, & Margraf, 1999; Cloitre, Cancienne, Heimberg, Holt, & Liebowitz, 1995; Rapee et al., 1994; Sanz, 1996) or implicit memory (Rapee et al., 1994) tasks. The studies that have found evidence of a memory bias for social threat in social anxiety have done so for self-referent social threat words (Breck & Smith, 1983; Gotlib et al., 2004; Smith et al., 1983) particularly when they are public self-referent (e.g., describing how others might see you; Smith et al., 1983) rather than private self-referent (e.g., describing how you see yourself). Additionally, enhanced memory for self-referent social threat information among individuals with social anxiety appears more likely to be detected when the material is encoded under conditions of social threat, such as receiving feedback following an interaction (O'Banion & Arkowitz, 1977; Smith et al., 1983) or retrieved under conditions of social threat, such as anticipating giving a speech (Breck & Smith, 1983; Mansell & Clark, 1999). However, it should be noted that Mansell and Clark (1999) found that individuals with social anxiety recalled significantly less positive and non-significantly more negative public self-referent information compared to control participants.

One possible reason for some of the inconsistencies in detecting memory biases using word stimuli may lie in the lack of ecological validity of such paradigms. Non-

spoken words are not typically the stimuli encountered by individuals in social situations. Consistent with this hypothesis, many of the studies that have had difficulty detecting memory biases have often used imaginary social situations rather than actual social interactions (e.g., Rapee et al., 1994), or have not used a self-referent encoding task (e.g., Becker et al., 1999; Cloitre et al., 1995).

Several researchers have explored whether individuals with social anxiety exhibit biased memory for more ecologically valid stimuli such as faces. The first studies to explore memory for facial stimuli were conducted by Lundh and Öst (1996a, 1996b). In each study, participants with and without SAD were required to view photographs of different faces. Participants were subsequently given a recognition test for those faces. In the first study (Lundh & Öst, 1996a), during which participants were asked to rate the expected quality of contact for each face, no memory bias was detected among participants with SAD. In contrast, in the second study (Lundh & Öst, 1996b), during which participants were asked to rate how accepting or critical each face was, individuals with SAD recognized more faces they had rated as critical compared to the control group. Coles and Heimberg (2005) attempted to replicate findings from the second study, and found that the higher rates of recognition among individuals with social phobia can be accounted for by response bias.

Other researchers have examined whether SAD is characterized by a memory bias for specific negative facial expressions. Foa, Gilboa-Schechtman, Amir, and Freshman (2000) found that individuals with generalized SAD recognized more names and faces containing negative facial expressions compared to a control group. In contrast, D'Argembeau, Van der Linden, Etienne, and Comblain (2003) found no difference

between high and low socially anxious participants in recognition of angry or happy faces or in the recall of the initial emotion of faces. Using a forced choice recognition task, Pérez-López and Woody (2001) also failed to find evidence for enhanced memory for threatening facial expressions. In summary, most studies assessing memory for facial stimuli have failed to find that social anxiety is associated with a memory bias for various negative facial expressions. Only one study (Foa et al., 2000) found evidence of a memory bias that could not be attributed to response bias. Consistent with research using word stimuli, there is scant evidence for a memory bias for faces in social anxiety.

Several studies have assessed memory for imagined and actual social interactions. These studies have also generally failed to find enhanced memory for threat information in social anxiety. In two studies, Wenzel and colleagues failed to find any difference in the recall between high and low socially anxious participants for vignettes describing positive, negative social or neutral events (Brendle & Wenzel, 2004; Wenzel & Holt, 2002), though it was found that high socially anxious participants interpreted information from the events more negatively (Brendle & Wenzel, 2004). These results were replicated using video-taped vignettes (Wenzel, Finstrom, Jordan, & Brendle, 2005).

A few studies have assessed exactly what information during a social interaction is remembered by individuals with social anxiety. Stopa and Clark (1993) had individuals with SAD as well as anxious and non-anxious control participants interact with a female confederate. They were subsequently asked to recognize details about the confederate, about the room and sounds they heard during the conversation and to recall the conversation they had. No differences were found in the amount of information recognized or the amount of conversation recalled. Three other studies, however, have

found that individuals with social anxiety may actually have a less accurate memory for information about social interactions (Daly, Vangelisti, & Lawrence, 1989; Hope, Heimberg, & Klein, 1990; Mellings & Alden, 2000).

Daly and colleagues (1989) found that individuals reporting high levels of social anxiety recognized less information about details of the room and audience members after having given a speech. However, when asked to describe the speech, it was found that high socially anxious participants recalled more negative self-related and less non-self related information about the speech compared to low anxious participants. Mellings and Alden (2000) also assessed memory for external and internal self-related information following a social interaction with a confederate. Mirroring the findings by Daly and colleagues (1989), high socially anxious participants were found to recall significantly less information about the partner compared to low socially anxious participants during the structured recall task. However, in an open ended subjective recall task, high socially anxious participants remembered more negative self-related information compared to low socially anxious participants. In both studies social anxiety was associated with decreased accuracy in remembering external aspects of the interaction, however subjective recall of the interactions were generally characterized by greater negative information about the self relative to recollections made by low socially anxious participants.

Despite the fact that research assessing memory in social anxiety under controlled laboratory conditions is largely equivocal, the work by Mellings and Alden (2000) and Daly and colleagues (1989) suggest that the autobiographical memories of individuals with social anxiety may be different from those with lower levels of social anxiety. The

autobiographical memories of social events generated by individuals with social anxiety or SAD have been found to be more negative and contain more anxiety related information than those generated by non-anxious individuals (D'Argembeau, Van der Linden, d'Acremont, & Mayer, 2006; Field & Morgan, 2004; Wenzel, Jackson, & Holt, 2002). Wenzel and colleagues (2002), however, note that in their study this effect was small with only 8% of SAD memories referencing negative affect. Autobiographical memories in these studies were generated in response to social threat cues (Wenzel et al., 2002) or by having participants think about a recent negative or ambiguous social event (D'Argembeau et al., 2006; Field & Morgan, 2004). Differences in the negativity of autobiographical memories between SAD and non-anxious participants do not appear to be apparent when such memories are generated in response to neutral social words (e.g., "talk"; Rapee et al., 1994). Thus, generation of more negative autobiographical memories seems to only occur in response to negative or ambiguous stimuli.

The autobiographical memories of individuals with social anxiety may also be phenomenologically distinct from the autobiographical memories of non-anxious individuals. D'Argembeau, and colleagues (2006) found that compared to memories of control participants the social memories of individuals with SAD contained fewer sensorial details and more self-referent information. Furthermore, memories of SAD participants were more likely seen from an observer perspective, viewing him/herself as if from the outside. This finding is consistent with results from research by Mellings and Alden (2000) as well as Daly and colleagues (1989) which found that social anxiety is associated with a less accurate memory for external aspects of an event but more recall of self-referent information. D'Argembeau and colleagues (2006) assessed memory for

auditory, visual, and tactile sensorial details. They did not assess for sensations of arousal.

Hackmann, Clark, and McManus (2000) assessed a wider array of sensory modalities. They assessed the phenomenological characteristics of recurrent images reported by individuals with SAD which were often linked to memories for adverse social events. They found that though the most common sensory modality for these images and memories was visual, the second most frequently reported modality was bodily sensations, such as sweating. Furthermore, the second and third most common themes of these images and memories were of other people pointing out anxiety symptoms and of worry about other people noticing anxiety symptoms. Unfortunately as Hackmann and colleagues (2000) did not include a control group and D'Argembeau and colleagues (2006) did not assess for bodily sensations in their study, it is not possible to determine if autobiographical memories among individuals with social anxiety or SAD are characterized by enhanced recollection of bodily sensorial information. Though it is virtually impossible to assess the accuracy of retrospective recall of autobiographical memories, studies assessing such memories suggest that the autobiographical memories of social events among individuals with social anxiety are characterized by greater negative tone, self-referent information, and possibly greater bodily sensorial detail (D'Argembeau et al., 2006; Field & Morgan, 2004; Hackmann et al., 2000; Wenzel et al,, 2002).

In summary, the evidence that social anxiety is characterized by enhanced memory for social threat information is weak, though there is some support for the possibility of enhanced memory for negative self-referent information. Research

assessing memory biases in other anxiety disorders have had similar difficulty in consistently finding evidence for enhanced memory for threat. Though some studies find evidence of a memory bias for information consistent with individual fears (Lundh, Thulin, Czyzykow, & Öst, 1998; Nunn, Stevenson, & Whalan, 1984; Radomsky & Rachman, 1999; Radomsky, Rachman & Hammond, 2001), many others fail to find evidence for a memory bias for threat information (Becker et al., 1999; Bradley, Mogg, & Williams., 1995; Foa, Amir, Gershuny, Molnar, & Kozak, 1997; Mogg & Mathews, 1990; Pickles & van den Broek, 1988; Rapee, 1994). It is notable however that many of the studies that have failed to find a memory bias in anxiety disorders have generally used encoding tasks and stimuli that encourage shallow encoding (e.g., Foa et al., 1997; Pickles & van den Broek, 1988; Rapee, 1994), whereas studies finding evidence of a memory bias have tended to use ecological valid stimuli (e.g., Radomsky & Rachman, 1999; Radomsky et al., 2001) and encoding tasks that are conceptually meaningful to the anxiety disorder under study (e.g., Lundh et al., 1998; Radomsky & Rachman, 1999).

A theory of information processing and emotion proposed by Williams, Watts, MacLeod and Mathews (1997) attempts to explain why explicit memory biases in social anxiety and anxiety in general have been difficult to demonstrate. They suggest that biases in information processing need not occur at all stages of information processing. In the case of anxiety the purpose of the emotion is to signal the presence of danger to the individual so that he/she can respond quickly and accordingly. The theory therefore hypothesizes that information processing biases in anxiety disorders occur at the automatic or perceptual level of processing. Biases at more conceptual or elaborative stages of processing are not predicted. Thus the model hypothesizes biases in attention

and possibly implicit memory, but not necessarily explicit memory among highly anxious individuals.

Consistent with William's model, individuals with social anxiety have exhibited enhanced detection of negative facial expressions (Mogg & Bradley, 2002; Mogg, Philippot, & Bradley, 2004) followed by avoidance of that stimuli (Chen, Ehlers, Clark, & Mansell, 2002; Mogg et al., 2004). In contrast, as discussed above, there is less consistent evidence that social anxiety is characterized by memorial biases for threat information. However, the theory is inconsistent with clinical observations. For instance, in one case example a woman who experienced anxiety when hosting cocktail parties participated in an exposure exercise during treatment that involved serving other people drinks (Clark & Wells, 1995). The exposure was successful, except for the fact that the woman spilled one drop of liquid. Though she initially felt positive about the outcome of the exposure, repeated rumination of the event resulted in her attempting suicide later that evening. Clearly the woman's memory for the exposure was biased towards negative aspects of the event.

An alternative explanation for the difficulty in detecting memory biases in social anxiety is that the stimuli used, frequently external examples of social threat, are not appropriate. In fact, a second significant component of the cognitive models of social anxiety suggests that it is not external aspects of the situation that individuals with social anxiety attend to, but rather their internal experience of the event, including their thoughts, feelings, and bodily sensations (Clark & Wells, 1995; Rapee & Heimberg, 1997). The woman from the previous example may not have been recollecting the

reactions of other people when she spilled the drop, but rather perhaps about how shaky her hands were or her anxiety-related feelings and thoughts as the event was happening.

Self-focused Attention and Perception of Bodily Sensations in Social Anxiety

Attention towards internally generated information, such as thoughts, feelings, and bodily sensations is known as self-focused attention. The concept was first introduced by Duval and Wicklund (1972). Fenigstein, Scheier, and Buss (1975) developed a questionnaire designed to assess a related concept known as self-consciousness. The questionnaire they developed distinguished between public self-consciousness (e.g., awareness of the self as a social object), and private self-consciousness (e.g., awareness of private aspects of the self, such as thoughts and feelings). Cognitive models of social anxiety have emphasized the role of self-focused attention, particularly during social situations, in the maintenance of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997) and many studies have explored the role of self-focused attention in social anxiety.

Several questionnaire based studies have demonstrated a positive relationship between level of social anxiety and public self-consciousness (Hope & Heimberg, 1988; Jostes, Pook, & Florin, 1999; Saboonchi, Lundh, & Öst, 1999) and in one instance also private self-consciousness (Jostes et al., 1999). Public but not private self-consciousness has also been correlated with fear of blushing, a fear common among individuals with social anxiety (Bögels, Alberts, & deJong, 1996). Furthermore, individuals reporting high levels of self-consciousness have been found to be more concerned about how they are perceived by others and respond more negatively to rejection during a social

interaction (Fenigstein, 1979). Thus social anxiety seems to be consistently related with the tendency to direct attention towards internal aspects of the self.

A few studies have specifically examined whether individuals with social anxiety exhibit enhanced attention towards internal sensations. Individuals with SAD have been found to have significantly longer response latencies during a modified Stroop colour-naming task in response to not only social threat words, and also words describing noticeable symptoms of anxiety (e.g., blushing), but not words describing non-noticeable symptoms of anxiety (e.g., breathlessness) compared to non-anxious individuals (Spector, Pecknold, & Libman, 2003).

Using a more ecologically valid paradigm, Mansell, Clark, and Ehlers (2003) further examined whether individuals with high social anxiety preferentially attend towards internal cues of anxiety (e.g., changes in physiology) rather than external cues of social evaluation (e.g., faces). Participants engaged in a modified dot-probe attention task in which they were required to detect an external probe, the letter "E," which was superimposed over images of either faces or household objects and an internal probe, a finger vibration which they were led to believe indicated changes in their physiological response. This task was completed either under conditions of social threat (e.g., giving a speech) or no threat. They found that high speech anxious participants exhibited an attentional bias towards internal arousal (as indicated by the buzzer) when anticipating giving a speech compared to low speech anxious participants.

Using a similar paradigm, Pineless and Mineka (2005) also examined preference to attend toward internal cues of arousal. Participants were shown two images on a computer screen, which was rapidly followed by a probe appearing in the location of one

of the images. Participants were required to indicate the location of the probe as quickly as possible. Participants believed that their heart rate was being monitored during the task. The image pairs included external social cues (e.g., happy vs. threat face) or internal information (e.g., photograph of what they believed was their heart rate wave vs. sound wave). They found that socially anxious participants responded faster in response to probes in the location of the heart rate rather than the sound wave compared to non-anxious participants, but were not different from non-anxious participants in their response to the external stimuli. Thus all three studies examining attention towards bodily sensations suggest that social anxiety is characterized by selective attention towards cues of internal arousal, which may be even greater when the arousal cues are related to sensations that are noticeable to others.

Not only is attention towards internal aspects of the self enhanced in individuals with social anxiety, changing the degree of self-focus seems to have specific effects on levels of social anxiety. Studies have manipulated the degree of self-focus during social interactions via the presence of either a mirror or a video-camera (Alden, Teschuk, & Tee, 1992; Fenigstein, 1979). Fenigstein (1979) found that when self-focused attention was increased via the presence of a mirror during a social interaction negative reactions towards rejection were enhanced. Individuals reporting low self-efficacy have been found to withdraw more from a social interaction in the presence of a video-camera compared to individuals reporting high self-efficacy (Alden et al., 1992).

A few studies have specifically examined the effect of increased self-focused attention in social anxiety (Bögels & Lamers, 2002; Bögels, Rijsemus, & DeJong, 2002; Woody, 1996; Woody & Rodriguez, 2000). Woody (1996) had individuals with SAD

either give a speech or stand on stage while another participant gave a speech. To manipulate self-focus the speech topic was either about him/herself or about the partner who was standing on stage. Self-focus (e.g., giving a speech about oneself or listening to a speech about oneself) increased anticipated anxiety and anxious appearance, but did not affect performance as rated by independent judges. Woody & Rodriguez (2000) replicated these results and demonstrated that increasing self-focus had similar effects on both SAD and control participants. This suggests that the effect of self-focus on anxiety in social situations is not specific to individuals with social anxiety.

In further support of the hypothesis that self-focus increases anxiety in social situations, Wells and Papageorgiou (1998) found that training individuals with SAD to shift attention externally during a session of exposure resulted in greater reductions of within-situation anxiety and the degree of belief in feared consequences compared to exposure alone. However, it should be noted that at least two studies have failed to find that increasing self-focus has an effect on fear, negative thinking, or physiological arousal in social situations among both high and low socially anxious participants (Bögels & Lamers, 2002; Bögels et al., 2002).

A few studies have examined the effect of manipulating the perception of a specific component of self-focused attention, changes in physiological arousal or bodily sensations. Researchers have found that information about increases in physiological response result in greater anxiety and negative beliefs about performance among individuals with SAD, as well as high and low socially anxious individuals (Wells & Papageorgiou, 2001; Wild, Clark, Ehlers, & McManus, 2008). Gerlach, Mourlane, and Rist (2004) examined the effects of anxiety visibility among individuals with SAD and

non-anxious controls. They had participants sit in a chair while being evaluated during which time they heard heart sounds initially via headphones and a second time over a loud speaker which was audible to observers. Consistent with findings by Spector and colleagues (2003) suggesting the observable anxiety may be particularly important, Gerlach and colleagues (2004) found that only individuals with SAD reported greater anxiety and worry when their heart rate was audible to others. Findings overall thus suggest that self-focused attention increases anxiety in social situations in most individuals regardless of level of social anxiety, but that individuals with high social anxiety may be more frequently self-focused.

Consistent with this, two studies suggest that beliefs about bodily sensations may be particularly important to social anxiety. In a questionnaire study, individuals with SAD reported that they believed other people would interpret anxiety symptoms as being indicative of intense anxiety or a psychiatric condition and less likely to interpret these symptoms as a normal physical state compared to non-anxious participants (Roth, Antony, & Swinson, 2001). Furthermore, individuals with SAD were found to infer danger based upon not only objective information about danger but also their anxiety response whereas control participants inferred danger only based upon objective information (Arntz, Rauner, & Van den Hout, 1995). Thus individuals with anxiety appear to have catastrophic beliefs concerning symptoms of anxiety and arousal. These findings clearly corroborate research on self-focused attention suggesting that social anxiety is closely related to the tendency to attach importance and direct attention towards internal aspects of the self, particularly bodily sensations.

Current Studies

Given the mounting evidence supporting the presence of self-focused attention in social anxiety, it may be that individuals with social anxiety exhibit a memory bias for internal information about the self rather than external information about social threat. Consistent with this hypothesis the few studies that have found enhanced memory for threat have done so for negative self-referent information (Breck & Smith, 1983; O'Banion & Arkowitz, 1977; Smith et al., 1983). Furthermore the research exploring autobiographical memory finds that memories and recurrent images often include information about one's anxiety symptoms (Hackmann et al., 2000; Hackmann, Surawy, & Clark, 1998). The purpose of the current studies was to explore whether social anxiety is associated with enhanced memory for bodily sensations.

The studies employed a variation of the false feedback paradigm used by Mansell and colleagues (2003). Participants in each study were asked to complete a performance task during which they were asked to monitor their physiology via feedback from a computer screen. Participants were later asked to recall and recognize the feedback they received.

The first study examined whether individuals diagnosed with SAD exhibit a memory bias for bodily sensations of arousal. Two groups, participants with SAD and non-anxious control (NAC) participants, completed the performance task as they monitored their physiological feedback. It was hypothesized that since individuals with SAD exhibit self-focused attention they should show enhanced memory for threatening internal information (e.g., changes in their physiological response), compared to NAC participants.

The second study examined the impact of beliefs about one's bodily sensations on memory for physiological feedback. Undergraduate students high and low in social anxiety were told that changes in their physiology were either related or unrelated to their speech performance. It was predicted that high social anxiety would result in enhanced memory for stimuli associated with physiological changes compared to low social anxiety, particularly when participants were led to believe that their physiological response was an important indicator of the quality of their performance.

Support for the hypothesis that social anxiety is associated with enhanced memory for internal rather than external threat may help explain previous difficulties in detecting memory biases in social anxiety. If individuals with SAD remember their internal sensations during social situations, it will further emphasize the role of self-focused attention not only at early stages of information processing (e.g., attentional stages) but also during elaborative, later stages of information processing.

Chapter 2

Memory Biases for Bodily Sensations in Social Anxiety Disorder[1]

1. Introduction

Cognitive models hypothesize that individuals with social anxiety disorder (SAD) will exhibit enhanced memory for social threat information (Clark & Wells, 1995; Rapee & Heimberg, 1997). However, most studies using social threat word stimuli have been unsuccessful in detecting a memory bias in SAD (Cloitre, Cancienne, Heimberg, Holt, & Liebowitz, 1995; Foa, McNally, & Murdock, 1989; Rapee, McCallum, Melville, Ravenscroft, & Rodney, 1994). The few studies that have found evidence of a memory bias in social anxiety have done so for negative public self-referent information (O'Banion & Arkowitz, 1977), particularly under conditions of social evaluation (Breck & Smith, 1983; Smith, Ingram, & Brehm, 1983). Though a few studies that have used more ecologically valid stimuli, such as critical or angry faces, few have found evidence of a memory bias among individuals with social anxiety (Foa, Gilboa-Schectman, Amir, & Freshman, 2000; Lundh & Öst, 1996a). Several other studies using the same stimuli have failed to find a memory bias (Coles & Heimberg, 2005; Lundh & Öst, 1996b; Pérèz-López & Woody, 2001).

Other researchers have assessed memory for social interactions using both vignettes and real interactions (Brendle & Wenzel, 2004; Daly, Vangelisti, & Lawrence, 1989; Kimble & Zehr, 1982; Mellings & Alden, 2000; Stopa & Clark, 1993; Wenzel, Finstrom, Jordan, & Brendle, 2005). Brendle and Wenzel (2004) failed to demonstrate that social anxiety was associated with enhanced recall of negative evaluative information presented in vignettes depicting prototypical social situations and

subsequently replicated this finding using video-taped social situations (Wenzel et al., 2005). Some studies have demonstrated that individuals with high levels of social anxiety remember fewer details of a social interaction compared to non-anxious controls (Daly et al., 1989; Kimble & Zehr, 1982; Mellings & Alden, 2000; Stopa & Clark, 1993).

The prediction that social anxiety is associated with enhanced memory for social threat information has generally not been supported. Studies with positive findings have used self-referent stimuli (Breck & Smith, 1983; O'Banion & Arkowitz, 1977; Smith et al., 1983), whereas most negative findings have used general social threat stimuli (Cloitre et al., 1995; Foa et al., 1989; Rapee et al., 1994). Null findings for memory bias in social anxiety for external social threat combined with research finding evidence for memory bias for self-referent information suggest that memory biases in social anxiety may be for information about the self in social situations.

This idea is consistent with another major aspect of cognitive-behavioural models of social anxiety; the tendency for socially anxious individuals, in social situations, to direct attention towards the self, particularly thoughts and beliefs about the self, as well as toward bodily sensations of arousal (Clark & Wells, 1995; Rapee & Heimberg, 1997). Individuals with SAD report greater levels of public self-consciousness, the tendency to direct attention towards observable aspects of the self (Fenigstein, Scheier, & Buss, 1975), compared to non-anxious participants (Hope & Heimberg, 1988; Jostes, Pook, & Florin, 1999; Lundh & Öst, 1996c; Saboonchi, Lundh, & Öst, 1999). When self-focused attention is experimentally induced, individuals with SAD exhibit enhanced concern over the impression they will leave (Alden, Teschuk, & Tee, 1992) and report increased anxiety (Woody, 1996; Woody & Rodriguez, 2000). Even among individuals without

SAD, experimentally induced self-focused attention results in increased concern over rejection (Fenigstein, 1979), suggesting that self-focused attention may play a causal role in the maintenance of social anxiety.

Consistent with evidence suggesting that social anxiety is associated with enhanced attention towards aspects of the self, two recent studies have found that individuals high in social anxiety exhibit attentional biases towards cues of internal arousal versus cues of external social threat (Mansell, Clark, & Ehlers, 2003; Pineles & Mineka, 2005). Mansell and colleagues (2003) found that under conditions of anticipated social threat, speech anxious individuals exhibited an internal bias, which indicated faster response to cues of internal arousal rather than an external probe, compared to non-anxious individuals. These findings were replicated by Pineles and Mineka (2005) using visual signals representing arousal rather than tactile signals.

The presence of enhanced attention towards internal cues of arousal in social anxiety may explain why researchers have generally been unsuccessful in detecting memory biases for external social threats. It may be that people with social anxiety have an enhanced memory for self-focused information. This is consistent with research demonstrating enhanced memory for self-referent information (Breck & Smith, 1983; O'Banion & Arkowitz, 1977; Smith et al., 1983).

The current study examined whether individuals with SAD exhibit a memory bias for internal physiological sensations. Participants were asked to complete a video-taped word pronunciation performance task, as they monitored their physiology. They were told that if the word appears on one side of the computer screen, it indicates that their physiology is changing, whereas if it appears on the opposite side of the screen it

indicates that their physiology is stable. After completing the task, participants were subsequently asked to recall and recognize the words they had seen. We predicted that SAD participants would remember more stimuli associated with changing physiology compared to non-anxious participants.

2. Method

2.1 *Participants*

Participants included individuals diagnosed with SAD ($n = 40$) and undergraduate students from Concordia University, Montreal, Quebec ($n = 42$), who served as a non-anxious control group (NAC). Participants were recruited via advertisements in local newspapers for SAD participants, and via notices posted around the university campus as well as announcements made in classes for NAC participants. In an attempt to match the two groups on age, students over the age of 30 in particular were encouraged to participate during recruitment. Exclusion criteria included current reports of psychosis, or a current diagnosis of bipolar or panic disorder. Participants received either cash remuneration, partial credit towards their classes or had their name entered in a draw for cash prizes in exchange for participating.

Participants were excluded if they indicated that they did not at all believe their physiology was being monitored (SAD $n = 1$; NAC $n = 1$) or they did not learn how to correctly monitor their physiology (SAD $n = 6$; NAC $n = 7$; see section 2.2.7 below for more information). After excluding these participants, there were 33 individuals in the SAD group and 34 individuals in the NAC group. The average age of SAD participants was 34.70 ($SD = 11.89$) and 64% were female. The average age of NAC participants was

29.53 (SD = 11.59) and 62% were female. There were no significant differences in age, t (65) = -1.80, p = .08, or gender, χ^2 (1) = .025, p = .87, between the groups.

Diagnoses were assessed with the Anxiety Disorders Interview Schedule – IV (ADIS-IV; T. A. Brown, DiNardo, & Barlow, 1994). Individuals in the NAC group did not meet criteria for any DSM-IV disorder. In the SAD group, the mean ADIS-IV severity score for SAD was 4.70 (Range 4-6; SD = .81). Participants reported an average of 7.48 (SD = 2.05) feared situations with a range from 3 – 11 feared situations. Thus most SAD participants in this study met criteria for the generalized subtype. Among SAD participants, 21.2% received one additional diagnosis, 30.3% received two additional diagnoses, and 3% received three additional diagnoses. Six met criteria for generalized anxiety disorder, 7 for obsessive-compulsive disorder, 3 for post-traumatic stress disorder, 6 for depression, 1 for substance dependence without physiological dependence and 1 for substance dependence without physiological dependence in sustained partial remission. Participants meeting criteria for substance dependence agreed not to use the substance(s) on the evening before or day of the experiment.

Participants were included if they were currently taking medications, though they were required to be stabilized on the same dosage for at least one month prior to participating in the study. Among the SAD participants, 27.3% reported currently taking a psychotropic medication. Medications included selective serotonin reuptake inhibitors (n = 4), tricyclic antidepressants (n = 1), other types of antidepressants (n = 2), and benzodiazepines (n = 2). Among the NAC group, 2 participants also reported taking psychotropic medication. One was prescribed an anti-psychotic drug and the other a benzodiazepine.[2]

2.2 *Measures*

2.2.1. *Anxiety Disorders Interview Schedule-IV (ADIS-IV; T.A. Brown, et al., 1994).*

The ADIS-IV is a semi-structured interview that assesses for the presence of anxiety and mood disorders using DSM-IV (American Psychiatric Association, 2000) criteria. For each diagnostic category a dimensional rating from 0 (*none*) to 8 (*very severely disturbing/disabling*) is given at the end of each subsection. Scores greater than 4 indicate that the problem causes significant distress or interference and that all DSM-IV criteria are met to warrant a diagnosis. The ADIS-IV has demonstrated good to excellent inter-rater reliability for all categories except for Dysthymia (T.A. Brown, DiNardo, Lehman, & Campbell, 2001). The interview was administered by doctoral level students trained to administer the ADIS-IV.

2.2.2. *Social Phobia Scale (SPS) and Social Interaction Anxiety Scale (SIAS; Mattick & Clarke, 1998).*

The SPS and SIAS are 20-item self-report questionnaires assessing the fear of being observed by others and social interaction anxiety, respectively. Scores greater than 24 on the SPS or greater than 34 on the SIAS are suggestive of SAD (Heimberg, Mueller, Holt, Hope, & Liebowitz, 1992). Both scales have exhibited excellent internal consistency, (αs > .85) (Heimberg et al., 1992; Mattick & Clarke, 1998; Osman, Gutierrez, Barrios, Kopper, & Chiros, 1998), test-retest reliability (Mattick & Clarke, 1998), and convergent and divergent validity in clinical and non-clinical samples (Heimberg et al., 1992; Mattick & Clarke, 1998). Additionally, the SPS and the SIAS have been shown to effectively discriminate those with SAD from those without SAD (E. J. Brown et al., 1997; Mattick & Clarke, 1998; Peters, 2000).

2.2.3 *Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996).*

The BDI-II is a 21-item self-report measure assessing cognitive, affective, and somatic symptoms of depression. The scale has exhibited acceptable internal consistency (αs > .89) (Beck et al., 1996; Carmody, 2005; Dozois, Dobson, & Ahnberg, 1998; Osman et al., 1997; Wiebe & Penley, 2005), test-retest reliability (Beck et al., 1996; Wiebe & Penley, 2005), as well as acceptable convergent and divergent validity (Beck et al., 1996; Osman et al., 1997) in clinical and non-clinical samples.

2.2.4 *Body Sensations Questionnaire (BSQ; Chambless, Caputo, Bright, & Gallagher, 1984).*

The BSQ is a 17-item self-report questionnaire assessing concern and preoccupation with autonomic arousal using a Likert scale ranging from 1 (not frightened or worried by this sensation) to 5 (extremely frightened or worried by this sensation). A total score is calculated by averaging the 17 individual items, thus scores can range from 1 to 5. The scale has exhibited acceptable internal consistency (α = .87) and 1-month test-retest reliability among a sample of individuals with agoraphobia (Chambless et al., 1984). The scale has also exhibited acceptable convergent and divergent validity (Chambless et al., 1984). Research also suggests that this scale is appropriate for use among individuals with other anxiety disorders beyond agoraphobia (Zgourides, Warren, & Englert, 1989). The BSQ was used as a measure of fear of bodily sensations rather than the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986) because items simply assess fears of bodily sensations whereas the ASI also includes wording within the items related to beliefs about the meaning of some sensations (e.g.,

"When I notice my heart is beating rapidly, I worry that I might have a heart attack") that are likely to be more relevant to panic disorder than SAD.

2.2.5 *Subjective Units of Distress Scale (SUDS).*

Participants were asked to rate how happy, angry, anxious, and depressed they were feeling at the present moment using a 100 mm visual analog scale (VAS) from 0 (*I do not feel at all X*) to 100 (*I feel extremely X*) for each emotion at baseline, just prior to, and just after the word pronunciation task. Only ratings of anxiety were analyzed; the other emotion ratings were used as filler items. (See Appendix B)

2.2.6 *Performance ratings.*

Participants were asked to rate how accurate, clear, expressive and likeable they anticipated appearing from 0 (*not at all*) to 100 (*completely*) just prior to the word pronunciation task. They were asked to make self-evaluations of these variables using the same rating scale just after completing the word pronunciation task. (See Appendix C and Appendix D)

2.2.7 *Manipulation check.*

At the end of the study participants were asked to rate, using a 100mm VAS, the degree to which they believed the computer was measuring their physiology from 0 (*completely believed*) to 100 (*did not believe at all*). Participants who did not at all believe the computer was measuring their performance were excluded. They were also asked using a 100mm VAS the degree to which they believed that their physiology was a good indicator of their performance from 0 (*physiology reflected my performance*) to 100 (*physiology was unrelated to my performance*). To ensure that participants correctly learned how to monitor their physiology based upon the location of the words on the

computer screen during the word pronunciation task, participants were asked whether words on the left indicated their physiology was stable, changing, or unrelated to their performance. Participants who answered incorrectly were excluded. (See Appendix E)

2.3 *Word Stimuli*

A total of 60 nouns were selected from the Toronto Word List (Friendly, Franklin, Hoffman, & Rubin, 1982) for use during the word pronunciation and the recognition tasks. The Toronto Word List contains 1080 nouns that are rated for frequency, imagery, and concreteness in the English language. Words with the 20 highest and 20 lowest rankings of frequency, imagery, and concreteness were eliminated from the word list. Words that were shorter than 5 letters were also eliminated. Additionally, all nouns from the Toronto Word List were screened by nine individuals from the Fear and Anxiety Disorders Lab at Concordia University, who are familiar with stimuli that may appear threatening to someone with an anxiety disorder, particularly SAD. Any word identified as potentially threatening (e.g., "speech", "party" and "needle") was eliminated from the word list. From the remaining words, 60 were randomly selected; 30 words were used for the word pronunciation task and 30 words were used as lures during the recognition test. All words were matched for word frequency, imagery and concreteness. (See Appendix F)

2.4 *Procedure*

Participants were told that the study examines whether performance on a word pronunciation task improves if one knows how his/her physiology is responding. Participants were told word pronunciation is an important part of giving a good speech and that changes in physiology increase the likelihood of word mispronunciation. After

being informed of the study purpose, baseline SUDS were taken and participants were administered the ADIS-IV.

2.4.1 *Task Training Phase*

After completing the interview, participants were seated in front of a computer. All experimental tasks (with the exception of questionnaire completion) were completed on the computer using SuperLab Pro V 2.0.4 (Cedrus Corporation, 2003) software.

During the training phase, the operation of the computer was demonstrated to participants. Participants were asked to focus on a + that appeared in the centre of the screen. The + appeared for 1000 ms, and was subsequently replaced by a colored triangle that appeared either on the left (3.5 inches [8.89 cm] from the top and 1.60 inches [4.11 cm] from the left) or on the right (3.5 inches [8.89 cm] from the top and 6.34 inches [16.10 cm] from the left) side of a 16 inch (40.64 cm) screen. Participants were asked to press "F" on the keyboard whenever the triangle appeared on the left and "J" on the keyboard whenever it appeared on the right, and then to name the color of the triangle. These keys were chosen because they are distinguished by raised marks, corresponding to the placement of the left and right index finger when touch typing. After completing 6 training trails, during which half the triangles appeared on the left and half appeared on the right, the experimenter verified that participants understood the computer task before continuing on to the next phase of the study.

2.4.2 *Physiology Monitoring Training*

Following the task training phase, participants were connected to physiology monitoring equipment. TD-142G vinyl disposable electrodes were attached to the inner elbow of each arm and a Velcro electrode cuff was attached to the left ring finger of

participants. Participants were told that the electrodes attached to the arm measured heart rate fluctuation and the electrode attached to the finger measured sweating. A Panasonic video camera was mounted directly on top of the computer monitor facing the participant and a computer microphone was placed just to the left of the monitor. Participants were told that the camera would measure "jerky awkward movements," and that the microphone would measure fluctuations in voice quality. A webcam was mounted on top of the computer monitor and participants were told that it was an infra-red camera that would measure how much heat was coming off their body, "a good measure of how much [they were] blushing."

Participants were told that the equipment would monitor their physiology and that they would receive feedback as to whether their physiology was changing or not changing. At no point in time during the experiment was the physiology of participants ever measured. Participants were told that when the stimuli appears on one side of the screen (e.g., left) it indicates that their physiology is changing and when it appears on the other side of the screen (e.g., right) it indicates that it is stable. The location of stimuli associated with changing and stable physiology was counterbalanced across participants.

Participants then completed a practice exercise to help them better remember how to monitor their physiology. The practice exercise was the same as the training task, except that participants were also asked to say out loud whether their physiology was changing or stable based on feedback from the computer. To increase the believability of the physiology manipulation, the practice exercise was completed under two conditions; while sitting quietly when 5 out of 6 of the triangles appeared in the location associated

with stable physiology, and after having jogged on the spot for 30 seconds when 5 of out 6 of the triangles appeared in the location associated with changing physiology.

2.4.3 *Word Pronunciation Task*

Just prior to completing the word pronunciation task, participants were reminded of the supposed purpose of the experiment. To increase the level of threat provoked by the word pronunciation task, participants were also told that their performance was being videotaped and would be shown to a psychologist and a linguist at a later date who would evaluate their performance. In reality, though the task was video-taped, the recordings were erased after each testing session. Just prior to beginning the task, participants provided SUDS ratings and answered anticipatory performance rating questions.

During the word pronunciation task, participants saw 30 words in total, half of which were randomly assigned to appear on the left, with remaining words appearing on the right. As soon as they detected the word, participants were asked to indicate if the word appeared on the left or the right by pressing "F" or "J" respectively, and then to say the word to the camera. Reaction time (RT) between the word appearing on the screen and participants pressing the key was measured. No more than two words in a row appeared on the same side consecutively.

After completing the word pronunciation task, participants once again provided SUDS ratings and completed the self-evaluation performance questions. Participants were then given a 3 minute distraction task consisting of a series of simple math problems to ensure that study words were not held in working memory.

2.4.4 *Memory Assessment*

Participants were told that they would be completing two more word pronunciation tasks and although their performance was still being evaluated and their physiology would continue to be monitored, they would no longer receive feedback on how their physiology was responding.

2.4.4.1 *Free recall.*

Participants were asked to recall and say out-loud to the video camera as many of the words they saw during the first task as possible. Participants were then given 3 minutes to recall as many words as possible. At the end of 3 minutes, participants were asked to rate how confident they were that they were correct from 0 (*not at all confident*) to 100 (*completely confident*) for each word they said.

2.4.4.2 *Recognition.*

Participants were then shown 60 consecutive words on the computer appearing in the center of the screen. Half of the words were from the word pronunciation task, while remaining words had not been seen during the experiment. No more than three words in a row were targets or lures and no more than two consecutive words were targets that had appeared on the left or the right. Participants were asked to indicate by pressing a key on the keyboard if the word was new ("N" key), old and appeared on the left ("F" key), or old and appeared on the right ("J" key). They were then asked to say the word to the camera.

Once the recognition task was completed participants were disconnected from the equipment and completed questionnaire packages which included the questionnaires listed above. Finally, participants answered the manipulation check questions and were debriefed concerning the true nature of the study.

2.5 *Statistical Analyses*

The percentage of correctly recalled words associated with changing and stable physiology were calculated, as were the percentages of hits and false alarms during the recognition task. Hit rates were calculated as the percentage of items correctly recognized (e.g., described as old) regardless of whether they correctly remembered the location of the word (e.g., whether it appeared on the left or right). False alarms were calculated as the percentage of new items participants said appeared on the left or right. Because hit and false alarm rates do not adequately distinguish memory accuracy from response bias, signal detection theory was used. *d'*, a measure of sensitivity, reflects the degree of overlap between distribution of signal (e.g., responses to old items) and noise (e.g., the responses to new items) measured in standard deviation units (MacMillan & Creelman, 2005; Stanislaw & Todorov, 1999). Criterion *c* was used as a measure of response bias. It reflects the distance, measured in standard deviations, between the neutral point (where the signal and noise distributions intersect) and the response criterion set by the participant. Positive values of *c* reflect a tendency to say an item was new (e.g., they had not seen it before) and negative values reflect the tendency to say an item was old (e.g., they had seen it before). Criterion *c* was chosen as a measure of response bias because it is less affected by changes in *d'* compared to other measures of response bias (MacMillan & Crellman, 2005; Stanisklow & Todorov, 1999). *d'* and *c* were calculated using the formulas described by Sorkin (1999). Because *d'* and *c* cannot be calculated when hit or false alarm rates are equal to 0 or 1, log linear adjustments, which have been shown to yield less biased results than other adjustment methods (Miller, 1996), were used to calculate hit and false alarm rates.

3. Results

3.1 *Psychopathology*

Independent *t*-tests revealed that SAD participants scored significantly higher on the SPS, t (62) = -9.94, $p < .001$, the SIAS, t (61) = -9.27, $p < .001$, the BDI-II, t (64) = -4.71, $p < .001$, and the BSQ, t (64) = -3.99, $p < .001$. Participants' scores are presented in Table 2.1.

3.2 *Manipulation Check*

There was no significant difference between SAD and NAC participants in the degree to which they believed the computer was measuring their physiology, t (65) = 1.03, $p = .31$. In general both SAD ($M = 27.58$, $SD = 24.77$) and NAC ($M = 34.74$, $SD = 31.57$) participants moderately believed that the computer was measuring their physiology.

There was also no significant difference between SAD and NAC participants in the degree to which they thought that their physiology might be a good indicator of their performance, t (65) = 1.17, $p = .25$. In general both SAD ($M = 23.58$, $SD = 19.69$) and NAC ($M = 29.26$, $SD = 20.06$) participants moderately believed that their physiology would be a good indicator of their performance.

3.3 *Anxiety and Perceived Performance during Word Pronunciation Task*

To examine the effect of the word pronunciation task on anxiety and beliefs about performance we examined anxiety SUDS and performance measures prior to and after the task. For anxiety, a group (SAD vs. NAC) x time (baseline vs. pre-task vs. post-task) ANOVA revealed that SAD participants ($M = 55.01$, $SD = 24.71$) reported significantly more state anxiety than NAC participants ($M = 34.22$, $SD = 23.50$), F (1, 64) = 23.19, $p <$

Table 2.1

Mean (SD) Scores on Symptom Measures for Social Anxiety Disorder (SAD) and Non-anxious Control (NAC) Participants

Measure	SAD	NAC
	(*n* =33)	(*n* = 34)
SPS[a]	37.35 [x]	9.36 [y]
	(13.68)	(8.39)
SIAS[b]	46.65 [x]	17.22 [y]
	(13.50)	(11.65)
BDI-II[c]	16.82 [x]	6.42 [y]
	(11.04)	(6.24)
BSQ[d]	2.46 [x]	1.77 [y]
	(.72)	(.68)

Note. Values with differing superscripts in the same row are significantly different from each other at $p < .05$.

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

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

[c] Beck Depression Inventory-II (Beck et al., 1996)

[d] Body Sensations Questionnaire (Chambless et al., 1984)

.001, $\eta^2 = .27$. The main effect of time was also significant, $F(2, 128) = 10.94, p < .001$, $\eta^2 = .15$. Pairwise comparisons show that anxiety was significantly greater at pre-task ($M = 48.61$, $SD = 26.58$) than at baseline ($M = 41.62$, $SD = 28.19$) or post-task ($M = 36.56$, $SD = 26.17$). The group x time interaction was not significant, $F(2, 128) = .17, p = .85$.

For performance perception, a group (SAD vs. NAC) x time (anticipated vs. perceived) MANOVA with ratings of accuracy, clarity, expressiveness, and likeability as the dependent variables revealed a main effect for group, $F(4, 62) = 7.45, p < .001$, $\eta^2 = .33$, and time, $F(4, 62) = 5.07, p < .001$, $\eta^2 = .25$, but no group x time interaction, $F(4, 62) = 1.15, p = .34$. Univariate ANOVAs demonstrated that compared to perceived ratings, anticipatory ratings were significantly lower for accuracy, $F(1, 65) = 13.36, p < .001$, $\eta^2 = .17$, and significantly higher for how likeable participants thought they were, $F(1, 65) = 6.76, p < .05$, $\eta^2 = .09$. There was a trend for participants to also give lower ratings for how clear, $F(1, 65) = 3.26, p = .08$, $\eta^2 = .05$, and higher ratings for how expressive, $F(1, 65) = 3.40, p = .07$, $\eta^2 = .05$ they were, when anticipating their performance prior to the task compared to their perception of their performance after the task. That is, on some performance measures participants under-anticipated their performance whereas on other measures they over-anticipated their performance. SAD participants rated themselves as significantly less accurate, $F(1, 65) = 9.26, p < .01$, $\eta^2 = .13$, clear, $F(1, 65) = 16.45, p < .001$, $\eta^2 = .20$, expressive, $F(1, 65) = 9.06, p < .01$, $\eta^2 = .12$, and likable, $F(1, 65) = 21.62, p < .001$, $\eta^2 = .25$, overall compared to NAC participants. Results are presented in Table 2.2. (See Appendix G for further Analyses related to performance)

Table 2.2

Mean (SD) Anticipated and Perceived Performance for Social Anxiety Disorder (SAD) and Non-anxious Control (NAC) Participants

	SAD		NAC	
Performance Variable	Anticipated	Perceived	Anticipated	Perceived
Accurate	74.55 ^{y}	78.24 ^{y}	81.15 ^{x}	90.41 ^{z}
	(15.78)	(18.55)	(11.61)	(11.20)
Clear	71.06 ^{y}	71.76 ^{y}	81.74 ^{x}	87.06 ^{z}
	(16.00)	(18.98)	(10.81)	(12.05)
Expressive	58.33 ^{y}	52.00 ^{y}	73.06 ^{x}	67.62 ^{x}
	(23.11)	(25.28)	(17.05)	(24.21)
Likeable	52.36 ^{y}	51.33 ^{y}	77.53 ^{x}	72.94 ^{z}
	(24.61)	(22.88)	(16.78)	(21.10)

Note. Values in the same row with differing superscripts are significantly different from each other at $p < .05$.

3.4 *Reaction Time during the Word Pronunciation Task*

A group (SAD vs. NAC) x variable (change vs. stable words) ANOVA revealed that SAD participants responded significantly slower than NAC participants during the word pronunciation task, $F(1, 64) = 8.35, p < .01, \eta^2 = .12$. There was no main effect for variable, $F(1, 64) = .70, p = .41$, however there was a significant group x variable interaction, $F(91, 64) = 5.74, p < .05, \eta^2 = .08$. Pairwise comparisons demonstrate that participants in the SAD group responded significantly more slowly to words associated with changing physiology ($M = 1330.42$ms, $SD = 506.80$ms) compared to words associated with stable physiology ($M = 1237.69$ms, $SD = 473.03$ms), $F(1, 64) = 5.08, p < .05, \eta^2 = .07$, whereas there was no significant difference in the NAC group with regard to reaction time for words associated with changing ($M = 935.94$ms, $SD = 442.52$ms) or stable ($M = 980.59$ms, $SD = 467.48$ms), physiology, $F(1, 64) = 1.25, p = .27$.

3.5 *Memory*

3.5.1 *Free Recall*

All memory-related results are presented in Table 2.3. For the percentage of items recalled, a group x variable ANOVA revealed no significant main effects for group, $F(1, 65) = .17, p = .68$, variable, $F(1, 65) = .34, p = .56$, nor a significant group x variable interaction, $F(1, 65) = .006, p = .94$. Of items that were correctly recalled, a group x variable ANOVA found that participants reported significantly greater confidence in their memory for words associated with changing compared to stable physiology, $F(1, 34) = 5.34, p < .05, \eta^2 = .14$. There were no significant differences in confidence ratings between groups, $F(1, 34) = .76, p = .39$, nor was there a significant group x variable interaction, $F(1, 34) = .61, p = .44$.

Table 2.3

Mean (SD) Recall and Recognition Scores for Words Associated with Changing and Stable Physiology for Social Anxiety Disorder (SAD) and Non-anxious Control (NAC) Participants

	SAD		NAC	
Memory Variable	Change	Stable	Change	Stable
% Recalled	9.23	8.67	8.82	8.04
	(6.86)	(6.77)	(8.16)	(7.48)
Recall	93.65^{x}	82.51^{y}	95.33^{x}	89.83^{y}
Confidence	(11.64)	(25.44)	(12.88)	(20.13)
% Recognition	72.12	71.92	74.12	69.22
Hits	(15.37)	(13.92)	(18.70)	(15.22)
% Recognition	10.51	11.92	8.24	10.69
False Alarms	(8.04)	(10.71)	(6.88)	(9.56)
Recognition *d'*	1.88^{x}	1.82^{y}	2.08^{x}	1.82^{y}
	(.67)	(.63)	(.62)	(.38)
Recognition *c*	.34	.32	.35	.41
	(.31)	(.33)	(.38)	(.39)

Note. Values in the same row with differing superscripts are significantly different from each other at $p < .05$.

3.5.2 *Recognition*

For the percentage of hits, a group x variable ANOVA revealed no significant main effects for group, $F(1, 65) = .002, p = .97$, variable, $F(1, 65) = 1.78, p = .19$, nor a significant group x variable interaction, $F(1, 65) = 2.10, p = .15$.

For false alarm rates, the group x variable ANOVA revealed no significant main effects for group, $F(1, 65) = .13, p = .34$, or variable, $F(1, 65) = 2.67, p = .11$, nor a significant group x variable interaction, $F(1, 65) = .19, p = .66$.

To determine if there were any differences in overall memory accuracy during recognition we also examined *d'*. The group x variable ANOVA revealed a significant main effect for variable, $F(1, 65) = 5.05, p < .05, \eta^2 = .10$. Participants were more accurate at detecting words associated with changing compared to stable physiology. The main effect of group was not significant, $F(1, 65) = .51, p = .48$, nor was the group x variable interaction, $F(1, 65) = 2.16, p = .15$.

For response bias, a group x variable ANOVA revealed no significant, main effects for group, $F(1, 65) = .35, p = .56$, or variable, $F(1, 65) = .15, p = .70$, nor a significant group x variable interaction, $F(1, 65) = .75, p = .39$. (See Appendix H for Source Memory Analyses and Appendix I for Analyses for participants' beliefs about their physiological response)

3.6 *Correlations Between Information Processing. Depression and Anxiety*

To examine the relationships between information processing with symptoms of depression, social anxiety, and fear of bodily sensations, correlations between the BDI, SPS, SIAS, and the BSQ with RT during the word task and percentage of items recognized were calculated. They are presented in Table 2.4 for each group.

Table 2.4

Correlations Between Symptom and Encoding and Memory measures for Social Anxiety Disorder (SAD) and Non-anxious Control (NAC) Participants

Variable	SPS[a]	SIAS[b]	BDI[c]	BSQ[d]
		SAD (n = 33)		
SPS	--	.66**	.18	.52**
SIAS	--	--	.18	.29
BDI	--	--	--	.26
RT Change	.21	-.08	.18	.09
RT Stable	.27	-.05	.29	.28
% Hits Change	.13	.12	.22	.45**
% Hits Stable	.23	.07	.22	.43*
		NAC (n = 34)		
SPS	--	.79**	.29	.58**
SIAS	--	--	.38*	.60**
BDI	--	--	--	.33
RT Change	-.28	-.08	.04	-.27
RT Stable	-.21	-.09	.02	-.25
% Hits Change	-.13	-.24	-.14	-.01
% Hits Stable	.07	-.03	-.11	-.12

* $p < .05$

** $p < .01$

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

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

[c] Beck Depression Inventory-II (Beck et al., 1996)

[d] Body Sensations Questionnaire (Chambless et al., 1984)

There were no significant correlations between these symptom variables and RT during the task in the NAC and SAD groups separately. Among SAD participants, scores on the BSQ were significantly and positively correlated with percentage of recognized changing and stable items. In the NAC group there were no significant correlations between recognition and any symptom measure.

To examine if the correlation between the BSQ and the percentage of recognized changing and stable items was significantly larger among SAD than NAC participants *r* s were transformed to Fisher's Z to test for the significance of differences between independent *r*s (Glass & Hopkins, 1984). The correlations for SAD participants were significant larger than the correlations for NAC participants for both the correlation between the BSQ and the percentage of hits for stimuli associated with changing physiology, $z = 9.03$, $p < .001$, and stimuli associated with stable physiology, $z = 10.60$, $p < .001$.

4. Discussion

This study examined whether individuals with SAD exhibit a memory bias for cues they believed indicated changing physiological arousal. Contrary to expectations we did not find that individuals with SAD remembered more words associated with changing physiology compared to a non-anxious control group. We did, however, find that participants, regardless of social anxiety status, were more accurate in recognizing words associated with changing than stable physiology and were more confident in their recall of words associated with changing than stable physiology. That is all participants appeared to show enhanced memory for information that their physiology was changing.

These results suggest that a memory bias for increasing arousal is not specific to social anxiety. Other studies have also found that all participants, regardless of social anxiety level, show enhanced memory for social threat words (Rapee et al., 1994) or affectively valenced words (Cloitre et al., 1995). One possible explanation for these findings is that processes implicated in social anxiety, such as self-focused attention, are activated in most individuals when anxiety increases in social situations. Mellings and Alden (2000) found that regardless of level of social anxiety, greater self-reported self-focused attention resulted in more negative judgments and recollections about performance during an interaction. Additionally, Wild and colleagues (2008) found that all participants, regardless of level of social anxiety, responded to false feedback that their physiology was increasing with greater self-reported anxiety and poorer perceived performance during a conversation with a stooge. What may distinguish individuals with SAD from individuals without SAD is the degree and frequency of anxiety experienced. To detect memory biases in SAD, it may be necessary to use a control group reporting minimal levels of social anxiety or to test memory using performance tasks that provoke very minimal anxiety in control participants.

An alternative hypothesis is that individual differences in the type(s) of feared stimuli among SAD participants may determine if memory biases for bodily sensations exist. We found that among SAD participants only, there was a positive correlation between a measure of fear of bodily sensations and the percentage of items associated with changing and stable physiology recognized. The relationship between recognition and fear of body sensations was not apparent among non-anxious participants. That is,

SAD participants who tended to report greater fear of bodily sensations also remembered more stimuli associated with their bodily response.

We also found higher correlations between the SPS and the BSQ than the SIAS and the BSQ, particularly among SAD participants. This is consistent with other research suggesting that fear of public speaking, but not fear of social interactions, is associated with fear of bodily sensations and panic-like symptoms (Hofmann, Ehlers, & Roth, 1995; Norton, Cox, Hewitt, & McLeod, 1997).

To account for the difficulty in demonstrating memory biases in anxiety, Williams and colleagues' (1997) model of emotion and information processing suggests that anxiety is associated with early pre-attentive information processing biases apparent in attentional tasks followed by avoidance at the voluntary stage of information processing where explicit memory biases are likely to occur. This model, however, is inconsistent with clinical observations that suggest individuals with anxiety often dwell upon fearful situations and models of social anxiety in particular that implicate post-event processing as one of the maintaining factors (Clark & Wells, 1995). Our results, though correlational, point to another possibility consistent with a different approach based on personal significance (see Radomsky & Rachman, 2004). It may be that at later stages of processing individuals selectively elaborate aspects of a social situation they believe are most relevant to their anxiety experiences. Individuals with SAD who fear bodily sensations would be more likely to remember the arousal they experienced during a social situation but may not be more likely to remember information about bored audience members, whereas the opposite may be true for individuals with SAD who report fear of judgment from others but less fear of their bodily sensations. Consistent

with this alternative hypothesis regarding anxiety and memory, the few studies that have demonstrated enhanced memory for threat in social anxiety have used personally relevant stimuli (Breck & Smith, 1983; Daly et al., 1989; Mellings & Alden, 2000; O'Banion, & Arkowitz, 1977, Smith, et al., 1983). It is also consistent with research suggesting that memorial biases are likely only to be detected when interpretation biases are examined concurrently (Hertel, Brozovich, Joormann, & Gotlib, 2008). Future research assessing memory using more idiographic approaches is warranted. Furthermore research in which the interpretation of social experiences, such as the meaning of bodily sensations during a social performance, is manipulated should be conducted to examine how such interpretations influence memory.

One other interesting finding emerged from this study and warrants discussion. During the encoding task we found that participants with SAD had longer RTs than non-anxious participants for words associated with changing but not stable physiology. It may be that slower response times for stimuli associated with changing physiology observed among SAD participants resemble the slower response of anxious compared to non-anxious participants to the 'emotional Stroop' paradigm (e.g., Lundh & Öst, 1996c). Results could reflect factors that have also been suggested to affect the emotional Stroop response including cognitive avoidance and inhibition of response due to the emotional reaction elicited by information that one's physiology is changing (Bögels & Mansell, 2004). Previous research has demonstrated that individuals with social anxiety preferentially attend to internal cues of arousal rather than external cues of social threat (Mansell et al., 2003; Pineles & Mineka, 2005). Current results suggest that selective attention may be further refined and directed towards specifically changes in

physiological response. As this study was designed as a memory study rather than an attention study, participants were not asked to respond as soon as they detect the location of the word, interpretation of these results needs to be made with caution. Future research examining selective attention for different types of internal cues in social anxiety warrants examination.

Methodologically, this study was one of the few studies to assess memory during a social task rather than in anticipation of a task. More particularly, this was one of the first studies to assess memory for personal internal information using an objective method. The alternative performance task (e.g., the word pronunciation task) in this study was successful in provoking anxiety. Changes in self-reported anxiety and differences in performance perception between the SAD and NAC groups are consistent with research using other standard performance task such as speeches (e.g., Ashbaugh, McCabe, Antony, Schmidt, & Swinson, 2005) or an interaction with a confederate (e.g., Mellings & Alden, 2000). This new methodology may allow researchers to examine memory and other information processes during anxiety provoking events rather than in anticipation of them as is frequently done (e.g., Mansell et al., 2003). However, rates of recall among participants were low ranging from 8.04% to 9.23%. These low rates of recall may have prevented us from detecting group or stimulus differences in recall. A task that encourages deeper encoding, such as having participants create sentences with the words, may have increased rates of recall.

In addition to this methodological challenge, a few other limitations should be noted. First, the SAD group reported higher levels of depression than the NAC group. However, correlations between reaction time, recognition and scores on the BDI-II were

non-significant for both the NAC and SAD groups, suggesting that depression may not have played a significant role in determining results. Secondly, our NAC group was comprised of undergraduate students. Though we attempted to reduce potential differences between the two groups by actively recruiting students over the age of 30, a community control group may have been a better comparison group. Future researchers may wish to replicate findings from this study with depression as a further exclusionary criterion and use a community control group to further examine memory for physiological arousal in social anxiety. Finally, control for familywise error rates was not possible without substantially reducing the power of the study. To ensure that results were not due to Type I error, replication, perhaps with a larger sample, is warranted.

The results of this study suggest that enhanced memory for bodily sensations of arousal may be apparent in some individuals with SAD, specifically those who report elevated fears of those sensations. For these individuals, reappraisal of beliefs about bodily sensations, interoceptive exposure, and attention retraining to reduce self-focus (Wells & Papageorgiou, 1998) may be particularly beneficial during cognitive-behavioural treatment. More broadly, these findings suggest the importance of taking an idiographic approach toward feared stimuli in both the research and cognitive-behavioural treatment of SAD.

Chapter 3

Bridge

Results of this first study suggest that all individuals, regardless of their level of social anxiety, remember information that physiology is changing better than information that physiology is stable. Among individuals with social anxiety, enhanced memory for physiological response in general may be associated with greater fear of bodily sensations. These later findings in particular suggest that beliefs concerning the meaning of one's physiological sensations, particularly among individuals high in social anxiety, may be important in determining if a memory bias for physiological arousal exists.

The purpose of study 2 (see Chapter 4, below) is to examine the role that beliefs about bodily sensations play in memory for information about physiological response during a performance task. To that end, using a similar false physiological feedback task, memory for the feedback was assessed among undergraduate students. Half of these students were told that physiological response is closely related to the quality of one's performance and half were told that physiological response is unrelated to the quality of one's performance. If beliefs about bodily sensations, particularly that they are an important factor in determining the quality of one's performance, are significant in generating memory biases for those sensations, it was anticipated that students who were told that physiological response is closely related to the quality of performance would exhibit enhanced memory for the feedback compared to the students told that physiological response was unrelated to performance. Furthermore, given that the relationship between fear of bodily sensations and memory for physiological feedback was only apparent among SAD participants in study one, in study two participants were

also divided into high and low socially anxious groups to test the hypothesis that manipulating beliefs about physiological sensations would have a greater impact on memory within high socially anxious participants compared to low socially anxious participants. Finally, since all participants exhibited a better memory for feedback associated with changing physiology compared to stable physiology in study one, it was decided to examine memory for this feedback in greater detail. High and low socially anxious individuals may attend to different types of changes in their physiological response, such as increased versus decreased arousal. Rather than being provided with information indicating physiology is either stable or changing, participants in study two were provided with information indicating physiology is increasing, decreasing, or stable. Given that individuals with social anxiety are particularly concerned about increases in arousal associated with anxiety (e.g., Arntz, Rauner, & Van den Hout; Gerlach, Mourlane, & Rish, 2004; Hackmann, Clakr & McManus, 2000; Spector, Pecknold, & Libman, 2003), it was predicted that participants high in social anxiety would exhibit enhanced memory for information about increasing physiology compared to low socially anxious participants.

Chapter 4

Interpretation of and Memory for Bodily Sensations during Public Speaking3

1. Introduction

Self-focused attention refers to the process of directing attention away from external and 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. 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.

Consistent with these models, high levels of self-focused attention appear to negatively impact people in social contexts. Individuals reporting high levels of self-focused attention, particularly towards observable aspects of the self as assessed by Fenigstein's (1979) public self-consciousness subscale, and individuals in which self-focused attention was experimentally induced via the presence of a mirror, react more strongly in response to rejection (Fenigstein, 1979), and exhibit reduced memory accuracy for external social information (e.g., names, characteristics of a conversation partner) (Kimble, Hirt, & Arnold, 1985; Kimble & Zehr, 1982), compared to individuals

reporting low levels of self-focused attention or those in which self-focus was not experimentally induced.

The negative effects of self-focused attention appear to be particularly salient in individuals with social anxiety disorder (SAD). When self-focused attention is experimentally induced, individuals with SAD respond with enhanced concern over the impression they leave, increased social withdrawal (Alden, Teschuk, & Tee, 1992), and increased anxiety (Woody, 1996; Woody & Rodriguez, 2000). Furthermore, 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 SAD have been found to score higher on measures of public self-consciousness (Hope & Heimberg, 1988; Jostes, Pook, & Florin, 1999; Lundh & Ost, 1996c; Saboonchi, Lundh, & Ost, 1999) and in some instances also on private self-consciousness, the tendency to direct attention inwards towards private aspects of the self such as one's thoughts and beliefs (Hope, Rapee, Heimberg, & Dombeck, 1990; Jostes et al., 1999) compared to individuals without SAD. In summary, self-focused attention appears to result in increased anxiety in individuals with and without social anxiety. Measures of dispositional self-consciousness (e.g., the tendency to engage in self-focused attention) suggest that individuals with SAD are more likely to engage in self-focused attention than individuals without SAD.

Consistent with these findings are studies demonstrating that social anxiety is associated with an attentional bias towards internal cues of anxiety. Using a novel false physiology feedback paradigm, Mansell, Clark and Ehlers (2003) examined attention

towards external versus internal cues of social threat. They found that under conditions of social threat (e.g., anticipation of giving a speech) speech anxious individuals responded faster to internal cues of social threat, a finger vibration that they believed indicated their physiology was changing compared to non-speech anxious individuals. This difference was not observed for external cues of social threat (angry facial expressions). Similar results were found by Pineles and Mineka (2005), though in this instance the physiological cue was visual rather than tactile.

Not only do individuals with social anxiety appear to exhibit an attentional bias for heightened internal arousal, they 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, whereas 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 individuals without SAD, 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 to beliefs of how other people interpret those sensations and may be related to performance in social situations. However, a recent study found that

individuals regardless of the level of social anxiety reported greater anxiety, and underestimated their performance during a social interaction following false-feedback indicating increased arousal compared to false-feedback indicating decreased 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 examined the phenomenological characteristics of recurrent images and memories of social events in SAD (Hackmann, Clark, & McManus, 2000; Hackmann, Surawy, & Clark, 1998). They 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 et al., 2000). Importantly for this discussion, though the main modality of the images and memories was visual, the second most frequent modality was bodily sensations. Furthermore, the second and third most common themes of the images and memories were of others noticing anxiety symptoms and of having the symptoms and fearing that others would notice (Hackmann et al., 2000; Hackmann et al., 1998).

The salience that negative social memories have among individuals with SAD is consistent with current models of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997) as well as with associative network models of mood and memory (eg. Bower, 1981). Interestingly, these studies assessing autobiographical memories of individuals with SAD (Hackmann et al., 2000; Hackmann et al., 1998) are among the few studies assessing memory in social anxiety to find evidence for a memory bias for negative social evaluative information. Researchers have generally been unsuccessfully

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). Though some studies suggest that individuals with SAD in fact exhibit memory biases for critical faces, an external source of social threat, (Foa, Gilboa-Schechtman, Amir, & Freshman, 2000; Lundh & Ost, 1996b), a more recent study suggests that this result may be due to a response bias rather than enhanced accuracy (Coles & Heimberg, 2005).

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. This would be consistent with several studies that have demonstrated that social anxiety is associated with poorer memory compared to non-anxious individuals for external social information such as characteristics of a conversation partner or their name (Daly, Vangelisti, & Lawrence, 1989; Hope, Heimberg, & Klein, 1990; Kimble & Zehr, 1982; Stopa & Clark, 1993).

Studies assessing attention towards, and the meaning of, internal arousal 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 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.

Building upon the false physiology feedback paradigm developed by Mansell and colleagues (2003), 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 a memory bias for information consistent with those beliefs (e.g., 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 biases for changing physiological arousal would be more apparent in individuals reporting high levels of social anxiety and that encouraging the interpretation of bodily sensations as being a meaningful indicator for quality of performance would result in a greater enhancement in memory biases for changing physiological arousal among these individuals.

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). 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.

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. 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 4.1 displays the average age of participants after removal of outliers, as well as the sex distribution and level of education.

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 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).

Table 4.1

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					
% University		6	35	10	27
% 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[a]	*M*	22.65[x]	21.15[x]	6.00[y]	6.93[y]
	SD	8.29	9.24	3.21	3.79
SIAS[b]	*M*	22.82[x]	26.70[x]	15.43[y]	14.00[y]
	SD	12.94	9.44	10.31	9.85
BDI-II[c]	*M*	10.82[x]	12.32[x]	5.52[y]	9.87[y]
	SD	8.35	11.29	3.93	8.61
BAI[d]	*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] Social Phobia Scale (Mattick & Clarke, 1998).

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

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

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

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. (See Appendix J)

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. (See Appendix K)

2.5 Procedure

2.5.1 Physiology monitoring training. 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; Stanisklow & 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 4.1 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 indicating 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, $Fs < 1.00$. 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. (See Appendix L for Further Analyses)

3.5 Free Recall

Free recall scores for each group and condition are displayed in Table 4.2. For recall, there was a significant main effect of condition, $F(1, 71) = 4.52$, $p = .04$, $\eta^2 = .06$. Table 4.2 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, Fs < .87.

3.6 Recognition

We first examined the hits and false alarm rates. For hit rate, the main effect of condition approached significance, $F(1, 71) = 5.17$, $p = .03$, $\eta^2 = .07$. 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, Fs < 1.91.

Table 4.2

Percentage of Correctly Recalled Stimuli Associated with Increasing, Decreasing, and Stable Physiological Response, After Controlling for Differences in Depression and Anxiety.[a]

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

[a] Columns with differing superscripts indicate that there was a significant difference between those groups.

For false alarms, there was a significant main effect of condition, $F(1, 71) = 4.67$, $p = .03$, $\eta^2 = .06$. 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, $Fs < 1.22$. Results for hits and false alarms are displayed in Table 4.3.

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, $F(1, 71) = 9.10$, $p = .004$, $\eta^2 = .11$. 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, $Fs < 2.11$, nor were any of the two-way interactions, $Fs < .56$. However, the condition x social anxiety group x stimulus type interaction nearly reached traditional levels of significance, $F(2, 142) = 2.83$, $p = .06$, $\eta^2 = .04$. 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, $F(1, 71) = 4.90$, $p = .03$, $\eta^2 = .07$, 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 participants in the low-importance condition in recognizing stable items, $F(1, 71) = 8.65$, $p = .004$, $\eta^2 = .11$, and non-significantly more accurate in recognizing decreasing

Table 4.3

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[x]	Low-importance[y]	High-importance[x]	Low-importance[y]
Hits					
Increasing	*M*	65.20	55.30	66.30	70.56
	SD	17.74	22.79	25.56	18.33
Decreasing	*M*	68.14	59.85	67.03	62.78
	SD	19.60	19.86	19.38	23.12
Stable	*M*	72.06	59.85	71.38	57.22
	SD	13.48	21.15	15.86	19.38
False Alarms					
Increasing	*M*	21.08	32.58	27.90	33.89
	SD	16.17	17.61	15.61	22.60
Decreasing	*M*	26.96	28.79	24.28	36.11
	SD	16.54	18.50	16.27	23.29
Stable	*M*	33.82	33.33	27.90	35.00
	SD	25.08	16.86	17.15	20.70

[a] Columns with differing superscripts indicate that there was a significant difference between those groups.

items, $F(1, 71) = 2.64, p = .09, \eta^2 = .04$, but not increasing items , $F(1, 71) = .002, p = .96$. These results are presented in Figure 4.1.

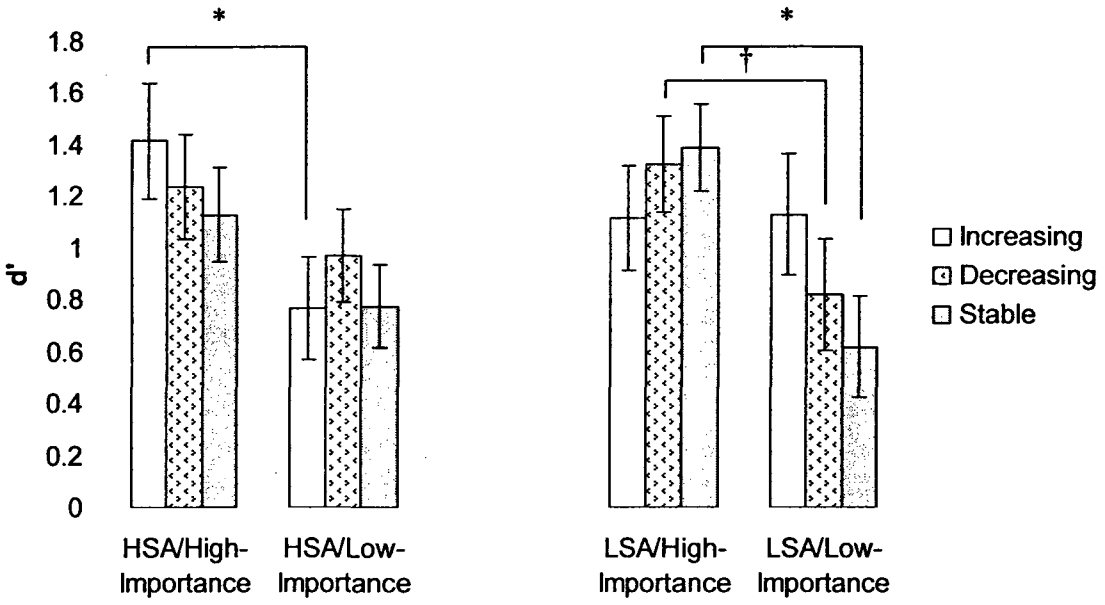
3.7 Response Bias

c was examined to determine if there were differences in response bias between the two conditions. Results for *c* are presented in Table 4.4. None of the main effects or interactions were significant, Fs < 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.



HSA = High Social Anxiety, LSA = Low Social Anxiety

* = $p < .05$, † = $p < .06$

Figure 4.1. Recognition Accuracy for Stimuli Associated with Increasing, Decreasing, and Stable Physiological Response

Table 4.4

Response Bias (Criterion c) for Recognition for Stimuli Associated with Increasing, Decreasing, and Stable Physiological Response.

		High Social Anxiety		Low Social Anxiety	
		High-importance	Low-importance	High-importance	Low-importance
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

Though we anticipated that individuals who interpret changes in bodily sensations as being important in assessing quality of performance 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 when interpreting bodily sensations as reflecting quality of performance 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. Though there were no differences in recall or recognition accuracy between high and low socially anxious participants, the importance manipulation influenced memory differently depending on whether an individual reported high or low social anxiety. Among high social anxiety participants, if they believed that their physiology should be stable if they gave a good speech, they more accurately recognized stimuli associated with increases in physiological response compared high social anxiety participants who believed that their physiology was unrelated to their performance. In contrast, among low social anxiety participants, if they believed that their physiology should be stable if they gave a good speech, they more accurately recognized stimuli associated with stable and to some extent decreasing physiological response compared to low social anxiety participants who believed that their physiology was unrelated to their performance. These findings suggest that individuals with low social anxiety show enhanced memory for cues that their performance is going well, that their physiological response is not changing or that they are even relaxing, as indicated by decreasing physiology. This could be viewed as a type of safety information. In contrast, individuals with high social anxiety show enhanced memory for cues that their performance is going poorly -- that their physiological response is not only changing, but increasing. This could be viewed as one type of threat information. 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 show

enhanced detection of negative whereas non-anxious individuals show enhanced detection of positive audience feedback(Perowne & Mansell, 2002; Veljaca & Rapee, 1998), that individuals with social anxiety interpret ambiguous social events in a threatening manner whereas non-anxious individuals interpret such events in a positive manner(Constans, Penn, Ihen, & Hope, 1999), that individuals with high social anxiety estimate the probability of negative events as higher and positive events as lower compared to low anxious individual(Gilboa-Schechtman, Franklin, & Foa, 2000), and that individuals high in social anxiety recall more negative self-descriptive traits whereas individuals low in social anxiety recall more positive self-descriptive traits (Breck & Smith, 1983).

What was remembered in the high and low social anxiety groups may be consistent with beliefs about the self. Individuals high in social anxiety are fearful that they will perform poorly and research suggests that they often believe that they do perform more poorly relative to independent observers (Alden & Wallace, 1995; Ashbaugh, McCabe, Antony, Schmidt, & Swinson, 2005; Clark & Arkowitz, 1975; Mellings & Alden, 2000; Norton & Hope, 2001; Rapee & Lima, 1992; Stopa & Clark, 1993; Woody & Rodriguez, 2000). It may be that these expectations of personal performance determine what aspects of the physiological feedback are attended to and therefore better remembered. Furthermore, memory for this information may actually enhance those beliefs about the self and contribute to the negative image of the self that is developed by individuals with social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997).

It should be noted however that the 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 ability to assess memory accuracy via *d'* in recognition as the three-way interaction was not significant for general hit rate in recognition.

In addition to the limitation concerning general memory described above, it is important to note other limitations of this study. First, a median split was used to create the high and low social anxiety groups. Absence of a large number of participants with very high scores on the SPS precluded dividing the groups based upon clinical cut-offs. Future research will need to replicate these results using a selected sample of individuals with high social anxiety, perhaps a clinical sample of individuals diagnosed with SAD. 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. Though correction was made by controlling for BAI scores in the analyses, this difference also points towards the need for replication.

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 successful in detecting a memory bias. In fact, this indirect method of assessing memory may actually enhance the detection of memory for threat information among anxious individuals as it may reduce the tendency to avoid threat information among high anxious individuals. 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. This could potentially minimize the possibility of detecting 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. Given the novel nature of the study design, future research is needed to further demonstrate the utility of this paradigm in the study of SAD and other problems such as panic disorder.

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 attention biases towards the self 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.

In summary this study examined whether a negative interpretation of physiological arousal results in enhanced memory for bodily sensations. Our findings suggest that the belief that one's physiological response provides important information about one's performance enhances memory for bodily sensations in general and expectations about performance outcome determine what type of information about one's bodily sensations is remembered.

Chapter 5

General Discussion

Cognitive models of social phobia/social anxiety disorder (e.g., Clark & Wells, 1995; Rapee & Heimberg, 1997) suggest that attentional and memorial bias exist in social anxiety. They predict that individuals with social anxiety will preferentially attend to negative threat information, particularly internal information such as self-evaluative thoughts, feelings, and sensations of arousal. Clark and Wells (1995) also suggest that memory for past social situations will be activated when anticipating a social situation and that individuals with high social anxiety will repeatedly review a social event after it has occurred. In essence, these models suggest that people with social anxiety will exhibit self-focused attention and that they will have a memory bias for social threat information. The two studies presented in this dissertation extended the basic premises described above to hypothesize that some the information better remembered during a social event by people with social anxiety may be for internal bodily sensations of arousal. Using a false physiology feedback paradigm, two studies assessed whether social anxiety and fear of bodily sensations is associated with enhanced memory for information that one's physiology is changing.

Results of these studies were partially consistent with predictions. Study one examined whether individuals diagnosed with SAD have a memory bias for cues associated with physiological arousal. Participants with SAD and without SAD completed a performance task while monitoring stimuli they believed provided feedback on their performance. Memory for that feedback was assessed. It was found that all participants exhibited better recognition for feedback concerning changing physiology

compared to stable physiology. Though individuals with SAD were not found to significantly differ from control participants in their memory for changing or stable physiological feedback, it was found that greater fear of bodily sensations among SAD but not control participants was associated with better recognition of the stimuli associated with physiological response.

In the second study, undergraduate students high and low in social anxiety gave a speech while monitoring stimuli they believed provided feedback on their physiology. Some participants were told that physiology is a good predictor of performance whereas others were told that physiology is unrelated to performance. Similar to findings from study one, it was found that believing physiology is a good predictor of performance led to enhanced memory for all stimuli associated with physiological response. The level of social anxiety determined what components of the physiological response were best remembered – high social anxiety resulted in better memory for stimuli associated with increases in physiological response whereas low social anxiety resulted in better memory for stimuli associated with stable and to some extent decreases in physiological response.

Partially consistent with initial predictions, some individuals with high levels of social anxiety exhibited a memory bias for feedback concerning physiological response, particularly concerning increases in physiological response, compared to low socially anxious individuals. However results are inconsistent with the predictions as both studies suggest that only a subgroup of individuals with social anxiety, those who also fear their bodily sensations, have a better memory for stimuli associated with internal arousal. Though current cognitive models of social anxiety (e.g., Clark & Wells, 1995; Rapee & Heimberg, 1997) do suggest that a variety of beliefs can contribute to the development

and maintenance of social anxiety, results from these studies clearly demonstrate how the focus of feared beliefs can lead to very different information processing biases depending upon where that focus lies. That is, memory biases for physiological sensations were apparent only among those individuals who reported concern about judgment from others (e.g, experienced social anxiety) and who also reported fearing bodily sensations.

These results may also provide a partial explanation for the challenge in demonstrating memory biases in social anxiety (e.g., Cloitre, Cancienne, Heimberg, Holt, & Liebowitz, 1995; Coles & Heimberg, 2005; Foa, McNally, & Murdock, 1989; Pérèz-López & Woody, 2001; Rapee, McCallum, Melville, Ravenscroft, & Rodney, 1994). Most researchers have used the same stimuli for all individuals in a study (e.g., critical faces; social threat words) and/or have only assessed level of social anxiety. Rarely have belief domains relevant to social anxiety, such as fear of bodily sensations or perfectionism, been assessed. If belief domains interact with social anxiety to produce memory biases, previous studies would have had difficulty in detecting such biases when examining socially anxious individuals as a group. The concept that there are multiple beliefs domains operating to different degrees in an individual with social anxiety may also explain why studies that assess memory for personally relevant words (e.g., Breck & Smith, 1983; Gotlib et al., 2004; Smith, Ingram, & Brehm, 1983) or for personal experiences of social situations (e.g., D'Argembeau, Van der Linden, d'Acremont, & Mayer, 2006; Daly, Vangelisti, & Lawrence, 1989; Field & Morgan, 2004; Mellings & Alden, 2000; Wenzel, Jackson, & Holt, 2002) have detected memory biases.

The importance of the interaction between the individual interpretation of a social event and memory for that event has also been recently emphasized by other researchers.

Hertel, Brozovich, Joormann, and Gotlib (2008) had individuals with SAD and non-anxious participants imagine themselves in various ambiguous social and non-social scenarios and then to finish the story of each scenario. Participants were subsequently asked to recall the scenarios and then to recall their personal ending of the scenario. Not only did SAD participants provide more socially anxious endings for the social scenarios compared to non-anxious participants they also exhibited a higher number of intrusions that were related to their personal endings when recalling the ambiguous scenario. They did not differ from non-anxious participants in how much of the social scenario was actually recalled. Furthermore, when low-anxious participants were provided with the scenarios and with endings created by SAD participants and asked to imagine themselves in the scenario, they also produced more intrusions related to the endings when recalling the scenario. These results suggest that the personal meaning of an event influences the objective memory for that event without necessarily altering access to or accuracy of the objective information itself. Further demonstrating the importance of the meaning of a social situation, Wild and colleagues (2007, 2008) have demonstrated that one session of rescripting the meaning of distressing early social memories in individuals with SAD results not only in decreased vividness and a change in the meaning of the memory but also reduces overall level of social anxiety and amount of anxiety experienced in social situations. This finding is particularly important in that it suggests that even if initial memories are encoded in a negative fashion it remains possible to update the meaning of the memory. The studies presented in this dissertation as well as the research reviewed above all suggest that interpretation and beliefs are integral components in determining how social material is remembered.

Implications for Models of Mood and Memory

Recent formulations of associative network models of mood and memory may help further inform the role of beliefs and interpretation on memory. Associative network models (e.g., Anderson & Bower, 1973; Collins & Loftus, 1975) of memory propose that memory is stored via associative links between propositional nodes. Encoding of memory occurs via the creation and/or strengthening of associative links between nodes when they are activated at the same time whereas retrieval occurs via the reactivation of those associative links. When a node is activated, other nodes that have strong associative links with the original activated node are more likely themselves to be activated. Bower (1981) proposed that emotion, like other information, is stored as a node within an associative network. This model predicted the presence of mood-congruent encoding, such that information consistent with current mood is more likely to be encoded; and mood-state dependent retrieval, such that information is more likely to be retrieved if the emotion during retrieval matches the emotion during encoding. It also predicted the presence of emotion biases, such as interpreting ambiguous stimuli in a manner consistent with the current emotional state. Recent revisions of the model suggest that not only must the activation of information and emotion occur contiguously, but also that the individual must believe that the activated information is the cause of that emotion (Bower & Forgas, 2000; Eich & Macaulay, 2000).

Results of the current studies are consistent with this recent reformulation of the associative network model of mood and memory as it was only participants who experienced higher levels of anxiety and believed that their physiological response was related to their performance who exhibited enhanced memory for stimuli associated with

increased arousal. That is, it was those individuals who were most likely to attach a causal link between the feedback they received and the emotion they experienced who were also most likely to remember that feedback. Though target stimuli (e.g., faces; social threat words) used in previous studies are often relevant to social anxiety, simply viewing the stimuli, even under conditions of social threat, may not be enough for the individual to associate his/her anxiety with the stimuli. In contrast, research assessing memory for personally relevant information may be more likely deemed by participants to be causally related with the activation of anxiety and therefore more likely to become incorporated into the associative network, thereby producing the predicted memory biases.

What results of this study and its interpretation based on models of cognition and emotion converge upon is the concept that beliefs and interpretations influence perception and memory for social events. This is consistent with schema based models of anxiety (e.g., Beck & Clark, 1997) which propose that later elaborative stages of processing are influenced not only by threat-related schemas or beliefs but also other schemas representing personal concerns of the individual.

Idiographic approaches to the study of memory in social anxiety, in which the target stimuli is chosen to be meaningful and important to each socially anxious participant, may be beneficial in helping researchers to better understand memory biases in social anxiety. Similar arguments have been put forward for the study of memory and other anxiety disorders, specifically obsessive compulsive disorder (Radomsky & Rachman, 2004). Idiographic approaches to the selection of stimuli may ensure that the content is personally meaningful thus maximizing the potential for target content to be

incorporated into the memorial system of each individual. Research using an idiographic approach for stimuli selection have proven successful in studying memory biases in OCD (Radomsky, Rachman, & Hammond, 2001; Tolin et al., 2001) and in demonstrating that autobiographical memories for negative events are not necessarily over-generalized in depressed individuals (Rottenberg, Hildner, & Gotlib, 2006). Idiographical approaches to studying social anxiety could include varying the context of the learning environment (e.g., a speech, social interaction etc.) or varying the target information to reflect interpretations consistent with beliefs (e.g., memory for bodily sensations, faces, performance perfection).

Despite the promise that idiographic approaches of memory research, it is important not to overlook the challenges and limitations of this sort of research. One challenge is determining how to select stimuli idiographically. Are target stimuli selected only by the population of interest with control participants yoked to target participants? This approach could potentially confound meaningfulness with anxiety since only the target population selected personally relevant stimuli. Alternatively, if each participant selects meaningful stimuli, this may reduce variance between groups, reducing the power of the study. This may be particularly relevant in the case of social anxiety, as many individuals without SAD also report varying degrees of anxiety in social situations. With both approaches, since target stimuli vary across participants, it becomes difficult to control for potentially confounding variables such as stimulus frequency or the degree of imagery of each stimulus. A third, semi-idiographic approach, in which participants rate the meaningfulness of each stimulus following the memory test, potentially reduces such confounding variables. A challenge in using this method is that stimuli remain pre-

selected for participants, thus for some participants personally meaningful and important stimuli may not be present.

An alternative approach may be to employ Eich and colleagues' (1994) methodology for detecting mood-dependent memory. They argued that in order for mood-dependent memory effects to be apparent, the to-be-learned material should be internally generated and elaborative. They argue that autobiographical memories provide the right type of rich, personally meaningful material. To that end, under conditions of either positive or negative mood they had participants generate autobiographical memories to neutral cues words. Two days later participants were asked to recall the memories they had generated either under similar or different mood conditions. Using this more elaborative encoding method they were able to reliably demonstrate mood dependence. A similar design could be employed under social threat or neutral conditions in which participants are asked to generate autobiographical memories and recall them during a subsequent retrieval sessions. Importantly, this would allow for the assessment not just of phenomenological differences of autobiographical memories, but also for the predicted presence of mood-congruent and mood-dependent memory in social anxiety. Modifications to this paradigm wherein, for example, participants are required to generate memories in response to words related to beliefs common in social anxiety (e.g., perfection; success; blushing) could be used to assess if interpretation is also important to the generation of biased memory in social anxiety. In such a paradigm it might be expected that at time two participants with social anxiety who attach importance to their bodily sensations would be more likely to recall autobiographical memories generated in response to words describing physical sensations whereas those

who attach importance to their self-perceived perfection would better recall memories generated in response to words describing perfection. A further advantage of such paradigms may be that recollection of prior social experiences may better reflect the type of ruminative recall of past experiences predicted by models of social anxiety (Clark & Wells, 1995; Rapee & Heimberg, 1997). Refined memorial experiments that include rich, detailed, self-generated stimuli as those outlined above may enable researchers to more clearly establish the importance of interpretation and beliefs in the generation of memorial biases in social anxiety.

Treatment Implications

The conclusion derived from the current studies, that there is variability in the types of beliefs held by individuals with SAD and that these beliefs impact information processing differently, may also have implications for the treatment of SAD. Currently, cognitive behaviour therapy (CBT) and exposure are recognized as efficacious treatments for SAD (Chambless & Ollendick, 2001; Heimberg, 2002; Rodebaugh, Holaway, & Heimberg, 2004). Interventions may include exposure, relaxation training, social skills training and/or cognitive restructuring (Radomsky & Otto, 2001).

Meta-analyses suggest that relaxation and social skills training may result in less improvement than exposure (Federoff & Taylor, 2001; Gould, Buckmeister, Pollack, Otto, & Yap, 1997; Taylor, 1996). The effectiveness of cognitive restructuring in comparison to exposure is less clear. It is generally concluded that cognitive restructuring plus exposure is as effective as exposure alone (Heimberg, 2002; Rodebaugh et al., 2004), though a more recent review suggests that there may be evidence that cognitive restructuring and exposure is more effective than exposure alone

(Poniah & Hollon, 2008). In particular, a recent randomized placebo-controlled trial comparing cognitive therapy (CT) to fluoxetine found that CT was superior to both fluoxetine plus self-exposure and placebo plus self-exposure at post-treatment and at 12-month follow-up (Clark et al., 2003). Importantly the effect size for CT was larger than effect sizes observed for other well-designed randomized controlled trials of CBT for SAD (e.g., Heimberg et al., 1998; Liebowitz et al., 1999).

The enhanced efficacy of Clark and colleagues' (2003) CT may rest on the fact that the treatment protocol directly targets important sources of biased information processing, specifically self-focused attention. Clients are asked to shift attentional focus towards external aspects of an event and are provided with behavioural experiments to explore the effects of self-focused attention on anxiety. Directly targeting this important component of information processing in social anxiety, one that is directly related to beliefs about physiological sensations may have enhanced the efficacy of CBT for SAD. Results from the current studies that imply that beliefs concerning bodily sensations may be particularly relevant for some individuals with SAD suggests that additional behavioural experiments designed to explore not only the effects of self-focused attention on levels of anxiety, but also the meaning of internal sensations may also be helpful. Interoceptive exposure (e.g., exposure to feared bodily sensations), for example, could help individuals evaluate the validity of their beliefs about the meaning of their sensations.

Though Clark and colleagues (2003) treatment enhanced the efficacy of CBT for SAD by including specific modules targeting self-focused attention, results from particularly study 1 suggest that not all individuals with SAD may benefit from this new

treatment. The current studies suggest that aspects of the self attended to (e.g., physiological sensations vs. thoughts vs. feelings) may be variable among individuals with SAD. Treatment efficacy may be further improved by taking an idiographic approach to treatment for SAD. It may be important to ask the individual how they determine their performance in a social context. For individuals who believe that the increased arousal they experience in social situations indicates their ineptness in social situations, treatments that target beliefs about the meaning of bodily sensations and that help the individual to use other information (e.g., external feedback) in evaluating performance in social situations may be helpful. For individuals for whom social anxiety is not related to the meaning of bodily sensations, but perhaps other factors such as high perfectionism, other interventions may be more beneficial. By taking an idiographic approach to identify how an individual evaluates his/her social competence (e.g., via bodily sensations, perfectionism, negative audience behaviours) and what components of the self are attended to, CBT for SAD may be further enhanced.

CT that includes components that target self-focused attention (Clark et al., 2003) suggests that addressing attentional biases may be important in the treatment of SAD. How important is addressing memorial biases, should they exist, in the treatment of SAD? Recent research demonstrating that memory rescripting may be an effective treatment for SAD (Wild et al., 2007, 2008) suggests that targeting memorial processes may also be of benefit. Studies comparing CT with rescripting to CT without rescripting, however, are necessary to demonstrate that memory rescripting enhances the treatment of SAD. Should the efficacy of memory rescripting be demonstrated it would suggest, consistent with cognitive models of social anxiety (Clark & Wells, 1995; Rapee &

Heimberg, 1997), that memorial processes are important in SAD and would support a call for additional research to study memory in SAD. Innovative paradigms, such as the methodology employed in the current studies and the idiographic approaches to studying memory described above, would be beneficial in helping researchers to understand memory in SAD.

Concluding Remarks

The implications of findings from the two studies presented should be considered in light of some of the general limitations of this research. First, neither study included a general measure of memory ability and therefore it cannot be ruled out that significant differences observed between groups, particularly in study 2, were attributable to differences in general memory. This explanation, however, seems unlikely as participants in study 2 were drawn from the same population. More importantly, memory for physiological response was indirectly assessed. That is, participants were asked to recall and recognize neutral stimuli that were associated with feedback concerning physiological response. This false feedback paradigm was used in order to develop an objective measure of memory for physiological response. Future research may wish to develop more direct measurements of memory for physiological response in order to more definitively establish a link between enhanced memory for physiological arousal and social anxiety. For example, assessing memory for feedback based on actual physiological response may lend itself to a more direct way of assessing memory for this information.

Finally, as discussed above, taking an idiographic approach to studying memory may be particularly beneficial in detecting memory biases in social anxiety. As an

idiographic approach was not used in these studies it is possible that the physiological indicators used in this study may not have been anxiety provoking for all participants. This may have reduced the ability to detect differences in memory between groups. In addition to the recommendation that future research assess memory for social stimuli associated with idiographic beliefs concerning social situations (e.g., perfectionism, fear of bodily sensations), researchers may also want to take a more idiographic approach to the current research, tailoring the types of physiological measurements to the types of physiological sensations that participants fear.

In summary, results suggest that individuals who are socially anxious and also report fearing their bodily sensations exhibit enhanced memory for some aspects of their physiological response. These results are consistent with both recent research on memory and social anxiety and recent formulations of models of mood and memory that suggest that the feared stimuli used in memory experiments must be rich, elaborative material that is relevant to the personal beliefs of each participant.

Future investigators may wish to explore further the relationships between beliefs and different stages of information processing in order to better understand the role such processes play in the maintenance of anxiety disorders. For example, given the relative ease in detecting attentional biases in anxiety disorders (Williams, Watts, MacLeod, & Mathews, 1997), it is possible that personal beliefs have less of an impact at earlier stages of processing than more general threat related beliefs. Identifying these relationships between different stages of information processing and beliefs may help researchers and clinicians to refine models of anxiety and subsequent treatments derived from these models. Finally, given past difficulties in detecting memory biases in other anxiety

disorders (Coles & Heimberg, 2002) researchers may wish to study the impact of interpretation in memory for other anxiety disorders. The incorporation of examining beliefs and interpretations of feared stimuli in the study of memory biases in the anxiety disorders may help researchers to study a phenomenon that intuitively and clinically seems apparent but has experimentally proven elusive to demonstrate.

Endnotes

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2. Results pertaining to the predictions of the study did not change when analyses were rerun excluding the two SAD participants meeting diagnostic criteria for substance dependence without physiological dependence and the two NAC participants who reporting taking psychotropic medication.

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4. 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 greatly differ depending on whether social anxiety was analyzed categorically or dimensionally, we only report the categorical data here.

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Appendix A – Consent Forms

Participant ID ____

CONSENT FORM TO PARTICIPATE IN RESEARCH

This form is to state that I agree to participate in a program of research being supervised by Dr. Adam S. Radomsky in the Psychology Department of Concordia University.

A. PURPOSE

I have been informed that the purpose of this study is to advance our understanding of physiological responses during word pronunciation, which is an important component of public speaking.

B. PROCEDURES

This study involves completing a short interview in which the experimenter will ask you some questions about anxiety and your everyday experiences. The experimenter will then attach skin conductance and heart rate monitors to your body, and you will be asked to complete a performance task in front of the researcher and to a camera which will record your performance. Your performance on the task will be evaluated by a psychologist and a linguist at a later date. After this, you will be asked to complete a series of questionnaires. This will conclude the study, which should take approximately 3-4 hours. After completion of the study, you will receive twenty dollars for your time.

CONDITIONS OF PARTICIPATION

I understand that I am free to withdraw my consent and discontinue my participation in this study at any time, without any negative consequences whatsoever. I understand that all information obtained will be kept strictly confidential and will be stored under lock and key for a period of seven years, at which point it will be destroyed. Access to this information will be made available only to members of Dr. Radomsky's research team. I understand that to ensure my confidentiality, all data will be coded by number only and will be kept separate from my name. I understand that data from this study may be published, but that no identifying information will be released.

If you have any questions concerning this study, please feel free to ask the researcher or call the lab at 848-2424 ext. 2199. If you have questions about your rights as a research participant please contact Adela Reid, Compliance officer, (514)848-2424, x. 7481.

A. Radomsky, Ph.D., Assistant Professor.
Andrea R. Ashbaugh, M.A., Graduate student.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARITY AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print)_____ AGE_____ SEX M / F

SIGNATURE_____ DATE_____

WITNESS SIGNATURE_____

CONSENT FORM TO PARTICIPATE IN RESEARCH Participant ID

This form is to state that I agree to participate in a program of research being supervised by Dr. Adam S. Radomsky in the Psychology Department of Concordia University.

A. PURPOSE

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C. PROCEDURES

This study involves completing a short interview in which the experimenter will ask you some questions about anxiety and your everyday experiences. The experimenter will then attach skin conductance and heart rate monitors to your body, and you will be asked to complete a performance task in front of the researcher and to a camera which will record your performance. Your performance on the task will be evaluated by a psychologist at a later date. After this, you will be asked to complete a series of questionnaires. This will conclude the study, which should take approximately 2-3 hours. After completion of the study you will receive experimental entire study, you will receive either experimental credit for Psychology Department Pool (1 credit per study hour), or have your name entered in a draw for one of four cash prizes ($50-$300).

CONDITIONS OF PARTICIPATION

I understand that I am free to withdraw my consent and discontinue my participation in this study at any time, without any negative consequences whatsoever. I understand that all information obtained will be kept strictly confidential and will be stored under lock and key for a period of seven years, at which point it will be destroyed. Access to this information will be made available only to members of Dr. Radomsky's research team. I understand that to ensure my confidentiality, all data will be coded by number only and will be kept separate from my name. I understand that data from this study may be published, but that no identifying information will be released.

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I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARITY AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print)_____ AGE_____ SEX M / F

SIGNATURE_____
DATE_____

WITNESS SIGNATURE_____

Participant ID ____

FINAL CONSENT FORM

It was necessary for us to make you believe that we were recording your heart rate and skin conductance in this study. In fact, these measures were never actually recorded. This was necessary because we were interested in examining memory for internal physiological sensations during a performance task. Additionally, you were told that the changes in physiology result in poorer pronunciation of words and subsequently poorer performance during a speech. This was necessary in order for us to examine if internal cues that are interpreted as threatening are bettered remembered, especially by those with social anxiety disorder, than internal cues that are not threatening. In fact, we know very little about how physiology and speaking ability are related to each other. Furthermore, the videotape of your performance will only be seen by researchers directly involved in this study and not by a psychologist. It was necessary to make you believe that a psychologist would be evaluating your speech in order to increase the importance and impact of the speech task. Furthermore, you were not informed at the outset of the study that this would be an experiment assessing your memory. This was necessary because often if individuals anticipate that their memory will be tested they may attend to the information in a different manner than how they normally would.

We hope that you understand why this deception was necessary for this project. Please feel free to ask any questions that you may have about the study at this time.

By signing below you indicate that you have been informed of the deception used in this study and allow us to include your results (non-identifying data) in our analyses.

Signature _____

Witness _____

Date _____

If you have any questions concerning this study, please feel free to ask the researcher or call the lab at 848-2424 x.2199.

A. S. Radomsky, Ph.D., Assistant Professor.
Andrea R. Ashbaugh, M.A., graduate student.

CONSENT FORM TO PARTICIPATE IN RESEARCH Participant ID

This form is to state that I agree to participate in a program of research being supervised by Dr. Adam S. Radomsky in the Psychology Department of Concordia University.

A. PURPOSE

I have been informed that the purpose of this study is to advance our understanding of physiological responses to public speaking.

D. PROCEDURES

This study involves 2 laboratory visits, approximately one week apart. During the first visit (today), you will complete a short interview in which the experimenter will ask you some questions about anxiety and your everyday experiences. The experimenter will then attach skin conductance and heart rate monitors to your body, and you will be asked to give a short speech about a specific topic which will be videotaped and shown to an evaluation team at a later date. After this, you will be asked to complete a series of questionnaires. This will conclude the end of part one of the study, which should take approximately 1- 2 hours. Part two of the study will occur in one week and will take approximately 15 minutes. It will involve completing a second series of questionnaires. At the completion of the entire study (i.e., parts 1 and 2), you will receive either experimental credit for Psychology Department Pool (1 credit per study hour), or have your name entered in a draw for one of two cash prizes.

CONDITIONS OF PARTICIPATION

I understand that I am free to withdraw my consent and discontinue my participation in this study at any time, without any negative consequences whatsoever. I understand that all information obtained will be kept strictly confidential and will be stored under lock and key for a period of seven years, at which point it will be destroyed. Access to this information will be made available only to members of Dr. Radomsky's research team. I understand that to ensure my confidentiality, all data will be coded by number only and will be kept separate from my name. I understand that data from this study may be published, but that no identifying information will be released.

If you have any questions concerning this study, please feel free to ask the researcher or call the lab at 848-2424, ext. 2199. If you have any questions about your rights as a research participant, please contact Adela Reid, Compliance Officer, (514)848-2424, x. 7481

A. Radomsky, Ph.D., Assistant Professor.
Andrea R. Ashbaugh, M.A., Graduate student.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT. I FREELY CONSENT AND VOLUNTARITY AGREE TO PARTICIPATE IN THIS STUDY.

NAME (please print)_____ AGE_____ SEX M / F

SIGNATURE_____ DATE_____

WITNESS SIGNATURE_____

Participant ID ____

FINAL CONSENT FORM

It was necessary for us to make you believe that we were recording your heart rate and skin conductance in this study. In fact, these measures were never actually recorded. This was necessary because we were interested in examining memory for internal physiological sensations during public speaking. Additionally, some of you were told that physiology is reflective of your public speaking performance, and some of you were told that physiology is not reflective of your public speaking performance. This was necessary in order for us to examine how one's interpretation of physiology influences memory biases for physiological sensations during public speaking. In fact, we know very little about how physiology and speaking ability are related to each other. Furthermore, the videotape of your speech will only be seen by researchers directly involved in this study and not by a panel of psychologists. It was necessary to make you believe that a group of psychologists would be evaluating your speech in order to increase the importance and impact of the speech task. Furthermore, you were not informed at the outset of the study that this would be an experiment assessing your memory. This was necessary because often if individuals anticipate that their memory will be tested they may attend to the information in a different manner than how they normally would.

We hope that you understand why this deception was necessary for this project. Please feel free to ask any questions that you may have about the study at this time.

By signing below you indicate that you have been informed of the deception used in this study and allow us to include your results (non-identifying data) in our analyses.

Signature _____

Witness _____

Date _____

If you have any questions concerning this study, please feel free to ask the researcher or call the lab at 848-2424 x.2199.

A. S. Radomsky, Ph.D., Assistant Professor.
Andrea R. Ashbaugh, M.A., graduate student.

Appendix B - Current Mood Ratings

Please indicate by placing an X on each line at the point that best corresponds to how you are currently feeling in regards to the following emotions:

0_____100
I do not feel at all happy — I feel extremely happy

0_____100
I do not feel at all angry — I feel extremely angry

0_____100
I do not feel at all anxious — I feel extremely anxious

0_____100
I do not feel at all depressed — I feel extremely depressed

Appendix C - Study 1: Performance Prediction

1. What percentage of words do you think you will accurately pronounce from 0% accurately pronounced to 100% accurately pronounced?

_____

2. How clearly do you think you will pronounce the words during the word pronunciation task from 0 (Not at all clearly) to 100 (Completely clearly)?

_____

3. How expressive do you think you will be during the word pronunciation task from 0 (Not at all expressive) to 100 (Completely expressive)?

_____

4. How likable do you think you will appear during the word pronunciation task from 0 (Not at all likable) to 100 (Completely likable)?

_____

Appendix D: Study 1: Performance Evaluation

Overall do you think your physiology was most often changing, stable, or both equally, during the first word pronunciation task?

1 = Mostly stable

2 = Was stable and changing an equal amount of time

3 = Mostly changing

What percentage of words do you think you accurately pronounced during the word pronunciation task from 0% accurately pronounced to 100% accurately pronounced?

_____

How clearly do you think you pronounced the words during the word pronunciation task from 0 (Not at all clearly) to 100 (Completely clearly)?

_____

How expressive do you think you were during the word pronunciation task from 0 (Not at all expressive) to 100 (Completely expressive)?

_____

How likable do you think you appeared during the word pronunciation task from 0 (Not at all likable) to 100 (Completely likable)?

_____

Please circle the number below that best corresponds to how well you think you did on this performance task relative to how you think other participants performed:

1 = I performed the worst on this task relative to other participants
2 = I performed worse than most participants, but there were others who performed worse than I did.
3 = I performed about the same on this task relative to other participants
4 = I performed better than most participants, but there were others who performed better than I did.
5 = I performed the best on this task relative to other participants

Appendix E - Study 1: Manipulation Check

Please answer the following questions by marking the point on the bar which best represents how you feel regarding each of the following questions.

Did you believe that your physiology might be a good indicator of your performance on the task?

Physiology reflected my performance — Physiology was unrelated to my performance

Did you believe that the computer was measuring your physiology?

Completely believed — Did not believe at all

When you saw a word on the left that meant (please circle the one that is most correct:

1 = My physiology was increasing
2 = My physiology was stable
3 = My physiology was decreasing
4 = My physiology was changing (either increasing or decreasing)
5 = The location of the word on the screen was unrelated to my physiology

Appendix F - Study 1: Word Stimuli

Word Pronunciation Task – Left	Word Pronunciation Task – Right	Recognition Task – Lures
Figure	Province	Compass
Basket	Cluster	Fountain
Silver	Colonel	Channel
Mayor	Costume	Device
Carriage	Resort	Fabric
Harvest	Cousin	Circle
Liquid	Timber	Frontier
Parent	Package	Motion
Harbour	Butter	Angle
Bedroom	Collar	Clothing
Agent	Autumn	Pocket
Circuit	Flavour	Angel
Painting	Novel	Author
Worker	Bureau	Linen
Jersey	Cable	Merchant
		Crystal
		Ribbon
		Scholar
		Farmer

Word Pronunciation Task - Left	Word Pronunciation Task – Right	Recognition Task – Lures
		Cotton
		Saddle
		Double
		Blanket
		Minute
		Bubble
		Palace
		Carbon
		Marble
		Puzzle
		Parlour

Appendix G - Study 1: Participants Ranking of Performance

To further evaluate the validity of the word pronunciation task as an analog performance task designed to elicit responses from individuals with SAD in a manner consistent with other established methods (e.g., speech task), following the word pronunciation task participants were asked to indicate if they thought their performance was the worst relative to others, worse than others, the same as others, better than others, or the best relative to other people. Among SAD participants 21% indicated that they thought they did worse than others, 69% indicated that they thought they did as well as others, and 9% indicated that they thought they did better than others. Among NAC participants 6% indicated that they thought they did worse than others, 74% indicated they thought they did as well as others, 15% indicated they thought they did better than others, 6% indicated they thought they did the best. Though the majority of participants in both groups indicated that they thought they did as well as others, a Mann-Whitney *U*-statistic indicates that the groups were significantly different in their rankings, $U = 414.50$, $p < .05$, $r = .26$. Thus consistent with other measures of anticipated and perceived performance, SAD participants provided generally lower rankings of their performance compared to NAC participants.

Appendix H - Study 1: Source memory for bodily sensations

To examine if there were any differences in source memory accuracy the percentage of correctly recognized items in which the source of the item was accurately indicated was calculated. For items associated with changing physiology, SAD participants correctly identified the source of 60.04% (*SD* = 22.41) and NAC participants correctly identified 56.87% (*SD* = 13.94) of items. For items associated with stable physiology, SAD participants correctly identified the source of 60.25% (*SD* = 21.65) of items and NAC participants correctly identified 64.23% (*SD* = 26.49) of items. A mixed ANOVA with variable (Change vs. Stable) as the within-participant factor and group (SAD vs. NAC) as the between-participant factor revealed no significant main effects of interactions, *F*s < .35.

The source of items was accurately identified for only 50-60% of items correctly recognized. Though participants were more accurate in recognizing whether or not they had seen a word association with changing compared to stable physiology, they were not more accurate with regards to whether the item was located on the left or right side of the screen.

Appendix I – Study 1: Beliefs about physiological response during the word pronunciation task

In addition to assessing objective memory for stimuli reflecting physiological feedback, participants were also asked for their subjective interpretation of their physiology. Following the word pronunciation task, participants were asked to indicate if their physiology during the task was mostly stable, equally stable and changing, or most changing. Among SAD participants, 13% indicated their physiology was mostly stable, 68% indicated their physiology was equally stable and changing, and 19% indicated their physiology was mostly changing. Among NAC participants, 38% indicated their physiology was mostly stable, 52% indicated their physiology was equally changing and stable, and 10% indicated that their physiology was mostly changing. A Mann-Whitney *U*-statistic revealed that there was a significant difference in ranking between the groups, $U = 323.50$, $p < .05$, $r = .27$. In general, SAD participants appeared to be more accurate than NAC participants in indicating that their physiology was equally stable and changing, whereas NAC participants tended to perceive their physiology response as being mostly stable. Thus, although participants with and without SAD did not differ with regards to their objective memory for physiological feedback, subjectively, SAD participants tended to be more accurate in recalling their physiological feedback compared to NAC participants.

Appendix J – Study 2: Integrity Check

Please answer the following question by marking the point on the bar which best represents how you feel regarding each of the following questions.

Did you believe that the computer was measuring your physiology?

Completely believed Did not believe at all

Appendix K – Study 2: Image Stimuli

Task Type	Animal	Fruit/Vegetable	Man-made Object
Task Demonstration	Swan	Avocado	Violin
	Lion	Green onions	BBQ
	Rabbit	Artichokes	Microwave
	Koala	Radishes	Bowls
	Eagle	Limes	Pan
Speech	Giraffes[a]	Peach[a]	Red Stoplight[a]
	Frog[a]	Banana[a]	Chair[a]
	Owl[a]	Garlic[a]	Computer[a]
	Fly[a]	Tomato[a]	Truck[a]
	Polar bear[a]	Pineapple[a]	Keys[a]
	Butterfly[b]	Apple[b]	Filing Cabinet[b]
	Cat[b]	Watermelon[b]	Fork[b]
	Fish[b]	Broccoli[b]	Book[b]
	Camel[b]	Carrots[b]	Mug[b]
	Duck[b]	Cherry[b]	Piano[b]
Recognition Lures–	Bee	Cabbage	Bed
Time 1	Parrot	Oranges	Laptop
	Dog	Potatoes	Telephone
	Hippo	Cucumber	Sailboat
	Horse	Strawberry	Trumpet

	Animal	Fruit/Vegetable	Man-Made Object
Recognition Lures –	Elephant	Cauliflower	Stapler
Time 2	Kangaroo	Grape	Car
	Bear	Pepper	Drums
	Turtle	Onion	Spoon
	Donkey	Grapefruit	Teapot

[a] Image appeared as a target during recognition time 1.

[b] Image appeared as a target during recognition time 2.

Appendix L – Study 2: The impact of time on memory for bodily sensations

Recall and recognition was also tested a second time approximately one week later. Participants were first asked to recall as many images as possible from the speech task. They were then shown 60 images, 30 of which were images they had not been previously shown, and 30 of which were the remaining images from the speech task that had not been shown during the first recognition task. Participants were asked to indicate which images were old and which were new.

A 2 (time 1 vs. time 2) x 3 (increasing vs. decreasing vs. stable) x 2 (HSA vs. LSA) x 2 (high-importance vs. low-importance) ANOVA was conducted to examine the effect of time on percentage of items recalled, the percentage of hits and false alarms, *d'* and criterion c.

There were significant main effects of time for the percentage of hits, $F(1, 73) = 80.33, p < .001, \eta^2 = .52$, percentage of false alarms, $F(1, 73) = 39.94, p < .001, \eta^2 = .35$, *d'*, $F(1, 73) = 111.14, p < .001, \eta^2 = .60$, criterion c, $F(1, 73) = 8.30, p = .005, \eta^2 = .10$. The main effect of time for recall approached significance, $F(1, 73) = 3.09, p = .08$. As can be seen in Table L1, though the percentage of items recalled non-significantly increased from time 1 to time 2, recognition accuracy dropped and participants adopted an increasingly conservative response bias. Consequently, results from time 1 only will be examined further.

Table L1

Mean(SD) Memory Scores at Time 1 and Time 2.

Memory Score	Time 1	Time 2
Percentage Recalled	11.4	12.6
	(9.82)	(10.43)
Percentage Hits	64.6^{x}	48.6^{y}
	(21.24)	(20.92)
Percentage False Alarms	30.1^{x}	38.9^{y}
	(18.77)	(19.27)
d'	1.06^{x}	$.28^{y}$
	(.84)	(.72)
Criterion c	$.06^{x}$	$.18^{y}$
	(.48)	(.49)

Note: Rows with differing subscripts are significantly different at $p < .05$.