INFORMATION-PROCESSING BIASES TOWARD INTEROCEPTIVE STIMULI IN CLAUSTROPHOBIA

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INFORMATION-PROCESSING BIASES TOWARD INTEROCEPTIVE STIMULI IN CLAUSTROPHOBIA

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INFORMATION-PROCESSING BIASES TOWARD INTEROCEPTIVE

STIMULI IN CLAUSTROPHOBIA

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Todd Alan Smitherman, son of Johnny and Katherine (King) Smitherman, was born November 11, 1977, in Birmingham, Alabama. He graduated from Hoover High School in 1996. He attended Samford University for four years and graduated *cum laude* with a Bachelor of Arts degree in Psychology in May, 2000. The following fall, he entered graduate school at Auburn University in a doctoral program in Clinical Psychology. He obtained a Masters degree in Clinical Psychology in August, 2002, and attended the University of Mississippi Medical Center/G.V. (Sonny) Montgomery Veterans Affairs Medical Center for his predoctoral internship training.

DISSERTATION ABSTRACT

INFORMATION-PROCESSING BIASES TOWARD INTEROCEPTIVE STIMULI IN CLAUSTROPHOBIA

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The present study endeavored to ascertain whether claustrophobic individuals manifest information-processing biases toward interoceptive stimuli, consistent with recent conceptualizations of this disorder. Nine hundred one participants were screened until 18 females were identified who met inclusion criteria for each of the three experimental groups (claustrophobic, snake phobic, nonphobic control). The 54 participants were administered a series of measures designed to assess interpretive, attentional, and memory biases toward interoceptive stimuli. Anxiety sensitivity scores were used also in an attempt to predict the relevant bias data.

The purpose of this study was to evaluate one conceptualization of claustrophobia, which maintains that claustrophobia is characterized primarily by a fear of bodily sensations. Interoceptive fear is thought to differentiate claustrophobic individuals from those who suffer from animal phobias (e.g., snake, spider, etc.). We hypothesized that claustrophobic individuals would display interpretive, attentional, and memory biases toward interoceptive stimuli, compared to neutral and positively-valenced stimuli and to snake phobics and nonphobic controls.

The results of this study did not support the hypotheses. The claustrophobic group did not evidence differential interpretive or attentional biases toward interoceptive stimuli. The snake phobic group did not differ from the other groups on most measures related to interpretive and attentional bias. No group effects were found for memory bias. Anxiety sensitivity was a poor predictor of the relevant bias scores.

Several potential explanations for the obtained results are considered, including word emotionality and anxiety sensitivity. The most likely explanation seems to be one that challenges the interoceptive fear conceptualization of claustrophobia, but this will need to be confirmed by subsequent studies. Other considerations and directions for future research on competing models of claustrophobia are discussed.

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I. INTRODUCTION

Claustrophobia is a specific phobia characterized by a fear of enclosed spaces. Among the specific phobia subtypes listed in the *Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition, Text Revision* (*DSM-IV-TR*; American Psychiatric Association, 2000), claustrophobia is grouped into the situational subtype, as are phobias of flying, driving, and bridges. Although most individuals with specific phobias rarely present for treatment—because they simply avoid the objects they fear—a substantial number of people suffer from claustrophobia. Epidemiological data indicate that claustrophobia has a lifetime prevalence of 4.2% (Curtis, Magee, Eaton, Wittchen, & Kessler, 1998). Fredrikson, Annas, Fischer, and Wik (1996) reported a similar figure (4.0%) for the point prevalence of claustrophobia using *DSM-IV* (APA, 1994) criteria. Of all the specific phobias, only height, animal, and blood phobias are more common than claustrophobia (Curtis et al.).

Current Conceptualizations of Claustrophobia

With recognition of the prevalence of claustrophobia has come a surge of interest in the disorder. Over the past 15 years, approximately 100 articles have been published on claustrophobia. This research has eventuated in two main conceptualizations of the disorder. Though these two accounts are by no means mutually exclusive, studies conducted to date have not made strong attempts to integrate or compare them. According to the first, claustrophobia is a function of the partially independent fears of suffocation and restriction (Rachman & Taylor, 1993). In 1990, Rachman observed that the most commonly-reported fearful cognition of claustrophobics was that of suffocating. Second only to the fear of suffocation was the fear of being confined and unable to escape (broadly termed "restriction"). The role of suffocation and restriction fears in claustrophobia has been confirmed by subsequent research using exposure to diverse situations and factor-analyses of various self-report instruments (e.g., Febbraro & Clum, 1995; Radomsky, Rachman, Thordarson, McIsaac, & Teachman, 2001; Shafran, Booth, & Rachman, 1993; Valentiner, Telch, Petruzzi, & Bolte, 1996).

According to this component fear account, suffocation fear may arise from the belief that an enclosed space is dramatically limited in air supply, that access to air is impeded in some way, or that a physiological dysfunction blocks air intake (Rachman, 1990). A fear of restriction is likely to be situationally mediated, being a function of the degree of confinement perceived in a given situation. Evidence differentiating suffocation and restriction fears comes from studies in which fearful responding to claustrophobia-related stimuli is predicted by one fear but not the other (e.g., McGlynn, Karg, & Lawyer, 2003) and from studies in which therapeutic exposure to a particular situation reduces one fear but not the other (Harris, Robinson, & Menzies, 1999). Other studies indicate that both constructs significantly predict fear behavior (e.g., McGlynn, Smitherman, Hammel, & Lazarte, in press) and are strongly correlated with each other (Rachman & Taylor, 1993). At present, the extent to which these two fears are orthogonal is open for debate, and which one is primary seems partly a function of the stimulus of interest.

The second conceptualization regards claustrophobia as a disorder characterized by a fear of bodily sensations associated with anxiety and arousal (interoceptive stimuli), rather than a fear of external stimuli, as is typical of animal phobias (Craske, Mohlman, Yi, Glover, & Valeri, 1995). Several studies highlight the role of interoceptive fear in claustrophobics. For example, Craske and Sipsas (1992) found that claustrophobics were more fearful of bodily sensations than were snake and spider phobics. The claustrophobic group reported more physical symptoms of arousal upon exposure to a small closet than did the animal phobics upon exposure to a snake or spider. In fact, the claustrophobic group reported as intense physical symptomatology when exposed to a snake or spider as did the animal phobics when exposed to the same stimuli. Furthermore, the claustrophobics were as fearful of a hyperventilation challenge as they were of exposure to the small closet.

Two studies by Rachman, Levitt, and Lopatka (1987, 1988) highlight the importance of interoceptive fear in claustrophobics. Rachman et al. (1988) instructed one group of claustrophobic participants to focus on their bodily symptoms during a behavioral avoidance test (BAT) involving a claustrophobic chamber; another group engaged in an irrelevant task during the BAT. Participants who were able to focus on their bodily symptoms reported elevated panic scores and had the highest incidence of panic, compared with those who were unable to focus on their bodily symptoms and with the control group. Rachman et al. (1987) investigated how congruence between physical and cognitive symptoms contributes to panic. They found that claustrophobic participants most often experienced a panic attack when the cognition of suffocation occurred in conjunction with at least two of the following physical symptoms: choking, shortness of breath, and dizziness. Panic is thus more likely when fearful cognitions coincide with the experienced bodily sensations, presumably because such congruence facilitates catastrophizing and may result in a self-fulfilling prophecy. Taken together, these studies highlight the positive correlation between interoceptive fear and frequency of panic.

Interoceptive fear may be mediated or maintained by anxiety sensitivity, the belief that anxiety symptoms are threatening because they have harmful consequences (Reiss & McNally, 1985). The construct of anxiety sensitivity typically is associated with psychological theories of panic disorder (PD; McNally, 1990). Indeed, the tendency to misinterpret bodily sensations in catastrophic ways is the cardinal feature of cognitive models of panic (Clark, 1986). It has been suggested also that anxiety sensitivity plays a role in claustrophobic fear (Reiss, Peterson, Gursky, & McNally, 1986). In the study by Craske and Sipsas (1992), the claustrophobic group attained the highest scores on the Anxiety Sensitivity Index (ASI; Reiss et al.), scores that approached those of individuals diagnosed with PD (cf. Antony, Brown, & Barlow, 1997).

Other studies have used the ASI as a predictor of various indices of claustrophobic fear. In two studies by Valentiner and colleagues (Valentiner, Telch, Ilai, & Hehmsoth, 1993; Valentiner et al., 1996), an interaction between ASI scores and expected anxiety predicted behavioral performance during exposure to a claustrophobic chamber. In the study by McGlynn et al. (in press), a revised form of the ASI (ASI-R-36; Taylor & Cox, 1998) significantly predicted subjective and behavioral indices of claustrophobic fear during exposure to a mock MRI device. In fact, scores on one subscale of this measure (Publicly Observable Anxiety Reactions) provided significant incremental validity to suffocation fear in predicting subjective fear ratings. In short, using measures of anxiety sensitivity to predict claustrophobic fear has become both commonplace and successful.

Though etiology cannot be inferred from response to treatment, at least one treatment study has underscored the role of anxiety sensitivity in claustrophobic fear. Craske et al. (1995) found that a treatment disconfirming misappraisals of bodily sensations yielded reductions in claustrophobic fear but was ineffective for fears of snakes and spiders. Thus, when compared with animal phobics, treatments targeting anxiety sensitivity appear to have effects that are relatively specific to claustrophobics.

Taken together, these studies highlight the importance of a fear of interoceptive stimuli and their consequences in claustrophobia. Further, this fear seems to differentiate claustrophobia from animal phobias, as the latter have not been strongly associated with interoceptive fear. Coupled with findings that subtypes of specific phobias differ in terms of ages of onset (Öst, 1987), unpredictability of panic (e.g., Curtis, Hill, & Lewis, 1990), and patterns of physiological response (Öst, Sterner, & Lindahl, 1984), the experimental literature has strongly challenged the traditional assumption that various phobia subtypes are homogenous.

The argument that claustrophobia is distinct from other specific phobias, and animal phobias in particular, is bolstered by the similarities between claustrophobia and panic disorder with agoraphobia (PDA). Most notably, claustrophobia and PDA have the following characteristics in common: significant comorbidity (Curtis et al., 1990; Starcevic & Bogojevic, 1997), bimodal ages of onset and similar ontogenies (Öst, 1985, 1987), safety signal utilization (Rachman, 1984; Sloan & Telch, 2002), the presence of uncued/unexpected panic (Curtis et al., 1990; Craske, Zarate, Burton, & Barlow, 1993), and fear and avoidance of interoceptive stimuli (Clark, 1986; Curtis, Himle, Lewis, & Lee, 1989; McNally, 1990). Moreover, though almost all anxiety disorders are characterized by avoidance behavior and a fear response of some sort, the overlap between claustrophobia and PDA appears to be rather specific to these two disorders. That is, many of the studies cited above included other phobic groups (e.g., animal phobics, height phobics, etc.) in addition to claustrophobics, but did not find a similar degree of overlap with PDA.

Assessment of Information-Processing Biases in Anxiety Disorders

The studies reviewed thus far have furthered our understanding of claustrophobia and its relation to other anxiety disorders, but many of them suffer from reliance on self-report data only. Out of concern for the associated weaknesses of self-report data, many anxiety researchers have begun adopting the paradigms of cognitive psychology. Though once eschewed as mentalistic, cognitive approaches to psychopathology have grown in popularity and credibility, largely because the innovative experimental paradigms of cognitive psychologists are being recognized as providing more objective means of assessing fear. The theoretical pluralism characteristic of neobehaviorism coincided with recognition of the inadequacies in traditional learning accounts of anxiety (Rachman, 1976). Together, these developments served to legitimize interest in identifying the ways anxious individuals process information, as well as how to modify maladaptive cognition in treatment.

M. W. Eysenck’s (1992) hypervigilance theory can be credited with popularizing interest in how anxious individuals interpret, attend to, and remember threatening information. According to Eysenck, the primary function of anxiety is to facilitate detection of danger in threatening situations, which in turn allows avoidance behavior. In anxious individuals, the “danger detection system” is overactive and maladaptive, and is maintained by three types of biases in the way that information is processed.

Interpretive bias refers to the tendency of anxious individuals to interpret a benign situation as threatening. The tendency to misinterpret ambiguous bodily sensations as indicators of some impending catastrophe has for two decades been central to psychological models of panic disorder (Clark, 1986). Misinterpretations of bodily sensations increase anxiety, which amplifies the bodily sensations, resulting in a vicious cycle that eventually culminates in a panic attack. The second type of bias occurs when attention is devoted to threat-related stimuli rather than neutral stimuli. This type of bias is referred to as a selective *attentional bias*. The anxious individual is characterized by a particular pattern of attention: Attention is broadened prior to detection of threat, and then narrowed once a threatening stimulus is detected (Williams, Watts, MacLeod, & Mathews, 1997). Hypervigilance may also be manifested in frequent environmental scanning, directed either externally toward physical stimuli (e.g., in animal phobics) or internally toward feared bodily sensations (e.g., in PD patients). The last type of bias is known as a *memory bias*, or the tendency to remember more threat-relevant than non-threat information. Individuals prone to interpret stimuli as threatening and selectively attend to such stimuli are expected to have an enhanced memory for threat-related information.

The idea that anxious individuals are characterized by biases in the way they process information was implied also by the cognitive theories of Beck and Emery (1985) and Bower (1981). Beck and Emery (1985) argued that schemata—cognitive structures that represent past knowledge and experience—influence the way that information is encoded, organized, and stored. In individuals suffering from anxiety disorders, the central schemata are about danger and vulnerability. Information that is consistent with danger schemata is selectively attended to and encoded, while inconsistent information is ignored or discarded. Beck and Emery's schema theory has received support directly from empirical evidence of schema-congruent processing (see Eysenck, 1992) and indirectly from the efficacy of cognitive treatments in reducing anxiety. The theory is weakened by the imprecision inherent in the schema construct and uncertainty as to whether schemata represent manifestations of pathology or are etiological factors.

According to Bower's (1981) associative network theory, memory for events can be conceptualized as associative connections between nodes (or concepts) that describe the event. New memories are made through the process of spreading activation, which creates new connections between nodes. In Bower's model, each emotion is represented by a particular node, which in turn is linked through a series of pathways to concepts associated with that emotion. Anxious individuals have a series of pathways through which their central fear is linked with its associated features, facilitating quick retrieval of memories associated with anxiety. Bower's model accounts well for the observations that learning and memory are biased toward mood-congruent material, both at encoding and retrieval. According to Bower, when individuals are anxious they are more likely to remember material that was first encoded when they were anxious, which would account for the persistence of anxiety-related cognitions. Though Bower's model stimulated a considerable amount of research, concerns have been raised as to whether it is accurate to represent emotional states in a semantic network model (Williams et al., 1997).

The theories of Beck and Emery (1985) and Bower (1981) both incorporate the idea that anxious individuals differentially process threat-relevant information: Beck and Emery (1985) by noting enhanced processing of schema-congruent information and Bower (1981) by referencing memory pathways. Although differential processing facilitates adaptive detection of danger (Eysenck, 1992), biases in information processing likely contribute to the maladaptive maintenance of anxiety. Such biases interfere with performance on other tasks, perpetuate avoidance behavior, and prevent the processing of corrective information (see Foa & Kozak, 1986).

The information-processing biases outlined by Eysenck (1992) and supported by the theories of Beck and Emery (1985) and Bower (1981) are relatively narrow. That is, with some exceptions, anxiety-disordered individuals only show information-processing biases toward themes of threat related to their anxiety diagnosis. Coupled with consistent observations that they reflect the presence of anxiety and successfully resolve with cognitive-behavioral treatment, an information-processing bias serves as a "psychological marker" of anxiety (Barlow, 2002). As such, psychologists should become adept at identifying such biases. A variety of experimental paradigms, many of them borrowed from cognitive psychology, have been used by clinical psychologists to identify information-processing biases in anxious individuals. These methods are reviewed below.

In addition to these three types of biases, some researchers (e.g., McNally, 1990) have suggested a fourth type of cognitive bias. Interoceptive acuity bias refers to the tendency of anxiety-disordered individuals to more accurately detect changes in their physiology (e.g., heart-rate changes) than non-anxious individuals. With some exceptions, research on interoceptive acuity biases has produced null results in individuals with PD (Rapee, 1984) and claustrophobia (Johansson & Öst, 1982). As such, this particular bias was not a focus of the present study.

Assessment of interpretive bias. In studying interpretive biases, researchers have used primarily two methods. The first is to auditorily present a series of homophones and ask participants to write down their spellings. Some homophones have negative and neutral interpretations ("die" and "dye"), and some have positive and neutral interpretations ("won" and "one"). Anxious individuals have typically interpreted the homophones negatively, as indexed by their writing down more negative than neutral and positive spellings (e.g., Byrne & Eysenck, 1993).

The second method is the one used most frequently. It involves presenting participants with a series of several written scenarios in booklet form and asking them to write down the first explanation for that scenario that comes to mind. The most common approach is to use McNally and Foa's (1987) Interpretation Questionnaire or a modified version (e.g. Clark et al., 1997). Because this method is described in more detail later, a brief description will suffice here. Some of the scenarios in these measures focus on internal (interoceptive) stimuli and others focus on external stimuli. In addition to providing written explanations for each scenario, respondents are instructed to rank-order three printed explanations (one of which is threatening) in terms of the likelihood that such an explanation would come to mind when confronted with that scenario. Respondents also provide ratings of the extent to which they would believe the printed explanations. Experimental groups are then compared across scenario type on the relevant likelihood and belief responses.

Studies using both the homophone and scenario response methods support the conclusion that anxiety-disordered individuals are characterized by a tendency to interpret ambiguous stimuli as threatening. Studies have found interpretive biases toward interoceptive stimuli in individuals meeting criteria for PDA (Clark et al., 1997; Kamieniecki, Wade, & Tsourtos, 1997; McNally & Foa, 1987) as well as in nonclinical panickers (Richards, Austin, & Alvarenga, 2001). Most typically, these interpretive biases are manifested toward stimuli pertaining to feared bodily sensations and panic. Other studies have found that idiosyncratic interpretive biases also exist in social phobia (see Heinrichs & Hofmann, 2001, for a review) and generalized anxiety disorder (GAD; Butler & Mathews, 1983). Interpretive biases have been found even in studies with nonclinical individuals high in trait anxiety (Byrne & Eysenck, 1993), anxiety sensitivity (McNally, Hornig, Hoffman, & Han, 1999), and height fear (Davey, Menzies, & Gallardo, 1997). These studies suggest that interpretive biases not only characterize anxiety-disordered individuals, but also may serve as a risk factor for the development of clinical disorders.

Assessment of attentional bias. Historically, the construct of attention has been defined in different ways (Eysenck & Keane, 1990). Attention has been regarded as synonymous with concentration, as a process of scanning the environment for particular stimuli, and as a function of one's arousal level. Most commonly, however, attention refers to the selective nature of information processing (i.e. focusing on some information at the expense of other information). In anxiety-disordered individuals, selectivity of processing is reflected in the tendency to differentially attend to threatening information (Barlow, 2002).

Various experimental procedures have been used to study attentional bias in anxious individuals. These methods employ one of two general strategies (Williams, Mathews, & MacLeod, 1996). The first strategy is to show how selectively attending to threatening stimuli facilitates performance on certain tasks, such as the dichotic listening task (e.g., Foa & McNally, 1986) and dot-probe task (MacLeod, Mathews, & Tata, 1986). Anxious individuals' performance on these tasks may be enhanced by increased auditory and visual sensitivity for anxiety-related stimuli. With some exceptions, the findings from these paradigms confirm the presence of attentional biases toward threat-related stimuli in individuals with anxiety disorders (Barlow, 2002).

The second general strategy involves demonstrating how differentially attending to threatening stimuli interferes with performance on a competing task. The method synonymous with this strategy, and by far the most popular of all the methods used to assess attentional bias, is a modified version of the Stroop color-naming test. Almost seventy years ago, J. R. Stroop (1935) developed a procedure whereby an individual is asked to name the ink color in which various words and non-words are printed. His dissertation found that color naming was longest for words of incongruent ink color (e.g., the word "yellow" printed in red ink). Subsequent research over the past seven decades has confirmed these results with remarkable consistency (see MacLeod, 1991).

Beginning in the mid-1980s, researchers interested in anxiety disorders introduced modifications to Stroop's original task. In this modified "emotional Stroop" paradigm (Mathews & MacLeod, 1985), anxiety-disordered individuals color-name words that are relevant and not relevant to their disorder. The typical finding is that individuals diagnosed with anxiety disorders take longer to name the colors of threat-related words than do control participants (the “emotional Stroop effect”), while the participants do not differ in color-naming latencies of the neutral words. The emotional Stroop effect occurs also when word presentations are masked, or presented for so brief a time that they cannot be consciously perceived (e.g., Mogg, Bradley, Williams, & Mathews, 1993; van den Hout, Tenney, Huygens, & De Jong, 1997). Attentional biases can thus be either strategic or automatic. This is not surprising, since traditional theories of attention account for processing of unattended information (e.g., Treisman, 1960).

The emotional Stroop effect is quite robust. With the exception of blood-injection-injury phobia (Sawchuck, Lohr, Lee, & Tolin, 1999), increased color-naming latencies of idiosyncratic anxiety-related words have been observed in practically every anxiety disorder studied with the emotional Stroop: PD (Ehlers, Margraf, Davies, & Ross, 1988; McNally et al., 1994), GAD (Mathews & MacLeod, 1985; see also Mogg & Bradley, 2005), posttraumatic stress disorder (PTSD; Foa, Feske, Murdock, Kozak, & McCarthy, 1991), obsessive-compulsive disorder (OCD; Foa, Ilai, McCarthy, Shoyer, & Murdock, 1993; Muller & Roberts, 2005), social phobia (Amir, Freshman, & Foa, 2002), spider phobia (van den Hout et al., 1997), and snake phobia (Mathews & Sebastian, 1993; Wikstrom, Lundh, Westerlund, & Hogman, 2004). The emotional Stroop effect has even been observed among nonclinical individuals high in trait anxiety (Richards & Millwood, 1989) and anxiety sensitivity (Stewart, Conrod, Gignac, & Pihl, 1998; but see Lang & Sarmiento, 2004). For a detailed review, see Williams et al. (1996).

Many researchers agree that the emotional Stroop is an adequate measure of attentional bias, in which performance on the color-naming task is disrupted by devoting attention to anxiety-relevant stimuli. The mechanism by which the Stroop effect captures attentional bias has been a source of considerable discussion, however. Some explanations have suggested that increased color-naming latencies are a function of various procedural artifacts, such as word emotionality, interitem priming effects, item repetition, word familiarity, or conscious strategies (e.g., Algom, Chajut, & Lev, 2004; Becker, Rinck, Margraf, & Roth, 2001). With the possible exception of word emotionality effects in GAD patients, studies controlling for these factors suggest that they cannot account for the emotional Stroop effect (Williams et al., 1996). Explanations that appeal to expertise and practice are weakened by findings that attentional bias is reduced after successful treatment, even when posttreatment assessment uses a parallel form of the pretreatment Stroop task (e.g., Mathews, Mogg, Kentish, & Eysenck, 1995).

The most well-accepted explanations of the underlying mechanisms responsible for the emotional Stroop effect have referenced the theories of Beck and Emery (1985) and Bower (1981). Threat-relevant stimuli attract most processing resources because they activate knowledge structures representing threat; the activation of these knowledge structures interferes with performing unrelated tasks such as color-naming (Mogg, Mathews, & Weinman, 1989). Mathews and MacLeod (1994) argued that Stroop interference can best be accounted for by a change in processing priorities. When emotions such as anxiety become activated, the information-processing system prioritizes encoding of related stimuli. As a result of this encoding priority, performance on other encoding tasks is delayed. The parallel distributed processing model proposed by Cohen, Dunbar, and McClelland (1990) offers yet another explanation. They proposed an information-processing pathway made up of input units (colors and words), intermediate units, and output units (responses). In the Stroop task, parallel task demands exist: word reading and color naming. When the word stimuli are emotionally salient, attention is drawn to word content and thus strengthens the activation of the word reading pathway. Though the participant attempts to ignore the word, semantic information is processed due to the increased level of activation of this pathway. As a result, activation of the competing color-naming pathway is reduced and color-naming latencies are increased.

Though no consensus has been reached as to the mechanisms responsible for the emotional Stroop effect, the emotional Stroop task is generally well-accepted and very widely-used as a measure of attentional bias. Studies using the Stroop and other tasks have demonstrated the presence of attentional biases in almost every anxiety disorder. Their presence reflects the tendency of anxious individuals to differentially focus on threat-relevant stimuli, which interferes with performance on unrelated tasks.

Assessment of memory bias. Most anxiety disorders are characterized by a prominent memory component. Posttraumatic stress disorder (PTSD), for example, is typified by intrusive memories in the form of nightmares, flashbacks, and recurrent images and thoughts of a traumatic event. Neuropsychological evidence indicates that OCD patients have visuospatial and verbal memory deficits, which may account for their compulsive behavior such as checking (Tallis, 1997). The worry behavior characteristic of GAD may be viewed as a form of mental rehearsal of anxiety-related themes. Individuals with PD and social phobia are often able to remember in detail the conditioning experiences that presumably led to their fear, and these memories may fuel their avoidance behavior and magnify their anxiety. The importance of memory processes in anxiety disorders suggests that anxious individuals may show enhanced memory for threatening information germane to their disorder. This phenomenon is known as memory bias and is typically assessed by comparing memory for threatening vs. non-threatening material.

Researchers who study memory bias differentiate between explicit and implicit memory biases. Explicit memory involves conscious, purposeful retrieval of material that has been learned previously. This type of memory is typically assessed directly using free recall and recognition tests. Implicit memory, on the other hand, represents unintentional learning and is typically measured indirectly using lexical decision tasks, primed word stem completions, tachistoscopic identification tasks, and white noise judgment paradigms (see Coles & Heimberg, 2002). These tests are indirect because individuals are not told to search their memory to perform the test, and no reference is made to the prior learning episode.

The research on memory biases among the anxiety disorders is less conclusive than the literature on interpretive and attentional biases (Barlow, 2002; MacLeod & Mathews, 2004). The memory bias literature recently has been reviewed and summarized by Coles and Heimberg (2002). They conclude that explicit memory biases exist in some anxiety disorders but not in others, while implicit memory biases have been observed in each anxiety disorder but need further study. More specifically, most studies using PD patients have found an explicit memory bias in this population toward threat-relevant information such as feared bodily sensations. This is particularly true in those studies encouraging semantic processing of the stimuli. Preliminary support exists for the presence of an explicit memory bias in OCD and PTSD patients, but few studies have been conducted using these populations. Explicit memory biases have not been observed consistently in social phobia or GAD, and studies of memory biases in spider phobics have produced mixed results (see Antony & Swinson, 2000). In terms of implicit memory, Coles and Heimberg found that implicit memory biases had been shown in at least 40% of studies for each of the following disorders: PD, GAD, OCD, PTSD, and social phobia.

At present, no compelling explanations account for why explicit memory biases seem to vary across anxiety disorders. However, explanations have been offered for the differential patterns of explicit and implicit memory biases. Coles and Heimberg (2002) argue that explicit memory biases are more difficult to observe because many studies of these biases have not encouraged processing of semantic content during encoding. Also, they note that in retrieval tasks requiring production of threatening stimuli, the anxious individual may be motivated to avoid producing a threat-relevant response. This seek-to-avoid heuristic has received some support from the model of Williams, Watts, MacLeod, and Mathews (1988, 1997), which predicts that anxious individuals will display stronger implicit than explicit memory biases. They suggest that anxiety-disordered individuals manifest an initial, automatic vigilance for threatening information, followed by strategic, purposeful efforts to avoid such information. According to this model, threat-relevant information is encoded, but strategic avoidance efforts prevent the observation of memory biases on direct recall and recognition tasks. Indirect tests of implicit memory, however, are likely to reveal such a bias since they do not rely on strategic processing. The Williams et al. model can account well for interpretive and attentional biases at the initial stages of threat detection and hypervigilance; however, their model cannot account for the rather robust findings of explicit memory biases in PD patients.

At the time of the Coles and Heimberg (2002) review, no disorder had a total of more than 5 studies investigating implicit memory biases. Since then, at least one study on social phobia has failed to find clear evidence of explicit or implicit memory biases (Rinck & Becker, 2005), and one critical review has suggested that findings of memory bias among anxiety disorders may be a function of the anxious individual's tendency to interpret ambiguous stimuli in a threatening way, rather than being a reflection of remembering specific emotional information (MacLeod & Mathews, 2004). Clearly, more research is needed on the role of memory biases in all the anxiety disorders.

Summary on Cognitive Biases

At the cognitive level of description, anxiety-disordered individuals appear to be characterized by a tendency to interpret stimuli as threatening and to differentially attend to threat-relevant information. In some anxiety disorders, particularly PD, individuals also seem to manifest an explicit memory bias for threatening information. These interpretive, attentional, and memory biases may serve as markers of anxiety and may participate in the etiology of various anxiety disorders.

Of all the anxiety disorders, the three information-processing biases reviewed here have been observed most frequently in PD. In panic-disordered individuals, interpretive, attentional, and both explicit and implicit memory biases have been observed consistently. In most studies, these biases are directed toward interoceptive stimuli. Individuals diagnosed with social phobia and GAD manifest interpretive and attentional biases, but explicit memory biases have not been observed with much consistency. People diagnosed with disorders such as OCD, PTSD, and specific phobias show attentional biases, but more research on interpretive and memory biases is needed.

Rationale for the Present Study

The last twenty or so years have witnessed a proliferation of studies examining information processing in anxiety disorders. Surprisingly, no published studies have assessed information-processing biases in claustrophobia. The present study was developed with the aim of exploring interpretive, attentional, and memory biases in claustrophobia. Given the presumed role of interoceptive fear as a feature that differentiates claustrophobia from animal phobias, the present study endeavored to determine whether interoceptive fear manifests as information-processing biases. The study was an outgrowth of previous research in our lab directed at identifying the component fears that comprise claustrophobia (see McGlynn et al., 2003, in press).

The current study compared claustrophobic, snake phobic, and nonphobic participants on commonly-used measures of interpretive, attentional, and memory bias. (Spider phobics were not included in the animal phobia comparison group due to the potentially confounding effect of disgust.) To measure attentional bias, participants were first administered a computerized emotional Stroop task that included interoceptive, neutral, and positively-valenced stimuli that were presented in block format. They were later asked to recall as many words as possible from the Stroop task and to complete a recognition task that included the Stroop words as well as foil words. The free recall and recognition tasks were used as indicators of memory bias for the different word types. Participants also completed a modified version of McNally and Foa's (1987) Interpretation Questionnaire to assess interpretive bias toward interoceptive and external stimuli (described below).

The protocol used here represents an improvement over previous studies of this type. Modifications were introduced to afford a relatively valid assessment of memory bias. Time spent viewing the Stroop stimuli was equated across all participants to ensure equivalent exposure to the stimuli for the memory bias assessment. Semantic processing of the word stimuli was promoted by having participants rate the emotional valence of each Stroop word prior to the memory bias tasks. As noted above, two measures of explicit memory bias were used instead of one.

We hypothesized that claustrophobics would show interpretive, attentional, and explicit memory biases toward interoceptive stimuli, whereas the snake phobic group and the nonphobic control group would not. We also hypothesized that these biases in the claustrophobic group would exist only for interoceptive stimuli, and not for stimuli of other types. This finding would serve to differentiate claustrophobics from snake phobics at the level of information processing. Furthermore, we hypothesized that anxiety sensitivity would predict information-processing biases toward interoceptive stimuli, given the presumed importance of this construct in claustrophobia. The results of this study have implications in terms of furthering our conceptualization of claustrophobia as a disorder with primary interoceptive components, objectively differentiating claustrophobia from animal phobias, confirming the overlap between claustrophobia and PDA, and supporting the use of analogue populations to conduct research on constructs related to fear and anxiety.

II. METHOD

Participants

The 54 participants comprising the three experimental groups (claustrophobic, snake phobic, nonphobics) ranged in age from 19 to 29, and had a mean age of 20.5 years ($SD = 1.66$). Forty-seven were Caucasian, 6 were African-American, and 1 was Asian. Six participants reported current use of psychotropic medication. The three experimental groups did not differ significantly in age, race, or current use of psychotropic medication.

Apparatus and Materials

Psychometric measures. The following questionnaires provided psychometric data: the Claustrophobia Questionnaire (Radomsky et al., 2001), the Snake Questionnaire (Klorman, Hastings, Weerts, Melamed, & Lang, 1974), the Anxiety Sensitivity Index (Reiss et al., 1986), and the Fear Survey Schedule-II-Revised (Wolpe & Lang, 1977). These questionnaires were selected because they have strong psychometric support and are relevant to the construct of claustrophobia.

The Claustrophobia Questionnaire (CLQ; Radomsky et al., 2001) is a 26-item Likert-scale instrument on which respondents rate (0-4) their anxiety when in a variety of situations. The CLQ provides a total score for claustrophobic fear and subscale scores for fear of suffocation (CLQ-SS) and fear of restriction (CLQ-RS). Fourteen items comprise the suffocation subscale and 12 items make up the restriction subscale. The CLQ has been shown to possess satisfactory internal consistency, test-retest stability, and predictive and discriminant validity (Radomsky et al.; McGlynn et al., in press).

The Snake Questionnaire (SNAQ; Klorman et al., 1974) is a 30-item true/false instrument that assesses the respondent's fear of snakes and various snake-related stimuli. A score of "1" is assigned to items marked true, and a score of "0" is assigned to each false response. Nine items are reverse-scored, and scores range from 0 to 30. The SNAQ has demonstrated satisfactory internal consistency and test-retest reliability (Fredrikson, 1983; Klorman et al.) and is sensitive to treatment effects (Öst, 1978).

The Anxiety Sensitivity Index (ASI; Reiss et al., 1986) is a popular Likert-scale questionnaire that quantifies the construct of anxiety sensitivity. Respondents rate the extent to which they agree with 16 statements regarding their fear of the presumed consequences of various bodily sensations associated with anxiety. The ASI is a well-researched instrument with strong psychometric properties (Peterson & Reiss, 1993). The ASI has been shown to afford prediction of variables such as response to biological challenge tests (see Smitherman, 2005) and sensitivity to treatment, particularly in individuals with PD (see Taylor, 1999).

The Fear Survey Schedule-II-Revised (FSS-II-R; Wolpe & Lang, 1977) is a widely-used omnibus questionnaire on which respondents rate their fear of each of 28 items on a 1-7 Likert scale. As noted by Antony and Swinson (2000), the fear survey schedules are not ideal for diagnosing specific phobias, because many items are related to social phobia, agoraphobia, and situations not typically associated with anxiety disorders in general ("being with drunks", "being in a fight", etc.). Our use of the FSS-II-R was thus informational in nature and focused only on the face-valid items (e.g., “small, enclosed spaces” and “snakes”).

The Anxiety Disorders Interview Schedule-4th edition, (ADIS-IV; Brown, Di Nardo, & Barlow, 1994) is a reliable and valid semi-structured interview designed to assess the nature and severity of a person’s anxiety. Oftentimes, administration of the ADIS-IV assists in determining whether or not symptoms are frequent enough and severe enough to warrant a *DSM-IV* clinical diagnosis. The ADIS-IV is comprised of several modules specific to certain anxiety disorders. For our purposes, only the specific phobia module was administered, in order to determine which participants met *DSM-IV* criteria for a diagnosis of claustrophobia or snake phobia.

Measure of interpretive bias. The Brief Body Sensations Interpretation Questionnaire (BBSIQ; Clark et al., 1997) is a modified version of McNally and Foa’s (1987) Interpretation Questionnaire. The BBSIQ presents 14 ambiguous scenarios in booklet form, each of which is printed on a separate page. Seven of the scenarios describe panic body sensations (e.g., “You feel discomfort in your chest. Why?”), and seven describe various external events (e.g., “You wake with a startle during the night, thinking you heard a noise, but all is quiet. What do you think woke you up?”). Respondents rank-order (1-3) three printed explanations for each scenario in terms of the *likelihood* of each explanation coming to mind. One of the three explanations is threat-related (“Something is wrong with your heart”), and the other two are either both neutral (e.g., “Because you have indigestion”) or one is neutral and one is positive (e.g., “Because you are excited”). After completing the booklet, respondents are told to return to each page of rank-ordered responses and rate each provided explanation in terms of how much they would *believe* the explanation to be true if they found themselves in that situation, using a scale from 0 (*not at all*) to 10 (*very likely to be true*).

For the rank-ordered responses, a score of 3 is assigned to the threat-relevant interpretation when it is ranked first, a score of 2 when it is ranked second, and a score of 1 when it is ranked last. Mean likelihood rankings and mean belief ratings of the negative interpretations are then computed separately for the internal and external scenarios. The BBSIQ thus provides two measures of interpretive bias for each scenario type: the mean ranking of the likelihood that a negative interpretation will come to mind (range = 1-3) and the mean rating of belief in a negative interpretation (range = 0-10).

The BBSIQ is relatively new in comparison to the Interpretation Questionnaire, but more psychometric data are available on the BBSIQ. Specifically, the BBSIQ has been shown to possess satisfactory internal consistency and test-retest stability, is sensitive to treatment influence, and distinguishes between treatments with differing effects on panic (Clark et al., 1997). The BBSIQ has also differentiated PD patients from GAD patients and normal controls (Clark et al.; Richards et al., 2001). Further, in contrast to the Interpretation Questionnaire, the BBSIQ assesses the strength of beliefs in negative interpretations in addition to their frequency.

Measure of attentional bias. An emotional Stroop task was presented on a personal computer using E-Prime software. Participants sat approximately 18 in. from the screen. Words appeared in lowercase 1.0-cm letters and in the colors red, green, blue, and black. Three categories of words were presented: interoceptive (body sensation words), neutral, and positive. The 15 words comprising each category are presented in Table 1 (located in Appendix A with all tables and figures), many of which were taken from previous studies by McNally and colleagues (McNally et al., 1994, 1999; McNally, Riemann, Louro, Lukach, & Kim, 1992) and from descriptors of panic attacks listed in *DSM-IV*. The words for each category (interoceptive, neutral, positive) did not differ in mean letters per word or in mean frequency of usage in American English (Carroll, Davies, & Richman, 1971; Francis & Kucera, 1982). The 15 words comprising each category were arranged in 4 different fixed random orders; no word or color was allowed to occur twice in succession. The 4 orders were then presented sequentially to comprise a category block. There were thus 180 total experimental trials (60 words per category block x 3 category blocks). Because there were 3 category blocks presented, 6 block order combinations were possible. Since 18 participants comprised each group, each group experienced the 6 block orders exactly three times, providing a complete counterbalancing of block order presentations across participants by experimental groups.

Following the procedures of McNally et al. (1992, 1994, 1999), each trial began with a 500 ms presentation of a white fixation cross at the center of the screen, designed to orient the participant's attention. The fixation cross was replaced by the stimulus word for 1.5 sec, regardless of the speed of the participant's response. (Having a set time for word presentation ensured that all participants would see each word for the same amount of time, which was essential for the memory bias test.) Participants were instructed to ignore the meaning of the word and to name the word color as quickly as possible into a Radio Shack electret condenser headset microphone (100-10,000 Hz frequency; -58dB ± 4dB sensitivity at 1 kHz). The microphone was positioned 1 in. from the participant's mouth and connected to a timer that recorded vocal response latency with millisecond precision. Prior to beginning the emotional Stroop task, participants were given 20 practice trials naming the ink color of the words ONE, TWO, THREE, and FOUR.

Mean response latencies for each of the three word types were computed for each participant. Two additional measures of attentional bias were computed for each participant: the mean response latency for interoceptive words minus the mean response latency for neutral words, and the mean response latency for positive words minus the mean response latency for neutral words. These difference scores serve as Stroop "interference indices" that allow for relative comparisons of interference for emotional stimuli (interoceptive and positive words) while controlling for individual differences in overall color-naming speed (see McNally, Riemann, & Kim, 1990).

Measures of explicit memory bias. Two measures of explicit memory bias for Stroop words were used: a free recall task and a recognition task. Following administration of a 5-min distractor task (described below), participants were instructed to write down as many words as they could remember from the computerized Stroop task, without regard for spelling. The mean number of words recalled for each category was computed for each participant. As was conducted with the Stroop data, two additional measures of memory bias were computed for each participant: the mean number of interoceptive words recalled minus the mean number of neutral words recalled, and the mean number of positive words recalled minus the mean number of neutral words recalled. Similar to the Stroop interference index scores, these recall index scores are designed to help control for individual differences in memory ability.

The recognition task was administered immediately following the free recall test. Participants were provided a sheet of paper that listed 75 words, all 15 words from each of the three Stroop categories as well as 30 foil words, and instructed to circle each word that they recognized from the Stroop task. Foils were included that were presumed to be similar to the types of Stroop words (10 interoceptive foils, 10 neutral foils, and 10 positive foils). The percentage of words per type correctly recognized was calculated for each participant (hit rates), as was the percentage of foils incorrectly identified (false alarm rates). Recognition index scores were calculated in the same way as were the index scores used with the free recall data.

Procedure

Participant screening. Undergraduate students seeking extra credit were solicited for participation via classroom announcements and on-campus flyers, which described the study as one exploring the relationship between emotions and cognitive psychology. During the initial screening, self-selected undergraduate students completed an Informed Consent Form; the ASI, CLQ, SNAQ, and FSS-II-R; and a demographic questionnaire that also asked about any history of panic disorder. Those reporting a history of panic disorder were ineligible for further participation.

Nine hundred one participants (772 female, 129 male) completed the battery of self-report measures over the course of a one-year period. Cutoff scores for the experimental groupings were determined based on a review of those participants screened during the first month of the study ($n = 385$), so as to expedite the transition of participants from screening to participation in the experimental protocol and to minimize attrition. A review of the scores from these participants indicated that the large majority of participants scoring in the upper 20% of the CLQ and SNAQ were women, while those scoring in the bottom 20% of both measures were almost exclusively men. We thus decided to use only female participants to negate the bimodal sex distribution and in consideration of elevated rates of anxiety disorders in women (Craske, 2003).

Of the 385 participants screened during the first month of the study, 256 were female. The claustrophobic group was designated as those females who scored in the upper 15% on the CLQ and the lower 40% on the SNAQ (CLQ $\geq$ 57 and SNAQ $\leq$ 8). The snake phobic group was made up of those females who scored in the upper 15% on the SNAQ and the lower 40% on the CLQ (CLQ $\leq$ 31 and SNAQ $\geq$ 19). The nonphobic control group was comprised of those females who scored in the bottom 20% on both the CLQ and SNAQ (CLQ $\leq$ 20 and SNAQ $\leq$ 4). In total, 772 females were screened until 18 participants were identified that met the inclusion criteria for each of the experimental groups (n = 54 total), after excluding eleven participants due to missing data/computer difficulties and one claustrophobic participant who met ADIS-IV criteria for snake phobia.

Experimental protocol. Participants appropriate for membership in one of the three experimental groups were contacted by phone and scheduled to return individually for the experimental portion of the study. Upon arriving, they were told that they would be completing a task on the computer as well as several paper-and-pencil measures. Each participant completed the following tasks in the following order: computerized Stroop task, word emotionality ratings (described below), distractor task, free recall memory task, recognition task, BBSIQ, and administration of the ADIS-IV specific phobia module. With the exception of the Stroop task, the BBSIQ, and the ADIS-IV, the time spent on all tasks by each participant was 5 min. Those participants finishing any task before 5 min were instructed to look over their answers until time was called. Equating the time spent on these tasks standardized the duration of exposure to the stimuli.

Following the Stroop task, participants were given a list of the 45 Stroop words, with the 15 words of each type distributed evenly across the list. Participants were instructed to rate each word in terms of its emotional valence using a Likert scale of –3 (*very negative*) to +3 (*very positive*). The word emotionality rating was included to promote semantic processing of each word before the upcoming memory tasks. After the emotionality ratings, a distractor task was administered in which participants were instructed to subtract backward (on paper) from 1000 by 7 for 5 mins. Administration of the free recall memory task, recognition task, BBSIQ, and ADIS-IV then proceeded as described earlier. After completion of the ADIS-IV, participants were debriefed about the purpose of the experiment and given an opportunity to ask any questions.

III. RESULTS

Experimental Groupings

Five separate one-way ANOVAs were conducted comparing the three groups on the primary questionnaire measures administered during screening (ASI, CLQ and its two subscales, and SNAQ). Table 2 presents the mean scores of each group on these measures and indicates significant differences obtained from post-hoc analyses (Tukey HSD). Claustrophobics scored significantly higher on the total scale and both subscales of the CLQ than did the snake phobics and nonphobics, who did not differ from each other. Snake phobics scored significantly higher than the claustrophobics and the nonphobics on the SNAQ. Although claustrophobics scored significantly higher on the SNAQ than did the nonphobics, mean scores of both these groups were quite low and well below the clinical range. These comparisons show that the criteria used for assigning participants to experimental groups were successful in creating three rather distinct groups. Consistent with research reviewed earlier, claustrophobics also scored significantly higher on the ASI than did both other groups.

Regarding the participants' ADIS-IV responses, 9 claustrophobics and 8 snake phobics fulfilled ADIS-IV criteria for their respective phobias. When "sub-clinical" diagnoses were included, in which all diagnostic criteria were met except for functional impairment/marked distress, 12 claustrophobics and 18 snake phobics fulfilled the respective ADIS-IV criteria. In short, the questionnaire selection criteria were relatively successful, albeit imperfect, in establishing experimental groups of significantly fearful participants.

Interpretive Bias

Likelihood rankings. Table 3 presents the mean likelihood rankings for each experimental group. A 3 (Group: Claustrophobic, Snake Phobic, Nonphobic) x 2 (Likelihood Ranking Type: External vs. Panic Body Sensation) repeated measures ANOVA (repeated on Likelihood Ranking Type) revealed a significant main effect for Group, $F(2, 51) = 7.37$, $p < .01$, partial $\eta^2 = .22$. A trend toward statistical significance was observed for the main effect of Likelihood Rating Type, $F(1, 51) = 2.84$, $p = .098$, partial $\eta^2 = .05$, in which the negative interpretations for external scenarios received higher likelihood rankings by all participants than did the negative interpretations for scenarios related to panic body sensations. There was no significant interaction. Post-hoc analyses (Tukey HSD) revealed that the main effect for Group was produced by the claustrophobics providing higher likelihood rankings overall for the negative interpretations relative to both snake phobics and nonphobics, who did not differ from each other in their rankings.

Belief ratings. Table 3 also presents the mean belief ratings for each experimental group. A 3 (Group) x 2 (Belief Rating Type: External vs. Panic Body Sensation) repeated measures ANOVA (repeated on Belief Rating Type) revealed significant main effects for Group, $F(2, 51) = 6.07$, $p < .01$, partial $\eta^2 = .19$, and for Belief Rating Type, $F(1, 51) = 30.66$, $p < .001$, partial $\eta^2 = .38$. There was no significant interaction. Tukey post-hoc analyses revealed that the main effect for Group was a function of the claustrophobics providing significantly higher belief ratings overall for the negative interpretations than did the nonphobics; the snake phobics did not differ from either group in their overall ratings. Within-subjects contrasts showed that the main effect for Rating Type was a result of all groups rating their belief in the negative interpretations for the external scenarios more highly than their belief in the negative interpretations for the scenarios related to panic body sensations.

Attentional Bias

Word emotionality ratings. In addition to promoting semantic processing of the Stroop stimuli before assessments of memory bias, the word emotionality rating task served as a manipulation check for the presumed emotional valence of the three Stroop word types. Mean emotionality ratings for each word type were computed using the absolute values of the individual word ratings, in keeping with previous research (e.g., McNally et al., 1992).

A 3 (Group) x 3 (Word Type) repeated measures ANOVA (repeated on Word Type) revealed significant main effects for both Group, $F(2, 51) = 4.94$, $p < .05$, partial $\eta^2 = .16$, and Word Type, $F(2, 102) = 515.37$, $p < .001$, partial $\eta^2 = .91$. There was no significant interaction. The main effect for Group was a function of the claustrophobics providing significantly higher emotionality ratings overall than did the nonphobics or the snake phobics; the ratings of nonphobics and snake phobics did not differ. Within-subjects contrasts revealed that the main effect for Word Type was a result of all groups rating the positive words as more emotional than the interoceptive words, which in turn were rated as significantly more emotional than the neutral words. Figure 1 displays the mean emotionality rankings by group.

Stroop interference. Errors on the emotional Stroop task were extremely rare, occurring on 0.77% of the 9,720 responses. Errors included trials in which the participant spoke too softly to trip the relay, tripped the relay prematurely (latencies < 300 ms), did not respond within 1500 ms, or made an incorrect response (e.g., naming the word instead of the ink color). Trials with errors were excluded from computation of mean response times. Errors in which the participant incorrectly named the word color were classified as those occurring during the interoceptive word block, during the neutral word block, and during the positive word block. There were no significant differences in these errors between the three experimental groups.

Reaction time data were averaged for each participant for each of the three word types: interoceptive, neutral, and positive (see Table 4). The 162 mean scores were then evaluated using a 3 (Group) x 3 (Word Type) repeated measures ANOVA (repeated on Word Type). A significant main effect was obtained for Group, $F(2, 51) = 3.94$, $p < .05$, partial $\eta^2 = .13$. A trend toward significance was observed for the main effect of Word Type, $F(2, 102) = 3.04$, $p = .052$, partial $\eta^2 = .06$; slower response times were obtained for the interoceptive words than for the neutral or positive words. There was no significant interaction. Post-hoc analyses (Tukey HSD) revealed that the main effect for Group was a result of the claustrophobics exhibiting significantly slower reaction times compared to the nonphobics. The snake phobics did not differ in overall reaction time from either group, though their slower times compared to the times of nonphobics approached statistical significance ($p = .057$). (These analyses were performed also with square-root and logarithm transformed latency data, as is commonly done with data such as these that are positively skewed [Tabachnik & Fidell, 2001]. The results were the same for both transformed and untransformed latencies.)

Finally, two Stroop interference index scores (see McNally et al., 1990, 1994) were computed for each participant, which serve to control for general color-naming speed. These were obtained by subtracting the mean time taken to color-name the neutral words from the mean times taken to color-name the interoceptive and positive words. The interference index scores were analyzed using a 3 (Group) x 2 (Word Type: Interoceptive, Positive) repeated measures ANOVA. There were no significant effects for Group, Word Type, or the Group x Word Type Interaction, suggesting that the interoceptive and positive words did not differ in the amount of relative interference they produced for the groups.

Memory Bias

Recall memory. Permitting mistakes in spelling (e.g., “breatheless” for “breathless”) and form variations (e.g., “nauseous” for “nausea”), the number of words correctly recalled from the Stroop and emotionality rating tasks was calculated for each of the three word types. Errors were defined as those words generated by the participant that had not been presented during the Stroop and emotionality rating tasks. There were no differences between the three groups in the number of recall errors.

A 3 (Group) x 3 (Word Type) repeated measures ANOVA (repeated on Word Type) within the numbers of words recalled correctly revealed a significant main effect for Word Type, $F(2, 102) = 26.27$, $p < .001$, partial $\eta^2 = .34$. There were no significant effects for Group or for the Group x Word Type Interaction. Within-subjects contrasts showed that the main effect for Word Type was a function of the three groups recalling significantly more interoceptive words than neutral words and significantly more neutral words than positive words. Overall, participants recalled a mean 6.37 interoceptive words (*SD* = 2.22), 5.00 neutral words (*SD* = 2.22), and 4.02 positive words (*SD* = 1.49). Translating these numbers into percentages, overall participants recalled 42.47%, 33.33%, and 26.80% of the interoceptive, neutral, and positive words, respectively.

Two recall index scores were computed for each participant as an attempt to control for overall differences in memory while comparing recall of interoceptive and positive words. These were obtained by subtracting the mean number of neutral words recalled from the mean numbers of interoceptive and positive words recalled. The recall index scores were analyzed using a 3 (Group) x 2 (Word Type) repeated measures ANOVA. A significant main effect was found for Word Type, F(1,51) = 64.11, $p < .001$, partial $\eta^2 = .56$. All groups scored significantly higher on the recall index for interoceptive words than on the recall index for positive words (see Figure 2).

Recognition memory. The inclusion on the recognition memory task of all 45 words (15 per type) from the Stroop task as well as 30 foils (10 per type) allowed for analyses of percentage of words from the Stroop task correctly identified (hit rate) and percentage of foils incorrectly identified (false alarm rate) by word type. Analysis of false alarms was conducted using a 3 (Group) x 3 (Word Type) repeated measures ANOVA. There was a significant effect for Word Type, F(2, 102) = 9.42, $p < .001$, partial $\eta^2 = .16$. Within-subjects contrasts showed higher "recognition" rates for interoceptive and positive foils (which did not differ from each other) than for neutral foils.

Analyses of the percentages of words recognized correctly using a 3 (Group) x 3 (Word Type) repeated measures ANOVA (repeated on Word Type) yielded a significant effect for Word Type, $F(2, 102) = 21.91$, $p < .001$, partial $\eta^2 = .30$. Again, there was no significant effect for Group or the Group x Word Type Interaction. Within-subjects contrasts explained the main effect for Word Type: All groups recognized more interoceptive words than neutral words and more neutral words than positive words. An analysis of "hit rates" minus "false alarm rates" produced a result somewhat similar to that of the ANOVA within correct words recognized. Recognition was superior and not different for interoceptive and neutral words, by contrast with positive words. The mean data for correct and incorrect words recognized are presented in Table 5.

As was conducted with the free recall data, two recognition index scores were computed for each participant as an attempt to control for overall differences in memory while comparing recognition of interoceptive and positive words. To maintain consistency with the recall index scores, the recognition index scores were obtained by subtracting the mean number of neutral words correctly recognized from the mean number of interoceptive words correctly recognized and from the mean number of positive words correctly recognized. The recognition index scores were analyzed using a 3 (Group) x 2 (Word Type) repeated measures ANOVA. A significant main effect was found for Word Type, $F(1,51) = 39.06$, $p <.001$, partial $\eta^2 = .43$. All groups recognized significantly more net interoceptive words than net positive words (see Figure 3).

Anxiety Sensitivity and Information-Processing Biases

Given the hypothesized importance of anxiety sensitivity in claustrophobia, we endeavored to ascertain the role of anxiety sensitivity in the information-processing biases studied here. The ASI total scores for participants in the claustrophobic group were entered as predictor variables in a series of linear regression analyses in which the criterion variables were: BBSIQ likelihood rankings and belief ratings, Stroop response latencies and interference index scores, words recalled during the free recall task and recall index scores, and hit rates from the recognition task and the recognition index scores. Among the claustrophobic participants, the ASI scores significantly predicted the numbers of interoceptive words recalled during the recall test, $R^2 = 24.9\%$, $F(1, 16) = 5.30$, $p < .05$, and the recall interference index for interoceptive words, $R^2 = 31.5\%$, $F(1, 16) = 7.35$, $p < .05$. ASI scores did not predict either of those two criterion variables among either snake phobics or nonphobics.

For purposes of comparison, regression analyses similar to those above were conducted in which the Suffocation and Restriction subscales of the CLQ were entered separately as predictor variables in order to predict the outcome variables above for the claustrophobic participants. Neither subscale predicted any of the outcome measures.

IV. DISCUSSION

The work reported here is part of a larger program of research aimed at identifying the component fears that characterize claustrophobia (see McGlynn et al., 2003, in press). The present study was designed to extend the program by focusing specifically on the role of interoceptive fear in claustrophobia as it is manifested in information-processing biases. Commonly-used measures of interpretive, attentional, and memory bias were employed to maintain consistency with previous research in the anxiety literature. Several efforts were made to improve the experimental approach as it is typically used. The work included a complete counterbalancing of Stroop block orders to eliminate unequal block-to-block priming/carryover effects. Time spent viewing the Stroop words was equated across participants, and two measures of explicit memory bias were incorporated (free recall and recognition). Finally, participant ratings of Stroop word emotionality were obtained to promote semantic processing of memory stimuli and to inform statements regarding hypothesized information-processing mechanisms.

The major conclusions from the present study are described below. First, the data regarding interpretive, attentional, and memory biases are reviewed and summarized. Although claustrophobics did not display differential information-processing biases toward interoceptive stimuli, different patterns of results were obtained across the three bias assessments. Theoretical and empirical explanations for the findings are considered, in particular the vigilance-avoidance theory of Williams et al. (1988, 1997) and the literature on component fears of claustrophobia. Finally, limitations of the study are addressed and some directions for future research on claustrophobia are described.

Interpretive Bias in Claustrophobia

Results from the measures of interpretive bias contradict the notion that the tendency to interpret interoceptive stimuli as threatening differentiates claustrophobics from animal phobics. Although the claustrophobic participants provided significantly higher likelihood rankings (indicating the likelihood of generating negative interpretations for ambiguous stimuli) for external and internal stimuli than did the other two groups, they did not differ from the snake phobics in their belief ratings (designating the believability of negative interpretations for ambiguous stimuli). However, neither of these findings was specific to interoceptive stimuli. In fact, all groups produced significantly higher belief ratings for the external stimuli than for the interoceptive stimuli.

With the caveat that snake phobics did not differ from the claustrophobics on the belief ratings data, the BBSIQ data provide modest evidence that claustrophobics are prone to interpret both internal and external stimuli as threatening. This conclusion argues against the specificity of interpretive bias in this population. This is the first study to report the presence of an interpretive bias for both external and internal stimuli in claustrophobia, compared to nonphobic individuals. Although it will need to be borne out by future research, one potential explanation for this finding is that claustrophobia is comprised of prominent interoceptive *and* external stimuli. Indeed, one popular conceptualization of claustrophobia (e.g., Rachman & Taylor, 1993) emphasizes the dual importance of fears related to internal stimuli (suffocation) and those defined by situation-specific stimulus characteristics (perceived restriction in an enclosed space). The relevance of this conceptualization to the present study is considered in more detail below.

Attentional Bias in Claustrophobia

Findings from the emotional Stroop portion of the study were generally similar to those observed on the measures of interpretive bias: Claustrophobic participants demonstrated significantly longer color-naming latencies for all words, as compared to nonphobic controls; snake phobics did not differ from either other group. While there was a trend toward statistical significance indicating longer response latencies for the interoceptive words across all groups, the Stroop interference index scores indicated no significant differences between the amount of relative interference produced by the interoceptive and positive words, after controlling for overall differences in memory. The emotional Stroop data thus run contrary to the idea that claustrophobia is characterized by an attentional bias specific to interoceptive stimuli.

As some researchers (e.g., Becker et al., 2001; Martin, Williams, & Clark, 1991) have suggested, it is plausible that differences in emotional valence of the three word types influenced the emotional Stroop results. If emotionality in general influenced the attentional bias findings, one would expect to observe attentional biases congruent with word emotionality ratings. Because the positive words were rated by all groups as significantly more emotional than were the other words, the emotionality hypothesis predicts more attentional bias toward positive words relative to interoceptive words. The emotionality hypothesis was not supported by the present study; there was no main effect for word type, and a trend approaching statistical significance indicated the longest response latencies to interoceptive words. Thus, although word emotionality has received some support as an explanation for attentional biases in GAD patients (Becker et al.), it does not appear responsible for the findings in the present study (or for attentional biases in other anxiety disorders; Williams et al., 1996).

The emotional Stroop results are difficult to dismiss by appeal to methodological issues: Word types did not differ in their mean length or mean frequency of usage in English (even using two references of frequency data), block presentations were completely counterbalanced across participants within each experimental group, two types of comparison word stimuli (positive, neutral) were used, errors and outliers were excluded, and results were confirmed with both logarithm and square-root transformed latency data. Some researchers (e.g., Mathews and Sebastian, 1993) have found that longer response latencies disappear when phobic individuals are in the presence of their feared stimulus. The emotional Stroop was conducted in a windowless room measuring approximately 8 ft x 14 ft. While it is conceivable that being anxious about escaping from a windowless room might increase anxiety and serve to "override" the emotional Stroop effect in the claustrophobic participants, latencies of the claustrophobic group still exceeded those of the nonphobic group (and were similar to those of the snake phobic group), arguing against this explanation.

No published study has reported on attentional bias in claustrophobia. The failure to find a bias specific to interoceptive stimuli runs contrary to many studies cited earlier that have found disorder-specific attentional biases in most anxiety disorders. However, in the absence of contradictory published data and without striking methodological weaknesses here, we conclude that the presence of a disorder-specific attentional bias in claustrophobia is yet to be documented. Failures to find a disorder-specific bias have been reported by several other researchers studying attentional bias in other anxiety conditions (e.g., Craske, 1999; Kampman, Keijsers, Verbraak, Näring, & Hoogduin, 2002; Martin et al., 1991). More research is needed on the boundary conditions of attentional bias in anxious individuals.

Memory Bias in Claustrophobia

Findings from both the recall and recognition tasks were remarkably consistent across all groups: Memory as assessed either way was best for interoceptive words and worst for positive words. Recall and recognition index scores confirmed significantly better memory for interoceptive words than for positive words, after controlling for overall memory differences. However, in all these comparisons no effects were found for "diagnostic" group. The lack of a significant group effect or interaction does not support the expectation that an explicit memory bias toward interoceptive stimuli differentiates claustrophobics from snake phobics and nonphobic individuals.

An inadequate experimental preparation seems an unlikely explanation for the memory bias findings. The experimental design here allowed each participant to view each stimulus word five times before the memory bias tasks (four times per word during the emotional Stroop and once during the word emotionality rating task). Also, the emotionality rating task should have promoted semantic processing of the word stimuli.

Despite these manipulations, the lack of observed memory biases was not entirely unexpected. Memory biases in the anxiety disorders have received only mixed empirical support, as discussed earlier (see Coles & Heimberg, 2002). While several studies on explicit memory biases in PD patients have found enhanced memory for threat-relevant stimuli, others have not (e.g., Otto, McNally, Pollack, Chen, & Rosenbaum, 1994; Pickles & van den Broek, 1988). By comparison to attentional biases in anxiety disorders, the evidence is relatively weak and inconsistent in showing memory biases across the anxiety disorders.

Anxiety Sensitivity

The finding that claustrophobic participants reported higher levels of interoceptive fear (based on ASI scores) than the other two groups was expected: Reports of elevated ASI scores in claustrophobics have appeared for some time (e.g., Craske et al., 1995; Craske & Sipsas, 1992). Perhaps most surprising about the differential ASI scores, however, is their lack of predictive power in almost every measure of information-processing bias studied here. ASI scores for the claustrophobic group predicted only their recall of interoceptive words, an outcome variable on which the claustrophobics did not differ from the other two groups. ASI scores did not figure significantly into interpretive, attentional, or recognition memory biases of any stimulus type. McNally et al. (1999) reported a thematically similar result, concluding that anxiety sensitivity correlates poorly with measures of information-processing bias and may operate independently of cognitive bias variables.

Vigilance-Avoidance Theory

If word emotionality, anxiety sensitivity, and methodological issues do not account for the pattern of results obtained here, what other explanations might have merit? The theories of Beck and Emery (1985) and Bower (1981) both predict that information-processing biases should be consistent across various tasks. That is, they predict that anxious individuals will demonstrate interpretive, attentional, *and* memory biases. The present results challenge those theories. Compared to nonphobic controls, claustrophobic participants evidenced a tendency to interpret stimuli of various types as threatening and produced longer response latencies on the emotional Stroop for all stimuli (presumably indicative of increased attentional allocation). However, the claustrophobic group did not differ from the nonphobic group on the memory bias tasks.

Other researchers have also found minimal correlations between measures of attention and memory (e.g., Gotlib et al., 2004). Overall, our results accord well with the vigilance-avoidance theory of Williams et al. (1988, 1997), which predicts discordance across tasks assessing interpretive, attentional, and memory processes. According to their theory, anxiety is characterized by an initial, automatic process of hypervigilance designed to detect threat in the environment. Subsequent to threat detection, however, anxious individuals make strategic efforts to avoid the threatening stimuli. Depressed individuals, by contrast, are less vigilant initially but have trouble disengaging from depression-related stimuli, as evidenced by the frequency and persistence of depressive rumination.

In the vigilance-avoidance model, interpretive and attentional biases for threat are predicted in anxious individuals, as these biases tend to occur at the initial stages of threat detection and appraisal. Subsequent avoidance, however, prohibits further processing of threatening information and inhibits memory consolidation for such stimuli. By contrast, memory biases are characteristic of depression, due to depressed individuals' elaborative rumination on depressive themes. The vigilance-avoidance model, and others derived from it, have received considerable empirical support over the last two decades (Mogg &

Bradley, 1998; Mogg, Bradley, Miles, & Dixon, 2004; Williams et al., 1997), with studies finding disorder-congruent attentional biases in anxiety and disorder-congruent memory biases in depression (e.g., Mogg & Bradley, 2005)

Our findings of interpretive and attentional biases, but not memory biases, for claustrophobic individuals provide the first empirical support for the vigilance-avoidance model insofar as it pertains to the construct of claustrophobia. Our general pattern of findings is well-predicted by this model. What is difficult to explain, however, is the lack of specificity in interpretive and attentional biases observed in the claustrophobic group.

Restriction and Suffocation in Claustrophobia

Perhaps phobic individuals, regardless of diagnosis, are prone to make negative interpretations and devote significant attentional resources to all types of stimuli. This argument has some parallels to Eysenck's (1992) hypervigilance theory, in which anxious individuals frequently direct their cognitive resources to scanning the environment for potential threat. Because of their hypervigilance for threatening stimuli, it is plausible that the phobic individuals in this study devoted more attention to all stimuli while they attempted to discriminate those that were threatening from those that were not, thus accounting for the longer response latencies on all types of Stroop words.

Another explanation for the nonspecificity of attentional biases challenges the validity of the emotional Stroop as a measure of selective attention. This argument is articulated well by Fox (1993), who asserts that the emotional Stroop is an inadequate measure of selective attention because target and distracting stimuli are not presented in spatially separate locations (see also Algom et al., 2004). Thus, the emotional Stroop cannot differentiate between the processing of information that is central or marginal to the focus of attention. The importance of differentiating target from distractor stimuli has been confirmed by subsequent experimental studies (see Fox, 1995, for a review), including those showing that the dot-probe task may be more effective than the emotional Stroop in identifying biases in selective attention (e.g., Gotlib et al., 2004). Indeed, even the original Stroop (1935) has been criticized as being an inadequate measure of selective attention (Treisman, 1969). Although an exhaustive review of this issue is beyond the scope of the present paper, it is worth noting that the popularity of other methods for assessing attention in anxious individuals appears to be growing (e.g., dot-probe task).

The most plausible explanation for the absence of bias specificity is perhaps one that asserts the accuracy of the null hypothesis, at least within the boundary conditions here. Our results suggest that perhaps interoceptive fear is simply not the defining feature of claustrophobia. Other accounts of claustrophobia maintain that claustrophobia is primarily a function of the partially independent fears of restriction and suffocation (Harris et al., 1999; Rachman, 1990; Rachman & Taylor, 1993; Radomsky et al., 2001). Although one unpublished study (Ilai, 1992) has reported the presence of attentional bias toward stimuli typically associated with these constructs, no published research has evaluated how restriction and suffocation fears might be manifested in information-processing biases. In the present study, restriction-related stimuli were not incorporated into any task, and only 4 of 15 interoceptive words from the Stroop task were germane to fear of suffocation (*breathless*, *choking*, *suffocation*, *smothering*).

The argument that interoceptive fear is not the defining feature of claustrophobia is supported by recent studies evaluating the prediction afforded to subjective and behavioral indices of claustrophobic fear by the constructs of fear of restriction and fear of suffocation. McGlynn et al. (in press) evaluated the extent to which these two constructs, plus sensitivity to anxiety symptoms, predicted fear behavior during exposure to a mock magnetic resonance imaging (MRI) device. Fear of suffocation was the strongest individual predictor of subjective fear ratings; a measure of anxiety sensitivity increased the predicted variance by only 6.1%. Fear of restriction most strongly predicted behavioral failure of the 6-min mock MRI exposure; anxiety sensitivity did not provide incremental validity to the prediction afforded by restriction alone. McGlynn et al. (2003) reported thematically similar results, in which ASI scores did not figure significantly into a three-variable model that predicted subjective fear ratings and included total scores from the CLQ; ASI scores also did not afford prediction of behavioral failure during mock MRI exposure.

While self-reported interoceptive fear differentiates claustrophobia from animal phobias (Craske et al., 1995; Craske & Sipsas, 1992), results of the present study suggest that information-processing biases toward interoceptive stimuli do not. The three studies cited above further challenge the role of anxiety sensitivity in claustrophobia. Cumulatively, these studies and the findings reported here raise the possibility that while heightened interoceptive fear is a characteristic of claustrophobia (confirmed here by significantly higher ASI scores in the claustrophobic group), fears of suffocation and restriction may be more salient in terms of information-processing biases. Of course, this explanation requires empirical verification from future studies.

Limitations of the Study

The major limitations of this study revolve around the representativeness of our experimental groups. Because the sample was comprised entirely of females who were not seeking treatment, the generalizability of these results to males and to clinical populations is uncertain. However, it is extremely well-established that anxiety disorders are much more prevalent in women than in men (Craske, 2003), and approximately 75-90% of individuals diagnosed with animal and situational specific phobias (e.g., claustrophobia) are female (APA, 1994). Nonetheless, these findings would benefit from replication with a male sample.

Regarding the use of nonclinical participants, the large majority of individuals that suffer from specific phobias do not seek treatment. Although our failure to find specific information-processing biases may be due to the lack of a clinical sample, our experimental grouping criteria were designed to be stringent in order to identify sufficiently fearful participants. The cutoff score of 57 on the CLQ that was required for inclusion in the claustrophobia group was quite conservative; other studies on claustrophobia have reported that scores in the range of 46-52 differentiate individuals exhibiting significant claustrophobic fear during exposure to claustrophobia-related stimuli (e.g., McGlynn et al., in press; Radomsky et al., 2001). Likewise, the cutoff score of 19 on the SNAQ required for membership in the snake phobia group is almost 2 standard deviations above the mean SNAQ score for females reported in the original article by Klorman et al. (1974). Considering also that 30 of the 36 participants comprising the two phobic groups met diagnostic or subclinical diagnostic criteria for their respective disorder, the questionnaire measures and ADIS-IV responses suggest that our sample was quite fearful.

Conclusions and Future Directions

The work reported here is the first of its kind in exploring information-processing biases toward interoceptive stimuli as factors that differentiate claustrophobia from animal phobias and from nonphobic individuals. In brief, the results did not support the hypothesis that claustrophobic individuals would exhibit interpretive, attentional, or memory biases toward interoceptive stimuli, in comparison to stimuli of other types and in comparison to snake phobics and nonphobic controls. Instead, claustrophobics evidenced a tendency to interpret all types of stimuli as threatening and to produce longer color-naming latencies for all types of words, compared to nonphobics. The snake phobics typically did not differ from the claustrophobics in this regard. This general pattern of results is consistent with the major tenets of the vigilance-avoidance theory. Word emotionality and anxiety sensitivity do not appear to account for the findings. Instead, the findings challenge the conceptualization of claustrophobia as a disorder characterized primarily by a fear of interoceptive stimuli, a conclusion that has received some support from other studies on subjective and behavioral manifestations of claustrophobic fear.

Although our group sizes were comparable to most other studies of this genre, the present study was somewhat under-powered in terms of identifying significant interaction effects. Thus, future work in this area should focus on replicating these procedures with a larger sample, preferably one that includes males and participants who are seeking treatment. To provide an empirical test of the competing hypothesis that fears of suffocation and restriction are primary in claustrophobia, conducting a study with stimuli germane to suffocation and restriction is warranted. The proposed study could take several forms. Perhaps the most interesting would be one in which information-processing biases toward restriction- and suffocation-relevant stimuli are evaluated in comparison with interoceptive stimuli more generally. Attentional bias could be compared using both the emotional Stroop and the dot-probe paradigm. Another would be to compare claustrophobics directly with PDA patients on measures of bias toward interoceptive stimuli. These studies and others would further contribute to a growing literature that focuses on identifying the component fears that comprise claustrophobia, discriminating between phobia subtypes, and exploring whether claustrophobia is best conceptualized as a variant of panic disorder.

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APPENDICES

APPENDIX A

TABLES AND FIGURES

Table 1.

Stroop Stimuli by Word Type

Interoceptive Words		**Neutral Words**		**Positive Words**	
Dizzy	(5-11-5)	Tourist	(7-39-16)	Enjoyable	(9-32-2)
Breathless	(10-33-5)	Uncertain	(9-39-22)	Loyalty	(7-30-25)
Faint	(5-117-26)	Counter	(7-98-29)	Healthy	(7-140-33)
Palpitation	(11-0-0)	Spotlight	(9-11-6)	Reassure	(8-5-1)
Choking	(7-26-7)	Moderate	(8-58-27)	Polite	(6-64-7)
Shaky	(5-19-5)	Sparrow	(7-19-1)	Joyful	(7-23-1)
Tense	(5-194-16)	Bedroom	(7-125-52)	Calm	(4-137-35)
Tremble	(7-24-10)	Tub	(3-75-13)	Consoling	(9-2-1)
Sweat	(5-105-23)	Fan	(3-72-18)	Secure	(6-75-30)
Heartbeat	(9-18-4)	Banister	(8-9-5)	Carefree	(8-17-9)
Nausea	(6-6-3)	Mailbox	(7-9-1)	Bliss	(5-6-4)
Tingling	(8-6-6)	Dishwasher	(10-6-0)	Sincere	(7-11-15)
Chills	(6-7-2)	Blender	(7-8-0)	Relaxing	(8-9-5)
Suffocation	(11-2-1)	Microwave	(9-2-2)	Elation	(7-3-2)
Smothering	(10-3-1)	Shoelace	(8-3-1)	Easygoing	(9-3-1)

Note. The first number in the parentheses represents the number of letters in that word. The second number represents the frequency with which that word appears in the English language (from Carroll et al., 1971), as does the third (but from Francis & Kucera, 1982). There were no significant differences between word types in terms of mean length or mean frequency of usage, when compared using the frequencies of either Carroll et al. (1971) or Francis and Kucera (1982).

Table 2.

Anxiety Sensitivity Index (ASI), Claustrophobia Questionnaire (CLQ), and Snake Questionnaire (SNAQ) Scores by Experimental Group

	M (and *SD*) for group		
Questionnaire	Claustrophobic	Snake Phobic	Nonphobic
Anxiety Sensitivity Index	26.39_b (9.37)	16.22_a (7.42)	15.11_a (6.95)
Claustrophobia Questionnaire	66.83_b (11.68)	18.06_a (10.23)	14.28_a (5.35)
Suffocation Subscale	27.28_b (9.88)	5.67_a (4.43)	3.67_a (2.61)
Restriction Subscale	39.56_b (3.40)	12.39_a (7.04)	10.61_a (4.60)
Snake Questionnaire	4.11_b (2.22)	21.33_c (2.22)	2.39_a (1.38)

Note. Means with different subscripts differ significantly from each other ($p < .05$).

Table 3.

Brief Body Sensations Interpretation Questionnaire Scores

	M (and *SD*) for group		
Variable	Claustrophobic	Snake Phobic	Nonphobic
Likelihood Rankings (1-3)			
Panic body sensations	1.47 (0.39)	1.23 (0.27)	1.18 (0.28)
External Events	1.67 (0.51)	1.25 (0.36)	1.18 (0.30)
Belief Ratings (0-8)			
Panic body sensations	2.57 (1.26)	1.89 (1.24)	1.39 (0.88)
External Events	3.42 (1.46)	2.63 (1.57)	1.90 (0.95)

Note. For the likelihood rankings data, higher scores denote that the negative interpretation is more likely to come to mind.

Table 4.

Emotional Stroop Reaction Time Data

	M (and *SD*) for group, in milliseconds		
Word Type	Claustrophobic	Snake Phobic	Nonphobic
Interoceptive Words	715.17 (102.64)	710.84 (105.58)	634.72 (69.05)
Neutral Words	691.36 (75.99)	689.09 (94.90)	626.20 (66.61)
Positive Words	698.91 (89.90)	694.30 (93.62)	640.35 (79.98)

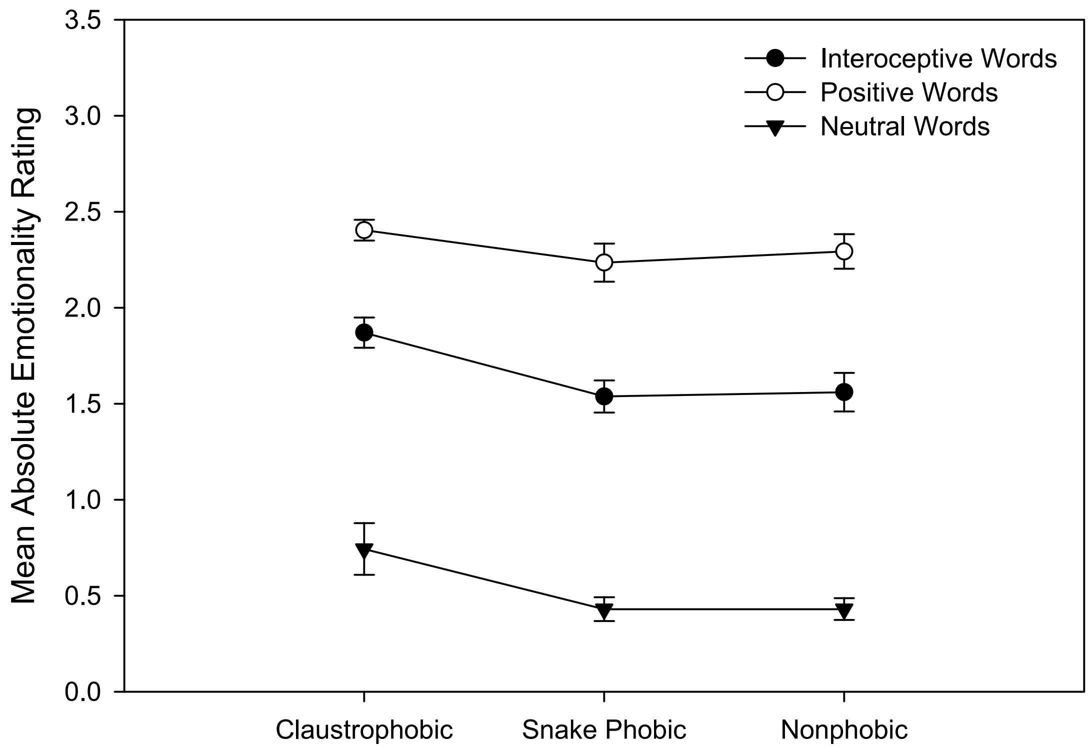
Table 5.

Hit Rates and False Alarm Rates on the Recognition Memory Task

	M (and *SD*) for group, expressed as percentages		
Variable	Claustrophobic	Snake Phobic	Nonphobic
Hit Rates			
Interoceptive Words	91.48 (7.16)	88.15 (10.11)	88.52 (10.18)
Neutral Words	87.41 (14.62)	82.59 (15.19)	85.56 (11.12)
Positive Words	79.63 (16.25)	73.33 (12.10)	70.74 (16.19)
False Alarm Rates			
Interoceptive Words	10.00 (10.29)	11.11 (13.67)	7.78 (10.60)
Neutral Words	2.22 (6.47)	6.11 (13.78)	1.67 (3.84)
Positive Words	12.78 (16.38)	11.67 (14.53)	9.44 (9.38)

Note. For the hit rate data, higher numbers denote a higher percentage of *correct* responses (i.e., correctly recognizing words from the Stroop task). For the false alarm rate data, higher numbers denote a higher percentage of *incorrect* responses (i.e., incorrectly identifying foil words that were not on the Stroop task).

Figure 1. Mean absolute emotionality ratings by Stroop word type.



Note. Error bars denote standard error of the mean.

Figure 2. Recall index scores for interoceptive and positive words.

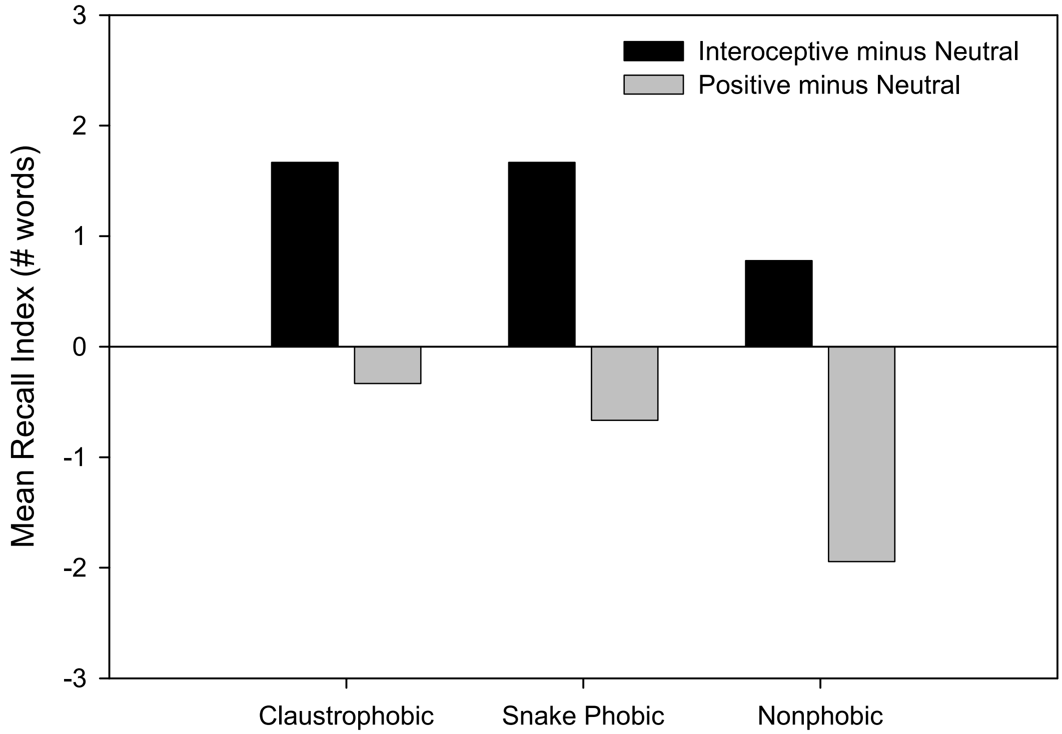
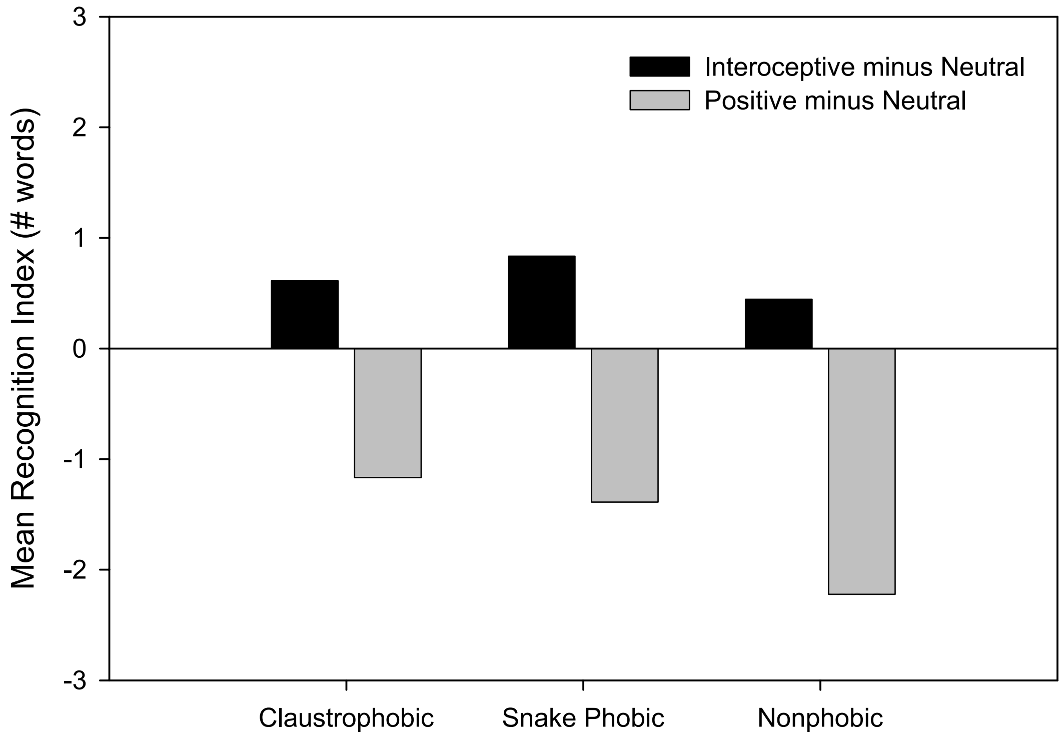


Figure 3. Recognition index scores for interoceptive and positive words.



APPENDIX B

INFORMED CONSENT

INFORMED CONSENT FOR
Emotional Factors Influencing Performance on Cognitive Tasks

Principal Investigators: Todd Smitherman and F. Dudley McGlynn

You are invited to participate in a study exploring how certain emotions influence performance on a variety of cognitive tasks. You were selected as a possible participant because you are an Auburn University undergraduate student and are 19 years of age or older.

If you decide to participate, you will first be asked to fill out several questionnaires about a variety of objects, situations, and emotions. You will receive 1 hour of extra credit towards applicable Psychology courses for your participation in this portion of the study, which should last approximately 15-20 minutes.

Depending on your responses in the questionnaires, you may be invited to participate in the second portion of the study. The second portion of the study will consist of completing a questionnaire, naming the font color of words displayed on a computer screen, and responding to several interview questions. This portion of the study will last approximately 1 hour and you will receive 1 hour of credit towards applicable Psychology courses for your participation. There are no known risks involved in being in this study beyond those of everyday life.

There is a possible risk of emotional distress in this study. Any participants who find the study distressing will be provided a list of local clinics that may be contacted to address these issues. Any and all treatment costs will be borne by the participant.

Your name will be connected to a code number in the event that we need to contact you for participation in the second portion of the study. Any information obtained in connection with this study that can be identified with you will remain confidential. If you give us your permission by signing this document, the information gathered will be provided anonymously to Auburn University as a doctoral dissertation and to professionals in psychology in the form of conference presentations and/or journal publications. After you complete this study, personal information identifying you with your responses will be destroyed. Your participation in this study is voluntary and you may refuse to participate, or stop participating at any time without penalty. Your decision whether or not to participate will not jeopardize your future relations with Auburn University or the Department of Psychology. You will be provided a copy of this form to keep.

Should you have any questions about the research, please feel free to contact Todd Smitherman at (334) 559-8633 (smitht7@auburn.edu). Further information regarding this study may also be obtained from F. Dudley McGlynn at (334) 844-6472 (mcglyfd@auburn.edu).

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Participant's Initials

For more information regarding your rights as a research participant you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

______________________________	______________________________
Participant's signature Date	Investigator's signature Date
______________________________	______________________________
Print name	Print name