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Modification of Interpretive Bias: Impact on Anxiety Sensitivity, Information Processing and Response to Induced Bodily Sensations

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MODIFICATION OF INTERPRETIVE BIAS:

IMPACT ON ANXIETY SENSITIVITY, INFORMATION PROCESSING AND RESPONSE TO INDUCED BODILY SENSATIONS

by

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ABSTRACT

Anxiety Sensitivity (AS) is the fear of normal, arousal-related bodily sensations due to the belief that they have negative consequences. High AS is associated with interpretive biases whereby normal bodily sensations are perceived as threatening. Research shows that interpretive biases can be modified through cognitive training. In the present study, the impact of interpretation training on cognitive processes and behaviour was examined in people with high AS. Thirty-four participants were assigned to either a training condition designed to induce a benign interpretive bias, or a "sham" condition designed to have no effect on existing biases. Participants in the training condition reported significant decreases in overall AS and fear of the physical consequences of anxiety. Interpretive bias measures yielded mixed findings. Both conditions displayed decreased negative interpretations of explanations of physical sensations, but only the training condition displayed decreased interpretations of specific, negative explanations of physical sensations. Theoretical implications are discussed.

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In 1985, Reiss and McNally published their expectancy theory of fear in which they proposed three fundamental fears that are believed to underlie all other fears. They posited that there are two features that distinguish fundamental fears from common fears. First, fundamental fears are of stimuli that are intrinsically aversive. That is, the feared object is naturally perceived as noxious. Second, all common fears, such as fear of spiders or heights, can be reduced to fundamental fears. In other words, a fundamental fear is the basis of every common fear (Reiss, 1991). The three fundamental fears are fear of illness/injury, fear of negative evaluation and anxiety sensitivity (AS). The fear of injury/illness refers to catastrophic fears of injury, illness or death. The fear of negative evaluation is characterized by fear of negative judgement from others and avoidance of situations in which unfavourable evaluations are a possibility (Reiss, 1991). AS is the fear of anxiety-related bodily sensations due to the belief that they have negative physical, social or psychological consequences (Reiss & McNally, 1985). Individuals with high levels of AS tend to catastrophize when experiencing benign bodily sensations, such as increased heart rate. In contrast, individuals with low levels of AS correctly assume that these experiences are innocuous. AS is believed to be a relatively stable dispositional characteristic (McNally, 1994; Schmidt & Woolaway-Bickel, 2006).

AS as a Cognitive Vulnerability for Panic-Related Psychopathology

According to the cognitive vulnerability model of panic disorder, the development of panic disorder is cyclical in nature (Schmidt & Woolaway-Bickel, 2006). That is, the events that precede panic symptoms occur in a predictable, recurring pattern, all of which contribute to both the development and maintenance of panic disorder. An aversive life event, such as a panic attack, is experienced and is processed in accordance with pre-existing cognitive vulnerabilities. A cognitive vulnerability is a trait-like factor that predisposes an individual to a certain outcome. Cognitive vulnerabilities have been described as maladaptive schemas and develop through previous direct or indirect experiences (Beck, 1967, 1976). Schmidt and Woolaway-Bickel suggest that there are two types of cognitive vulnerabilities that differ in their relationship to the outcome (e.g., a panic attack). First, *distal* vulnerabilities act upon panic outcomes by way of influencing other lower order processes. These types of vulnerability factors include high levels of AS beliefs, attentional biases and memory biases. These biases result in stimuli being perceived in accordance with pre-existing beliefs, and most often these beliefs are about the harmful nature of physical sensations. The distal vulnerability factors are important in both the development and maintenance of panic through their influence on *proximal* cognitive vulnerabilities, which are directly related to panic outcomes. In the cognitive vulnerability model of panic, "catastrophic cognitions" are the proximal vulnerability factor (Schmidt & Woolaway-Bickel, 2006). Catastrophic cognitions are interpretive biases that result in changes in physical sensations being perceived as more dangerous than they actually are. For example, a healthy person who is experiencing dizziness may think "This is a sign that I am having a stroke". These types of cognitions are believed to immediately precede the occurrence of panic symptoms. (Schmidt & Woolaway-Bickel, 2006). Based on this framework, there is a clear relationship between the presence of cognitive vulnerabilities and the occurrence of panic symptoms.

Three conditions must be met for a variable to be considered a cognitive vulnerability factor (Garber & Hollon, 1991). First, there must be a correlation between a supposed cognitive vulnerability and the related outcome. It should be noted that a correlation is a necessary but insufficient condition for classification of a cognitive vulnerability, as a correlation does not provide any information about the causal status of a putative cognitive vulnerability. Second, the vulnerability factor must always *precede* the outcome in time. This is known as temporal antecedence. Finally, manipulation of the vulnerability factor must result in a change in the outcome in the expected direction. In other words, "triggering" the cognitive vulnerability should bring about the associated outcome (e.g., a symptom; Garber & Hollon, 1991).

Based on these three tenets, there is empirical evidence supporting the idea that AS is a distal cognitive vulnerability for the development of panic disorder. The first condition requires a correlation between the cognitive vulnerability factor and the outcome. Numerous studies have showed that there is a robust relationship between AS (as assessed via the *Anxiety Sensitivity Index* [ASI]; Reiss, Peterson, McNally & Gursky, 1986) and panic disorder in adults (e.g., Ehlers, 1995; Olatunji & Wolitzky-Taylor, 2009) and adolescents (e.g., Lau, Calamari & Waraczynski, 1996). Research consistently indicates that the first condition of the cognitive vulnerability theory has been met.

The second condition pertains to the temporal relationship of the cognitive vulnerability and associated outcomes. In terms of AS and panic, the occurrence of high AS must predate the occurrence of panic symptoms, or changes in AS must precede changes in panic symptoms. This has been demonstrated in a number of ways. Donnell and McNally (1990) assessed the presence of high AS and panic attacks in a nonclinical population. They found that the majority of participants with high levels of AS had never experienced a panic attack, suggesting that AS is present before the development of panic symptoms. Maller and Reiss (1992) conducted a longitudinal study to investigate the relationship between scores on the ASI (Reiss et al., 1986) and the occurrence of panic attacks over a 3-year period. The results indicated that ASI scores in

1984 predicted the frequency and intensity of panic attacks in 1987. Furthermore, participants with high ASI scores in 1984 were five times more likely to have experienced a panic attack by 1987, even without a previous history of panic (Maller & Reiss, 1992). Schmidt, Lerew and Jackson (1997, 1999) also reported similar findings across two studies. Air force cadets were followed throughout their 5-week “boot camp” training. In both studies, high levels of AS predicted the future occurrence of panic attacks, even after controlling for level of trait anxiety and previous history of panic (Schmidt et al., 1997, 1999). Based on this research, it appears the presence of high levels of AS precedes the occurrence of panic attacks and increases the likelihood of panic-like symptoms, which satisfies the second requirement of a cognitive vulnerability factor.

The third condition for classification of a cognitive process as a vulnerability factor is that direct manipulation of the putative vulnerability factor leads to a corresponding change in the outcome in the expected direction. In terms of AS and panic, this would require that manipulation of AS results in a direct change in associated cognitive processes and panic symptoms.

Telch and colleagues (1993) assessed the efficacy of group cognitive-behavioural therapy (CBT) for panic disorder, a treatment that presumably targets AS. The treatment was found to be efficacious in treating panic disorder, as participants in the treatment condition reported decreases in the frequency and intensity of panic symptoms. Furthermore, participants in the treatment condition also reported significant reductions in AS from pre- to posttreatment. Schmidt, Trakowski and Staab (1997) also investigated the efficacy of CBT for panic disorder. They found that CBT decreased AS and panic symptoms, as measured by responses to a biological challenge designed to elicit panic symptoms. These data may support the third criterion, but this is not unambiguous evidence for the potential causal role of AS in panic symptoms. In order to successfully satisfy the third criterion, it must be shown that the cognitive vulnerability factor is independent of state. Pre- to posttreatment changes in AS may simply be *a result* of changes in anxiety.

Very few studies have attempted to experimentally manipulate AS. Schmidt and colleagues (2007) attempted to alter AS via psychoeducation. Participants with high levels of AS and no history of psychiatric illness were randomly assigned to one of two conditions. In the experimental condition, participants watched an educational video that contained information about anxiety symptoms and their effects (e.g., anxiety helps people deal with stressors). In the control condition, participants watched a health and nutrition video that was expected to have a minimal impact on AS. The participants were then followed for 2 years, and the incidence of panic disorder was assessed. The results indicated that participants in the experimental condition were significantly less likely to develop panic disorder in the 2 years' post intervention compared to participants in the control condition (Schmidt et al., 2007). In other words, targeting AS may have had a direct impact on panic symptoms, which would satisfy the third criterion.

Information Processing Biases as Cognitive Vulnerability Factors for Panic-Related Psychopathology

While research appears to support the notion of AS as a distal cognitive vulnerability for panic, the presence of high AS is not a sufficient condition for developing panic disorder. According to the cognitive vulnerability model of panic disorder (Schmidt & Woolaway-Bickel, 2006), information processing biases are associated with AS beliefs and may in themselves confer vulnerability to panic symptoms. This model, however, is not the first cognitive theory to implicate information-processing biases as central to the development and maintenance of panic disorder. In 1986, Clark proposed a model that highlighted the role of catastrophic misinterpretations of bodily sensations as central to the development and maintenance of panic disorder. According to Clark, a person attends to a mild change in his or her body (e.g., racing heart beat) and then interprets this change as threatening (e.g., “My heart is beating fast. I’m having a heart attack”). The person then continues to monitor his or her bodily sensations, which only increases the intensity of the sensations. The person also interprets the new sensations as threatening, and this may result in a panic attack (Clark, 1986). According to Clark, catastrophic misinterpretations are involved in the experience of the initial panic attack as well as recurrences of panic attacks.

Attentional and memory biases have been observed in people with panic disorder, and are classified as distal cognitive vulnerabilities because of the influence that they have on the occurrence of catastrophic cognitions (Schmidt & Woolaway-Bickel, 2006). Wenzel (2006) had participants with social anxiety disorder, panic disorder or no anxiety disorder listen to descriptions of ambiguous, potentially threatening situations. All stories contained references to both physical sensations and social threat. At the same time, participants also heard distracter words that were panic-related, social anxiety-related, or neutral. Participants were asked to repeat the stories out loud as they were listening to them. The results showed that participants with panic disorder made more errors and had slower repetition reaction times when the distracter words were panic-related. Therefore, the authors concluded that participants with panic disorder displayed an attentional bias for anxiety-specific information relating only to physical sensations. Furthermore, Becker, Roth, Andrich and Margraf (1999) used a free recall memory task to investigate the memory biases of participants with and without panic disorder. The results indicated that participants with panic disorder recalled significantly more words referring to bodily sensations compared to the non-clinical control group, which is consistent with the presence of a memory bias for panic-specific information.

Another type of cognitive bias that has received research attention is interpretation bias. An interpretive bias is a tendency to appraise ambiguous information in accordance with pre-existing schemas (Beard & Amir, 2008). In individuals with psychopathology, the interpretation bias is most often negative. In the cognitive vulnerability model of panic disorder (Schmidt & Woolaway-Bickel, 2006), interpretive biases are catastrophic cognitions and are considered a proximal vulnerability factor for the development of panic. Research supports the presence of negative interpretive biases in people with panic disorder. Harvey, Richards, Dziadosz and Swindell (1993) studied these interpretive biases in participants with panic disorder, participants with social anxiety disorder and healthy controls. Participants were presented with the *Interpretation Questionnaire* (McNally & Foa, 1987), part of which required participants to rank order three possible explanations of an ambiguous situation. Half of the items referred to internal sensations (e.g., “You feel discomfort in your chest area. Why?”), while the other half referred to external stimuli (e.g., “You wake with a start in the middle of the night, thinking you heard a noise, but all is quiet. What do you think woke you up?”; McNally & Foa, 1987). One of the three potential responses was always threat-related. The results of the study showed that participants with panic disorder ranked the threat explanations of internal stimuli as more likely to occur, compared with participants with social anxiety disorder and those without a psychological disorder (Harvey et al., 1993), thereby demonstrating a negative interpretive bias in response to internal sensations. In a similar study (Kamieniecki, Wade & Tsourtos, 1997), participants were presented with hypothetical scenarios in which an internal sensation and its cause were described, followed by filler information. Participants were first asked to imagine a scenario unfolding (e.g., “You water the plants and then do some physical exercises for 15 minutes. You then have a glass of cold water, rearrange some magazines on the coffee table and turn on the television. You suddenly realize that you are short of breath and your heart is beating fast”; Kamieniecki et al., 1997, p. 144). Participants were then asked to provide an explanation for the sensations, which should have been the explanation provided in the scenario (i.e., physical exercise). Participants with panic disorder provided significantly more catastrophic explanations for the symptoms compared to healthy control participants (Kamieniecki et al., 1997). Taken together, research suggests that individuals with panic disorder impose threat interpretations on ambiguous physical sensations.

Research has also demonstrated that individuals with panic disorder display a negative interpretive bias in response to induced physical sensations. One common method of studying this is by using a carbon dioxide (CO_2) challenge. Inhalation of CO_2-enriched air results in the onset of innocuous but uncomfortable physical sensations that resemble those during a panic attack. The procedure is simple and safe to use (Rassovsky & Kushner, 2003) and as a result, numerous studies have compared individuals with and without psychopathology on their responses to CO_2 inhalation. For example, Perna, Gabriele, Caldirola and Bellodi (1995) investigated the effects of a CO_2 challenge in participants with panic disorder, participants with sporadic panic attacks and healthy control participants. The results showed that participants with panic disorder or sporadic panic attacks experienced significantly more panic symptoms and anxiety in response to the CO_2 challenge compared to the healthy control group (Perna et al., 1995).

Studies that have used other types of behavioural tasks to induce physical discomfort have produced similar findings. Antony, Ledley, Liss and Swinson (2006) investigated the effects of brief panic-symptom induction tasks in participants with panic disorder and in those without psychopathology. It was found that participants with panic disorder reported significantly more fear and distress during most of the tasks compared to participants without panic disorder. Though not directly assessed, it can be inferred that participants with panic disorder imposed negative interpretations on the induced sensations.

Although research indicates that individuals who have panic disorder have a tendency to interpret ambiguous sensations and situations in a negative fashion, there is not sufficient evidence to determine that interpretive biases have a *causal role* in panic disorder. It could be that interpretive biases are merely a by-product of high levels of anxiety. To demonstrate that information processing biases cause panic symptoms, one must demonstrate that such biases temporally precede panic symptoms and that their manipulation or induction leads to corresponding changes in symptoms in the expected direction (Garber & Hollon, 1991).

A number of studies have examined interpretive biases among individuals who do not (yet) have an anxiety disorder but are at high cognitive risk by virtue of having high levels of AS. Teachman (2005) evaluated interpretive biases in participants with high versus low levels of AS, via the *Brief Bodily Sensations Interpretations Questionnaire* (BBSIQ; Clark et al., 1997). Participants were asked to rank order and rate the plausibility of explanations for ambiguous internal sensations and external events that were presented in vignettes. Teachman (2005) found that the participants high in AS ranked the negative explanations as significantly more likely and more plausible than did participants low in AS. Thus, pre-existing high levels of AS may influence interpretations of ambiguous sensations even if people do not have a history of psychopathology, which supports the notion that AS and interpretive biases may precede the onset of panic disorder.

As previously discussed, one way of demonstrating that a cognitive process has a potential causal role in a psychological disorder is to demonstrate that its manipulation has a direct impact on the symptoms and cognitive processes of that disorder (Garber & Hollon, 1991). Methods have been developed to directly manipulate interpretive biases. Mathews and Mackintosh (2000) induced a positive or negative socially-relevant interpretation bias in previously unbiased participants using a computerized cognitive bias modification (CBM) task. Participants were randomly assigned to generate either positive or negative outcomes to ambiguous situations. For example, one vignette was as follows:

> "Your partner asks you to go to an anniversary dinner that their company is holding. You have not met any of their work colleagues before. Getting ready to go, you think that the new people you will meet will find you (boring/friendly)" (Mathews & Mackintosh, 2000, p. 604).

In the example above, the final word was presented as an incomplete word fragment (bo---g or fri----y). Depending on the training condition, the final word of the vignette resulted in a positive or negative disambiguation. Participants were asked to complete the word fragment and answer a comprehension question intended to help with consolidation of the training. Training in this procedure resulted in participants adopting an interpretive bias that was consistent with their training (Mathews & Mackintosh, 2000). This finding has been replicated in many other studies (e.g., Grey & Mathews, 2000; Grey & Mathews, 2009; Mackintosh, Mathews, Yiend, Ridgeway, & Cook, 2006). Trained interpretive biases have been shown to endure for up to 24 hours and to generalize to new descriptions of ambiguous situations (e.g., Mackintosh et al., 2006; Yiend, Mackintosh & Mathews, 2005).

It is important to note that as research in interpretation training has progressed, several different types of training tasks have been developed. Although there are differences in most training tasks, it is possible to categorize tasks as *active* or *passive* training. In an active task, participants are required to actively respond to each trial by spontaneously generating an appropriate answer. A passive task may be considered a priming task, whereby participants read a vignette that is associated with their assigned condition (Hoppitt, Mathews, Yiend & Mackintosh, 2010). By this definition, the training task used in the aforementioned study by Mathews and Mackintosh would be considered an active training task. While each type of task has its benefits, the robustness of the training effect differs. Hoppitt et al., (2010) randomly assigned participants to complete an active or passive training task, both of which were designed to induce a negative emotional bias. In both tasks, participants were presented with brief vignettes that discussed physical threat. In the active training condition, the vignettes were ambiguous until participants completed the last word. Participants in the passive condition were presented with the same vignette; however, the last word was visible. All participants completed an imagery task to assess emotionality both pre- and posttraining. After training, participants in the active condition rated images as significantly more unpleasant compared to their pretest scores, while there were no significant differences of the ratings of participants in the passive condition (Hoppitt et al., 2010). This study suggests that both the training procedure and the effort that must be expended by participants during training have direct effects on the strength of the changes in interpretive biases, whereby increased cognitive effort results in stronger training effects. However, that is not to say that passive tasks do not modify interpretive biases. Rather, the study by Hoppitt et al. simply highlights the increased efficacy of active training tasks.

Manipulation of Interpretive Biases Associated with Anxiety

A limited number of studies have focused on the direct modification of interpretive styles in individuals with anxiety disorders, and most of this work has been conducted with people with social anxiety disorder. Murphy, Hirsch, Mathews, Smith and Clark (2007) successfully modified the erroneous interpretations of individuals high in social anxiety using a passive CBM task. Participants who received either positive or nonnegative CBM training endorsed significantly more positive interpretations on a subsequent recognition task designed to assess interpretation biases, compared with individuals in a no-training condition. At the end of the study, all participants were presented with a hypothetical social situation and were asked to predict their level of anxiety in the situation. Compared to the participants in the no-training condition, participants who received interpretation training predicted lower levels of anxiety (Murphy et al., 2007).

Beard and Amir (2008) conducted a study in which participants high in social anxiety completed an 8-session *active* CBM training task over 4 weeks. All participants were presented with a word representing either a benign interpretation (e.g., "funny") or threat interpretation (e.g., "embarrassing") of a situation. They were then presented with an ambiguous sentence (e.g., "People laugh at something you said"). Participants then had to indicate if the word and sentence were related by responding on a keyboard. This task is considered an active training task because participants had to make explicit decisions about the relationship between the word and sentence, and this presumably required considerable cognitive effort. Feedback was based on group assignment and there were two experimental conditions. In the training condition, participants received consistent positive feedback for endorsing benign interpretations and rejecting negative interpretations of the situations. Participants in the "sham" training condition received inconsistent feedback. The results indicated that participants in the active training condition subsequently endorsed significantly more benign interpretations and significantly fewer threat interpretations when tested with a set of new ambiguous situations compared to both their pretest scores and compared to the control group. Furthermore, participants in the active training condition reported significantly fewer social anxiety symptoms compared to those in the sham training condition at posttest (Beard & Amir, 2008).

Steinman and Teachman (2010) published the first known study of interpretive bias modification in people at high cognitive risk for panic disorder. Participants with a high level of AS first completed the ASI (Reiss et al., 1986) and the BBSIQ (Clark et al., 1997). The researchers used a modified version of the CBM procedure developed by Mathews and Mackintosh (2000). In each trial, participants were presented with a short vignette that reflected a concern related to AS. The final word in the vignette was missing one letter, and participants had to input the letter in order to resolve the situation in a way that was congruent with their training condition. By the Hoppitt et al. (2010) definition, this training task is an active training task because participants had to decide which letter completed the word. Participants were randomly assigned to one of three experimental conditions. In the positive training condition, the vignettes in the CBM task were always resolved in a positive manner (e.g., A racing heart during exercise is "in_igorating", with the final word being "invigorating"). In the neutral condition, half the vignettes were resolved in a positive manner, whereas the remaining vignettes were resolved in a negative manner. Finally, participants in the control condition did not complete any training tasks (Steinman & Teachman, 2010). Following training, participants engaged in two behavioural approach tests (BATs) to assess fear of bodily sensations. The BATs were designed to induce uncomfortable but innocuous physical sensations, and were used as a measure of the impact of training on physical response to changes in bodily sensations. The two BATs employed in this study were Candle blowing (i.e., participants pretended their finger was a candle and attempted to blow it out continuously for 1 minute) and Straw breathing (i.e., participants continuously breathed through a straw for 1 minute). Following training, participants in the positive training condition endorsed more positive and fewer negative interpretations when presented with novel, ambiguous situations. In addition, participants in the positive training condition produced significantly lower posttraining scores on the ASI compared to participants in the control condition. There was, however, no difference in ASI scores between participants in the positive training and neutral training conditions. The training groups also did not differ in their performance on the BATs posttraining. Although the CBM task led to a change in interpretive biases, it did not influence reactions to internal sensations. This may have been due to the type of CBM task used. As previously discussed, research has demonstrated that active (versus passive) training results in more robust changes in interpretive biases (Hoppitt et al., 2010). Although the training task used by Steinman and Teachman (2010) can be considered an active task, the cognitive effort required to complete this task appears to be less than the cognitive effort required to complete other active training tasks, such as that used by Beard and Amir (2008). The procedure may have elicited stronger interpretation changes had it challenged participants to work harder to complete the task. In support of this idea, Beard and Amir (2008) reported between-group effect sizes of Cohen's $d = 2.35$ and Cohen's $d = 1.85$ for endorsement of benign and threat interpretations, respectively, while the between-group change in interpretive bias reported by Steinman and Teachman was Cohen's $d = 0.34$, indicating that a greater magnitude of change was associated with the more difficult training task. An additional limitation of this study is related to the possibility of ceiling effects for performances on the

BATs, with 88% of participants completing at least one of the BATs for the maximum duration of time (Steniman & Teachman, 2010). This suggests that the BATs may not have been challenging enough to differentiate between participants in the three training conditions.

Present study

The goal of the present study was to investigate the effects of experimentally inducing a benign interpretive bias on self-reported AS, information processing, and responses to induced uncomfortable bodily sensations in individuals high in AS. This was accomplished through use of a modified version of the CBM task of Beard and Amir (2008). It was hypothesized that:

(1) Immediately following training and two days posttraining, participants in the training condition would report lower levels of AS than participants in the sham condition, as assessed via the ASI (Reiss et al., 1986);

(1.2) Immediately following training and 2 days posttraining, only participants in the training condition would report a decrease in ASI.

(2) Immediately following training and 2 days posttraining, participants in the training condition would report lower negative interpretive biases as compared to participants in the sham condition, as measured by the BBSIQ (Clark et al., 1997);

(2.1) Immediately following training and 2 days posttraining, only participants in the training condition would report a decrease in negative interpretive biases;

(3) Immediately following training and 2 days posttraining, participants in the training condition would report less fear and avoidance compared to participants in the sham condition in response to a brief induction of uncomfortable bodily sensations;

(3.1) Immediately following training and 2 days posttraining, only participants in the training condition would report a decrease in fear and avoidance in response to a brief induction of uncomfortable bodily sensations.

Method

Participants

Participants between the ages of 18 and 65 years were recruited from the community via newspaper ads, online ads (i.e., Craigslist and Kijiji) and flyers around Ryerson University and the University of Toronto. The ads and flyers were worded to attract the attention of people who experience specific bodily sensations (i.e., the symptoms of a panic attack), pay attention to these sensations, feel afraid when they notice these sensations, worry that other people will notice these sensations, and worry that these sensations are harmful to their health.

Telephone screen. The telephone screen consisted of the *Anxiety Sensitivity Index* (ASI; Reiss et al., 1986) and specific sections of the *Mini International Neuropsychiatric Interview* (MINI; Sheehan et al., 1998). Eligible participants had to score 28.0 or higher on the ASI. This cut-score is one standard deviation above the mean AS in a nonclinical population, as per the norms reported by Peterson and Reiss (1992). Exclusion criteria were as follows: (1) current diagnosis of a psychotic episode or substance dependence, or a current/past manic episode; (2) current CBT; (3) current suicidality; (4) medical conditions that would preclude participation in BATs, such as respiratory conditions (e.g., asthma), cardiovascular conditions (e.g., high blood pressure), neurological conditions (e.g., epilepsy) or balance-related medical conditions (e.g., inner ear problems), as per Antony et al. (2006) and; (5) limited use of psychotropic medication (i.e., if taking antidepressants, participants must have had stable antidepressant dosage for a minimum of 6 weeks; excluded for current daily benzodiazepine or antipsychotic use).

Recruitment and exclusions. In total, 133 potential participants completed the telephone screen. Of these individuals, 55 were deemed eligible to complete the study and 78 participants were deemed not eligible. Of the 78 participants who were not eligible for the study, the majority were excluded due to an insufficient score on the ASI (*n*= 36), met criteria for manic episode (*n*= 18), were currently completing CBT (*n*= 9), had medical conditions that would preclude participation (i.e., asthma, unspecified respiratory condition, hypertension, unspecified cardiac condition) (*n*= 8), had daily benzodiazepine use (*n*= 3), met criteria for psychosis (*n*= 2), met criteria for substance-dependence (marijuana) (*n*= 1) or reported suicidality (*n*=1). Of the 55 participants invited to complete the study, 11 did not complete the study, resulting in a sample size of 44. However, 10 of these participants were excluded from data analysis due to an insufficient ASI score at pretest (*n*= 8), having not completed the second session (*n*= 1) and having an extended period of time between the first and second testing sessions (i.e., 9 days) (*n*= 1). Therefore, the final sample size was 34 participants.

Demographic characteristics. The sample consisted of 34 participants (25 women, 9 men). Participants ranged in age from 18 to 56 years (*M* = 33.41, *SD* = 13.37). The majority of participants reported being single (73.5%), whereas fewer reported being divorced/widowed (17.7%) or in a married/common-law relationship (8.8%). Most participants reported their ethnicity as Caucasian (70.7%), followed by Black (8.8%), South East Asian (5.9%), Mixed (5.9%), Arab/West Asian (2.9%), East Asian (2.9%) and Other (2.9%). With regards to education, 58.9% of participants reported being enrolled in an academic program at the time of the study. Of those enrolled, 70 % were enrolled in a university degree program, 15% were enrolled in a college diploma program and 15% were enrolled in an adult education program. Of those not enrolled, 14.7% reported having a college diploma, 11.8% reported having a Bachelor's degree, 8.8% reported having a high school diploma, 2.9% reported having a Master's degree and 2.9% reported having a doctoral degree.

Participants' symptoms were assessed for Axis I diagnoses, per the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; DSM-IV-TR; American Psychiatric Association, 2000). In total, 94.1% of the sample (*n* = 32) reported symptoms that were consistent with at least one diagnosis and 73.5% (*n* = 25) of the total sample reported symptoms that were consistent with more than one diagnosis. Among the subsample of participants who reported symptoms consistent with at least one diagnosis (*n* = 32), the most common disorder was generalized anxiety disorder (46.9%), followed by major depressive disorder (40.6%), panic disorder with agoraphobia (37.5%), social anxiety disorder (34.4%), alcohol dependence (21.9%), panic disorder (18.8%), agoraphobia (18.8%), bulimia (12.5%), dysthymic disorder (9.4%), obsessive-compulsive disorder (9.4%), posttraumatic stress disorder (9.4%), alcohol abuse (3.1%) and substance abuse (3.1%).

Although participants were assessed for Axis I diagnoses, only the diagnoses discussed in the *Participants* section were considered exclusion criteria. Initially, this study set out to test the cognitive vulnerability model of panic disorder (Schmidt & Woolaway-Bickel, 2006) that proposes that negative interpretations of bodily sensations cause panic disorder. A strict test of this assertion would require a sample of individuals who are high in AS but do not (yet) have psychopathology to exclude the possibility that negative interpretive biases are simply an epiphenomenon of the disorder itself. If a causal connection between negative interpretive biases and reactions to uncomfortable physical sensations is observed in individuals who do not have psychopathology, this provides some indication of the etiological role of information processing biases in panic and related disorders. However, it was extremely difficult to find participants who were high in AS but did not have symptoms of Axis I diagnoses. As a result, the inclusion criteria were loosened and participants with certain psychological disorders were allowed into the study. On the surface, this appears to be a questionable decision that could have undermined the goals of the study. However, inclusion of individuals with psychopathology in a study of the causal role of negative interpretive biases in reactions to uncomfortable physical sensations is still informative because it may provide answers to important questions about the factors that initiate panic attacks, as well as the factors that maintain the cycle of panic. This information may have important theoretical and treatment implications.

Given that a decision was made to include participants with certain forms of psychopathology into the present study, it was necessary to consider which psychological disorders would be included and which would be excluded. Previous research has consistently found that AS is significantly elevated across mood and anxiety disorders (e.g., Deacon & Abramowitz, 2006; Naragon-Gainey, 2010). Various anxiety disorders have also been found to be associated with elevated scores on different subscales of the ASI. For example, participants with social anxiety disorder reported elevated concerns on the ASI social subscale (Deacon & Abramowitz, 2006). Despite these subscale differences, research has also demonstrated that high AS is associated with the same interpretive biases across psychological disorders (Rosmarin, Bourque, Antony, & McCabe, 2009). In light of this information, participants with varied psychopathology were included in the present study, with the exception of psychosis, substance dependence and mania, which remained part of the exclusion criteria.

Table 1 summarizes the demographic and clinical characteristics of participants in the training condition and the sham condition. There were no significant between-group differences at pretest.

Table 1

Sample Characteristics Separated by Study Condition

	Training Condition (*n* = 18)	Sham Condition (*n* = 16)
Age in years - *M* (*SD*)	36.83 (13.66)	29.56 (12.33)
Gender - Frequency (%)		
Female	14 (77.8%)	11 (68.8%)
Male	4 (22.2%)	5 (31.2%)
Race/Ethnicity - Frequency (%)		
Caucasian	13 (72.2%)	11 (68.7%)
East Asian	1 (5.6%)	0 (0%)
Black	0 (0%)	3 (18.8%)
Mixed Race	2 (11.0%)	0 (0%)
Arab/West Asian	1 (5.6%)	0 (0%)
South East Asian	0 (0%)	2 (12.5%)
Other Ethnicity	1 (5.6%)	0 (0%)
Employment Status - Frequency (%)		
Unemployed	10 (55.5%)	4 (26.7%)
Employed part-time	7 (38.9%)	8 (53.3%)
Employed full-time	1 (5.6%)	3 (20.0%)
Marital Status - Frequency (%)		
Single	10 (55.5%)	15 (93.8%)
Divorced/Widowed	5 (27.8%)	1 (6.2%)
Married/Common-law	3 (16.7%)	0 (0%)

	Training Condition (n = 18)	Sham Condition (n = 16)
Enrolled in Educational Program- Frequency (%)		
Yes	10 (55.6%)	9 (56.2%)
No	8 (44.4%)	7 (43.8%)
Highest Education - Frequency (%)		
High School Diploma	0 (0%)	3 (50.0%)
College Diploma	5 (62.5%)	0 (0%)
Bachelor's Degree	2 (25%)	2 (33.3%)
Master's Degree	0 (0%)	1 (16.7%)
Doctorate Degree	1(12.5%)	0 (0%)
Diagnoses - Frequency (%)		
Generalized Anxiety Disorder	9 (50.0%)	6 (37.5%)
Major Depressive Disorder	7 (38.9%)	6 (37.5%)
Panic Disorder with Agoraphobia	6 (33.3%)	6 (37.5%)
Social Anxiety Disorder	5 (27.8%)	6 (37.5%)
Alcohol Dependence	4 (22.2%)	3 (18.8%)
Agoraphobia	3 (16.7%)	3 (18.8%)s
Panic Disorder	2 (11.1%)	4 (25.0%)
Bulimia Nervosa	2 (11.1%)	2 (12.5%)
Obsessive-Compulsive Disorder	2 (11.1%)	1 (6.3%)
Dysthymic Disorder	2 (11.1%)	1 (6.3%)
Posttraumatic Stress Disorder	1 (5.6%)	2 (12.5%)
Alcohol Abuse	1 (5.6%)	0 (0%)
Substance Abuse	1 (5.6%)	0 (0%)

Note. There were no significant differences between conditions on any of the variables.

Measures

The *Mini International Neuropsychiatric Interview* (MINI; Sheehan et al., 1998) is a brief, structured diagnostic interview designed to assess the presence of DSM-IV-TR Axis I disorders. The MINI consists of the MINI Screen and the MINI Modules. The MINI Screen includes 16 questions that assess the main symptoms of Axis I disorders. All questions are close-ended, requiring a "yes" or "no" response. If a participant answers "yes" to any of the screening questions, the corresponding module is administered. For the telephone screen, only sections pertaining to psychosis, substance abuse and dependence, mania and suicidality were administered, as these were part of the exclusion criteria. In addition, the complete MINI was administered to each participant during the first testing session. The MINI has been found to have good inter-rater reliability, with the majority of Cohen's kappa coefficients as greater than 0.90 (Sheehan et al., 1998). It also has good test-retest reliability, with almost all r values greater than 0.75, with the exception of current mania (r= 0.35). The MINI has high convergent validity with other clinical interviews, such as the *Structured Clinical Interview for DSM-IV* (SCID). Finally, the MINI has been found to have adequate specificity and sensitivity (Sheehan et al., 1998).

The *Anxiety Sensitivity Index* (ASI; Reiss et al., 1986) is a 16-item self-report measure that assesses beliefs about the experience of anxiety-related bodily sensations. All questions are rated on a 5-point Likert scale, ranging from 0 (agree very little) to 4 (agree very much). The total score ranges from 0 to 64. There are three subscales that assess Cognitive ("When I am nervous, I worry that I might be mentally ill"), Social ("It is important to me not to appear nervous") and Physical ("It scares me when I feel faint") concerns. Although there are newer versions of the ASI developed by other authors (e.g., ASI-3; Taylor et al., 2007), the present study used the original version of the ASI to maintain consistency with similar studies (e.g., Steinman & Teachman, 2010). The ASI has been shown to have excellent reliability and adequate validity. Schmidt et al. (2007) found that the ASI had an internal consistency of alpha = .87. The test-retest reliability has been reported as r =.72 -.75 (Reiss et al., 1986; Rodriguez, Bruce, Pagano, Spencer & Keller, 2004), which is considered satisfactory for an anxiety measure (Peterson & Reiss, 1992).

The *Brief Bodily Sensations Interpretation Questionnaire* (BBSIQ) was developed by Clark et al. (1997). It was based on the *Interpretation Questionnaire* (McNally & Foa, 1987), an earlier measure of negative interpretive biases in panic disorder. The BBSIQ is a 14-item self-report questionnaire in which participants are presented with descriptions of ambiguous situations (internal sensations and external events) and are asked to imagine that they are experiencing these situations. Participants are presented with three possible explanations designed to disambiguate each scenario. For each scenario, there is always one negative explanation and two positive/neutral explanations. There are two separate scales of the BBSIQ that result in a Belief score and a Ranking score for each item. Each scale assesses different facets of interpretive bias (Clark et al., 1997). The Belief scale was designed to assess the belief in the plausibility of each explanation occurring. This scale was developed to account for the role of dysfunctional beliefs, as it has been suggested that extent of belief in a thought can be critical to the maintenance of the cycle of panic disorder (Clark et al., 1997). This scale is a unique feature of the BBSIQ. The Belief scale requires that participants rate the plausibility of each explanation on a Likert scale ranging from 0 (“Not Likely at All”) to 8 (“Extremely Likely”). Belief scores are calculated by determining the mean rating of the negative explanations and the mean of the positive/neutral explanations. This results in four scores: Internal Negative (negative interpretations of bodily sensations), Internal Neutral (neutral interpretations of bodily sensations), External Negative (negative interpretations of external situations) and External Neutral (neutral interpretations of external situations). The second subscale, the Ranking scale, was designed to assess the presence of specific interpretations of bodily sensations and external situations by having participants make forced-choice rankings of the interpretations. Because of this, the explanations of each scenario have been chosen to accurately represent a range of interpretations (i.e., negative and positive/neutral interpretations). The Ranking scale requires participants to rank the order in which each explanation would come to mind (i.e., 1st, 2nd, 3rd) given each scenario. This scale is reverse-coded, as a score of 3, 2, or 1 is assigned for providing a ranking of 1, 2, or 3, respectively. The two final Ranking scores are the mean "position" of the negative explanations for situations describing ambiguous bodily sensations (Internal Ranking Score) and situations describing external events (External Ranking Score). Therefore, larger scores come from ranking the *negative* explanations as being *more* probable (Clark et al., 1997). The BBSIQ has been found to have adequate internal consistency for each subscale (α= .90 for the Internal Belief subscale; α= .86 for the Internal Ranking subscale; α= .80 for the External Beliefs subscale; α= 0.74 for External Ranking subscale; Clark et al., 1997). Test-retest reliability has been reported as satisfactory for the Ranking subscale (.73-.75). The Belief subscale, however, has more inconsistent test-retest reliability, ranging from poor (.41) to good (.81; Clark et al., 1997).

Behavioural approach tests. Behavioural approach tests (BATs) were used to assess fear and avoidance of panic-related sensations. The same two BATs were used at each of the three assessment points to induce unpleasant, but harmless, physical sensations. Both BATs were chosen based on their ability to provoke symptoms that are similar to those experienced during a natural panic attack, as reported by Antony et al. (2006). The Chair spinning task required that participants sit in a swivel chair and spin for up to 60 seconds at a medium speed. This task brings on feelings of breathlessness, dizziness, and rapid heartbeat (Antony et al., 2006). The Straw breathing task required that participants breathe through a narrow straw for up to 120 seconds while holding their nostrils closed. This task elicits feelings of breathlessness, rapid heartbeat and choking (Antony et al., 2006).

Levels of fear and avoidance during each of the BATs were assessed. Fear experienced during the BATs was assessed by asking participants to rate their fear on a 100mm Visual Analogue Scale (VAS), ranging from “No fear” to “Extreme fear.” Avoidance was measured in two ways. The first measure was the amount of time (in seconds) that participants engaged in each BAT. The second measure was the extent of participants’ desire to terminate each of the tasks, which was also assessed using a VAS, ranging from “No desire to stop” to “Extreme desire to stop.”

Cognitive Bias Modification (CBM) Training. The CBM training task was modeled after the training task used by Beard and Amir (2008). This task was chosen because active participation is required to successfully complete the task, as participants have to make explicit decisions about the relationships between words and sentences. This task has been found to produce large changes in negative interpretive biases in participants high in social anxiety (Beard & Amir, 2008). It was adapted for the present study by using the training stimuli developed by Steinman and Teachman (2010).

Each CBM trial had four phases. First, a white cross appeared on the computer screen for 500ms to focus participants’ attention on the centre of the screen. Next, a word appeared on the computer screen for 500ms. The word represented either a positive (e.g., Enjoyable) or negative (e.g., Horrifying) interpretation. A statement with ambiguous content pertaining to an AS-related concern then appeared on the screen (e.g., "You laugh so much that it feels like you can't get enough air.″). The sentence remained on the screen until participants indicated whether the word was related to the sentence by pressing either "1" to indicate that the word and the sentence were related or "3" to indicate that the word and the sentence were not related.

Participants then received feedback on their response that was in accordance with their condition assignment. Participants assigned to the training condition received positive feedback (i.e., "You are CORRECT!") when they endorsed benign interpretations or rejected threat interpretations of the sentences. Participants received negative feedback (i.e., "You are INCORRECT.") when they endorsed threat interpretations or rejected benign interpretations of the sentences. Thus, this feedback contingency positively reinforced benign interpretations and did not reinforce threat interpretations. The sham condition was the control condition, and participants received noncontingent feedback. They received positive feedback for half of the trials for which they endorsed a benign interpretation or rejected a threat interpretation, and received negative feedback for the other half of the trials. The same feedback contingency was used for trials in which they endorsed a threat interpretation or rejected a benign interpretation. Participants did not have the opportunity to correct their incorrect responses after they received feedback. The next trial began immediately after the participant received feedback.

Participants completed 120 trials. There were 60 sentences, and each one was presented once with its corresponding benign word and once with its corresponding threat word. The trials were presented in random order across participants. All text appeared in black, Arial, size 12 point font on a grey background, as per specifications of Beard and Amir (2008).

Manipulation check. The present study included a manipulation check task that was nearly identical to the CBM task that was used to train interpretation bias. For the manipulation check, participants were presented with 48 trials in which they were asked to indicate whether a word and an ambiguous sentence were related (Beard & Amir, 2008); however, in contrast with the training task, participants were not presented with feedback. Three versions of the task were created, and were administered at pretest, posttest and at follow-up. Unfortunately, the data from the manipulation check could not be accurately analyzed. The results of the manipulation check could not be interpreted and will therefore not be discussed in the present study.

Procedure

As stated earlier, participants were required to complete a telephone screen to determine eligibility. This involved verbal administration of the ASI (Reiss et al., 1986) and specific sections of the MINI (Sheehan et al., 1998). Participants who met the eligibility criteria were invited to the Psychology Research and Training Centre (PRTC) at Ryerson University. Upon arrival, participants provided written informed consent. The first task involved administration of the MINI (Sheehan et al., 1998) in its entirety. Participants then completed the questionnaire package, which included a Demographics measure, the ASI (Reiss et al., 1986), and the BBSIQ (Clark et al., 1997). Next, participants completed the BATs (i.e., Chair spinning and Straw breathing). Participants then completed the CBM training protocol as per their randomly assigned condition, after which they completed the ASI, BBSIQ and BATs. Approximately 48 hours later, participants returned to the PRTC for the second testing session. Participants were once again asked to complete the ASI, BBSIQ and BATs. Finally, participants received a verbal and written debriefing, and were thanked for their participation.

Results

Data Screening

The data were screened for outliers, using methods described by Tabachnick and Fidell (2007). Outliers were considered to be data points with *z*-score values greater than the absolute value of 3.29. Using this criterion, 3 outliers were identified in the present study. These values were replaced by the second most extreme value in that measure's distribution. Missing data points were rare. When there was a missing value, the mean score on the questionnaire replaced the missing value and was used to compute the final score. This method is considered appropriate, yet conservative, for data sets that are missing less than 5 percent of the data (Tabachnick & Fidell, 2007).

Several participants elected not to attempt the Chair spinning task at posttest ($n = 4$) and follow-up ($n = 7$). The number of participants who attempted versus did not attempt the Chair spinning task did not differ significantly by condition at posttest, $\chi^2(1) = .89$, $p > .05$, or at follow-up, $\chi^2(1) = .06$, $p > .05$. There were, however, significant differences between attempters and non-attempters on one of the pretest measures of avoidance of the Chair spinning task. Participants who did not attempt the Chair spinning task at posttest ($M = 87.00$, $SD = 11.36$) reported significantly higher scores on the desire to terminate VAS measure at pretest, $t(6.19) = 3.19$, $p < .02$, two-tailed, Cohen's $d = 1.16$, compared to those participants who did attempt the task ($M = 59.00$, $SD = 32.07$). Furthermore, participants who did not attempt the Chair spinning task at follow-up ($M = 84.17$, $SD = 10.34$) also reported significantly higher score on the pretest desire to terminate VAS measure, $t(26.67) = 3.64$, $p < .01$, two-tailed, Cohen's $d = 1.14$, compared to participants who did attempt the task ($M = 56.52$, $SD = 32.78$). There were no significant differences for any of the other Chair spinning pretest measures.

Between-Group Differences at Pretest

Independent *t*-tests were used to assess between-group differences on outcome measures at pretest. Means and standard deviations of the ASI are in Table 2; BBSIQ in Table 3; and BATs in Table 4. There were no significant differences between the training and sham conditions on any of the measures, with the exception of the desire to terminate for Chair spinning. Participants in the training condition (M= 73.71, SD= 21.81) reported a significantly greater desire to terminate the Chair spinning task relative to people in the sham condition (M= 48.63, SD= 35.98), $t(31)$= 2.44, p= .02, two-tailed, Cohen's d= 0.84. Of note, all participants attempted to complete the Chair spinning task at pretest (training condition n= 18; sham condition n= 16).

Hypothesis 1: Self-reported AS

Mean scores and standard deviations for the ASI scales and subscales (i.e., Cognitive, Social, Physical) separated by condition are reported in Table 2. Four 2 (Condition: training, sham) x 3 (Time: pretest, posttest, follow-up) mixed analyses of variance (ANOVAs) were conducted. Statistical significance was set at $p < .05$ and a Bonferroni correction was applied to all follow-up tests of main effects and interactions.

For all measures, post hoc analyses were used to follow-up on nonsignificant omnibus tests. Although there is debate about this practice post hoc tests were deemed necessary because specific within- and between-group differences were hypothesized. This decision was corroborated by the fact that there is a precedent for the use of post hoc analyses in the absence of a nonsignificant omnibus test (e.g., Hancock & Klockars, 1996).

It was hypothesized that participants in the training condition would report lower AS than participants in the sham condition at posttest and at follow-up, as assessed by the ASI (Reiss et al., 1986). It was also hypothesized that participants in the training condition only would display a reduction in AS over time. There was a significant main effect of Time, $F(2,64) = 8.56$, $p < .01$, $\eta_p^2 = .21$. There was no significant main effect of Condition, and no significant interaction of Time and Condition. Bonferroni post hoc analyses revealed a significant decrease in ASI total scores from pretest ($M = 40.78$, $SD = 8.83$) to posttest ($M = 34.78$, $SD = 10.31$) in the training condition only, $p < .01$, Cohen's $d = 0.63$. Analyses also revealed a significant decrease from pretest ($M = 40.78$, $SD = 8.83$) to follow-up ($M = 33.17$, $SD = 12.61$), also only in the training condition, $p < .01$, Cohen's $d = 0.70$. Post hoc analyses did not reveal any significant between-group differences at the posttest or follow-up assessments. Effect sizes for between-group differences revealed small effects, Cohen's $d = 0.19$ at the posttest assessment and Cohen's $d = 0.13$ at the follow-up assessment, with participants in the training condition reporting lower AS at each time point.

Analyses of the ASI subscales revealed varied results. For ASI Cognitive subscale and ASI Social subscale, there were no significant main effects, interactions of Time and Condition or significant differences identified by post hoc analyses. However, for the ASI Physical subscale, there was a significant main effect of Time, $F(2, 64) = 9.98$, $p < .01$, $\eta_p^2 = .24$. Although there was no significant main effect of Condition, the interaction of Time and Condition approached significance, $F(2,64) = 2.95$, $p = .06$, $\eta_p^2 = .08$. Bonferroni post hoc analyses revealed a significant decrease from pretest ($M = 22.11$, $SD = 5.42$) to posttest ($M = 17.89$, $SD = 6.88$) on ASI Physical scores in the training condition only, $p < .01$, Cohen's $d = 0.68$, as well as a significant decrease from pretest ($M = 22.11$, $SD = 5.42$) to follow-up ($M = 16.94$, $SD = 7.58$), $p < .01$, Cohen's $d = 0.78$, in the same group. Post hoc analyses did not reveal any significant between-group differences at the posttest or follow-up assessments. Effect sizes for between-group differences revealed small effects, as Cohen's d=0.25 at post assessment and Cohen's d=0.10 at the follow-up assessment, with participants in the training condition reporting lower scores at each time point.

Table 2

Means and Standard Deviations of ASI Scores Separated by Condition

	Training Condition (*n* = 18)	Sham Condition (*n* = 16)
ASI Total		
Pretest	40.78 (8.83)	38.13 (7.95)
Posttest	34.78 (10.31)	36.88 (10.75)
Follow-up	33.17 (12.61)	34.81 (11.21)
ASI Cognitive		
Pretest	7.89 (4.01)	8.00 (3.35)
Posttest	7.17 (3.92)	7.19 (4.12)
Follow-up	6.89 (4.74)	7.31 (3.72)
ASI Social		
Pretest	8.28 (1.64)	8.50 (2.03)
Posttest	7.56 (2.12)	8.31 (2.15)
Follow-up	7.33 (2.83)	8.31 (2.24)
ASI Physical		
Pretest	22.11 (5.42)	19.94 (5.66)
Posttest	17.89 (6.88)	19.63 (7.23)
Follow-up	16.94 (7.58)	17.69 (7.69)

Note. ASI= Anxiety Sensitivity Index (Reiss et al., 1986).

Hypothesis 2: Interpretive Biases

As previously discussed, the BBSIQ presents participants with ambiguous situations, each followed by a series of three explanations that disambiguate the situation. Of the three explanations, one is negative and the other two are positive/neutral. Participants rate the plausibility of each explanation and the four BBSIQ Beliefs scales (i.e., Internal Negative, Internal Neutral, External Negative, External Neutral) are calculated from participants' mean ratings of the plausibility of each explanation occurring. The BBSIQ Ranking scales require participants to rank the order in which each explanation of the situation would come to mind (i.e., 1^{st}, 2^{nd}, 3^{rd}) given the scenario. Scores on the ranking subscale are coded as 3, 2, and 1, which indicate rankings of 1^{st}, 2^{nd}, and 3^{rd}, respectively. Final Ranking scores are the average ranking of the negative explanations of the items in each subscale (i.e., Internal and External scores). Therefore, larger Ranking scores represent negative explanations as being more prominent (Clark et al., 1997).

Mean scores and standard deviations for the BBSIQ Beliefs and Ranking subscales, separated by condition, are reported in Table 3. Six 2 (Condition: training, sham) x 3 (Time: pretest, posttest, follow-up) mixed ANOVAs were conducted, one for each subscale. Statistical significance was set at $p < .05$, and a Bonferroni correction was applied to all follow-up tests of main effects and interactions. Similar to previous analyses, post hoc analyses were again used to follow-up on nonsignificant omnibus tests.

It was hypothesized that participants in the training condition would exhibit decreased negative interpretive biases at posttest and follow-up, as reflected by changes in BBSIQ Scores, as compared to participants in the sham condition. It was also hypothesized that participants in the training condition only would display decreased negative interpretive biases over time.

Ambiguous body sensations scales. There were no significant main effects or interactions of Time and Condition, nor were there significant post hoc tests, for the Internal Negative Beliefs subscale. For the Internal Neutral Beliefs subscale, however, there was a significant main effect of Time, $F(2,60) = 11.073$, $p < .01$, $\eta_p^2 = .27$, whereby ratings of the plausibility of the neutral explanations generally increased over time. There was no significant main effect of Condition or interaction of Time and Condition. However, Bonferroni post hoc analyses revealed significant changes over time within each condition. In the training condition, there was a significant increase in the ratings of neutral explanations of internal sensations from pretest ($M = 4.79$, $SD = 1.41$) to posttest ($M = 5.16$, $SD = 1.56$), $p < .01$, Cohen's $d = 0.25$, and from the pretest ($M = 4.79$, $SD = 1.41$) to follow-up ($M = 5.32$, $SD = 1.47$), $p < .01$, Cohen's $d = 0.37$. In the sham condition, analyses also revealed significant increases in neutral explanations of internal sensations from pretest ($M = 5.53$, $SD = 0.88$) to posttest ($M = 5.92$, $SD = 0.79$), $p < .01$, Cohen's $d = 0.50$, and pretest ($M = 5.53$, $SD = 0.88$) to follow-up ($M = 5.99$, $SD = 0.96$), $p < .01$, Cohen's $d = 0.47$. Analyses did not reveal any significant between-group differences for either of these subscales. However, effect sizes for between-group differences were of a medium magnitude and were not in the expected direction. Participants in the sham condition endorsed stronger beliefs in the neutral explanations of internal sensations at posttest (Cohen's $d = -0.61$) and at follow-up (Cohen's $d = -0.54$).

With regard to the Internal Ranking subscale, there was a significant main effect of Time, $F(2,64) = 5.41$, $p < .01$, $\eta_p^2 = .16$, whereby the ranking placement decreased over time (i.e., items related to physical sensations were ranked less likely to occur over time). There was neither a significant main effect of Condition, nor a significant interaction of Time and Condition. Bonferroni post hoc analyses revealed a significant change from pretest ($M = 1.68$, $SD = 0.59$) to posttest (*M*= 1.48, *SD*= 0.51) for the training condition only, $p < .01$, Cohen's *d*= 0.37. Specifically, people in the training condition ranked negative explanations of internal sensations as being less likely to come to mind at posttest. Analyses did not reveal any significant between-group differences at the posttest or follow-up assessments. Effect sizes for between-group differences revealed small effects. The direction of the change, however, differed at each time point. At posttest, participants in the training condition ranked the negative explanations as *more* likely to come to mind (Cohen's *d*= -0.21), while at follow-up, participants in the training condition ranking the negative explanations as *less* likely to come to mind (Cohen's *d*= 0.07).

Ambiguous external events scales. There were no significant main effects, interactions or post hoc analyses for the External Negative Beliefs subscale. With regard to the External Neutral Beliefs subscale, there was a significant main effect of Time, $F(2,60)= 6.68$, $p < .01$, $\eta_p^2 = .18$, whereby neutral explanations of external events generally increased over time. There was no main effect of Condition. However, Bonferroni post hoc analyses revealed a significant between-group difference at follow-up only. Compared to participants in the sham condition (*M*= 6.11, *SD*= 0.77), participants in the training condition (*M*= 5.43, *SD*= 1.48) rated the neutral explanations of ambiguous external events as *less* likely, $p < .03$, Cohen's *d*= -0.84. Although there were no significant interactions of Time and Condition, analyses revealed significant changes within the sham condition only. There were significant increases in neutral explanations of external events from pretest (*M*= 5.59, *SD*= 1.15) to follow-up (*M*= 6.11, *SD*= 0.77), $p < .03$, Cohen's *d*= 0.53, and from posttest (*M*= 5.62, *SD*= 1.34) to follow-up (*M*= 6.11, *SD*= 0.77), $p < .03$, Cohen's *d*= 0.45. Analyses did not reveal any significant between-group differences at posttest. Effect sizes for between-group differences at posttest revealed a small magnitude of change (Cohen's *d*= -0.27), with participants in the sham condition having rated the neutral beliefs as more likely to occur.

With regard to the External Ranking subscale, there was a significant main effect of Time, $F(2,64)= 9.78$, $p<.001$, $\eta_p^2= .23$, whereby the rankings of negative explanations decreased over time. There was no significant main effect of Condition, and no significant interaction of Time and Condition. In spite of this, Bonferroni post hoc analyses revealed a significant decrease in negative rankings from pretest (*M*=1.75, *SD*=0.49) to posttest (*M*=1.53, *SD*=0.52) for the training group only, *p*= .04, Cohen's *d*= 0.44. However, significant differences were also observed in the sham condition. There was a significant decrease in negative rankings from pretest (*M*= 1.79, *SD*= 0.61) to follow-up (*M*= 1.41, *SD*=0.49) in the sham condition, *p*< .01, Cohen's *d*= 0.69. This finding indicates that participants in both conditions ranked neutral explanations of external ambiguous situations as more likely to come to mind over time. Analyses did not reveal any significant between-group differences at the posttest or follow-up assessments. Effect sizes for between-group differences revealed small effects, but once again, the direction of the effect differed by time of assessment. At posttest, participants in the training condition ranked the negative explanations as *less* likely to come to mind (Cohen's *d*= -0.23). At follow-up, participants in the training condition ranked the negative explanations as *more* likely to come to mind (Cohen's *d*= 0.22).

Table 3

Means and Standard Deviations of BBSIQ Scores Separated by Study Condition

	Training Condition (n = 18)	Sham Condition (n = 16)
BBSIQ Beliefs		
Internal Negative		
Pretest	2.54 (1.39)	2.96 (1.71)
Posttest	2.22 (1.08)	2.88 (1.54)
Follow-up	2.26 (1.30)	2.87 (1.43)
Internal Neutral		
Pretest	4.79 (1.41)	5.53 (0.88)
Posttest	5.16 (1.56)	5.92 (0.79)
Follow-up	5.32 (1.47)	5.99 (0.96)
External Negative		
Pretest	2.82 (1.68)	3.32 (1.78)
Posttest	2.82 (1.60)	3.15 (1.74)
Follow-up	2.73 (1.84)	3.08 (1.75)
External Neutral		
Pretest	4.95 (1.51)	5.59 (1.15)
Posttest	5.25 (1.53)	5.62 (1.34)
Follow-up	5.43 (1.48)	6.12 (0.77)
BBSIQ Ranking		
Internal		
Pretest	1.68 (0.59)	1.70 (0.54)
Posttest	1.48 (0.51)	1.61 (0.67)
Follow-up	1.51 (0.51)	1.47 (0.58)

	Training Condition (*n* = 18)	Sham Condition (*n* = 16)
External		
Pretest	1.75 (0.49)	1.79 (0.61)
Posttest	1.53 (0.52)	1.67 (0.66)
Follow-up	1.53 (0.49)	1.42 (0.49)

Note. BBSIQ = Brief Bodily Sensations Interpretation Questionnaire (Clark et al., 1997); BBSIQ Beliefs Internal Negative= rating of the probability of negative explanations of internal sensations. BBSIQ Beliefs Internal Neutral= ratings of the probability of neutral explanations of internal sensations. BBSIQ Beliefs External Negative= rating of the probability of negative explanations of external events. BBSIQ Beliefs External Neutral= ratings of the probability of neutral explanations of external events. BBSIQ Ranking Internal= rankings of the negative explanations of internal sensations. BBSIQ Ranking External= rankings of the negative explanations of external events.

Hypothesis 3: Behavioural Approach Tests

Each participant was asked to engage in two brief BATs at pretest, posttest and follow-up: spinning in a chair and breathing through a narrow straw. Time spent engaging in the task, desire to terminate the task, and fear experienced during the task were measured following each BAT. Mean scores and standard deviations for scores on both BATs are reported in Table 4. Six 2 (Condition: training, sham) x 3 (Time: pretest, posttest, follow-up) mixed ANOVAs were performed. Statistical significance was set at $p < .05$ and a Bonferroni correction was applied to all follow-up tests of main effects and interactions.

Overall, 79.3% of participants were able to complete at least one BAT for the maximum time limit over the course of the study. At pretest, 70.6% of the sample was able to complete at least one BAT for the maximum time limit, while this was accomplished by 76.5% of the sample at posttest and 70.6% of the sample at follow-up. All participants attempted to complete the Chair spinning task at pretest. Several participants, however, elected not to participate in the Chair spinning task at posttest and follow-up. Therefore, the proportion of participants who completed the BATs for the maximum time limit is based solely on those participants who *attempted* the task. In the training condition, 15 of 18 participants attempted the Chair spinning task at posttest and 14 of 18 participants attempted the Chair spinning task at follow-up. In the sham condition, 15 of 16 participants attempted the Chair spinning task at posttest and 13 of 16 participants attempted the Chair spinning task at follow-up. With regards to the Straw breathing task, all participants attempted to complete the task at all time points. Table 5 presents the proportion of participants who completed each BAT for the maximum time limit in the training and sham conditions.

Analyses revealed that there were no significant associations between condition and completion of a BAT for the maximum time limit at pretest (Chair spinning $\chi^2(1) = .22$, $p > .05$; Straw breathing $\chi^2(1) = .28$, $p > .05$), posttest (Chair spinning $\chi^2(1) = .14$, $p > .05$; Straw breathing $\chi^2(1) = .08$, $p > .05$), or follow-up (Chair spinning $\chi^2(1) = .30$, $p > .05$; Straw breathing $\chi^2(1) = .00$, $p > .05$).

Chair spinning task. There were no significant main effects or interactions of Time and Condition for time spent engaging in the BAT or fear experienced during the BAT. There was a significant Time and Condition interaction for the desire to terminate the Chair spinning task, $F(2,50) = 4.22$, $p = .02$, $\eta_p^2 = .23$. Bonferroni post hoc analyses revealed that, at pretest, participants in the training condition reported a significantly stronger desire to terminate the Chair spinning task (M=70.29, SD=22.38) relative to participants in the sham condition (M=41.69, SD=36.41), $p = .02$, Cohen's $d = -0.94$, which was consistent with analyses of pretest differences. Bonferroni post hoc analyses also revealed that participants in the training condition reported a decrease from pretest (M=70.29, SD=22.38) to follow-up (M=55.93, SD=31.06) in their desire to terminate the Chair spinning task. This change, however, did not reach significance ($p = .17$), but is associated with a medium effect (Cohen's $d = 0.53$). The opposite change was observed in participants in the sham condition, as they reported an increase in desire to terminate from pretest (M=41.69, SD=36.41) to follow-up (M=54.62, SD=33.06). Again, this change did not reach significance ($p = .29$) and is associated with a small to moderate effect size (Cohen's $d = -0.37$). There were no significant between-group differences at posttest or follow-up.

In light of the between-group pretest differences, a mixed analysis of covariance (ANCOVA) was conducted on the desire to terminate measures to evaluate differences at post-and follow-up assessments while controlling for pretest differences of desire to terminate the task. The results revealed nonsignificant main effects of Time and Condition, and a nonsignificant interaction of Time and Condition. Furthermore, contrasts did not reveal any significant differences either within- or between-groups.

Straw breathing task. Mixed ANOVAs did not reveal any effects of Time, Condition or their interaction on any of the BAT measures.

Table 4

Means and Standard Deviations of BAT measures Separated by Study Condition

	Training Condition	Sham Condition
Chair spinning		
Time (seconds)		
Pretest	48.17 (19.74)	50.75 (16.97)
Posttest	45.20 (22.27) [a]	47.00 (20.67) [a]
Follow-up	47.93 (20.31) [b]	49.77 (17.55) [c]
Fear		
Pretest	24.59 (25.89)	25.56 (28.00)
Posttest	27.80 (28.75) [a]	27.07 (28.16) [a]
Follow-up	23.50 (19.35) [b]	31.00 (33.49) [c]
Desire to Terminate		
Pretest	73.71 (21.81)	48.63 (35.98)
Posttest	71.20 (23.87) [a]	55.07 (39.27) [a]
Follow-up	55.93 (31.06) [b]	54.62 (33.06) [c]
Straw breathing		
Time (seconds)		
Pretest	72.22 (47.28)	78.13 (51.08)
Posttest	88.00 (44.15)	83.25 (50.03)
Follow-up	78.72 (48.24)	70.81 (51.69)
Fear		
Pretest	44.28 (30.14)	45.19 (28.11)
Posttest	38.11 (28.00)	37.50 (32.05)
Follow-up	39.28 (27.12)	33.75 (28.06)

	Training Condition	Sham Condition
Desire to Terminate		
Pretest	75.56 (24.03)	72.69 (24.10)
Posttest	69.44 (27.36)	69.31 (27.00)
Follow-up	65.83 (29.77)	65.75 (28.28)

Note. BAT = behavioural approach test. The maximum time limit for the Chair spinning task was 60 seconds and the maximum time limit for the Straw breathing task was 120 seconds. Fear and Desire to Terminate the task were measured on 100 mm visual analog scales. Several participants elected not to attempt to complete the Chair spinning task at posttest and/or follow-up. The information in this table is based on the proportion of participants who completed the Chair spinning task for the maximum time limit *of those who attempted the task.* Therefore, the *n* of the posttest and follow-up assessments of the Chair spinning task varies.
[a] The number of participants who attempted this task is n=15.
[b] The number of participants who attempted this task is n= 14.
[c] The number of participants who attempted this task is n= 13.

Table 5

Frequency of Participants who completed the BATs for the Maximum Time Limit Separated by Study Condition

	Training Condition	Sham Condition
Chair spinning		
Pretest	11 (61.8%)	11 (68.8%)
Posttest	10 (66.7%) [a]	9 (60.0%) [a]
Follow-up	10 (71.4%) [b]	8 (61.5%) [c]
Straw breathing		
Pretest	8 (47.1%)	9 (56.3%)
Posttest	11 (61.1%)	9 (56.3%)
Follow-up	9 (50.0%)	8 (50.0%)

Note. Several participants elected not to attempt to complete the Chair spinning task at posttest and/or follow-up. The information in this table is based on the proportion of participants who completed the Chair spinning task for the maximum time limit *of those who attempted the task.* Therefore, the *n* of the posttest and follow-up assessments of the Chair spinning task varies.
[a] The number of participants who attempted this task is n=15.
[b] The number of participants who attempted this task is n= 14.
[c] The number of participants who attempted this task is n= 13.

Discussion

Purpose of Study

The purpose of the current study was to investigate the effects of experimentally inducing a neutral AS-related interpretive bias on self-reported AS, interpretations of ambiguous physical sensations, and responses to uncomfortable bodily sensations, as current cognitive models of panic disorder suggest that interpretation bias has a causal role in the processes and symptoms that characterize this and related disorders. It was hypothesized that cognitive training would lead to decreases in self-reported AS and negative interpretive biases of physical sensations, and to a greater tolerance for uncomfortable, benign bodily sensations. It was also hypothesized that these effects would be more pronounced for participants in the training condition than for participants in the sham condition.

Interpretation of Results

In general, there was a significant reduction in AS over time for all participants. However, participants who were trained to interpret ambiguous sensations in a benign fashion reported a significant decrease in AS, while the AS decreases of participants who completed the sham training were not significant. Upon closer examination of the subtypes of AS, training appeared to reduce concerns related to the physical consequences of anxiety, but not concerns regarding the cognitive and social consequences of anxiety. Again, no changes were found in the participants in the sham condition.

While the aforementioned results support the presence of the hypothesized training effects, the results must be interpreted in light of the fact that there were no significant differences between participants in the training and sham conditions at any individual time point. Although participants who were trained to adopt benign interpretations of ambiguous bodily sensations reported a significant decrease in AS following training, their overall level of AS was comparable to that of participants in the sham condition at each assessment, which suggests that the magnitude of the decrease was not large enough to surpass the AS level of those in the sham condition. The magnitude of the between-group difference at posttest in the present study (Cohen's $d = 0.19$), however, is comparable to the results of Steinman and Teachman (2010). When comparing AS levels at posttest between their positive and neutral training conditions, the researchers found a small degree of difference (Cohen's $d = 0.34$). Although this is a greater degree of difference than in the present study, both effect sizes represent a small difference. Additionally, the magnitude of the within-group change in the training condition in the present study is smaller than the effect found in Steinman and Teachman's positive training condition. Their positive interpretation training was associated with a reduction in ASI scores of a large magnitude, with an effect size of Cohen's $d = 1.29$. In the present study, interpretation training resulted in a decrease in ASI scores of a moderate magnitude (Cohen's $d = 0.63$). From this information, it would appear that the training task used by Steinman and Teachman had a greater effect on AS than did the training task used in the present study. However, it should be noted that the mean baseline ASI score of participants in Steinman and Teachman's positive training condition ($M = 34.88$, $SD = 5.97$) was lower than that of the mean baseline score of participants in the training condition in the present study ($M = 40.78$, $SD = 8.83$). In fact, the baseline scores of participants in the positive training condition in Steinman and Teachman were similar to the *posttest* scores of participants in the training condition in the present study ($M = 34.78$, $SD = 10.31$), suggesting that the high AS participants in Steinman and Teachman's study were lower on cognitive risk; perhaps it was easier to modify their interpretive style. Nonetheless, the findings of the present study with regards to changes in AS-related concerns are interesting given that there were only significant changes in the physical concerns of AS, and not in the social or cognitive concerns. However, this may be attributed at least partially to the training stimuli. In the interpretation training task used by Steinman and Teachman, 57.8% of the stimuli were related to physical concerns of AS. In order to be consistent with that task, 57.1% of the training stimuli in the present study were related to physical concerns of AS. Therefore, the question arises as to whether it is possible that the overrepresentation of training items related to physical concerns resulted in an inflated effect specific to only those types of concerns. Unfortunately, this cannot be corroborated by the Steinman and Teachman study, as they did not report the results of the different concerns assessed by the ASI. Furthermore, if the overrepresentation of physical concerns in the training stimuli was responsible for the observed changes, this effect would be limited to self-reported level of AS and would presumably not influence the other measures in the present study. Nonetheless, is an interesting supposition.

An additional consideration in the interpretation of these results is the effect of repeated exposure to the ASI (Reiss et al., 1986). Previous research has demonstrated that scores on the ASI tend to decrease over repeated administrations, in spite of the conceptualization of AS as a stable, dispositional construct. Recently, Broman-Fulks, Berman, Martin, Marsic and Harris (2009) found that ASI scores significantly decreased with two assessments that ranged from 5 to 30 minutes apart, and that these changes were maintained for 2 weeks. The authors suggested that this effect could be due in part to the self-monitoring that occurs with repeated administrations of the ASI, as attention is drawn to thoughts and sensations that people may not have previously been aware of. It has been suggested that repeated self-assessment may make people more aware of their erroneous beliefs about the negative consequences of anxiety sensations and may cause people to evaluate the accuracy of these beliefs (Broman-Fulks et al., 2009). This explanation is consistent with other research on self-monitoring that has demonstrated that monitoring of behaviour leads to decreases in that behaviour (e.g. binge eating; Latner & Wilson, 2002). However, this possibility has not yet been empirically investigated, and therefore, it is speculative. Nonetheless, it is not known to what extent three administrations of the ASI within a 48-hour period influenced scores in the present study. However, there are at least two reasons to rule out practice effects as the exclusive reason for the findings. First, the decreases in AS were not found in all three domains of the ASI. Second, significant decreases in AS were found in only the training condition. Practice effects presumably would have resulted in decreased AS for all domains and across conditions. Therefore, it is suggested that the present findings may be partially attributed to practice effects, but that they are not exclusively responsible for the significant findings.

In general, changes in interpretive biases were inconsistent across conditions and measures. The first measure of interpretive biases assessed participants' belief in the plausibility of explanations for ambiguous bodily sensations and external situations. Participants who were trained to adopt benign interpretive biases of physical sensations reported significant increases in their belief in the plausibility of neutral explanations for ambiguous physical sensations. These changes were associated with small effect sizes. Interestingly, participants in the sham condition also reported a similar pattern of changes in beliefs, and these changes were associated with medium effect sizes, indicating that participants in the sham condition experienced greater change compared to participants in the training condition following the manipulation. This finding is not consistent with the hypotheses. Furthermore, although the differences between the training and sham condition did not reach statistical significance, these differences were of a medium magnitude, but not in the expected direction. That is, participants in the sham condition reported stronger beliefs in the plausibility of the neutral explanations compared to participants in the training condition. This finding is also not consistent with the hypotheses. The second measure of interpretive bias assessed participants' ranking of the negative explanations of ambiguous internal sensations. Explanations of the sensations that would be more likely to come to mind were ranked higher. Participants who completed the interpretation training task reported that negative explanations of changes in physical sensations were significantly *less likely* to come to mind over time. This finding is consistent with the hypotheses. Furthermore, these findings are most interesting when considered in light of the lack of changes in the beliefs of the plausibility of the *negative* explanations of changes in physical sensations. Given that participants, regardless of condition, did not report significant changes in the beliefs of the plausibility of negative explanations, it is surprising that participants who completed the cognitive training rated these same negative explanations as less likely to come to mind. This provides evidence for the fact that the two BBSIQ scales likely assess different facets of interpretive bias, as previously discussed (Clark et al., 1997). The Beliefs measure assesses the beliefs of the plausibility of specific explanations, while the Ranking measure assesses the extent to which participants personally identify with the specific explanations. Taken together, these findings suggest that interpretations change when presented with specific explanations, but that the deep-seated beliefs in the plausibility of explanations are not as malleable. It might be that the training effects were simply not strong enough to affect the strong, persistent beliefs about the negative explanations. If this were the case, more training potentially could have elicited changes in the beliefs similar to that of the rankings; however, this is speculation at this point.

Although the training task used in the present study was not designed to target interpretations of ambiguous external events, some interesting results were revealed, nonetheless.

At follow-up, participants who were trained to adopt benign interpretations of physical sensations reported significantly lower beliefs in the plausibility of the neutral explanations of external situations compared to participants who completed the sham training. Furthermore, participants who completed the sham training reported a significant increase in the plausibility of these explanations over time. With regard to the measure of the rankings of explanations, participants, on average, reported that the negative explanations of external situations were less likely to come to mind over time. However, the participants who completed the sham training reported greater changes compared to participants who completed the cognitive training. Given that the training tasks did not target interpretive biases associated with external situations, the findings for both conditions were surprising. It might be possible to account for the results of the training condition by deducing that the training generalized to induce a nonspecific, benign interpretive bias. However, this is unlikely for participants in the training condition, as they rated the negative explanations for ambiguous external situations as being more plausible following training. Furthermore, a generalized benign bias would also not account for the shift in interpretive biases of participants in the sham training condition.

The sham training task was designed to have no impact on pre-existing interpretations. Nonetheless, the results demonstrate changes in the sham condition with regard to both internal sensations and external situations, with medium effects observed for both measures. Therefore, practice effects must be considered. Participants completed the BBSIQ three times over the course of the study, with the first two administrations occurring within 2 hours. If present, practice effects would have an overarching effect over all the findings. Given the varied results, both across and within conditions, it is unlikely that practice effects are responsible for the findings. A more probable explanation of the changes comes from findings in previous research.

Both Murphy et al. (2007) and Salemink and colleagues (2008) found that, on average, participants across training conditions (i.e., positive versus control training) adopted a general, positive interpretive bias. This is similar to some of the changes in interpretations observed across conditions in the present study. Furthermore, Salemink, van den Hout, Kindt, and Rienties (2008) suggested a mechanism by which this occurred that is related to the design of their training paradigm. Salemink et al. (2008) randomly assigned people high in anxiety to a positive interpretation training task or a sham training task (i.e., half of the trials reinforced a positive interpretive bias and the other half reinforced a negative interpretive bias). Their findings revealed that a positive interpretive bias was induced in both conditions and the authors suggested that the sham training might have inadvertently induced a positive bias based on the proportion of trials in each feedback contingency. For example, when given a free response, pretest measure of interpretive bias, participants may have spontaneously made negative interpretations 90% of the time. If this were the case, then the sham training task with 50% positive trials might have induced a positive bias simply by presenting participants with positive interpretations more than they would have initially made them on their own (Salemink et al., 2008). This explanation may also be applicable to the present study, as the same feedback contingency was used. However, there is no way of confirming this without pretest assessments of interpretations in a task similar to the training task. Nonetheless, this does present a viable explanation of the findings of the present study.

Participants in this study were also asked to engage in two interoceptive tasks, Chair spinning and Straw breathing, before the experimental manipulation, immediately following the manipulation, and at the follow-up assessment approximately 48 hours later. Training did not appear to have an effect on the amount of time spent engaging in the tasks and did not affect self-reported fear. However, participants in the training condition did report a significant decrease from pretest to follow-up in the desire to terminate the Chair spinning task, suggesting that participants who were trained to adopt benign interpretations of ambiguous physical sensations demonstrated an increase in their tolerance for the sensations that spinning produces. However, these results must be interpreted with caution in light of the fact that individuals in the training condition reported a significantly greater desire to terminate the spinning task at pretest, relative to participants assigned to the sham condition, for reasons that are unknown given that the conditions did not differ on any of the other baseline measures. An additional confound to the interpretation of the results of the Chair spinning task is the fact that there were several participants who elected to not participate in the task at posttest and follow-up. At pretest, these participants reported a significantly greater desire to avoid the task than did participants who attempted to complete the task. Therefore, it appears that individuals who reported that they had a strong desire to stop the Chair spinning task at pretest chose not to experience sensations associated with this task at the subsequent assessment points. This could have skewed the results of the Chair spinning task, as the reactions of these extreme participants are not included in the sample. Participants who attempted the task at posttest and follow-up had less intense avoidance reactions to the task at pretest, and may also have had less intense reactions at the other assessment points. The fact that some participants chose to not attempt the Chair spinning task in the first place is evidence of extreme avoidance of bodily sensations and is consistent with their pretest experiences. This avoidance was not displayed by participants who chose to complete the task and may represent an important distinction between the two groups. Additionally, training did not influence responses to Straw breathing. Taken together, the results suggest no effect of interpretation training on responses to brief inductions of bodily sensations. This is consistent with the results of Steinman and Teachman (2010), who also did not find any significant effects of training on BAT performance. They, however, suggested that the null effect was due in part to the Candle blowing and Straw breathing tasks being too easy, as 88% of the participants in their study were able to completed at least one of the BATs for the maximum time limit. For this reason, a novel task (i.e., Chair spinning) and a more taxing variation of the Straw breathing task were used for the present study. Chair spinning and Straw breathing were chosen for their similarity to the experience of natural panic (Antony et al., 2005), and participants in this study were asked to engage in these tasks for a longer duration than in Steinman and Teachman (2010). Despite efforts to make the interoceptive tasks more challenging, 70.6% of participants were able to complete at least one BAT for the maximum time limit at pretest. Given this high proportion of completers in the absence of training, it is likely that, like Steinman and Teachman (2010), there were ceiling effects that it made it difficult to detect an effect of interpretation training on reactions to physical sensations. Although the fact that several participants elected to not attempt the Chair spinning task should be evidence of the difficulty of the task, the high number of completers at pretest does not support this assertion. In light of this, there is a strong possibility that ceiling effects may have in fact confounded the measurement of reactions to interoceptive changes.

Overall, there is partial support for the successful manipulation of the interpretive biases associated with AS through a computerized training task. This is evident through the significant changes in level of AS, as well as specific interpretations of changes in physical sensations. Given the distinct differences in both the content and the format of the ASI and the BBSIQ, these findings suggest generalizability of the training effects. However, there was no manipulation check; as such the extent to which a change in endorsements of benign interpretations and rejections of threat interpretations accounted for changes in AS and interpretation bias as assessed via the BBSIQ, could not be assessed.

Nonetheless, there was a medium effect observed for changes in self-reported AS and small effects observed for changes in self-reported interpretations of physical sensations. These results raise the question of the mechanism of change. Steinman and Teachman (2010) suggested that the training results in priming effects that alter cognitive processes and change subsequent interpretations when the content of the present situation matches that of the training content. In other words, training may have taught participants to alter the process by which they interpret an AS-related situation and resulted in a different interpretation. Steinman and Teachman's explanation could apply to the results of the present study. The cognitive training task presented participants with 60 specific situations twice, paired once with each a positive and negative word. Because the sentences pertained to specific situations (e.g., "You laugh so much that it feels like you can't get enough air″), the sentences did not bear any specific resemblance to the ASI items. In contrast, the ASI items inquire about the extent to which participants agree with general statements and experiences (e.g., "It scares me when I become short of breath"). The noncontext-specific construction of the ASI is intentional, as AS is conceptualized as a dispositional characteristic that is independent of context (McNally, 1994). Therefore, the dissimilarity of the training and assessment tasks do provide evidence that the training generalized to context-specific situations. However, a manipulation check would be needed to draw conclusions about the process of change. It would be important to know if the changes in interpretive biases would be observed in a task that is similar to the cognitive training task in order to conclude that the changes are, in fact, a result of the training. Without this measure, conclusions about the process of change are speculative.

The present study was designed to test the cognitive vulnerability model of panic disorder (Schmidt & Woolaway-Bickel, 2006). Specifically, the goal was to assess whether interpretation bias has a causal role in reactions to physical sensations in people who are high in AS. As previously discussed, there is empirical support for AS as a distal cognitive vulnerability for panic symptoms, as there are positive correlations between AS and panic symptoms; AS has been found to precede the development of panic symptoms; and manipulation of AS results in a change in cognitive processes or symptoms of panic disorder in the expected direction. However, there is limited evidence for the causal role of interpretive biases in panic symptoms, even though this has been suggested to be a proximal cognitive vulnerability factor (Schmidt & Woolaway-Bickel, 2006). Therefore, the present study sought to examine whether direct manipulation of interpretation bias affects cognitive, emotional, and behavioural reactions to innocuous bodily sensations in people who are at high-cognitive risk for panic- and related disorders. The present study demonstrates that targeting the negative interpretive biases associated with AS through cognitive training reduces both self-reported AS and negative interpretive biases of hypothetical changes in physical sensations. In other words, cognitive training resulted in changes in the information processing style associated with panic symptoms, which does in fact support the third requirement of a cognitive vulnerability factor. However, the findings also revealed that cognitive training affects expressions of interpretive biases in different ways. The perceptions of physical sensations as negative are more resistant to change than rankings of personal relevance of specific, negative explanations. When considered together with the lack of change in performance on the interoceptive tasks, it appears that not all facets of AS and negative interpretive biases were affected by the cognitive training. The lack of changes in some measures may be considered evidence against interpretive biases as a cognitive vulnerability for panic and related psychopathology, but that is a premature conclusion based on the current evidence. It might be more appropriate to consider these lack of changes not as evidence of the ineffectiveness of the training, but rather as evidence for the pervasive nature of the schemas associated with AS. The lack of changes would, therefore, also not be attributed to the inaccuracy of the cognitive model. Nonetheless, the findings of the present study are a positive step for this avenue of research. While the results were not conclusive, they are consistent with previous research. There is evidence that AS and the associated negative interpretive biases are cognitive vulnerability factors according to the cognitive vulnerability model of panic (Schmidt & Woolaway-Bickel, 2006) but more research is needed to fully disambiguate the conflicting research.

Methodological Strengths

The present study has several methodological strengths. First, this study employed an *active* cognitive training task. As previously discussed, active cognitive training requires that participants expend cognitive effort to complete the task. This type of training has been found to induce stronger effects compared to a passive training task (Hoppitt et al., 2010). The present task was modeled after the active training task of Beard and Amir (2008), which has been found to be efficacious in modifying interpretive biases. Furthermore, the present study assessed change in AS-related interpretive biases using a variety of measures, both self-report and behavioural. MacLeod, Koster and Fox (2009) recently stressed the importance of multiple assessment methods when testing the effects of cognitive training.

Limitations

The present study had several limitations. First, there were only 34 participants in total, which may have negatively affected the power of the experiment. More specifically, the present study may not have had adequate power to statistically detect actual (true) differences between the training and sham conditions. A larger sample size is needed to test these hypotheses. Also, an additional limitation of the present study is that it involved a single session of cognitive training. While this is consistent with the procedure of Steinman and Teachman (2010), other researchers have used multi-session training procedures that have resulted in strong effects. For example, Beard and Amir (2008) used a 4-week, 8-session training paradigm that yielded significant changes in the interpretive biases and symptoms associated with social anxiety disorder. These changes were associated with strong effects (i.e., Cohen's d= 1.85 and Cohen's d= 2.35). Therefore, the training in the present study may not have been sufficient to elicit the hypothesized changes between conditions. Finally, as previously mentioned, the lack of a manipulation check is a limitation. The present study originally included a computerized assessment task that was similar in format to the training task that was to be used as manipulation check. However, the data could not be analyzed and, as such, the manipulation check was not useful for understanding the results of the present study. However, the lack of manipulation check is not a fatal flaw. A manipulation check would have been crucial had the present study been investigating the mechanisms of change of interpretive biases. This study, however, focused on investigating only specific, self-reported changes in negative interpretive biases. Furthermore, had there been no significant changes in interpretation biases, a manipulation check task would have been vital. It could have clarified whether the lack of change in the dependent measures could be attributed to ineffective training. However, there were several significant findings. Therefore, the lack of manipulation check in the present study is a certainly a limitation, but not a major one.

Future Directions

Given that this is a relatively new area of research, there are a few questions that need to be addressed in future research. First, based on research to date, this is the second known study that has investigated the effects of cognitive training on interpretive biases associated with AS. Both studies failed to detect an effect of interpretation training on reactions to induced bodily sensations. Therefore, it is important to continue to investigate the effects of cognitive training on behavioural measures. It might be the case that different BATs are more appropriate in this type of research, or it might be that BATs are not at all appropriate to assess changes in interpretive biases. This requires further investigation. Also, there are several facets of cognitive training that have been explored in other CBM literature (e.g., populations high in social anxiety) that have yet to be addressed in the AS literature. For example, the effect of extended training and the long-term durability of the training effects can be studied. The present study had a follow-up assessment shortly after the training, but it would be beneficial to assess the long-term durability, with both single- and multi-session training. Assessments of durability of training effects can be used to better understand the malleability of AS and the associated negative interpretive biases. Finally, research should continue to investigate AS and negative interpretive biases as cognitive vulnerability factors for panic. At the present time, there is considerable evidence supporting this assertion, but it is not conclusive evidence. As previously discussed, the ambiguity lies with the third requirement of a cognitive vulnerability, that is, that a change in AS and associated negative interpretive biases would result in a change in panic symptoms in the expected direction. It would be beneficial to continue with this line of research to have a complete understanding of AS and negative interpretive biases as cognitive vulnerability factors for the development of panic disorder.

Conclusions

The present study demonstrates that cognitive training that targets negative interpretive biases can reduce both self-reported AS and the negative interpretive biases associated with AS, albeit in a limited capacity. These findings are consistent with those of Steinman and Teachman (2010), the only other investigation that used cognitive training to reduce AS-related negative interpretive biases. The present study adds to the CBM literature though the application of an existing cognitive training procedure to a different population, as the training task was originally used to target the interpretive biases associated with social anxiety. The present study also provides further support for the notion that AS and negative interpretive biases can be conceptualized as cognitive vulnerability factors for panic, although the evidence is not clear cut. Despite the previously discussed limitations, there is sufficient evidence to support the cognitive vulnerability model of panic (Schmidt & Woolaway-Bickel, 2006), and this avenue of research warrants continued investigation.

Appendix A- Consent Agreement

Informed Consent Form
Ryerson University

Title of Study: Reactions to Bodily Sensations

You are being asked to participate in a research study. Before you give your consent to be a volunteer, it is important that you read the following information and ask as many questions as necessary to be sure you understand what you will be asked to do.

Investigators:
Emma MacDonald, B.Sc., Graduate Student, Department of Psychology, Ryerson University
Naomi Koerner, Ph.D., Assistant Professor, Department of Psychology, Ryerson University

Purpose of the Study: The purpose of this study is to examine factors that have a role in how people experience physical sensations.

Description of the Study: The experiment will involve two visits to the Psychology Research and Training Centre at Ryerson University, located at 105 Bond Street. The total time commitment will be approximately 2 to 2.5 hours. Visit 1 will take approximately 1.5- 2 hours. Visit 2 will take approximately 30 minutes and will be 48 hours after Visit 1.

Visit 1. There will be six different tasks to complete during the first visit. First, you will be asked to answer some questions about your physical and emotional health. You will then be asked to complete a series of questionnaires that ask about thoughts, emotions and reactions to certain situations. You will then be asked to complete two behavioural exercises. One will involve breathing through a straw for up to 2 minutes, and the other will involve spinning in a swivel chair for up to 1 minute. You will be asked a few questions about your experience during these tasks. You will then complete a computer task where you will be asked to categorize words into groups as quickly as possible by responding on a keyboard. Next, you will complete a different computer task where you will have to decide if words and sentences are related or unrelated to each other. You will then be asked to complete the straw breathing task and spinning task again. You will also be asked a few questions about these experiences. Finally, the last activity of this visit involves completing another set of questionnaires. You will receive $20 for this visit.

Visit 2. You will be asked to return to the lab 2 days after Visit 1. You will be asked to complete a questionnaire package. Then, you will complete a computer task where you will have to decide if words and sentences are related or unrelated to each other. You will then be asked to breathe through a straw for up to 2 minutes and to spin in a swivel chair for up to 1 minute, after which you will be asked a few questions regarding your experience of these exercises. Finally, you will be asked to complete a computer task in which you have to categorize words into groups. You will receive $10 for this visit.

Potential Risks or Discomforts: There is minimal risk involved if you agree to take part in this study. You understand that you may experience some negative emotions when completing the questionnaires or computer tasks. You may experience some uncomfortable physical sensations when completing the breathing and spinning activities. You have the right to refuse or discontinue participation at any time. If you decided to stop participating, you will still be entitled to compensation (as outlined above) for any items that you have begun to complete during a visit.

Potential Benefits of the Study to You or Others: Participating in this study may not benefit you directly, but this study may enable us to learn new information that may be beneficial to others. Through participation in the study, you will gain first-hand experience into what it is like to be a research participant. You may also derive benefit from the self-assessment as it may increase your awareness of your thoughts, emotions and behaviours.

Confidentiality: Everything you disclose in this study will remain completely confidential; however, as part of this study, I am obligated to inform everyone that there are five cases in which I might need to break confidentiality:
(1) if you intend to harm yourself;
(2) if you intend to harm someone else;
(3) if there is reasonable suspicion that a child up to the age of 16 years is at risk of neglect or abuse, we are required by law to report this to the Children's Aid Society right away;
(4) if our files are subpoenaed by the courts (records can be opened by a specific court order)
(5) if a regulated health professional has engaged in inappropriate sexual behaviour toward you or another person and you provide us with the name of this individual, we are obligated to report them to their regulatory body.

This informed consent agreement and all data that identifies you will be stored in a locked storage space in the Psychology Research and Training Centre. An ID number as opposed to your name will be used on all forms you complete and in all computer files that will contain the data you generate during the study. The data you generate while participating in this study will be kept in a locked file cabinet, separate from this consent agreement and any data that identifies you. Your consent form and all data will be kept for seven years after the publication of findings from this research. Your confidentiality will be protected to the full extent allowed by law. Only group findings will be reported in publications and presentations arising from this research.

Compensation for Participation: You will earn up to $30 for participating in this study. You are asked to arrange to transport yourself to the Psychology Research and Training Centre at Ryerson University. You will not be paid for the telephone screen that you took part in to determine eligibility.

Voluntary Nature of Participation: Participation in this study is voluntary. Your choice of whether to participate will not influence your future relations with Ryerson University. If you decide to participate, you are free to withdraw your consent and to stop your participation at any time without penalty or loss of benefits to which you are allowed. Your right to withdraw your consent also applies to our use of your data. If you decide that you do not want us to keep or analyze data that you have provided during the course of your participation in this study, please feel free to notify us.

At any point in the study, you may refuse to answer any question or stop participation altogether.

Questions about the Study: If you have any questions about the research, please ask now. If you have questions later about the research, you may contact Emma MacDonald, B.Sc., Graduate Student, Department of Psychology, Ryerson University, 416-979-5000 extension 2182. You may also contact Dr. Naomi Koerner, Department of Psychology, Ryerson University, 416-979-5000 extension 2151.

If you have questions regarding your rights as a participant in this study, you may contact Dr. Nancy Walton, Chair of the Ryerson University Research Ethics Board.

Nancy Walton, PhD
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Agreement:
Your signature below indicates: (1) that you have read the information in this agreement and have had a chance to ask any questions you have about the Reactions to Bodily Sensations study; (2) that you agree that information collected from you during the telephone screen for the Reactions to Bodily Sensations study can be retained and analyzed and (3) that you agree to be in the Reactions to Bodily Sensations study (as described in this consent form) and have been told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement. You have been told that by signing this consent agreement you are not giving up any of your legal rights.

____
Name of Participant (please print)

______________________________________ ________________
Signature of Participant Date

______________________________________ ________________
Signature of Experimenter Who Obtained Informed Consent Date

Appendix B- Verbal Debriefing

Imagine that a person just realized that they can feel their heart beating quite fast. There are several possible explanations that could explain their heart rate, such as they may have just run up a flight of stairs or that they're scared. However, there are certain people who will think that their racing heart will mean that something bad is going to happen, for example that they're going to have a heart attack.

People who think that something bad is going to happen have high levels of Anxiety Sensitivity. This means that they have particular thought patterns, or thought biases, that affect the way that they perceive certain situations. In particular, people with high AS tend to believe that experiencing normal bodily sensations means that something bad is going to happen to them.

The purpose of this study is to determine if helping people change their patterns of thinking by interpreting these sensations in a benign way will change their reaction to bodily sensations. Because this is an experiment, all participants were randomly assigned to one of two groups. The first group completed a computer task that challenged their thought patterns in order to help them develop new ways of thinking. The second group completed a computer task that did not challenge their thought patterns. You were in the ____ group.

To determine if changes in thought patterns occurred, we used three different tasks. Questionnaires and a computer task were used to assess conscious and automatic responses. However, the best way to assess changes in thought patterns is to have people experience the bodily sensations in brief behavioural tasks.

In order to maintain the integrity of this research, please do not disclose the purpose of this experiment to others who may be interested in taking part in this study. When participants have too much prior knowledge about the purpose of an experiment, this can affect how they behave in the experiment and the data for that person may not be usable.

We provide everyone who completes this study with the same list of resources, in case they are interested in learning more about anxiety or methods of changing patterns of thinking. Our list of resources has titles of books on anxiety management, as well as referral sources.

Do you have any questions about the study or anything I just talked about?

Thanks for your participation and cooperation!

Appendix C- Written Debriefing

Reactions to Bodily Sensations

Background of the Study: People who think that experiencing normal, bodily sensations will result in negative consequences have certain patterns of thought, known as thought biases. Studies have shown that it is possible to change these patterns of thinking by completing activities that challenge these patterns. This is the goal of the current study.

Contact Information: If you have any questions or concerns about this experiment or your participation in this study you may contact:

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If you would like any information about the results of the study once it is completed, please contact Emma MacDonald.

Resources: We provide everyone who completes this study with the same list of resources, in case they are interested in learning more about anxiety or methods of changing patterns of thinking. Our list of resources has titles of books on anxiety management, as well as referral sources (please turn over this page for the list).

In order to maintain the integrity of this research, please do not disclose the purpose of this experiment to others who may be interested in taking part in this study. When participants have too much prior knowledge about the purpose of an experiment, this can affect how they behave in the experiment and the data for that person may not be usable.

Thank you very much for participating in this study!

Self-Help Books

Antony, M.M., & McCabe, R.E. (2004). *10 simple solutions to panic: How to overcome panic attacks, calm physical symptoms, and reclaim your life*. Oakland, CA: New Harbinger.

Antony, M. M., & Norton, P. J. (2009). *The anti-anxiety workbook: Proven strategies to overcome worry, panic, phobias and obsessions.* New York, NY: Guilford Press.

Watt, M. C., & Stewart, S. H. (2008). *Overcoming the fear of fear: How to reduce anxiety sensitivity*. Oakland, CA: New Harbinger.

Other anxiety resources: http://www.martinantony.com/links-RecReadingsandVideos.html

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Referrals in Toronto Area

OHIP-Covered and Sliding Scale Referrals

Adult Mental Health Program
Humber River Regional Hospital, Toronto
Contact: Heather Wheeler, Ph.D.
Tel: 416-658-2003

Anxiety Disorders Clinic
Centre for Addiction and Mental Health
250 College St., Toronto
Tel: 416-979-6819

Ryerson University Centre for Student Development and Counselling
(Available to Ryerson Students Only)
350 Victoria St., Room JOR-07C, Lower Ground Floor, Jorgenson Hall, Toronto
Tel: 416-979-5195

Private Psychology Referrals

CBT Associates of Toronto
100 Adelaide St. West, Suite 805, Toronto
Tel: 416-363-4228
Web: http://www.cbtassociates.net/
E-Mail: eilenna.denisoff@cbtassociates.net

David Moscovitch, Ph.D., C.Psych.
Randy Katz, Ph.D., C.Psych.
The Clinic
101 Dupont Street, Toronto, ON
Tel: 416-966-1692

Hank Frazer, Ph.D., C.Psych.
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