University of Cincinnati

Date: 8/14/2019

I, Emily M O'Bryan M.A., hereby submit this original work as part of the requirements for the degree of Doctor of Philosophy in Psychology.

It is entitled:

A Randomized Controlled Trial Evaluating the Efficacy of a Brief Computerized Anxiety Sensitivity Reduction Intervention for Health Anxiety

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**A Randomized Controlled Trial Evaluating the Efficacy of a Brief Computerized Anxiety
Sensitivity Reduction Intervention for Health Anxiety**

A dissertation submitted to the
Division of Graduate Education and Research
of the University of Cincinnati

in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

in the Department of Psychology
Of the College of Arts and Sciences

August 14th, 2019

by

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Abstract

Health anxiety is defined as fear of having or obtaining a serious illness or disease that is excessive relative to actual physical health status. It is estimated that individuals with severe health anxiety utilize 41%-78% more healthcare resources than individuals with a true medical condition. Thus, identifying targets for intervention and prevention efforts for severe health anxiety that are appropriate for primary care or specialty clinic settings is imperative. The aim of the present investigation was to evaluate the effects of a single-session, computerized anxiety sensitivity (AS) reduction intervention on self-report and behavioral indices of AS and health anxiety. Participants were 68 students recruited from the University of Cincinnati demonstrating elevated levels of AS and health anxiety. Participants were randomized to either the active condition (psychoeducation + interpretation bias modification; Capron et al., 2017) or the control condition (study skills training + sham interpretation bias modification) using a 1:1 allocation ratio. Self-report measures were completed at pre-intervention, post-intervention, one-week follow-up, and one-month follow-up. Participants completed a straw-breathing challenge at post-intervention and one-week follow-up, and a series of health-related behavioral avoidance tasks at one-week follow-up. Results indicated a significant Time x Condition interaction for ASI-3 at each follow-up assessment such that individuals in the active condition exhibited greater reductions in AS compared to the control condition. There was no significant Time x Condition interaction for health anxiety at any follow-up assessment, though the between-group effect size was medium at one-month follow-up. No significant effects were observed for behavioral task outcomes. The current findings suggest that this intervention improves AS and shows promise in terms of its ability to reduce health anxiety. A larger trial powered to detect differences in health anxiety, with longer-term follow-ups, and conducted in a clinical sample is needed.

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Introduction

Health anxiety is the fear of having or obtaining a serious illness or disease that is excessive relative to actual physical health status (Abramowitz & Braddock, 2010). While some degree of health-related anxiety is necessary to motivate adaptive health behaviors, health anxiety becomes functionally impairing when it persists without objective reason for concern. Research suggests that health anxiety exists on a continuum ranging from mild to the DSM-IV-TR (American Psychiatric Association [APA], 2000) diagnosis of hypochondriasis at the most severe end (Abramowitz, Schwartz, & Whiteside, 2002; Ferguson, 2009; Longley et al., 2010). Notably, hypochondriasis was removed in the DSM-5 due largely to the stigma associated with the diagnosis (Reuman & Abramowitz, 2015; American Psychiatric Association [APA], 2013), and severe forms of health anxiety are now best captured by the DSM-5 diagnoses of illness anxiety disorder and somatic symptom disorder (APA, 2013). Illness anxiety disorder involves fear of having or obtaining a serious illness in the absence of significant physical symptoms and is accompanied by either excessive health-related checking behaviors (e.g., examining body for signs of illness, seeking reassurance from physicians) or maladaptive avoidance of places associated with illness (e.g., hospitals, doctor's visits; APA, 2013). Somatic symptom disorder is characterized by excessive thoughts, feelings, or behaviors centering on distressing physical symptoms (e.g., pain; APA, 2013) and can involve fear of having a serious illness. However, the majority of previous research using clinical samples has been conducted among individuals diagnosed with hypochondriasis.¹

Given that medical reassurance-seeking is often a key symptom of these disorders, it is not surprising that severe health anxiety, or hypochondriasis, places substantial burden on the individual and the healthcare system as a whole. Less is known about the epidemiology of

¹ We will explicitly indicate when referencing studies conducted among individuals diagnosed with hypochondriasis, illness anxiety disorder, or somatic symptom disorder. Otherwise, we use the term "severe health anxiety" to capture samples exhibiting elevations on established self-report measures.

illness anxiety disorder or somatic symptom disorder because they are newer diagnoses; however, hypochondriasis was estimated to affect between 1% and 5% of the population according to the DSM-IV-TR (APA, 2000). Epidemiological studies have identified the presence of hypochondriasis in .02% to 7.7% of population-based samples and 0.8% to 8.5% in primary care samples (for a review of epidemiology, see Creed & Barsky, 2004), and approximately 20% of individuals seeking services in medical clinics report clinically elevated levels of health anxiety (Tyrer et al., 2011). Greater levels of health anxiety are associated with increased distress and functional impairment, including greater medical care utilization, increased healthcare costs, more frequent hospitalizations, and work-related disability (Barsky, Ettner, Horsky, & Bates, 2001; Fink, Ørnbøl, & Christensen, 2010; Mykletun et al., 2009; Sunderland, Newby, & Andrews, 2013). As one illustrative example, individuals demonstrating elevations on a screening measure of hypochondriasis reported significantly higher past-year outpatient healthcare costs (\$1312 vs \$954) and more frequent physician visits (9.21 vs 6.33) than individuals scoring below this cut-point (Barsky et al., 2001). Moreover, the presence of hypochondriasis has been found to be associated with greater odds of utilizing both general practice and specialized medical services compared to individuals without hypochondriasis (Bobeviski, Clarke, & Meadows, 2016). Importantly, individuals with severe health anxiety are estimated to use 41-78% more healthcare resources than individuals with a true medical condition (Mylekton et al., 2009). Given the prevalence of health anxiety in primary care and the associated burden on both the individual and the healthcare system as a whole, identifying and evaluating interventions for health anxiety that may be appropriate for use in primary care settings is imperative.

Cognitive-behavioral models of health anxiety suggest that severe health anxiety develops as a result of negative beliefs about the likelihood or seriousness of acquiring an illness, as well as the dangerousness of body sensations (Abramowitz et al., 2002; Warwick & Salkovskis, 1990). These negative beliefs are thought to be acquired through knowledge of, or

direct experience with, a serious illness in oneself or others, as well as learned patterns of symptom catastrophizing and related behavioral responding (Abramowitz et al., 2002; Warwick & Salkovskis, 1990). Once acquired, these maladaptive health-related beliefs facilitate heightened attention toward body sensations that are catastrophically appraised as signs of a serious medical condition, while ignoring any contradictory evidence of good health (Abramowitz et al., 2002). In turn, individuals experience health-related worry and engage in negatively reinforcing behaviors, such as avoidance of situations and behaviors that are perceived to lead to illness, self-examinations, reassurance-seeking from physicians, and obsessive internet searching aimed at reducing anxiety and gaining certainty about the status of one's health (Abramowitz et al., 2002; Warwick & Salkovskis, 1990).

Empirical support for this cognitive-behavioral model of health anxiety is well established. Indeed, individuals with severe health anxiety consider themselves to be at greater risk for developing a serious medical condition relative to individuals without severe health anxiety (Barsky et al., 2001). There is also an established link between childhood learning experiences surrounding illness and health anxiety in adulthood (Barsky, Wool, Barnett, & Cleary, 1994; Parker & Lipscombe, 1980; Schwartz Gramling, & Mancini, 1994; Watt & Stewart, 2000), and research findings indicate that individuals with hypochondriasis exhibit a greater tendency to interpret bodily sensations as signs of a serious illness (Weck, Neng, Richtberg, & Stangier, 2012). Body vigilance, or the monitoring of bodily sensations, is also highly correlated with health anxiety (Abramowitz, Olatunji, & Deacon, 2007; Olatunji, Deacon, Abramowitz, & Valentiner, 2007), and some evidence suggests that health anxiety is associated with a bias toward health threat words and pictorial stimuli (Jasper & Witthöft, 2011; Karademas, Christopoulou, Dimostheni, & Pavlu, 2008; Owens, Asmundson, Hadjistavropoulos, & Owens, 2004). Importantly, experimental research has demonstrated that engaging in health-related safety behaviors over a one-week period is associated with significant increases in health anxiety (Olatunji, Etzel, Tomarken, Ciesielski, & Deacon, 2011).

Anxiety Sensitivity

Consistent with the notion that beliefs about the dangerousness of bodily sensations contribute to the development and maintenance of health anxiety (Abramowitz et al., 2002; Warwick & Salkovskis, 1990), one promising target for health anxiety prevention and intervention efforts is anxiety sensitivity (AS). Anxiety sensitivity, or “fear of fear”, reflects a fear of anxiety and arousal-related symptoms (McNally, 2002; Reiss & McNally, 1985) due to beliefs that such symptoms will result in negative physical (AS-Physical Concerns), psychological (AS-Cognitive Concerns), or social consequences (AS-Social Concerns; Taylor et al., 2007). Indeed, psychometric studies suggest that AS consists of one higher order general AS factor and three distinct lower-order factors reflecting the feared consequences of arousal-related sensations (i.e., physical, cognitive, social; Taylor et al., 2007). Anxiety sensitivity is related to, yet distinct from, trait and state anxiety (Rapee & Medoro, 1994), as it reflects the fear of one’s anxiety symptoms as opposed to one’s general proneness to anxiety or the momentary experience of anxiety itself. Though generally trait-like, AS reflects a malleable cognitive vulnerability for anxiety symptoms and disorders, as it serves to amplify anxious responding to threat stimuli within personally relevant anxiety domains. For example, an individual who is high in AS and experiences social anxiety will not only be anxious during social situations, but will also fear their own anxious reactions to social stimuli (e.g., blushing), thus worsening overall anxiety levels.

Research has demonstrated that AS is a transdiagnostic cognitive vulnerability factor that is concurrently and prospectively associated with a number of anxiety symptoms and disorders (Olatunji & Wolitzky-Taylor, 2009; Taylor, Koch, & McNally, 1992). Specifically, higher levels of AS are associated with more severe panic symptoms and precede the development of panic attacks and panic disorder (Deacon & Valentiner, 2001; Maller & Reiss, 1992; Schmidt, Lerew, & Jackson, 1997; Schmidt, Mitchell, & Richey, 2008; Schmidt, Zvolensky, & Maner, 2006; Taylor, et al., 1992). AS is also concurrently and prospectively associated with symptoms

of posttraumatic stress disorder (Boffa et al., 2016; Fedoroff, Taylor, Asmundson, & Koch, 2000; Feldner, Zvolensky, Schmidt, & Rose, 2007; Lang, Kennedy, & Stein, 2002), and has also been implicated in social anxiety disorder (Deacon & Abramowitz, 2006; Drost et al., 2012; McLaughlin, Stewart, & Taylor, 2007; Wheaton, Deacon, McGrath, Berman, & Abramowitz, 2012; Zinbarg & Barlow, 1996), generalized anxiety disorder (Rector, Szacun-Shimizu, & Leybman, 2007; Rodriguez, Bruce, Pagano, Spencer, & Keller, 2004; Wheaton et al., 2012), and obsessive-compulsive disorder (Poli, Melli, Ghisi, Bottesi, & Sica, 2017; Wheaton et al., 2012).

Anxiety Sensitivity and Health Anxiety

Theoretically, higher levels of AS may predispose individuals with health anxiety to automatically misinterpret anxiety-related symptoms as signs of a serious illness or disease. Indeed, research has shown that greater levels of AS are positively associated with greater health anxiety above and beyond other theoretically relevant factors and across a variety of health anxiety measures in non-clinical youth (Wright, Adams Lebell, & Carleton, 2016), undergraduate (Fergus & Valentiner, 2010; Fetzner et al., 2014; O'Bryan & McLeish, 2017; O'Bryan, McLeish, & Johnson, 2017; Sexton, Norton, Walker, & Norton, 2003; Stewart et al., 2008; Stewart & Watt, 2000; Watt & Stewart, 2000; Wheaton, Berman, Franklin, & Abramowitz, 2010) and community samples (Fergus & Bardeen, 2013; Fetzner et al., 2014). AS-Physical Concerns (i.e., fear of anxiety and arousal due to perceived negative physical consequences), in particular, has shown incremental validity in the prediction of fear of the Ebola virus among undergraduates (Blakey, Reuman, Jacoby, & Abramowitz, 2015).

AS is also elevated in clinical and analogue clinical samples of severe health anxiety. Specifically, AS is significantly higher among individuals with high relative to low levels of health anxiety (Wheaton, Berman, & Abramowitz, 2010), is elevated among individuals with somatic symptom disorder and illness anxiety disorder relative to depressed individuals and healthy controls (Bailer et al., 2015), and is associated with greater levels of health anxiety among

individuals diagnosed with hypochondriasis (Abramowitz, Olatunji, & Deacon, 2007; Hedman et al., 2015). Similar to findings in non-clinical samples, there also appears to be some specificity for the AS-Physical Concerns domain in clinical and analog clinical samples of severe health anxiety and hypochondriasis (Abramowitz et al., 2007; Deacon & Abramowitz, 2008; Wheaton et al., 2010). For example, individuals with hypochondriasis report significantly higher levels AS-Physical Concerns relative to individuals with obsessive-compulsive disorder and panic disorder (Deacon & Abramowitz, 2008). However, despite the well-established link between AS and health anxiety, no research, to date, has examined the efficacy of interventions targeting AS as a treatment for health anxiety.

Anxiety Sensitivity Reduction Interventions

Given the well-documented role of AS in the exacerbation of anxiety and related disorders, research efforts have focused on the development and evaluation of interventions aimed at targeting AS specifically. These AS interventions have targeted either “top-down” or “bottom-up” anxiety-related processing, or a combination of the two. Top-down processing refers to conscious, effortful, voluntary control of cognitive responding to perceived threat (Clark & Beck, 2010; Oschsner & Gross, 2005). Bottom-up processing, on the other hand, consists of unconscious, automatic, and unintentional components of threat-related processing, including both attention and interpretation biases favoring threatening over neutral information (Clark & Beck, 2010; Oschsner & Gross, 2005; Teachman, Joormann, Steinman, & Gotlib, 2012).

Top-Down Approaches: Psychoeducation and Interoceptive Exposure. The most common AS interventions targeting top-down processing include psychoeducation and interoceptive exposure. The earliest AS reduction research was conducted by Gardenswartz and Craske (2001), who conducted a 5-hour workshop comprised of psychoeducation regarding panic and agoraphobia, cognitive restructuring, breathing retraining, interoceptive exposure, and instructions for in vivo exposure pertaining to avoided situations (Gardenswartz & Craske, 2001). While the workshop resulted in significantly lower rates of panic disorder development

and greater decreases in panic symptoms at six-month follow-up, there were no group differences in the reduction of AS over the course of the follow-up period (Gardenswartz & Craske, 2001). Aerobic exercise has also been used as an interoceptive exposure to target AS (Broman-Fulks & Storey, 2008), with findings indicating that individuals randomly assigned to engage in six 20-minute sessions of aerobic exercise across a period of two weeks demonstrated significantly greater reductions in AS relative to the no-exercise control group.

Of all of the top-down approaches to reducing AS, a series of related interventions developed by Schmidt and colleagues have received the most scholarly attention. The first was Anxiety Sensitivity Amelioration Training (ASAT; Schmidt et al., 2007), which is a self-guided, computerized intervention that includes psychoeducation regarding the benign effects of “stress” (i.e., anxiety) on the body followed by an interoceptive exposure component to typically feared body sensations (e.g., via hyperventilation; Schmidt & Trakowski, 2004). When compared to a health education control, ASAT yielded greater reductions in self-reported and behavioral indices of AS immediately following the presentation, although differences in self-reported AS between groups were not maintained at one- or two-year follow-up (Schmidt et al., 2007). However, a lower incidence of Axis I psychopathology was observed in the ASAT group relative to the control.

Due to concerns about the efficacy of self-guided interoceptive exposure, ASAT was revised to involve a study therapist who guided the participant through individualized interoceptive exposure exercises and assigned daily interoceptive exposure homework that participants were to do on their own over the next month. This revised program, Anxiety Sensitivity Education and Reduction Training (ASERT; Keough & Schmidt, 2012) resulted in greater reductions in AS immediately post-treatment which were maintained through the six-month follow-up period. Secondary analyses indicated that the addition of the interoceptive exposure homework component did not contribute significantly to reductions in AS, suggesting that ongoing exposure practice may not be a necessary component of treatment aimed at

reducing AS (Keough & Schmidt, 2012). Ongoing work evaluating ASERT has found that not only does this intervention result in significant reductions in AS, but also results in improvements in symptoms of obsessive-compulsive disorder (Timpano, Raines, Shaw, Keough, & Schmidt, 2016), posttraumatic stress disorder (Allan, Short, Albanese, Keough, & Schmidt, 2015), and both worry and anxiety (Norr, Allan, Macatee, Keough, & Schmidt, 2014) across a one-month follow-up period. Furthermore, reductions in AS one week post-intervention have been found to mediate these symptom reductions (Allan et al., 2015; Norr et al., 2014; Timpano et al., 2016).

A similar, fully computerized intervention targeting AS-Cognitive Concerns (i.e., feared cognitive consequences of arousal-related sensations) was recently developed by the same research group (Cognitive Anxiety Sensitivity Treatment; Schmidt, Capron, Raines, & Allan, 2014). CAST has been shown to be effective in reducing AS-Cognitive Concerns, which has resulted in lower levels of depression, anxiety, posttraumatic stress symptoms, insomnia, and suicidality (Raines, Short, Allan, Oglesby, & Schmidt, 2015; Schmidt et al., 2014; Schmidt, Norr, Allan, Raines, & Capron, 2017; Short, Allan, Raines, & Schmidt, 2015; Short et al., 2017). Most notable for the current study, recent work has demonstrated that the psychoeducation component of CAST is sufficient to reduce AS, negating the need for the interoceptive exposure exercises (Norr, Gibby, & Schmidt, 2017).

Bottom-Up Approaches: Cognitive Bias Modification. Bottom-up approaches to AS reduction have focused on cognitive bias modification, which attempt to directly target underlying attentional and interpretation biases shown to be causally related to the development and maintenance of anxiety disorders (Beck, 1976; Beck & Clark, 1997; Salkovskis, 1985, 1989). Such interventions target either attention bias (CBM-A) or interpretation bias (CBM-I) specific to various anxiety conditions by directly modifying the underlying preference for threatening over neutral information. Given that AS reflects a fear of anxiety- and arousal-related sensations due to the interpretation of such sensations as inherently dangerous (Reiss & McNally, 1985), empirical work has examined the utility of interpretation bias modification

interventions for AS. These interventions work by altering anxiety-congruent or “threat” interpretations of ambiguous stimuli to reflect more neutral, anxiety-incongruent interpretations of such stimuli (Beadel, Smyth, & Teachman, 2014).

Interventions targeting these maladaptive interpretations of anxiety symptoms and arousal-related body sensations have demonstrated some success in reducing AS (Capron & Schmidt, 2016; MacDonald, Koerner, & Antony, 2013; Steinman & Teachman, 2010). Steinman and Teachman (2010) found that, among a sample of undergraduate students with elevated AS, participants in the interpretation bias modification condition endorsed greater reductions in self-reported AS. Similarly, MacDonald and colleagues (2013) found significant within-group reductions in AS over time for community participants receiving interpretation bias modification, but not for those in the control condition; however, there were no significant between-group differences in self-reported AS at any follow-up period (MacDonald et al., 2013). Of note, another study evaluating interpretation bias modification for AS failed to demonstrate significant within- or between-group differences in self-reported AS (Clerkin, Beard, Fisher, & Schofield, 2015), and none of the aforementioned studies observed significant effects on behavioral indicators of AS (Clerkin et al., 2015; MacDonald et al., 2013; Steinman & Teachman, 2010). To address limitations of previous work, Capron and Schmidt (2016) increased the treatment dose by adding training trials, which resulted in significantly lower self-reported AS through one-month follow-up and lower levels of behavioral AS immediately post-intervention (Capron & Schmidt, 2016).

Combined Top-Down Bottom-Up Approach. Due to evidence suggesting that anxiety psychopathology involves deficits in both top-down and bottom-up processing (Beck, 1976; Beck & Clark, 1997; Clark & Beck, 2010; Oschner & Gross, 2005; Salkovskis, 1985, 189), recent AS reduction intervention work has combined both approaches in order to improve treatment success. Indeed, deficits in top-down and bottom-up processing may serve to mutually maintain one another, such that the tendency to favor threatening over neutral stimuli

(i.e., bottom-up processing) may negatively impact one's capacity to engage in effortful cognitive reappraisal (i.e., top-down processing), which only further reinforces bottom-up processing deficits (Clark & Beck, 2010; Oschsner & Gross, 2005). Thus, it was theorized that combining top-down and bottom-up approaches to AS reduction would yield larger treatment effects (Capron, Norr, Allan, & Schmidt, 2017).

The only study, to date, that examined a combination of such approaches delivered both psychoeducation (i.e., "top-down") and interpretation bias modification (i.e., "bottom-up") to a sample of individuals with elevated levels of AS (Capron et al., 2017). When compared to a condition involving the same AS-related psychoeducation module, but an inactive interpretation bias modification module, the active condition achieved a 59% reduction in overall AS immediately post-intervention and a 52% reduction from baseline to one-month follow-up (Capron et al., 2017). These findings demonstrated much larger effects on AS relative to the majority of previous interventions targeting either top-down (e.g., 28%-43%; Broman-Fulks & Storey, 2008; Gardenswarz & Craske, 2001; Schmidt et al., 2007; Schmidt & Keough, 2012) or bottom-up processing (29%; Steinman & Teachman, 2010) alone, lending further support for the utility of a combined approach.

Conclusions and Limitations of Past Research

Taken together, severe health anxiety poses a significant problem at both the individual and societal levels, placing substantial burden on affected individuals and the healthcare system as a whole. Given that these individuals seek reassurance in primary care and specialty clinic settings, brief interventions that do not place excessive burden on healthcare providers are greatly needed. A large body of work suggests that AS plays a key role in the exacerbation of health anxiety, and interventions specifically targeting this vulnerability factor have demonstrated success in just one session, with reductions in AS maintained over time (e.g., Allan et al., 2015; Capron et al., 2017; Norr et al., 2014; Timpano et al., 2016). Furthermore, there is evidence to suggest that AS interventions combining top-down and bottom-up

approaches are very successful in reducing AS (Capron et al., 2017). However, no research, to date, has evaluated the efficacy of AS interventions in targeting AS and health anxiety, in a health anxious sample. This is unfortunate, as such computerized interventions could be easily disseminated both online and in primary care or specialty clinic settings where health anxious individuals seek excessive reassurance, and with little burden on healthcare providers.

The Present Study

Therefore, the aim of the present investigation was to determine the effects of a brief, computerized, combined top-down bottom-up AS intervention on self-report and behavioral indices of AS and health anxiety, and to determine whether AS mediates the effects of this intervention on health anxiety. It was hypothesized that individuals in the AS intervention, relative to the control condition, would (1) report greater reductions in self-reported AS from baseline to post-intervention, one-week follow-up, and one-month follow-up; (2) exhibit lower levels of avoidance and subjective anxiety in response to a straw breathing challenge at post-intervention and one-week follow-up; (3) report greater reductions in self-reported health anxiety from baseline to one-week follow-up and one-month follow-up; and (4) exhibit less avoidance of, and lower anxiety in response to, a series of health-related behavioral avoidance tasks at one-week follow-up. (5) Lastly, it was hypothesized that there would be a significant indirect effect of the AS intervention on changes in health anxiety from baseline to one-week follow-up through changes in AS from baseline to post-intervention and changes in health anxiety from baseline to one-month follow-up through changes in AS from baseline to one-week follow-up, respectively.

Method

Participants

Participants were 68 students recruited from the University of Cincinnati (79.4% female; $M_{age} = 19.68$ years, $SD = 1.78$, range = 18-28). In order to be eligible for the current study, participants had to: (a) be age 18 or older; (b) report elevated levels of health anxiety as determined by a SHAI score at least 1 SD above the student mean (i.e., ≥ 14 ; Salkovskis et al.,

2002); and (c) report elevated anxiety sensitivity as determined by an ASI-3 score falling at least 1 SD above the nonclinical mean (i.e., ≥ 24 ; Taylor et al., 2007). Two individuals who did not meet initial eligibility criteria at the baseline visit on the SHA1 were erroneously randomized (one to each condition) and are included in analyses. Exclusion criteria included a self-reported diagnosis of a bipolar disorder or psychotic spectrum disorder (to control for any potentially confounding effects of severe mental illness), epilepsy (due to possible contraindications for the cognitive bias modification and straw breathing task) or pregnancy (due to contraindications for the straw breathing task). The minimum necessary sample size was initially determined via power analysis using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) with multiple linear regression as the anticipated analytic approach and an estimated large effect size based on previous studies (Capron et al., 2017). This analysis yielded a required minimum sample size of 48, though we increased the sample size in order to meet desirable sample sizes for detecting a mediational effect (i.e., $n = 60$; Fritz & MacKinnon, 2007) and to account for approximately 10% anticipated dropout. Research also points to a minimum sample size of 50 for multilevel modeling (Maas & Hox, 2005), suggesting that the present study was adequately powered to detect a medium effect for the primary analyses.

Self-Report Measures

Demographic and Clinical Information. Participants were asked to provide basic demographic information (i.e., age, gender, race/ethnicity) as well as information about their substance use and medical history. Specifically, participants were asked to report frequency of marijuana use in the past 30 days, frequency and quantity of alcohol use, and whether or not they were a regular daily cigarette smoker. Participants were then asked to endorse whether they had ever been diagnosed by a physician with the following medical conditions: multiple sclerosis, high blood pressure, diabetes, HIV/AIDS, heart disease, ulcer, kidney problems, cancer, gastrointestinal disease, and asthma. Participants were also asked to report whether or not they were currently experiencing chronic pain, defined as persistent pain lasting three

months or more. Regarding these medical conditions, 1.9% of the sample reported high blood pressure, 1.5% current kidney problems, 10.3% current gastrointestinal disease, 8.8% current asthma, and 31.8% endorsed current chronic pain.

Anxiety Sensitivity Index-3 (ASI-3). The ASI-3 (Taylor et al., 2007) is an 18-item measure assessing anxiety sensitivity. Respondents are asked to rate the degree to which each statement applies to them on a 5-point Likert-type scale (0 = *very little* to 5 = *very much*), with higher scores indicating higher levels of AS. The ASI-3 is comprised of one higher order (i.e., total score) and three lower-order factors (i.e., subscales) tapping fear of arousal due to perceived physical (e.g., “It scares me when my heart beats rapidly”), psychological (e.g., “When I cannot keep my mind on a task, I worry that I might be going crazy”), and social (e.g., “When I tremble in the presence of others, I fear what people might think of me”) consequences. The ASI-3 exhibits the strongest psychometric properties of any self-report measure of AS (Taylor et al., 2007). Specifically, the ASI-3 demonstrates excellent construct validity, convergent, discriminant, and criterion-related validity as well as internal consistency and test-retest reliability (Farris, Allan, Morales, Schmidt, & Zvolensky, 2015; Taylor et al., 2007). Internal consistency for the ASI-3 in the current sample was acceptable at baseline ($\alpha = .77$) and excellent at post-intervention ($\alpha = .94$), one-week follow-up ($\alpha = .93$), and one-month follow-up ($\alpha = .95$).

Short Health Anxiety Inventory (SHAI). The SHAI (Salkovskis et al., 2002) is an 18-item self-report measure assessing health-related worry, body vigilance, and perceived negative consequences of having a serious illness. Each item is comprised of 4 statements ranging in severity (e.g., 0 = “I do not worry about my health”; 3 = “I spend most of my time worrying about my health”); respondents are instructed to select which statement best describes them over the past six months. Higher scores indicate higher levels of health anxiety. Extant research on the factor structure of the SHAI most consistently supports a two-factor structure: a 14-item general

health anxiety subscale comprised of health-related worry and body vigilance items (i.e., SHAI Main) and a 4-item Negative Consequences subscale (e.g., “If I had a serious illness I would be completely unable to enjoy life at all”; Alberts, Hadjistavropoulos, Jones, & Sharpe, 2013). A recent meta-analysis revealed that the SHAI demonstrates good psychometric properties and uniquely predicts healthcare utilization, somatization, and safety-seeking behaviors (Alberts et al., 2013). Importantly, the SHAI has demonstrated good test-retest reliability (Olatunji, Etzel et al., 2011), and is sensitive to change resulting from intervention (Alberts et al., 2013). Only the 14-item general health anxiety subscale was used in the current study, as the second factor (i.e., negative consequences subscale) has not been shown to uniquely contribute to health anxiety beyond the main subscale (Alberts et al., 2013). Internal consistency reliability for the SHAI in the current sample was good at baseline ($\alpha = .80$) and one-week follow-up ($\alpha = .88$), and excellent at one-month follow-up ($\alpha = .91$).

Behavioral Measures

Straw-Breathing Task. Participants were asked to breathe through a cocktail straw while holding their nose for as long as possible immediately after the intervention and at the one-week follow-up assessment. This interoceptive exposure task has been previously used as a behavioral indicator of AS (Capron & Schmidt, 2016; Steinman & Teachman, 2010) as it mimics anxiety-related sensations (i.e., suffocation, lightheadedness, dizziness; Barlow & Craske, 1994). Participants were instructed to breathe through the straw for as long as they could while being timed with a stopwatch by the researcher, although the experimenter terminated the task if two minutes was reached. The researcher recorded straw breathing duration (i.e., task persistence) as a measure of task-related avoidance. Participants were asked to rate subjective anxiety just before beginning the task on a scale from 0 to 100 (0 = no fear/anxiety; 100 = extreme fear/anxiety), as well as anxiety immediately prior to terminating the task in order to evaluate increases in subjective anxiety associated with these anxiety-related

physiological sensations. Following completion of the straw-breathing task at both timepoints, participants were led through a brief diaphragmatic breathing exercise by the researcher to ensure that distress levels returned to baseline following completion of the task.

Health-Related Behavioral Avoidance Task (BAT). Participants completed a series of three health-related behavioral avoidance tasks in a randomized order at one-week follow-up (Fan & Olatunji, 2013; Olatunji et al., 2011). In line with previous work, the health-threat stimuli included: (1) a tissue reportedly used by someone with the common cold; (2) a thermometer reportedly used by someone with the Flu; and (3) a water bottle from which someone with mononucleosis reportedly drank (Fan & Olatunji, 2013; Olatunji et al., 2011). Participants were asked to systematically “approach” each stimulus, which was stored in a paper bag. However, during initial instructions, participants were told that they could refuse any step. Steps for each task include: (1) touching the bag; (2) opening the bag; (3) touching the item; (4) touching lips with the hand used to touch the item; and (5) touching the item to the lips. Participants were asked to rate their anxiety (0 = “no anxiety at all,” 5 = “moderate anxiety,” 10 = “extremely intense anxiety”) after each completed step. The BAT produces two scores: avoidance and anxiety. The BAT-Avoidance score was calculated by summing the number of steps refused for each stimulus. The anxiety score was calculated by first summing the anxiety ratings for each step and dividing by the number of completed steps for each stimulus. These scores were then summed across the three BAT stimuli to achieve a composite BAT-Anxiety score.

Procedure

Approval for all study procedures was obtained from the University of Cincinnati’s Institutional Review Board (IRB) prior to the start of data collection. Participants were recruited from undergraduate psychology courses online via Sona Systems, email announcements to professors of courses outside of the psychology department, in-class announcements, flyers placed across campus, and emails sent to previous study participants who had consented to being re-contacted for future paid research opportunities. Interested individuals completed a

screeners via Qualtrics, which included eligibility questions (i.e., age, epilepsy, severe mental illness, pregnancy), the ASI-3, and the SHAI. After emailing the researcher their completion code, potential participants were then informed of their initial eligibility, and interested and eligible participants were scheduled for the initial study appointment. Upon arrival to the initial appointment, participants provided informed, written consent. Then, participants were re-screened for all eligibility criteria, including completion of the ASI-3 and SHAI to ensure stability of prior elevations. Those who were ineligible were either granted research credit proportional to the time spent at the initial appointment if they were a psychology student or were compensated \$5 for their time if they were recruited from another source.

Eligible participants then completed remaining self-report measures before being randomized to the active treatment or control condition. Block randomization (block size = 10) was used to help ensure equal group sizes, thus increasing statistical power (Efird, 2011). Participants were blinded to treatment condition. Participants first completed the interpretation bias modification module (active or sham) followed by the psychoeducation module (AS-focused or study skills). Upon completion of the intervention, participants completed the ASI-3, the straw-breathing task, and were scheduled for their one-week follow-up appointment. The SHAI was not administered at post-intervention due to the fact that we expected more distal, rather than immediate, effects on health anxiety as a result of changes in AS, and also because items are not conducive to momentary assessment (e.g., 0 = “I do not worry about my health”; 3 = “I spend most of my time worrying about my health”). At the one-week follow-up appointment, participants again completed the self-report measures, the straw-breathing task, and were led through the BATs. Participants were debriefed following completion of the BATs as to the true nature of the task (i.e., no health threat) and provided written consent to allow their BAT data to be used given the use of deception in the task. Participants who were unable to attend the one-week follow-up assessment in person were sent a link to complete the self-report measures online via Qualtrics. The one-month follow-up was also administered online through Qualtrics.

Following completion of the study, participants who had been assigned to the control condition were given the option receive the active condition if interested. Participants were compensated for their time and effort after each study visit. Participants who were currently enrolled in psychology courses received research credit proportional to the time spent completing the study. They were given the option of receiving research credit or a \$10 Amazon gift card for completion of the one-month follow-up. All other participants received \$20 for completing the first study visit, \$15 for the one-week follow-up assessment, and \$10 for the one-month follow-up assessment.

Experimental Conditions

Active Condition (BIAS + ASAT-P). As implemented by Capron and colleagues (2017), an interpretation bias modification for AS (BIAS; Capron & Schmidt, 2016) was administered in conjunction with the psychoeducation portion of Anxiety Sensitivity Amelioration Training (ASAT-P; Schmidt et al., 2007) as a combined AS intervention targeting both effortful and automatic processing. This combined intervention has been previously demonstrated to reduce AS (Capron et al., 2017).

BIAS is a cognitive bias modification tailored to specifically target AS by modifying fearful interpretations of anxiety-related physical sensations (e.g., that heart racing means a heart attack; Capron & Schmidt, 2016). Using a modified version of the Word Sentence Association Paradigm (WSAP; Beard & Amir, 2008; Brosan, Hoppitt, Shelfer, Sillence, & Mackintosh, 2011), BIAS presents anxious arousal-related words (i.e., one or two-word phrases) for 1 second, as opposed to one word for a duration of 500 milliseconds (i.e., Beard & Amir, 2008; Brosan et al., 2011), followed by a sentence reflecting either a neutral or threatening interpretation of the word. Participants then decide, by pressing a key, whether the word and sentence are related or unrelated. Whereas in previous interpretation bias modifications the word itself has been the target of interpretation modification (e.g., choosing “funny” versus “embarrassing” in response to a sentence describing “people laughing at something you said”; Beard & Amir, 2008), BIAS

presents ambiguous body sensation words followed by a sentence reflecting either a neutral or threatening interpretation. Thus, using BIAS, the sentences, rather than the words, are the targets for modification. BIAS also incorporates positive punishment following any threatening appraisals using an 85 dB horn blast and doubles the amount of trials (i.e., from 80 to 160) by incorporating a context shift (i.e., 5 minutes of simple math problems) between sets (Capron & Schmidt, 2016).

First, 40 practice trials were administered to the participant to allow for assessment of baseline levels of interpretation bias. Next, participants completed 80 trials of the word-sentence pairings (40 neutral, 40 threatening) and received corrective feedback following each response. Then, participants spent 5 minutes completing math problems prior to advancing to the second set of 80 active trials. Lastly, participants were presented with 40 novel trials without corrective feedback to allow for assessment of changes in interpretive bias as a function of BIAS. Previous research has demonstrated that BIAS leads to significant reductions in interpretation bias among individuals high in AS (Capron & Schmidt, 2016). BIAS requires approximately 15 to 20 minutes to complete.

ASAT-P is a 22-minute, fully computerized presentation that provides psychoeducation about AS. ASAT-P specifically dispels myths about the physical, cognitive, and social consequences of anxiety-related physical sensations by verbally providing corrective information about these beliefs. For example, the intervention explains that decreases, rather than increases, in heart rate lead to heart attacks (i.e., physical consequences), that anxiety cannot make one 'go crazy' (i.e., cognitive consequences), and that people are often not paying enough attention to notice that one is visibly anxious (i.e., social consequences). While the full version of ASAT incorporates interoceptive exposure exercises in addition to psychoeducation, such exercises were excluded from the present intervention given the aim of evaluating interventions amenable to online and self-administration.

Control Condition (PIM + Study Skills Training). Similar to the control condition used by Capron and colleagues (2017), a placebo interpretation modification (PIM) will be administered in conjunction with study skills training. The placebo interpretation modification (PIM; Capron et al., 2017) mirrors the active IB condition (i.e., BIAS) in content; however, participants receive non-contingent feedback on 50% of neutral word-sentence pairings and 50% of threatening word-sentence pairings as done in previous research evaluating interpretation bias modification for AS (MacDonald et al., 2013). Prior research has demonstrated that PIM does not alter AS-related interpretation biases (Capron et al., 2017).

A study skills training PowerPoint was developed based on curriculum used at the University of Cincinnati's Learning Commons. Specifically, this intervention was developed in conjunction with an Academic Coach Mentor from the Learning Commons who also served as a research assistant for the present study. This intervention was generally matched to the active condition for time, lasting approximately 24 minutes. We also matched the control condition in terms of visual layout of the PowerPoint, incorporating the same background and many of the same images. Content included psychoeducation on techniques for improving the effectiveness of studying (e.g., chunking, repetition, using recall), as well as addressing possible myths serving as barriers to effective studying and academic success (e.g., effectiveness of cramming, professors aren't interested in helping).

Data Analytic Plan

Self-Report Outcomes. To examine the effect of the active condition on anxiety sensitivity and health anxiety over time, we first conducted multilevel mixed effects models using Stata 12.1, with separate models constructed for each outcome of interest. Specifically, for each respective model, self-reported anxiety sensitivity (ASI-3) and health anxiety (SHAI) served as the repeated measures dependent variables (level 1 unit) nested within subjects (level 2 unit). We allowed the intercept and slope to vary randomly. Group (Active or Control), Time (Baseline, Post-Treatment, One-Week Follow-up, One-Month Follow-Up), and the interaction of Group x

Time were included as predictors. Simple effects were examined to determine the nature of the interaction; that is, to determine the effect of Time on the outcome within each group. Missing data were handled using maximum likelihood estimation, allowing for all individuals who were randomized to be incorporated in each model (i.e., intent-to-treat analysis). Cohen's *d* was computed for each follow-up timepoint to determine between-condition effect sizes.

Behavioral Task Outcomes. To evaluate the effect of the intervention on behavioral indicators of anxiety sensitivity, we conducted a series of hierarchical multiple regression analyses in SPSS. This approach was chosen over multilevel modeling, as longitudinal multilevel models with fewer than three time points are not considered reliable. For both straw breathing duration and subjective anxiety, pre-task subjective anxiety was entered at Step 1 and Condition was entered at Step 2 for both time points. To evaluate the effect of the intervention on behavioral indicators of health anxiety, we conducted independent samples *t*-tests using SPSS to examine differences in BAT-Anxiety and BAT-Avoidance by Condition. We chose not to administer behavioral measures prior to the intervention as randomization should account for any baseline differences in performance on these tasks and we wanted to reduce the likelihood of practice effects.

Mediation Analyses. A series of simple mediation analyses was conducted using PROCESS for SPSS (Hayes, 2013), a statistical plug-in that utilizes bias-corrected bootstrapping as a means of directly testing, rather than inferring, the presence of a significant indirect (i.e., mediational) effect. For each mediation analysis, Condition was entered as the predictor [X]. Separate models were constructed to evaluate changes in health anxiety from baseline to one-week follow-up [Y_1] and from baseline to one-month follow-up [Y_2] as separate outcomes. Changes in AS from baseline to post-treatment [M_1] and from baseline to one-week follow-up [M_2] served as mediators, respectively. See Figures 2 and 3 for conceptual models. For the model examining change in health anxiety from baseline to one-month follow-up, we chose to examine changes in AS from baseline to one-week follow-up as the mediator (rather

than from baseline to post-intervention) as this is in line with previous research (e.g., Timpano et al., 2016) and also allowed us to test the specificity of the model by flipping the mediator and outcome (i.e., changes in health anxiety from baseline to one-week follow-up mediating changes in AS from baseline to one-month follow-up). Theoretically, if we expect that changes in health anxiety from baseline to one-month follow-up are explained, and thus preceded, by changes in AS, we should be able to demonstrate that treatment condition led to significant reductions in AS from baseline to a more delayed follow-up.

Results

Descriptive Analyses

Subject Attrition. See Figure 1 for the Consort diagram. Two individuals initially allocated to the control condition began the intervention, but discontinued the study prior to completing it and were missing all post-intervention and follow-up data. Specifically, one person elected to discontinue just after beginning the interpretation bias modification due to not wanting to hear the horn blast, and the other had to leave the study session before completing the intervention. One individual allocated to the active condition did not fully complete the intervention due to a power outage; however, this individual completed all follow-up data. An additional two participants in the control condition and two participants in the active condition did not complete the one-week follow-up or one-month follow-up assessments. Lastly, an additional five participants in the control condition and five participants in the active condition did not complete the one-month follow-up assessment. As such, there were missing data at one or more time points for seven participants in the active condition (21% attrition) and nine participants in the control condition (26% attrition). There were no significant correlations observed between dropout at post-intervention, one-week follow-up, or one-month follow-up and baseline ASI-3 scores, baseline SHAI scores, or treatment condition (all p 's > .05). Aggregate dropout at any time point was also not associated with baseline ASI-3, baseline SHAI, or treatment condition (all p 's > .05).

Missing Data. Primary study variables were examined for the presence of missing data. In terms of self-report measures, item-level missing data (i.e., single item) was observed on the baseline ASI-3 ($n = 1$; 1.5%) and post-intervention ASI-3 ($n = 5$; 7.4%). Due to having greater than 5% missing item-level data (Tabachnick & Fidell, 2007), associations between item-level missingness on the post-treatment ASI-3 and primary study (i.e., baseline ASI-3, baseline SHAI, condition) and demographic variables (i.e., age, gender, race, ethnicity, number of medical conditions) were examined via bivariate correlations, phi coefficients, or point-biserial correlations as applicable in order to determine if item-level data were missing completely at random. There were no significant associations observed; as such, all item-level missing data were handled via mean imputation. There was no other item-level missing data observed on primary study variables at one-week or one-month follow-up. Maximum likelihood estimation was used to handle missing self-report data for those lost to follow-up in the mixed effects models.

A total of eight participants (11.8%) did not complete the straw-breathing challenge at one-week follow-up due to being lost to follow-up ($n = 6$) or completing the visit online ($n = 2$). Missingness on this task was not associated with baseline ASI-3 ($r = .21, p = .08$), baseline SHAI ($r = .14, p = .27$), or condition ($r = -.17, p = .16$). There were also no significant correlations between missingness at one-week follow-up and demographic variables. Ten participants were missing data on the health-related BATs; eight due to being lost to follow-up or completing the visit online, one due to the fact that a stimulus was missing from one of the bags, and one due to refusing to complete the steps (which led to missing data for BAT anxiety ratings). Missingness on this task was not associated with baseline ASI-3 ($r = .10, p = .42$), SHAI ($r = .09, p = .48$), or condition ($r = -.15, p = .21$). There were also no significant associations between missingness on this task and demographic variables. As such, all missing behavioral task data were handled via listwise deletion. Mixed effects models require a

minimum of three time points in order produce reliable estimates; therefore, maximum likelihood could not be implemented within these analyses.

Group Differences. See Table 1 for descriptive statistics for baseline measures and demographic variables by treatment condition. Two participants who were randomized but did not fully complete the intervention were mistakenly replaced in the block randomization sequence by the next enrolled participant. This resulted in unequal sample sizes in the active condition ($n = 33$; 48.5%) and control condition ($n = 35$; 51.5%). There were no significant group differences in terms of age [$t(66) = -.63, p = .53$], gender [$\chi^2(1) = 1.75, p = .19$], race [$\chi^2(3) = 2.49, p = .48$], ethnicity [$\chi^2(1) = 2.19, p = .14$], smoking status [$\chi^2(1) = .99, p = .32$], alcohol consumption [$t(64) = -1.13, p = .26$], marijuana use [$t(58.95) = .89, p = .38$], baseline ASI-3 [$t(66) = 1.36, p = .18$], or baseline SHAI [$t(66) = 1.28, p = .21$]. Therefore, no covariates were used in subsequent analyses.

Zero-Order Correlations. See Table 2 for means and standard deviations of all study variables by condition and Table 3 for zero-order correlations among all study variables. The ASI-3 was significantly positively correlated with the SHAI at each timepoint. ASI-3 scores at both post-intervention and one-week follow-up were significantly associated with subjective anxiety ratings during the straw breathing task, but not with duration of task persistence. SHAI scores at one-week follow-up were not significantly associated with BAT-Anxiety or BAT-Avoidance. ASI-3 scores at one-week follow-up were also not significantly associated with BAT-Anxiety or BAT-Avoidance.

Analysis of Self-Report Outcomes

Change in Anxiety Sensitivity. See Figure 4 for ASI-3 scores across time points for each condition. Model residuals were normally distributed. There was a significant Time x Condition interaction for ASI-3 at post-intervention ($b = -13.59, p = .000, 95\% \text{ CI } [-19.89, -9.28]$), one-week follow-up ($b = -10.95, p = .000, 95\% \text{ CI } [-16.29, -5.60]$), and one-month follow-up ($b = -10.19, p = .004, 95\% \text{ CI } [-17.09, -3.28]$). Specifically, individuals in the active condition

exhibited a greater reduction in AS from baseline to post-intervention ($b = -21.98$, $p = .000$, 95% CI [-25.03, -18.93]), baseline to one-week follow-up ($b = -20.13$, $p = .000$, 95% CI [-23.91, -16.34]), and baseline to one-month follow-up ($b = -20.14$, $p = .000$, 95% CI [-25.02, -15.25]) relative to the control condition; however, significant reductions from baseline to post-intervention ($b = -8.39$, $p = .000$, 95% CI [-11.43, -5.36]), baseline to one-week follow-up ($b = -9.18$, $p = .000$, 95% CI [-12.96, -5.41]), and baseline to one-month follow-up ($b = -9.95$, $p = .000$, 95% CI [-14.83, -5.07]) were still observed for the control condition. Between-condition Cohen's d was 1.28 for post-treatment, 1.08 for one-week follow-up, and .88 for one-month follow-up. Within each condition, there were no significant differences in ASI-3 scores between post-intervention, 1-week follow-up, and 1-month follow-up assessments (all p 's > .05).

Change in Health Anxiety. See Figure 5 for SHAI scores across time points for each condition. Model residuals were normally distributed. There was no significant Time x Condition interaction for SHAI at one-week follow-up ($b = -.46$, $p = .67$, 95% CI [-2.63, 1.70]) or one-month follow-up ($b = -1.89$, $p = .18$, 95% CI [-4.65, 0.87]). Tests of simple effects revealed that there were significant reductions of a similar magnitude from baseline to each follow-up assessment in both the active and control conditions (all p 's < .001). Between-condition Cohen's d was .31 for one-week follow-up and .51 for one-month follow-up. There was a significant reduction in health anxiety between the one-week and one-month follow-up for the active condition ($b = -1.90$, $p = .025$), but not the control condition ($b = -.48$, $p > .05$).

Analysis of Behavioral Outcomes

Post-Intervention Straw-Breathing Task. In terms of subjective anxiety immediately prior to task termination, pre-task anxiety was a significant predictor ($\beta = .74$, $t = 8.90$, $p = .000$), accounting for 55.3% of variance. Condition was not a significant predictor of subjective anxiety immediately prior to terminating the straw breathing task at Step 2 ($\beta = -.07$, $t = -0.82$, $p = .41$; 0.5% unique variance).

In terms of task persistence, the assumption of multivariate normality was not fully met. A log transformation was applied to the task persistence variable, which led to improvement in normality of residuals, though did not impact the pattern of results. Findings for the task persistence model are, therefore, reported using the non-transformed data for ease of interpretation. Pre-task anxiety was not a significant predictor of task persistence at Step 1 ($\beta = -0.14$, $t = -1.11$, $p = .27$; 1.9% variance). The effect of Condition on task persistence at Step 2 was also non-significant ($\beta = -.06$, $t = -0.43$, $p = .67$; 0.3% unique variance).

Straw-Breathing Task at One-Week Follow-Up. In terms of subjective anxiety immediately prior to task termination, pre-task anxiety was a significant predictor ($\beta = .64$, $t = 6.42$, $p = .000$), accounting for 41.5% variance. The effect of Condition on subjective anxiety approached significance at Step 2 ($\beta = -0.17$, $t = -1.72$, $p = .09$), accounting for an additional 2.9% unique variance.

For task persistence, the assumption of multivariate normality was not fully met. A log transformation was applied to the outcome variable, which led to improvements in multivariate normality; however, this transformation did not impact the overall pattern of results. Findings are therefore reported based upon the non-transformed data for ease of interpretation. Pre-task anxiety was not a significant predictor at Step 1 ($\beta = .18$, $t = -0.16$, $p = .87$; 2.7% variance). The effect of Condition on task persistence at Step 2 was also non-significant ($\beta = -0.05$, $t = -0.35$, $p = .73$; 11.9% unique variance).

Health-Related Behavioral Avoidance Tasks. Results of the independent samples t -test for BAT-Anxiety indicated no significant differences between the active ($M = 10.02$, $SD = 6.64$) and control ($M = 9.57$, $SD = 5.95$) conditions [$t(56) = -.27$, $p = .79$]. There were also no significant differences between the active condition ($M = 4.23$, $SD = 3.80$) and control condition ($M = 4.66$, $SD = 4.26$) in terms of BAT-Avoidance [$t(57) = .40$, $p = .69$].

Mediation Analyses

See Figure 6 for a depiction of the mediation model examining the indirect effect of Condition on changes in health anxiety from baseline to one-week follow-up through changes in AS from baseline to post-treatment. The total effect model was non-significant ($R^2 = .00$, $df = 1$, 60 , $F = .22$, $p = .64$), reflecting that there was no main effect of condition on changes in health anxiety from baseline to one-week follow-up (path c). Condition was a significant predictor of reductions in AS from baseline to post-treatment (path a; $b = -14.54$, $t = -5.28$, $p = .000$) and greater changes in AS significantly predicted greater changes in health anxiety from baseline to one-week follow-up (path b; $b = .22$, $t = 5.12$, $p = .000$). There was a significant indirect (i.e., mediational) effect such that the active condition led to reductions in health anxiety indirectly through reductions in AS (indirect effect = -3.23 ; $SE = .96$; 95% CI = -5.23 to -1.47).

See Figure 7 for a depiction of the mediation model examining the indirect effect of Condition on changes in health anxiety from baseline to one-month follow-up through changes in AS from baseline to one-week follow-up. The total effect model was non-significant ($R^2 = .03$, $df = 1$, 50 , $F = 1.72$, $p = .20$), reflecting that there was no main effect of Condition on changes in health anxiety from baseline to one-month follow-up (path c). Condition was a significant predictor of reductions in AS from baseline to one-week follow-up (path a; $b = -11.17$, $t = -3.69$, $p = .001$) and greater changes in AS significantly predicted greater changes in health anxiety from baseline to one-month follow-up (path b; $b = .24$, $t = 4.21$, $p = .000$). There was a significant indirect effect such that the active condition led to reductions in health anxiety indirectly through reductions in AS (indirect effect = -2.67 ; $SE = .99$; 95% CI = -4.84 to -0.96).

In order to test the specificity of the model, we examined a flipped model with changes in health anxiety from baseline to one-week follow-up serving as the mediator and changes in AS from baseline to one-month follow-up serving as the outcome. The indirect effect for this flipped model was non-significant (indirect effect = $-.62$; $SE = 2.01$; 95% CI = -4.47 to 3.31).

Discussion

Given the well-established link between anxiety sensitivity (AS) and health anxiety, the aim of the present study was to evaluate the effect of a single-session, computerized AS reduction intervention (i.e., psychoeducation + interpretation bias modification; Capron et al., 2017) on self-report and behavioral indicators of AS and health anxiety among young adults with elevated levels of AS and health anxiety. Results indicated that, as hypothesized, individuals in the intervention group reported greater decreases in self-reported AS at all follow-up assessments compared to individuals in the control group. AS was reduced by 48% at post-intervention in the active condition, and these reductions were sustained at one-week (51%) and one-month follow-up (50%). Moreover, 51% participants in the active condition fell below the suggested clinical cut-score for high AS at the 1-week follow-up assessment and 58% at the 1-month follow-up assessment (i.e., ASI-3 < 23; Allan, Korte, Capron, Raines, & Schmidt, 2014). Moreover, the between-condition effect size was very large at post-treatment and large at the one-week and one-month follow-up assessments. These findings generally mirror what was found in the Capron et al. (2017) study, though the post-intervention effect size was larger in the current study ($d = 1.28$ vs. 1.08). These results provide evidence of the intervention's efficacy in reducing AS in a non-clinical sample with elevated levels of AS and health anxiety.

Inconsistent with prediction, results from the straw breathing task indicated that the intervention did not appear to have an effect on behavioral measures of AS. There were no associations between treatment condition and anxiety or persistence on the straw breathing task, although results for anxiety at the one-week follow-up assessment approached significance. This finding is somewhat inconsistent with previous studies, which have demonstrated significant effects of this intervention on panic responding to biological challenges (i.e., straw breathing, CO₂ inhalation) immediately post-intervention (Capron & Schmidt, 2016; Capron et al., 2017). It is possible that this discrepancy is due to methodological differences, as the present study relied on a single-item subjective distress rating to assess anxious responding compared to a more comprehensive assessment of panic responding following the straw-

breathing challenge in other studies (e.g., Capron & Schmidt, 2016). Alternatively, participants in the current study reported much higher levels of AS at baseline and post-intervention compared to those in the Capron and colleagues (2017) study. Thus, it is possible that further reductions in AS would be required in order to observe a change in objective measures of fearful responding to anxiety-related physical sensations. It is also important to note that neither ASI-3 scores nor subjective anxiety ratings during the straw-breathing task were significantly correlated with task persistence, possibly indicating that task persistence during the straw-breathing challenge was not meaningfully assessing AS. This lack of association between subjective anxiety and task persistence may indicate that participants were not making efforts to engage in the task.

Also inconsistent with prediction, the intervention did not result in statistically significant reductions in self-reported health anxiety compared to controls. This finding is somewhat inconsistent with previous research that has demonstrated reductions in other anxiety-related symptoms with similar AS interventions (e.g., Norr et al., 2014; Allan et al., 2015; Timpano et al., 2016; Short et al., 2017). However, some studies have also failed to observe main effects of an AS intervention involving the same psychoeducation component as the present study, but including an interoceptive exposure component, on global anxiety symptoms (Schmidt et al., 2007). It is important to note that while there were no statistically significant differences in change in health anxiety over time between conditions in the present study, differences in health anxiety between conditions did correspond to a small effect size at one-week follow-up ($d = .31$) and a medium effect size at one-month follow-up ($d = .51$). Given that the current study was powered to detect large effect sizes, we may have been underpowered to detect significant changes at the follow-up assessments due to attrition as well as smaller effects. Furthermore, the active condition continued to demonstrate significant reductions in health anxiety from the one-week to one-month follow-up, whereas health anxiety levels in the control condition remained stable between follow-up periods. Thus, significant between-group differences may

have emerged with longer follow-up periods. These non-significant findings may also be due to the very high baseline AS scores. It is possible that, for this population, a stronger dose of the AS intervention is required to maximally target AS and produce downstream improvements in health anxiety.

The present study also found no significant differences in anxiety or avoidance on the health-related BATs between the active and control conditions. Importantly, we did not observe a significant correlation between self-reported health anxiety at one-week follow-up and BAT-Avoidance which may indicate that the task was not specifically assessing health anxiety. It is possible that the task may more directly assess individuals' ability to tolerate health-related uncertainty rather than health anxiety per se. It will be important for future research to include alternative behavioral measures that may more accurately "tap" health anxiety, and to administer these measures at longer-term follow-ups.

Lastly, while examining a mediation model may not seem intuitive given that we did not observe a significant main effect of treatment condition on health anxiety over time, we thought that this analysis was important for several reasons. First, this intervention was designed to target an underlying risk factor (i.e., AS) known to exacerbate health anxiety rather than health anxiety symptoms directly. Furthermore, though not statistically significant, we observed a large between-condition effect size for health anxiety at the one-month follow-up. Thus, we believed that conducting a mediation model would be important for informing theoretical models of health anxiety and advancing future research in this area. Lastly, current perspectives on mediation analysis suggest that mediation can occur even in the absence of a significant main effect of the predictor on the outcome (Hayes, 2009; Hayes, 2013). Consistent with prediction, mediation analyses indicated that the active condition led to significantly greater decreases in AS from baseline to post-treatment and one-week follow-up relative to the control condition and that, in turn, these significant reductions in AS led to significant decreases in health anxiety from baseline to both one-week follow-up and one-month follow-up, respectively (see Figures 4 and

5). These findings may suggest that, while there were no significant differences between conditions in changes in health anxiety, the active condition may lead to changes in health anxiety indirectly through its significant effect on reductions in AS. That is, reductions in AS due to the intervention may, in turn, lead to reductions in health anxiety over time. These findings strengthen the notion that AS is an important putative intervention target for health anxiety and that efforts to maximally engage AS may result in meaningful changes in health anxiety over time.

Limitations and Future Directions

There are a number of important strengths of the present study, including its experimental design, multi-method assessment approach, and longitudinal follow-up. However, it is important to consider the present findings in light of the study's limitations. First, study personnel responsible for administering assessments and analyzing data were not blinded to treatment condition. Bias was minimized given the fully computerized nature of the intervention; however, there is still a possibility of bias due to lack of blinding. In addition, some individuals in the control condition reported that they suspected they had not been assigned to the active condition, as they caught on to the pattern of feedback given on the sham interpretation bias modification trials (i.e., the same response would be marked correct one time and incorrect another time). This suggests that participants in the study may not have been adequately blinded to treatment condition, which may have introduced bias in subsequent self-report and behavioral assessments. Second, we elected to use study skills training rather than the previously utilized health education control, as we had concerns about the appropriateness of a health-related control condition for individuals with health anxiety. This change unfortunately precludes direct comparison of our results to those of previous studies.

Third, the present study did not administer long-term follow-up assessments beyond one month. Future work should consider additional follow-up periods in order to clarify if reductions in AS are sustained beyond one month, as well as whether the intervention leads to statistically

significant reductions in health anxiety at later follow-up timepoints. Theoretically, it may take a longer period of time for reductions in AS to translate to meaningful reductions in health anxiety. Fourth, it should also be noted that the current sample consisted of university students largely recruited through undergraduate psychology courses for course credit who were relatively homogenous in terms of race, ethnicity, and gender. Future research will benefit from recruiting more diverse community samples to ensure generalizability of findings, as well as treatment-seeking samples. Fifth, we selected individuals with elevated levels of health anxiety based on a well-validated self-report measure rather than based on the presence of a diagnosis of illness anxiety disorder or somatic symptom disorder determined via semi-structured clinical interview. While future research should evaluate the efficacy of this intervention in a clinical sample, it is important to note that approximately 54% of our sample scored at or above the suggested cut-off for probable hypochondriasis (i.e., 14-item SHAI ≥ 21 ; Alberts et al., 2013). We also recruited individuals with higher levels of AS than have been observed in similar studies. Thus, while this was not a treatment seeking sample, it likely approximated what might be seen in a clinical setting.

Lastly, because this intervention has been feasibly implemented in previous research (Capron & Schmidt, 2016; Capron et al., 2017), feasibility was not formally evaluated in an *a priori* fashion as part of the present investigation. However, we did qualitatively observe a number of potential areas for future refinement that are worth noting. For example, we observed difficulties with adherence in terms of headphone use during the IBM portion of the intervention (e.g., taking them off, taking one side off). Anecdotally, this appeared to be more typical for participants in the control condition than the active condition, which is not surprising as the control condition was more frequently receiving the horn blasts than individuals in the active condition. Future research should consider using speakers as opposed to headphones in order for the intervention to be delivered consistently among all participants. We also observed some issues with inattention during the psychoeducation portion of the intervention (e.g., cell

phone use, not looking at the computer screen). It would be beneficial for future research to formally assess adherence and attention as well as systematically inquire about participant experience immediately following the intervention to better determine reasons for any observed inattention. Such information could allow researchers to determine if aspects of the intervention need to be modified to increase adherence.

Clinical Implications

Despite these limitations, findings from the present study have important clinical implications. Clinically, these findings point to the utility of this intervention in reducing AS among individuals with high levels of health anxiety. As such, individuals with severe health anxiety should be evaluated for elevated AS to determine appropriateness of the present intervention, as findings suggest that reductions in AS due to this computerized intervention could lead to subsequent reductions in health anxiety. While this intervention needs to be more rigorously tested, including incorporating longer follow-ups to ensure durability of effects, there may be utility to testing these interventions in primary care or specialty clinic settings given high rates of healthcare utilization in this population (Barsky et al., 2001; Fink et al., 2010). This computerized intervention could, in theory, be easily delivered to individuals high in AS and health anxiety with little burden on healthcare workers and at low costs. Ongoing administration of this intervention to individuals with severe health anxiety in such settings could lead to reduced burden on both the individual and the healthcare system as a whole, as reductions in health anxiety may, in turn, reduce unnecessary healthcare utilization. Moreover, the computerized nature of the intervention may lend itself nicely to online administration, allowing healthcare avoidant individuals with severe health anxiety to potentially access the intervention.

Conclusions

In sum, these results suggest that a single-session, fully computerized AS reduction intervention targeting both top-down and bottom-up processing is effective in reducing AS through a one-month follow-up period among young adults with elevated levels of AS and health

anxiety. Furthermore, this intervention was able to indirectly reduce health anxiety through reductions in AS. Thus, there may be utility to testing these interventions in primary care or specialty clinic settings in the future.

References

- Abramowitz, J. S., & Braddock, A. (2008). *Psychological treatment of health anxiety and hypochondriasis: A biopsychosocial approach*. Hogrefe publishing.
- Abramowitz, J. S., Deacon, B. J., & Valentiner, D. P. (2007). The Short Health Anxiety Inventory: Psychometric properties and construct validity in a non-clinical sample. *Cognitive Therapy and Research*, 31, 871-883. doi: 10.1007/s10608-006-9058-1
- Abramowitz, J. S., Olatunji, B. O., & Deacon, B. J. (2007). Health anxiety, hypochondriasis, and the anxiety disorders. *Behavior Therapy*, 38, 86-94. doi:10.1016/j.brat.2006.04.005
- Abramowitz, J. S., Schwartz, S. A., & Whiteside, S. P. (2002). A contemporary conceptual model of hypochondriasis. *Mayo Clinic Proceedings*, 77, 1323-1330. doi:10.4065/77.12.1323
- Alberts, N. M., Hadjistavropoulos, H. D., Jones, S. L., & Sharpe, D. (2013). The Short Health Anxiety Inventory: A systematic review and meta-analysis. *Journal of Anxiety Disorders*, 27, 68-78. doi:10.1016/j.janxdis.2012.10.009
- Allan, N. P., Korte, K. J., Capron, D. W., Raines, A. M., & Schmidt, N. B. (2014). Factor mixture modeling of anxiety sensitivity: A three-class structure. *Psychological Assessment*, 26(4), 1184-1195. doi:10.1037/a0037436
- Allan, N. P., Short, N. A., Albanese, B. J., Keough, M. E., & Schmidt, N. B. (2015). Direct and mediating effects of an anxiety sensitivity intervention on posttraumatic stress disorder symptoms in trauma-exposed individuals. *Cognitive Behaviour Therapy*, 44, 512-524. doi:10.1080/16506073.2015.1075227
- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (5th ed.). Arlington, VA: American Psychiatric Publishing.

- Bailer, J., Kerstner, T., Witthöft, M., Diener, C., Mier, D., & Rist, F. (2016). Health anxiety and hypochondriasis in the light of DSM-5. *Anxiety, Stress, & Coping*, 29, 219-239.
doi:10.1080/10615806.2015.1036243
- Barlow DH, Craske MG. (1994). *Mastery of Your Anxiety and Panic*, Vol. II. Albany, NY: Graywind.
- Barsky, A. J., Ettner, S. L., Horsky, J., & Bates, D. W. (2001). Resource utilization of patients with hypochondriacal health anxiety and somatization. *Medical Care*, 39, 705-715.
- Barsky, A. J., Wool, C., Barnett, M. C., & Cleary, P. D. (1994). Histories of childhood trauma in adult hypochondriacal patients. *American Journal of Psychiatry*, 151, 397-397.
- Beadel, J. R., Smyth, F. L., & Teachman, B. A. (2014). Change processes during cognitive bias modification for obsessive compulsive beliefs. *Cognitive Therapy and Research*, 38, 103-119. doi:10.1007/s10608-013-9576-6
- Beard, C., & Amir, N. (2008). A multi-session interpretation modification program: Changes in interpretation and social anxiety symptoms. *Behaviour Research and Therapy*, 46, 1135-1141. doi:10.1016/j.brat.2008.05.012
- Beck, A. T. (1976). *Cognitive theory and emotional disorders*. New York: International Universities Press.
- Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: Automatic and strategic processes. *Behaviour Research and Therapy*, 35, 49–58. doi:10.1016/S0005-7967(96)00069-1.
- Blakey, S. M., Reuman, L., Jacoby, R. J., & Abramowitz, J. S. (2015). Tracing “Fearbola”: Psychological predictors of anxious responding to the threat of Ebola. *Cognitive Therapy and Research*, 39, 816-825. doi:10.1007/s10608-015-9701-9
- Bobevski, I., Clarke, D. M., & Meadows, G. (2016). Health anxiety and its relationship to disability and service use: Findings from a large epidemiological survey. *Psychosomatic Medicine*, 78, 13-25. doi:10.1097/PSY.0000000000000252

- Boffa, J. W., Norr, A. M., Raines, A. M., Albanese, B. J., Short, N. A., & Schmidt, N. B. (2016). Anxiety sensitivity prospectively predicts posttraumatic stress symptoms following a campus shooting. *Behavior therapy*, 47, 367-376. doi:10.1016/j.beth.2016.02.006
- Broman-Fulks, J. J., & Storey, K. M. (2008). Evaluation of a brief aerobic exercise intervention for high anxiety sensitivity. *Anxiety, Stress, & Coping*, 21, 117-128. doi:10.1080/10615800701762675
- Brosan, L., Hoppitt, L., Shelfer, L., Sillence, A., & Mackintosh, B. (2011). Cognitive bias modification for attention and interpretation reduces trait and state anxiety in anxious patients referred to an out-patient service: Results from a pilot study. *Journal of Behavior Therapy and Experimental Psychiatry*, 42, 258-264. doi:10.1016/j.jbtep.2010.12.006
- Capron, D. W., Norr, A. M., Allan, N. P., & Schmidt, N. B. (2017). Combined “top-down” and “bottom-up” intervention for anxiety sensitivity: Pilot randomized trial testing the additive effect of interpretation bias modification. *Journal of Psychiatric Research*, 85, 75-82. doi:10.1016/j.jpsychires.2016.11.003
- Capron, D. W., & Schmidt, N. B. (2016). Development and randomized trial evaluation of a novel computer-delivered anxiety sensitivity intervention. *Behaviour Research and Therapy*, 81, 47-55. doi:10.1016/j.brat.2016.04.001
- Clark, D. A., & Beck, A. T. (2010). Cognitive theory and therapy of anxiety and depression: Convergence with neurobiological findings. *Trends in Cognitive Sciences*, 14, 418-424. doi:10.1016/j.tics.2010.06.007
- Clerkin, E. M., Beard, C., Fisher, C. R., & Schofield, C. A. (2015). An attempt to target anxiety sensitivity via cognitive bias modification. *PloS one*, 10, e0114578. doi:10.1371/journal.pone.0114578
- Creed, F., & Barsky, A. (2004). A systematic review of the epidemiology of somatisation disorder and hypochondriasis. *Journal of Psychosomatic Research*, 56, 391-408. doi:10.1016/S0022-3999(03)00622-6

- Deacon, B., & Abramowitz, J. (2006). Anxiety sensitivity and its dimensions across the anxiety disorders. *Journal of Anxiety Disorders*, 20, 837-857. doi: 10.1016/j.janxdis.2006.01.003
- Deacon, B., & Abramowitz, J. S. (2008). Is hypochondriasis related to obsessive-compulsive disorder, panic disorder, or both? An empirical evaluation. *Journal of Cognitive Psychotherapy*, 22, 115-127. doi: 10.1891/0889-8391.22.2.115
- Deacon, B. J., & Valentiner, D. P. (2001). Dimensions of anxiety sensitivity and their relationship to nonclinical panic. *Journal of Psychopathology and Behavioral Assessment*, 23, 25-33.
- Drost, J., Van der Does, A. J. W., Antypa, N., Zitman, F. G., Van Dyck, R., & Spinhoven, P. (2012). General, specific and unique cognitive factors involved in anxiety and depressive disorders. *Cognitive Therapy and Research*, 36, 621-633. doi:10.1007/s10608-011-9401-z
- Efird, J. (2010). Blocked randomization with randomly selected block sizes. *International Journal of Environmental Research and Public Health*, 8(1), 15-20. doi:10.3390/ijerph8010015
- Fan, Q., & Olatunji, B. O. (2013). Individual differences in disgust sensitivity and health-related avoidance: Examination of specific associations. *Personality and Individual Differences*, 55, 454-458. doi:10.1016/j.paid.2013.04.007
- Farris, S. G., Allan, N. P., Morales, P. C., Schmidt, N. B., & Zvolensky, M. J. (2015). Does successful smoking cessation reduce anxious arousal among treatment-seeking smokers?. *Journal of Anxiety Disorders*, 36, 92-98. doi:10.1016/j.janxdis.2015.07.009
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175-191. doi:10.3758/BF03193146
- Fedroff, I. C., Taylor, S., Asmundson, G. J., & Koch, W. J. (2000). Cognitive factors in traumatic stress reactions: Predicting PTSD symptoms from anxiety sensitivity and beliefs about harmful events. *Behavioural and Cognitive Psychotherapy*, 28, 5-15.

- Feldner, M. T., Zvolensky, M. J., Schmidt, N. B., & Smith, R. C. (2008). A prospective test of anxiety sensitivity as a moderator of the relation between gender and posttraumatic symptom maintenance among high anxiety sensitive young adults. *Depression and Anxiety, 25*, 190-199. doi:10.1002/da.20281
- Fergus, T. A., & Bardeen, J. R. (2013). Anxiety sensitivity and intolerance of uncertainty: Evidence of incremental specificity in relation to health anxiety. *Personality and Individual Differences, 55*, 640-644. doi:10.1016/j.paid.2013.05.016
- Fergus, T. A., & Valentiner, D. P. (2009). Reexamining the domain of hypochondriasis: Comparing the Illness Attitudes Scale to other approaches. *Journal of Anxiety Disorders, 23*, 760-766.
- Fergus, T. A., & Valentiner, D. P. (2010). Disease phobia and disease conviction are separate dimensions underlying hypochondriasis. *Journal of Behavior Therapy and Experimental Psychiatry, 4*, 438-444. doi:10.1016/j.jbtep.2010.05.002
- Ferguson, E. (2009). A taxometric analysis of health anxiety. *Psychological Medicine, 39*, 277-285. doi:10.1017/S003329170800332
- Fetzner, M. G., Asmundson, G. J., Carey, C., Thibodeau, M. A., Brandt, C., Zvolensky, M. J., & Carleton, R. N. (2014). How do elements of a reduced capacity to withstand uncertainty relate to the severity of health anxiety? *Cognitive Behaviour Therapy, 43*, 262-274. doi:10.1080/16506073.2014.929170
- Fink, P., Ørnbøl, E., & Christensen, K. S. (2010). The outcome of health anxiety in primary care. A two-year follow-up study on health care costs and self-rated health. *PloS One, 5*, e9873. doi: 10.1371/journal.pone.0009873
- Fritz, M. S., & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science, 18*, 233-239. doi:10.1111/j.1467-9280.2007.01882.x
- Gardenswartz, C. A., & Craske, M. G. (2001). Prevention of panic disorder. *Behavior Therapy, 32*, 725-737. doi:10.1016/S0005-7894(01)80017-4

- Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, 76(4), 408-420.
doi:10.1080/03637750903310360
- Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: The Guilford Press.
- Hedman, E., Ljótsson, B., Andersson, E., Andersson, G., Lindefors, N., Rück, C., ... & Lekander, M. (2015). Psychometric properties of internet-administered measures of health anxiety: an investigation of the Health Anxiety Inventory, the Illness Attitude Scales, and the Whiteley Index. *Journal of Anxiety Disorders*, 31, 32-37.
doi:10.1016/j.janxdis.2015.01.008
- Jasper, F., & Witthöft, M. (2011). Health anxiety and attentional bias: The time course of vigilance and avoidance in light of pictorial illness information. *Journal of Anxiety Disorders*, 25, 1131-1138. doi:10.1016/j.janxdis.2011.08.004
- Karademas, E. C., Christopoulou, S., Dimostheni, A., & Pavlu, F. (2008). Health anxiety and cognitive interference: Evidence from the application of a modified Stroop task in two studies. *Personality and Individual Differences*, 44, 1138-1150.
doi:10.1016/j.paid.2007.11.007
- Keough, M. E., & Schmidt, N. B. (2012). Refinement of a brief anxiety sensitivity reduction intervention. *Journal of Consulting and Clinical Psychology*, 80, 766-772.
doi:10.1037/a0027961
- Lang, A. J., Kennedy, C. M., & Stein, M. B. (2002). Anxiety sensitivity and PTSD among female victims of intimate partner violence. *Depression and Anxiety*, 16, 77-83.
doi:10.1002/da.10062
- Longley, S. L., Broman-Fulks, J. J., Calamari, J. E., Noyes, R., Wade, M., & Orlando, C. M. (2010). A taxometric study of hypochondriasis symptoms. *Behavior Therapy*, 41, 505-514. doi:10.1016/j.beth.2010.02.002

- Maas, C. J., & Hox, J. J. (2005). Sufficient sample sizes for multilevel modeling. *Methodology*, 1(3), 86-92. doi:10.1027/1614-2241.1.3.86.
- MacDonald, E. M., Koerner, N., & Antony, M. M. (2013). Modification of interpretive bias: Impact on anxiety sensitivity, information processing and response to induced bodily sensations. *Cognitive Therapy and Research*, 37, 860-871. doi:10.1007/s10608-012-9519-7
- Maller, R. G., & Reiss, S. (1992). Anxiety sensitivity in 1984 and panic attacks in 1987. *Journal of Anxiety Disorders*, 6, 241-247. doi: 10.1016/0887-6185(92)90036-7
- McLaughlin, E. N., Stewart, S. H., & Taylor, S. (2007). Childhood anxiety sensitivity index factors predict unique variance in DSM-IV anxiety disorder symptoms. *Cognitive Behaviour Therapy*, 36, 210-219. doi:10.1080/16506070701499988
- McNally, R. J. (2002). Anxiety sensitivity and panic disorder. *Biological Psychiatry*, 52, 938-46. doi: 10.1016/S0006-3223(02)01475-0
- Mykletun, A., Heradstveit, O., Eriksen, K., Glozier, N., Øverland, S., Mæland, J. G., & Wilhelmsen, I. (2009). Health anxiety and disability pension award: The HUSK Study. *Psychosomatic Medicine*, 71, 353-360. doi:10.1097/PSY.0b013e31819cc772
- Norr, A. M., Allan, N. P., Macatee, R. J., Keough, M. E., & Schmidt, N. B. (2014). The effects of an anxiety sensitivity intervention on anxiety, depression, and worry: Mediation through affect tolerances. *Behaviour Research and Therapy*, 59, 12-19. doi:10.1016/j.brat.2014.05.011
- Norr, A. M., Gibby, B. A., & Schmidt, N. B. (2017). Is computerized psychoeducation sufficient to reduce anxiety sensitivity in an at-risk sample?: A randomized trial. *Journal of Affective Disorders*, 212, 48-55. doi:10.1016/j.jad.2017.01.032
- O'Bryan, E. M., & McLeish, A. C. (in press). An examination of the indirect effect of intolerance of uncertainty on health anxiety through anxiety sensitivity physical concerns. *Journal of Psychopathology and Behavioral Assessment*.

- O'Bryan, E. M., McLeish, A. C., & Johnson, A. L. (in press). The role of emotion reactivity in health anxiety. *Behavior Modification*.
- Olatunji, B. O., Deacon, B. J., & Abramowitz, J. S. (2009). Is hypochondriasis an anxiety disorder?. *The British Journal of Psychiatry*, 194, 481-482.
doi:10.1192/bjp.bp.108.061085
- Olatunji, B. O., Etzel, E. N., Tomarken, A. J., Ciesielski, B. G., & Deacon, B. (2011). The effects of safety behaviors on health anxiety: An experimental investigation. *Behaviour Research and Therapy*, 49, 719-728. doi:10.1016/j.brat.2011.07.008
- Olatunji, B. O. & Wolitzky-Taylor, K. B. (2009). Anxiety sensitivity and the anxiety disorders: A meta-analytic review and synthesis. *Psychological Bulletin*, 135, 974-999. doi: 10.1037/a0017428
- Olatunji, B. O., Wolitzky-Taylor, K. B., Elwood, L., Connolly, K., Gonzales, B., & Armstrong, T. (2009). Anxiety sensitivity and health anxiety in a nonclinical sample: Specificity and prospective relations with clinical stress. *Cognitive Therapy and Research*, 33, 416-424. doi: 10.1007/s10608-008-9188-8
- Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences*, 9, 242-249. doi:10.1016/j.tics.2005.03.010
- Owens, K. M., Asmundson, G. J., Hadjistavropoulos, T., & Owens, T. J. (2004). Attentional bias toward illness threat in individuals with elevated health anxiety. *Cognitive Therapy and Research*, 28, 57-66.
- Parker, G., & Lipscombe, P. (1980). The relevance of early parental experiences to adult dependency, hypochondriasis and utilization of primary physicians. *Psychology and Psychotherapy: Theory, Research and Practice*, 53, 355-363. doi:10.1111/j.2044-8341.1980.tb02563.x
- Poli, A., Melli, G., Ghisi, M., Bottesi, G., & Sica, C. (2017). Anxiety sensitivity and obsessive-compulsive symptom dimensions: Further evidence of specific relationships in a clinical

- sample. *Personality and Individual Differences*, 109, 130-136.
doi:10.1016/j.paid.2017.01.002
- Raines, A. M., Short, N. A., Allan, N. P., Oglesby, M. E., & Schmidt, N. B. (2015). Examination of a brief anxiety sensitivity cognitive concerns intervention on suicidality among individuals with obsessive-compulsive symptoms. *Contemporary Clinical Trials*, 45, 191-195. doi:10.1016/j.cct.2015.09.006
- Rapee, R. M., & Medoro, L. (1994). Fear of physical sensations and trait anxiety as mediators of the response to hyperventilation in nonclinical subjects. *Journal of Abnormal Psychology*, 103, 693-699. doi: 10.1037/0021-843X.103.4.693
- Rector, N. A., Szacun-Shimizu, K., & Leybman, M. (2007). Anxiety sensitivity within the anxiety disorders: Disorder-specific sensitivities and depression comorbidity. *Behaviour Research and Therapy*, 45, 1967-1975. doi:10.1016/j.brat.2006.09.017
- Reiss, S., & McNally, R. J. (1985). Expectancy model of fear. In S. Reiss & R. R. Bootzin (Eds.), *Theoretical issues in Behavior Therapy* (pp. 107–121). San Diego, CA: Academic Press.
- Reuman, L., & Abramowitz, J. S. (2015). Illness Anxiety Disorder. In Phillips, K. A. & Stein, D. J. (Eds.), *Handbook on obsessive-compulsive and related disorders* (225-245). Arlington, VA: American Psychiatric Association.
- Rodriguez, B. F., Bruce, S. E., Pagano, M. E., Spencer, M. A., & Keller, M. B. (2004). Factor structure and stability of the Anxiety Sensitivity Index in a longitudinal study of anxiety disorder patients. *Behaviour Research and Therapy*, 42, 79-91. doi:10.1016/S0005-7967(03)00074-3
- Salkovskis, P. M. (1985). Obsessional-compulsive problems: A cognitive-behavioral analysis. *Behaviour Research and Therapy*, 23, 571–584. doi:10.1016/0005-7967(85)90105-6.
- Salkovskis, P. M. (1989). Cognitive-behavioural factors and the persistence of intrusive thoughts in obsessional problems. *Behaviour Research and Therapy*, 27, 677–692.
doi:10.1016/0005-7967(89)90152-6.

- Salkovskis, P. M., Rimes, K. A., Warwick, H. M. C. & Clark, D. M. (2002). The Health Anxiety Inventory: Development and validation of scales for the measurement of health anxiety and hypochondriasis. *Psychological Medicine*, 32, 843–53.
doi:10.1017/S0033291702005822
- Schmidt, N. B., Capron, D. W., Raines, A. M., & Allan, N. P. (2014). Randomized clinical trial evaluating the efficacy of a brief intervention targeting anxiety sensitivity cognitive concerns. *Journal of Consulting and Clinical Psychology*, 82, 1023-1033.
doi:10.1037/a0036651
- Schmidt, N. B., Eggleston, A. M., Woolaway-Bickel, K., Fitzpatrick, K. K., Vasey, M. W., & Richey, J. A. (2007). Anxiety Sensitivity Amelioration Training (ASAT): A longitudinal primary prevention program targeting cognitive vulnerability. *Journal of Anxiety Disorders*, 21, 302-319. doi:10.1016/j.janxdis.2006.06.002
- Schmidt, N. B., Lerew, D. R., & Jackson, R. J. (1997). The role of anxiety sensitivity in the pathogenesis of panic: Prospective evaluation of spontaneous panic attacks during acute stress. *Journal of Abnormal Psychology*, 106, 355-364. doi:10.1037/0021-843X.106.3.355
- Schmidt, N. B., Mitchell, M. A., & Richey, J. A. (2008). Anxiety sensitivity as an incremental predictor of later anxiety symptoms and syndromes. *Comprehensive Psychiatry*, 49, 407-412. doi:10.1016/j.comppsy.2007.12.004
- Schmidt, N. B., Norr, A. M., Allan, N. P., Raines, A. M., & Capron, D. W. (2017). A randomized clinical trial targeting anxiety sensitivity for patients with suicidal ideation. *Journal of Consulting and Clinical Psychology*, 85, 596-610. doi:10.1037/ccp0000195
- Schmidt, N. B., & Trakowski, J. (2004). Interoceptive assessment and exposure in panic disorder: A descriptive study. *Cognitive and Behavioral Practice*, 11(1), 81-92.
doi:10.1016/S1077-7229(04)80010-5

- Schmidt, N. B., Zvolensky, M. J., & Maner, J. K. (2006). Anxiety sensitivity: Prospective prediction of panic attacks and Axis I pathology. *Journal of Psychiatric Research, 40*, 691-699. doi:10.1016/j.jpsychires.2006.07.009
- Schwartz, S. M., Gramling, S. E., & Mancini, T. (1994). The influence of life stress, personality, and learning history on illness behavior. *Journal of Behavior Therapy and Experimental Psychiatry, 25*, 135-142. doi:10.1016/0005-7916(94)90006-X
- Sexton, K. A., Norton, P. J., Walker, J. R., & Norton, G. R. (2003). Hierarchical model of generalized and specific vulnerabilities in anxiety. *Cognitive Behaviour Therapy, 32*, 82-94. doi: 10.1080/16506070302321
- Short, N. A., Allan, N. P., Raines, A. M., & Schmidt, N. B. (2015). The effects of an anxiety sensitivity intervention on insomnia symptoms. *Sleep Medicine, 16*, 152-159. doi:10.1016/j.sleep.2014.11.004
- Short, N. A., Boffa, J. W., Norr, A. M., Albanese, B. J., Allan, N. P., & Schmidt, N. B. (2017). Randomized clinical trial investigating the effects of an anxiety sensitivity intervention on posttraumatic stress symptoms: A replication and extension. *Journal of Traumatic Stress, 30*, 296-303. doi:10.1002/jts.22194
- Steinman, S. A., & Teachman, B. A. (2010). Modifying interpretations among individuals high in anxiety sensitivity. *Journal of Anxiety Disorders, 24*, 71-78. doi:10.1016/j.janxdis.2009.08.008.
- Stewart, S. H., Sherry, S. B., Watt, M. C., Grant, V. V., & Hadjistavropoulos, H. D. (2008). Psychometric evaluation of the Multidimensional Inventory of Hypochondriacal Traits: Factor structure and relationship to anxiety sensitivity. *Journal of Cognitive Psychotherapy, 22*, 97-114. doi:10.1891/0889-8391.22.2.97
- Stewart, S. H., & Watt, M. C. (2000). Illness Attitudes Scale dimensions and their associations with anxiety-related constructs in a nonclinical sample. *Behaviour Research and Therapy, 38*, 83-99. doi:10.1016/S0005-7967(98)00207-1

- Sunderland, M., Newby, J. M., & Andrews, G. (2013). Health anxiety in Australia: Prevalence, comorbidity, disability and service use. *The British Journal of Psychiatry*, 202, 56-61. doi: 10.1192/bjp.bp.111.103960
- Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). *Using multivariate statistics* (Vol. 5). Boston, MA: Pearson.
- Taylor, S., Koch, W. J., & McNally, R. J. (1992). How does anxiety sensitivity vary across the anxiety disorders?. *Journal of Anxiety Disorders*, 6, 249-259. doi:10.1016/0887-6185(92)90037-8
- Taylor, S., Zvolensky, M. J., Cox, B. J., Deacon, B., Heimberg, R. G., Ledley, D. R., ... Cardenas, S. J. (2007). Robust dimensions of anxiety sensitivity: Development and initial validation of the Anxiety Sensitivity Index-3. *Psychological Assessment*, 19, 176–188. doi:10.1037/1040-3590.19.2.176
- Teachman, B. A., Joormann, J., Steinman, S. A., & Gotlib, I. H. (2012). Automaticity in anxiety disorders and major depressive disorder. *Clinical Psychology Review*, 32, 575-603. doi:10.1016/j.cpr.2012.06.004
- Timpano, K. R., Raines, A. M., Shaw, A. M., Keough, M. E., & Schmidt, N. B. (2016). Effects of a brief anxiety sensitivity reduction intervention on obsessive compulsive spectrum symptoms in a young adult sample. *Journal of Psychiatric Research*, 83, 8-15. doi:10.1016/j.jpsychires.2016.07.022
- Tyrer, P., Cooper, S., Crawford, M., Dupont, S., Green, J., Murphy, D., ... & Keeling, M. (2011). Prevalence of health anxiety problems in medical clinics. *Journal of Psychosomatic Research*, 71, 392-394. doi:10.1016/j.jpsychores.2011.07.004
- Warwick, H. M., & Salkovskis, P. M. (1990). Hypochondriasis. *Behaviour Research and Therapy*, 28(2), 105-117.
- Watt, M. C., & Stewart, S. H. (2000). Anxiety sensitivity mediates the relationships between childhood learning experiences and elevated hypochondriacal concerns in young

- adulthood. *Journal of Psychosomatic Research*, 49, 107-118. doi: 10.1016/S0022-3999(00)00097-0
- Weck, F., Neng, J. M., Richtberg, S., & Stangier, U. (2012). The restrictive concept of good health in patients with hypochondriasis. *Journal of Anxiety Disorders*, 26, 792-798. doi:10.1016/j.janxdis.2012.07.001
- Wheaton, M. G., Berman, N. C., & Abramowitz, J. S. (2010). The contribution of experiential avoidance and anxiety sensitivity in the prediction of health anxiety. *Journal of Cognitive Psychotherapy*, 24, 229-239. doi:10.1891/0889-8391.24.3.229
- Wheaton, M. G., Berman, N. C., Franklin, J. C., & Abramowitz, J. S. (2010). Health anxiety: Latent structure and associations with anxiety-related psychological processes in a student sample. *Journal of Psychopathology and Behavioral Assessment*, 32, 565-574. doi:10.1007/s10862-010-9179-4
- Wheaton, M. G., Deacon, B. J., McGrath, P. B., Berman, N. C., & Abramowitz, J. S. (2012). Dimensions of anxiety sensitivity in the anxiety disorders: Evaluation of the ASI-3. *Journal of Anxiety Disorders*, 26, 401-408. doi:10.1016/j.janxdis.2012.01.002
- Wright, K. D., Adams Lebell, M. A. A., & Carleton, R. N. (2016). Intolerance of uncertainty, anxiety sensitivity, health anxiety, and anxiety disorder symptoms in youth. *Journal of Anxiety Disorders*, 41, 35-42. doi:10.1016/j.janxdis.2016.04.011
- Zinbarg, R. E., & Barlow, D. H. (1996). Structure of anxiety and the anxiety disorders: A hierarchical model. *Journal of Abnormal Psychology*, 105, 181-193. doi: 10.1037/0021-843X.105.2.181

Table 1. *Baseline Demographic and Clinical Characteristics*

	Active	Control
Age, <i>Mean (SD)</i>	19.82 (1.61)	19.54 (1.95)
Gender, <i>n (%)</i>		
Female	24 (72.7%)	30 (85.7%)
Male	9 (27.3%)	5 (14.3%)
Race, <i>n (%)</i>		
Caucasian	27 (81.8%)	29 (82.9%)
Asian	3 (9.1%)	4 (11.4%)
Black or African American	1 (3.0%)	2 (5.7%)
Multiracial	2 (6.1%)	0 (0%)
Ethnicity, <i>n (%)</i>		
Non-Hispanic	31 (93.9%)	35 (100%)
Hispanic	2 (6.1%)	0 (0%)
Number of medical conditions, <i>Mean (SD)</i>	0.58 (.71)	0.49 (.78)
Smoking status, <i>n (%)</i>	0 (0%)	1 (3.03%)
Alcohol consumption, <i>Mean (SD)</i>	3.82 (3.13)	3.00 (2.76)
Marijuana use, <i>Mean (SD)</i>	1.61 (4.34)	2.81 (5.90)

Note. There were no significant group differences on any of these variables. Smoking status = current daily cigarette smoker; Alcohol consumption = frequency x quantity composite; Marijuana use = frequency of marijuana use within the past 30 days.

Table 2. *Descriptive Statistics for Outcome Measures*

	Active Condition <i>Mean (SD)</i>	Control Condition <i>Mean (SD)</i>
Baseline AS	42.27 (9.57)	45.13 (7.73)
Post AS	20.29 (14.35)	36.45 (10.55)
1W AS	21.77 (13.52)	35.29 (11.45)
1M AS	21.15 (16.30)	34.54 (13.88)
Baseline SHAI	20.33 (4.69)	21.74 (4.39)
1W SHAI	16.84 (6.49)	18.61 (4.86)
1M SHAI	14.77 (6.95)	17.92 (5.30)
Post SUDS 1	33.21 (18.31)	41.64 (20.43)
Post SUDS 2	51.67 (21.35)	60.97 (19.02)
Post Straw Duration	44.04 (27.35)	45.36 (31.55)
1W SUDS 1	31.71 (21.10)	31.14 (18.89)
1W SUDS 2	46.35 (24.10)	53.90 (23.05)
1W Straw Duration	41.90 (22.77)	44.36 (31.24)
1W BAT Anxiety	10.02 (6.64)	9.57 (5.95)
1W BAT Avoidance	4.23 (3.80)	4.66 (4.26)

Note. There were no significant group differences in baseline levels of AS or SHAI. Post = Post-Intervention, 1W = One-Week Follow-Up, 1M = One-Month Follow-Up; ASI-3 = Anxiety Sensitivity Index-3 (Taylor et al., 2007); SHAI = Short Health Anxiety Index (14-item; Salkovskis et al., 2002); SUDS 1 = subjective anxiety before straw breathing challenge; SUDS 2 = subjective anxiety immediately prior to terminating straw breathing challenge; Duration = straw breathing duration in seconds; BAT Anxiety = composite anxiety score across completed health BAT steps; BAT Avoidance = total number of steps refused across the three health BATs.

Table 3. Zero-Order Correlations Among Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Baseline AS	-	.52**	.54**	.45**	.65**	.49**	.49**	.25*	.35**	-.06	.21	.22	-.11	.18	.08
2. Post AS	-	-	.87**	.78**	.36**	.58**	.49**	.45**	.45**	-.04	.32*	.34**	-.12	.21	.22
3. 1W AS	-	-	-	.86**	.41**	.68**	.63**	.25*	.31*	.02	.32*	.37**	-.08	.14	.20
4. 1M AS	-	-	-	-	.35*	.63**	.75**	.17	.22	.09	.25	.23	-.01	.12	.08
5. Baseline SHAI	-	-	-	-	-	.67**	.60**	.20	.28*	.12	.16	.16	-.09	.25	.14
6. 1W SHAI	-	-	-	-	-	-	.68**	.14	.22	-.02	.28*	.21	-.22	.21	.22
7. 1M SHAI	-	-	-	-	-	-	-	.11	.27	.08	.19	.29*	-.05	.05	.09
8. Post SUDS 1	-	-	-	-	-	-	-	-	.74**	-.14	.60**	.50**	-.25	.10	.29*
9. Post SUDS 2	-	-	-	-	-	-	-	-	-	-.15	.39**	.68**	-.30*	.01	.23
10. Post Straw Duration	-	-	-	-	-	-	-	-	-	-	.00	-.07	.78**	-.06	-.07
11. 1W SUDS 1	-	-	-	-	-	-	-	-	-	-	-	.64**	-.02	.18	.32*
12. 1W SUDS 2	-	-	-	-	-	-	-	-	-	-	-	-	-.11	-.01	.34**
13. 1W Straw Duration	-	-	-	-	-	-	-	-	-	-	-	-	-	-.13	-.11
14. 1W BAT Anxiety	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.11
15. 1W BAT Avoidance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

** $p < .01$, * $p < .05$

Note. Post = Post-Intervention, 1W = One-Week Follow-Up, 1M = One-Month Follow-Up; ASI-3 = Anxiety Sensitivity Index-3 (Taylor et al., 2007); SHAI = Short Health Anxiety Index (14-item; Salkovskis et al., 2002); SUDS 1 = subjective anxiety before straw breathing challenge; SUDS 2 = subjective anxiety immediately prior to terminating straw breathing challenge; Duration = straw breathing duration in seconds; BAT Anxiety = composite anxiety score across completed health BAT steps; BAT Avoidance = total number of steps refused across the three health BATs.

Figure 1. Consort diagram detailing participant flow, assignment, and dropout. All randomized participants were included in primary analyses of self-report outcomes. Individuals who did not complete the behavioral tasks or did not have necessary follow-up self-report data for calculating change scores were excluded from analysis of behavioral data and mediation models, respectively.

Figure 2. Conceptual model for the indirect effect of treatment condition on change in health anxiety from baseline to one-week follow-up through changes in anxiety sensitivity from baseline to post-treatment.

Figure 3. Conceptual model for the indirect effect of treatment condition on change in health anxiety from baseline to one-month follow-up through changes in anxiety sensitivity from baseline to one-week follow-up.

Figure 4. Changes in ASI-3 scores over time in active and control conditions.

Figure 5. Changes in SHAI scores over time in active and control conditions.

Figure 6. Indirect effect of treatment condition on change in health anxiety from baseline to one-week follow-up through changes in anxiety sensitivity from baseline to post-treatment. Unstandardized OLS regression path coefficients are shown. Solid line represents the total effect of treatment condition on change in health anxiety. Dotted line represents the direct effect model with change in anxiety sensitivity included as the mediator.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 7. Indirect effect of treatment condition on change in health anxiety from baseline to one-month follow-up through changes in anxiety sensitivity from baseline to one-week follow-up. Unstandardized OLS regression path coefficients are shown. Solid line represents the total effect of treatment condition on change in health anxiety. Dotted line represents the direct effect model with change in anxiety sensitivity included as the mediator.

* $p < .05$, ** $p < .01$, *** $p < .001$.