Health Anxiety and Attentional Control Interact to
Predict Uncertainty-related Attentional Biases

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Abstract

Background and Objectives: Current theories of health anxiety and a growing body of empirical literature suggest that those high in health anxiety symptoms might find uncertainty itself threatening and demonstrate attentional biases for uncertainty-related information (ABU). Moreover, a dual processes model of attention would suggest that individual differences in attentional control might modify such a relationship. The present study was designed to explore this proposed health anxiety-ABU relationship and also to consider attentional control as a moderator of theoretical and clinical relevance. Methods: Undergraduate participants \((N = 148)\) completed a self-report measure of health anxiety symptoms and two performance-based tasks to assess ABU and attentional control. Results: Hierarchical regression analyses showed a significant interaction between health anxiety and attention control in predicting attentional disengagement from, but not engagement with, uncertainty-related words. Specifically, results of the simple slopes analysis suggested that those with elevated health anxiety symptoms and better attentional control may use top-down attentional control processes to disengage their attention from distressing uncertainty-related stimuli faster than those with worse attentional control.

Limitations: The analogue sample is a study limitation. Conclusions: Results provide new insights into the nature of attentional biases within health anxiety. Results are discussed in light of recent work on attentional control and avoidance-based psychopathology.

Keywords: health anxiety, intolerance of uncertainty, attentional biases, attentional control
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Intolerance of uncertainty (IU), defined as the “dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information” (Carleton, 2016, p. 31), is an important risk factor for a variety of mental health problems, including health anxiety (Carleton, 2016; Hong & Cheung, 2015). IU explains unique information in health anxiety after accounting for other individual difference variables (e.g., negative affect; Fergus et al., 2015). Greater IU predicts more severe health anxiety symptoms in adults (Fergus & Bardeen, 2013) and adolescents (Wright et al., 2016), more severe illness-related worry (Boelen & Carleton, 2012), and potentiates more severe health anxiety symptoms following online searches for medical information (Fergus, 2013) and catastrophic appraisals of ambiguous physical symptoms (Fergus & Valentiner, 2011).

Uncertainty itself may serve as a threat cue (Carleton, 2012; Shihata et al., 2016). In an experimental manipulation of levels of uncertainty, Reuman et al. (2015) asked participants to rate their subjective state anxiety and their desire to perform safety-behaviors after reading vignettes describing either low- or high-threat situations in which the uncertainty of the situation was made either implicit or explicit. Participants reported higher state anxiety and stronger urges to perform safety behaviors in explicitly uncertain situations compared to implicitly uncertain situations; and further, participants rated even low-threat situations as significantly more anxiety provoking when uncertainty was made explicit as compared to when uncertainty was left implicit. In an experimental manipulation with more direct relevance to health anxiety, Rosen and Knäuper (2009) found a significant interaction between trait IU and situational uncertainty, such that high IU and high situational uncertainty regarding the possibility of having a fictitious
infection predicted greater illness-related worry and stronger intentions to seek out additional medical information. Results such as these show that uncertainty itself, even in low-threat situations (e.g., Reuman et al., 2015), elicits anxious responding and promotes safety-seeking behaviors, thus supporting the claim that uncertainty acts as a threat cue for certain individuals, likely including those high in health anxiety.

The relationship between IU and health anxiety may be conceptualized in terms of information processing biases. Several models of health anxiety suggest that attentional biases toward internal and external health-related threat cues are important factors in the development and maintenance of health anxiety (e.g., Abramowitz et al., 2002; Warwick & Salkovskis, 1990; Williams, 2004). However, empirical studies of attentional biases within health anxiety have yielded inconsistent results. In some investigations, elevated health anxiety was associated with faster engagement with health- and illness-related cues (e.g., Jasper & Witthöft, 2011; Lees et al., 2005), while in other investigations, health anxiety was associated with delayed or impaired disengagement from such cues (e.g., Owens et al., 2004; Witthöft et al., 2013, 2016). Inconsistencies such as these are not uncommon within the attentional bias literature (see Armstrong & Olatunji, 2012). Interestingly, within Witthöft et al.’s (2013) fMRI investigation, those high in health anxiety who displayed impaired disengagement from health- and illness-related stimuli were also found to demonstrate hypoactivation of neural structures associated with attentional control. Attentional control has been defined as the effortful and flexible allocation of attention toward goal-relevant stimuli amidst conflicting demands on attention that elicit more automatic, “bottom-up” responses (Sarapas et al., 2017). Results such as those of Witthöft et al. (2013) align with the literature on attentional control processes as potentially important moderators of the attentional bias-anxiety relationship (Corbetta & Shulman, 2002;
Derakshan & Eysenck, 2009; Eysenck et al., 2007). Recently, a growing number of researchers have noted the importance of modeling dual processes (automatic “bottom-up” reactivity and deliberate “top-down” control) when exploring attentional biases across a number of anxious/fearful presentations (e.g., social anxiety disorder [Heeren & McNally, 2016; Taylor et al., 2016], posttraumatic stress disorder [Bardeen, 2020]). Thus, it may be important to consider the role of individual differences in attentional control within information-processing models of health anxiety.

Consistent with a dual-processes conceptualization of health anxiety-related attentional biases, Kim and Lee (2016) found that those high in health anxiety exhibited a bias for attending to health- and illness-related information at early phases of attentional processing, while empirically dissociable patterns of attention allocation were observed at later stages of processing. Specifically, participants high in health anxiety exhibited either continuous attentional maintenance on health-related stimuli or attentional avoidance of these stimuli. Of further interest were Kim and Lee’s results showing that individuals high in health anxiety who shifted their attention away from distressing images reported no significant increase in state anxiety after completing the eye-tracking task, while individuals high in health anxiety who maintained their attention on study stimuli reported a significant increase in state anxiety as a result thereof. Consistent with a dual-processes model of attention, Kim and Lee’s results suggest that individuals high in health anxiety may at first preferentially attend to salient health- or illness-related information due to automatic, bottom-up processing. However, during later stages of attention processing, more deliberate top-down attentional control mechanisms may facilitate attentional disengagement from upsetting visual cues.
To review, health anxiety is characterized by both elevated IU and attentional biases for threat, and the current theoretical and empirical literature would suggest that health anxious individuals might find uncertainty itself threatening and demonstrate biased attention for uncertainty-related cues, that is, an attentional bias for uncertainty (ABU). However, to our knowledge, no investigation has yet examined ABU within the context of health anxiety. Moreover, investigators must take note of past inconsistencies in the attentional bias literature and the growing number of investigations demonstrating that attentional control is an important moderator of the attentional bias-anxiety relationship. Given the prevalence of severe health anxiety (i.e., .40% of the general population and roughly 3% of individuals in medical settings; Weck et al., 2014), its significant personal and societal burden (Sunderland et al., 2013), and its relative intransigence against our best treatment options (olde Hartman et al., 2009), correcting this gap in our understanding should be a high priority. Doing so may illuminate an important maintenance factor underlying health anxiety and lead to new insights for enhancing current treatment options.

In sum, health anxiety may be characterized by biased attention to uncertainty-related cues, and the nature of the relationship between health anxiety and ABU may depend on individual differences in attentional control. The aim of the current study was to remedy past gaps in the literature by examining attentional control as a moderator of a proposed health anxiety-ABU relationship. Drawing on the literature reviewed above, with particular emphasis on the vigilance-avoidance pattern of attention found in Kim and Lee’s (2016) eye-tracking study, we examined the following hypotheses. (1) Health anxiety would predict engagement with uncertainty-related stimuli such that participants with higher (versus lower) health anxiety symptoms would exhibit faster engagement with uncertainty-related stimuli relative to neutral
stimuli. (2) The relationship between health anxiety and disengagement from uncertainty-related stimuli would be moderated by attentional control. We predicted that the magnitude of the association between health anxiety and disengagement from uncertainty would become significantly stronger as attentional control increased. In other words, we predicted that higher health anxiety symptoms, coupled with relatively better attentional control, would predict faster disengagement from uncertainty cues (i.e., avoidance), while higher health anxiety symptoms and worse attentional control would predict slower disengagement from uncertainty cues (i.e., maintenance).

2. Methods and Materials

2.1. Participants

Participants were undergraduate students recruited from a mass testing pool at a mid-sized university in the Southeastern US. Students were eligible to participate if they were between the ages of 18-64, were native English speakers, and had normal or corrected vision. A total of 151 participants met these criteria. Cases that exhibited undue influence on the analytic models ($n = 3$; multivariate outliers defined by a Mahalanobis distance $> \chi^2[7] = 24.32, p < .001$; Ben-Gal, 2005; Rasmussen, 1988) were excluded from primary analyses. The average age of the final sample ($N = 148$) was 19.49 years ($SD = 2.14$), and 121 (81.76%) participants identified as female. In terms of race, 129 (87.16%) of the sample identified as White/European-American, 15 (10.14%) identified as Black/African-American, and four (2.70%) identified as any other race (e.g., Asian, American Indian, “biracial”). Lastly, five participants (3.38%) identified as Hispanic/Latinx. Given the racial and ethnic homogeneity of the current sample, race/ethnicity was re-coded as a dichotomous Majority/Minority variable, yielding 125 participants (84.46%) identifying as majority White non-Hispanic.
2.2. Self-report Measure

**Whiteley Index, 6-item version (WI-6)**

The WI-6 (Welch et al., 2009) is a brief measure of health anxiety. Participants are asked to rate on a scale from 1 (Not at all) to 5 (A great deal) how much six statements apply to them (e.g., “Do you worry a lot about your health?”). Higher scores indicate greater health anxiety. The WI-6 has exhibited adequate psychometric properties in previous research, including evidence of internal consistency (Fergus & Bardeen, 2013; Fergus et al., 2018; Welch et al., 2009), large magnitude convergent relations with other commonly used measures of health anxiety (Fergus, 2013), and a large magnitude correlation with the original 14-item version of the WI (Asmundson et al., 2008). Internal consistency of the WI-6 was adequate in the current sample ($\alpha = .85$)

2.3. Equipment

Participants used a computer keyboard and mouse to complete self-report measures and two performance-based tasks on a Hewlett Packard Z230 desktop computer with a 24-inch BenQ XL2430 monitor. Qualtrics (http://www.qualtrics.com/), an online surveying platform, presented the WI-6 as well as a battery of other self-report measures as part of a larger study. E-prime 2.0 software was used to present performance-task stimuli and record and aggregate response-time data.

2.4. Performance Tasks

2.4.1. Attentional Biases for Uncertainty

The visual search task (VST), informed by the methods of Pineles et al. (2007, 2009) and used by Fergus et al. (2013), was designed to independently assess the engagement and disengagement processes of ABU (Cisler & Koster, 2010). It comprised four blocks of 30 trials
each, with two blocks assessing engagement with uncertainty-related stimuli and two blocks assessing disengagement from uncertainty-related stimuli. Task stimuli included non-word letter strings (e.g., “iqngq”) and three types of English words: uncertainty-related words (e.g., “maybe”), neutral household-related words (e.g., “window”), and uncategorized neutral words (e.g., “rattle”; Fergus et al., 2013). Uncertainty-related words were taken from Dugas et al. (2005), who demonstrated that these words sufficiently convey uncertainty, are neutral in emotional valence, and are easily understood. Using household-related neutral words ensured that any observed effects could not be attributed to a category bias within the uncertainty-related words. Uncertainty-related words and household-related neutral words were matched according to their frequency of use (Frances & Kucera, 1982), number of syllables, and length.

Each trial began with a fixation cross presented in the center of the computer screen for 700ms, after which an array of four stimuli appeared, spaced equally apart and arranged in a 2x2 matrix. Within this array, one target stimulus always differed from three identical distractors. Participants were instructed to locate the target and to indicate whether the “oddball” was an English word by pressing either the “/” key for English words or the “Z” for non-words. Only trials in which participants responded correctly were analyzed. Stimuli remained on the screen until the participant responded. The inter-trial delay varied randomly from 750ms to 1250ms. Trial presentation was randomized within blocks, and a 15-second break separated one block from another, during which participants were instructed to “remain seated and use this time to take a break.” Block order (engagement blocks first vs disengagement blocks first) was randomized across participants. An illustration of the three trial categories within each block and of the sequence of events within trials is presented in Figure 1 (modified from Pineles et al., 2009).
Two ABU indices were calculated from trial response times (per Fergus et al., 2013). Engagement ABU was computed by subtracting response times to uncertainty targets embedded in an array of non-word stimuli from response times to household-related neutral targets in an array of non-word stimuli; higher values indicated faster engagement with uncertainty cues. Disengagement ABU was computed by subtracting response times to non-word targets in an array of household-related neutral distractors from response times to non-word targets in an array of uncertainty distractors; higher values indicated slower disengagement with uncertainty cues.

2.4.2. **Attentional Inhibition**

The attentional cueing task (ACT), designed to assess the inhibition and shifting components of attentional control, was based on a modified version of Posner’s (1980) cuing task (Derakshan & Eysenck, 2009). For each trial, two white frames were displayed on the computer screen, one to the left and one to the right, with a fixation cross presented in the center. At the beginning of the task, participants were told that a blue star would appear in one of the two frames, and they were instructed to “tell us, as QUICKLY and ACCURATELY as possible, where the blue star appears.” Participants pressed either the left or right keyboard arrow as quickly and accurately as possible to indicate which of the two frames the star appeared in. Participants were also informed that on some trials, one of the white rectangles would “light up and turn yellow” and would likely, but imperfectly, predict where the star would appear (i.e., illuminated frame trials). For these trials, the target stimulus was presented in one of the frames after one of the frames was illuminated. These illuminated frames were displayed for either 250ms or 750ms, with each duration representing an equal proportion of such cued trials (i.e., 50% with 250ms cues, 50% with 750ms cues). Variability of the attentional cue’s duration was meant to allow the task to capture both early and later stages of attentional processing,
respectively (e.g., Bradley et al., 2004). Subsequently, two indices of attentional inhibition were produced, one at the earlier cue duration of 250ms and one at the later cue duration of 750ms. The target stimulus remained on the screen until the participant responded. The inter-trial interval varied randomly in duration from 750ms to 1250ms.

Two types of trials were of interest in this study. Congruent trials (56% of all trials) were those during which the illuminated frame correctly predicted the star’s location, and incongruent trials (22%) were those during which the illuminated frame misled participants about the star’s location. The remaining 22% of trials did not include illuminated frames. These trials were not included in study analyses. The task comprised two blocks of 90 trials each with a 20-second break between blocks. Only trials with correct responses were analyzed. Response times across the incongruent trials (at both 250ms and 750ms durations) were averaged to produce two potential moderator variables for entry into hierarchical regressions and for computing interaction terms. Likewise, response times across congruent trials (at 250ms and 750ms) were averaged to produce two covariates in an effort to control for baseline differences in response times and also to avoid the shortcomings of difference scores (Peter et al., 1993). Given that attentional control is the effortful and flexible allocation of attention in the midst of competing demands (Sarapas et al., 2017), participants who were faster at inhibiting a response to an incongruent cue and effortfully redirecting their attention to the goal-relevant target were deemed to have better attentional inhibition. As such, a shorter average response time across incongruent trials indicated relatively better attentional inhibition.

2.5. Procedure

All study procedures were approved by the university Institutional Review Board. Participants completed study procedures at a university research laboratory. Participants
provided informed consent and demographic information and then completed the VST and the ACT. Next, participants completed self-report measures, and were then debriefed and compensated with university course credit.

2.6. Data Analytic Plan

SPSS (Version 26) was used to conduct four hierarchical linear regressions. Predictor variables (i.e., WI-6, ACT-incongruent trials at either 250ms or 750ms) and control variables (i.e., ACT-congruent trials at either 250ms or 750ms, sex, handedness, stimulant use [see below]) were mean-centered and entered simultaneously in the first step of each model (Aiken & West, 1991). An interaction term (i.e., WI-6 by either ACT-incongruent at 250ms or 750ms) was calculated and entered in the second step of each model. Regression models differed in their outcome variable; the first two regressions predicted engagement ABU, and the second two regressions predicted disengagement ABU. Simple slopes analysis was used to probe significant interactions at high (+1 SD) and low (-1 SD) levels of attentional inhibition.

3. Results

3.1. Preliminary Analyses

Demographic and study variables were examined as potential covariates with study outcomes. These included participant sex, age, dichotomized race/ethnicity, stimulant use (e.g., stimulant medication, caffeine, nicotine), handedness, and the starting condition of the VST. Disengagement ABU shared small but significant correlations with participant sex and prescription stimulant use, \( r(146) = -.19, p = .02 \) and \( r(146) = .27, p < .001 \), respectively. Likewise, engagement ABU shared a small but significant relationship with participant handedness, \( r(146) = .18, p = .03 \). As such, sex, handedness, and stimulant use served as covariates in study analyses.
3.2. Engagement with Uncertainty

In the first step of the models with health anxiety and attentional inhibition predicting engagement ABU, the main effects of health anxiety and attentional inhibition were non-significant at either duration of the ACT-incongruent variable (at 250ms: $\beta$s = -0.04 and -0.00 respectively, $R^2 = .02$; at 750ms: $\beta$s = -0.06 and .21 respectively, $R^2 = .07$). In the second step of these models, the health anxiety-attentional inhibition interaction similarly shared no significant relationship with engagement ABU at either ACT duration (at 250ms: $\beta = -.03$, $\Delta R^2 = .001$; at 750ms: $\beta = -.04$, $\Delta R^2 = .001$).

3.3. Disengagement from Uncertainty

In the first step of the models with health anxiety and attentional inhibition predicting disengagement ABU, the main effects of health anxiety were significant at both durations of the ACT-incongruent variable ($\beta$s = -0.18, $p = .02$), while the main effects of attentional inhibition were not significant at either duration (at 250ms: $\beta = -.09$, $p = .50$, $R^2 = .17$; at 750ms: $\beta = -.08$, $p = .48$, $R^2 = .16$). However, in both models, the significant main effect of health anxiety on disengagement ABU was qualified by a significant interaction effect. Specifically, in the second step of these models, the health anxiety-attentional inhibition interaction significantly predicted disengagement ABU at both ACT durations (at 250ms: $\beta = .16$, $p = .03$, $\Delta R^2 = .03$; at 750ms: $\beta = .17$, $p = .03$, $\Delta R^2 = .03$). Simple slopes analysis revealed that the negative relationship between health anxiety and disengagement ABU was significantly stronger at better levels of attentional inhibition (at 250ms: $\beta = -.36$, $p = .002$; at 750ms: $\beta = -.39$, $p < .001$), but was non-significant at worse levels of attentional inhibition (at 250ms: $\beta = .06$, $p = .61$; at 750ms: $\beta = .08$, $p = .51$). The direction of these effects indicated that individuals high in both attentional inhibition and health anxiety showed a stronger tendency to disengage from uncertainty.

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anxiety exhibited faster disengagement from uncertainty cues at both durations of the ACT-incongruent variable.

4. Discussion

In the present study, health anxiety, attentional inhibition, and the interaction between these variables were examined as predictors of ABU. Study hypotheses were partially supported. Neither health anxiety alone nor its interaction with attentional inhibition predicted engagement with uncertainty-related stimuli. However, higher health anxiety predicted faster disengagement from uncertainty stimuli in primary analyses, indicating that those high in health anxiety symptoms may be motivated to quickly shift their attention away from uncertainty-related cues. Importantly, the interaction of health anxiety and attentional inhibition significantly predicted disengagement ABU. Results of the simple slopes analysis suggested that those with elevated health anxiety symptoms and better attentional inhibition may use top-down attentional control processes to disengage their attention from distressing uncertainty-related stimuli faster than those with relatively worse attentional inhibition.

This result is consistent with evidence that those with higher anxiety and better attentional control disengage from threatening stimuli faster than those with relatively worse attentional control (Bardeen & Daniel, 2017; Derryberry & Reed, 2002; Taylor et al., 2016). Using attentional control in this way likely yields immediate, short-term benefits in the form of attenuated emotional distress. As discussed above, Kim and Lee’s (2016) eye-tracking study showed that health-anxious individuals who disengaged from distressing health-related stimuli did not report a significant increase in state anxiety after the eye-tracking task, while health-anxious individuals who maintained their attention on such stimuli reported a significant increase in anxiety thereafter. Succinctly, as demonstrated in the current study and in other investigations,
Attentional control can be used as an emotion regulation strategy with short-term, negatively reinforcing effects. However, using attentional control to avoid or escape distressing stimuli may prevent the extinction of heightened fear responses and the correction of erroneous expectations about threat. That is, better attentional control may not be a ubiquitous advantage. In fact, some evidence suggests exerting top-down influence over attention in this manner distinguishes beneficial from deleterious long-term outcomes (e.g., Bardeen et al., 2020).

Although attentional biases to threat have received much interest in the past two decades (e.g., Armstrong & Olatunji, 2012; Bar-Haim et al., 2007), the extension of attentional biases for uncertainty is relatively novel. As such, drawing definitive clinical implications from this investigation may be premature. However, implications of study results within the broader context of threat-related attentional biases are worth considering. Researchers have developed treatment protocols that target attentional biases by training attention (implicitly) away from threat toward non-threat stimuli (i.e., threat avoidance; Hakamata et al., 2010; Heeren et al., 2015). These interventions do not consistently alter threat-related attentional biases or reduce anxiety and related symptoms (Badura-Brack et al., 2015; Cristea et al., 2015), and a recent meta-analysis showed that attention bias modification has only a small effect on reducing anxiety symptom severity (Mogoașe et al., 2014). Results from the present study, as well as previous research on threat-related attentional biases in the context of anxiety and related disorders (e.g., Bardeen & Daniel, 2017; Bardeen et al., 2020; Derryberry & Reed, 2002), suggest that it is important to account for individual differences in attentional control to understand patterns of threat processing among those with fear- and anxiety-related pathology. Results of the present study suggest that it is inadvisable to develop a one-size-fits-all attention bias modification program to train attention away from uncertainty cues among those with higher health anxiety,
because those with higher health anxiety and higher attentional control already engage in rigid avoidance of uncertainty stimuli, which may very well increase the likelihood of symptom maintenance. These individuals may be better served by interventions that promote flexibility of attentional control (e.g., the attention training component of Emotion Regulation Therapy: Renna et al., 2018; the Attention Training Technique: Wells, 1990; see Fergus & Bardeen, 2016, for a review). It may also be beneficial to develop automated attention training programs that shape more adaptive responses to uncertainty among those with health anxiety based on the pattern of responding to uncertainty that the individual typically engages in. For example, encouraging avoidant clients to approach and engage with uncertainty-related stimuli may help to extinguish physiological arousal and emotional distress associated with such stimuli.

The results of the current study represent a novel extension of the literature on health anxiety and attentional biases to threat. Though Fergus et al. (2013) provided the first known exploration of ABU, their investigation fell short of examining ABU in relation to any clinical outcome. Thus, a key strength of the current investigation is its status as the first known examination of ABU vis-à-vis a clinically relevant presentation. Furthermore, by referencing a dual-processes model of attention, this study aimed to clarify some of the mixed results from previous investigations of attentional biases within health anxiety (e.g., Jasper & Witthöft, 2011; Kim & Lee, 2016; Lees et al., 2005; Owens et al., 2004; Witthöft et al., 2013, 2016). In doing so, the current study replicated a growing body of literature on the important influence of attentional control on anxiety-related attentional biases. Another strength of the current study is its use of a performance-based measure of key attentional control processes (i.e., inhibition, shifting). Although many investigations of attentional control have relied on self-report measures (e.g., the Attentional Control Scale; Derryberry & Reed, 2002), these measures have been criticized in
recent years. Such critiques include poor replications of their factor structures and less than optimal model fit (e.g., Clauss & Bardeen, 2020; Judah et al., 2014) and inconsistent convergence with performance-based measures of attentional control (e.g., Quigley et al., 2017). A performance-based measure of attentional inhibition was used in the current study to overcome these shortcomings.

This study is not without limitations. First, a convenience sample of undergraduate students was used in the present study. Replication of current results within clinical and more diverse samples is warranted to ensure that results generalize. Second, in a review of commonly used attentional bias tasks, Clarke et al. (2013) point out that visual search tasks are not optimally designed to parse apart engagement-based attentional biases from disengagement-based attentional biases. Although the VST used in the current study was selected based on precedent in the literature (Fergus et al., 2013; Pineles et al., 2007, 2009), future researchers should consider alternative tasks that are better able to distinguish attentional engagement and disengagement. Third, considerable research now suggests that the relationship between anxiety and attentional biases for threat is bidirectional and mutually reinforcing, rather than a straightforward example of cause and effect (Van Bockstaele et al., 2014). As such, repeated measurements of health anxiety and ABU within samples followed longitudinally are needed to better understand potential reciprocal relations. Lastly, current theories of IU and health anxiety would suggest that individuals high in health anxiety find uncertainty cues themselves threatening (Carleton, 2012; Reuman et al., 2015; Rosen & Knäuper, 2009). However, this study did not include an assessment of whether participants found the uncertainty stimuli of the VST threatening. Future investigations of ABU may include a measure of participants’ reaction to
uncertainty cues (e.g., assessment of valence and arousal) in order to support the threat value of uncertainty-related stimuli among high health anxiety individuals.

Avenues for future research are plentiful. As stated above, this is the first and only known investigation of ABU in the context of a clinical construct. However, IU is recognized as a transdiagnostic individual difference factor across anxiety and related disorders (Shihata et al., 2016), and threat-related attentional biases are similarly present across anxiety- and fear-related psychopathology (Bar-Haim et al., 2007; Van Bockstaele et al., 2014). An obvious extension of this novel line of research is to explore the relationship between ABU and other anxious presentations (e.g., generalized anxiety, social anxiety). All such presentations are characterized, in part, by a dispositional aversion to uncertainty (Carleton et al., 2012; Mahoney & McEvoy, 2012). Future investigations into ABU as a mechanism through which IU relates to anxiety may help to shed light on a plausible but as yet under-studied attentional bias within the anxiety disorders broadly.

Avenues also exist for extending the current line of investigation within health anxiety specifically. The spectrum of health anxiety concerns is characterized by two core features: disease phobia (the fear of having or acquiring serious illness and of the negative implications of disease) and disease conviction (the belief that one has a serious illness, which persists in spite of disconfirming information; Sirri & Fava, 2014). These core features often manifest in different behavioral strategies for ameliorating distress. Specifically, disease phobia is more likely to manifest in avoidance of internal and external illness-related stimuli, whereas disease conviction is more likely to occasion reassurance-seeking, active searches for information on medical conditions, and requests for medical examinations and lab procedures. Though avoidance and approach behaviors in health anxiety may serve similar functions (to reduce emotional distress),
they likely require different interventions (Sirri & Fava, 2014). It is unclear how ABU might relate to these differing behavioral patterns. One might suspect individuals with greater disease phobia to demonstrate an attentional bias away from uncertainty characterized by facilitated disengagement and avoidance of uncertainty-related cues (as found in the current investigation), while individuals with greater disease conviction might exhibit a pattern of attention characterized by faster engagement with uncertainty stimuli. Thus, future research on attentional biases within health anxiety may benefit from a more nuanced assessment of health anxiety than was used in the current study.
References


related attentional bias among those with posttraumatic stress symptomatology and predict symptom maintenance up to one year later. *Behaviour Research and Therapy, 133*, 103709.


### Figure 1. Trials and Within-Trial Sequences of the Visual Search Task. Trials (a) and (b) assessed engagement ABU, while trials (d) and (e) assessed disengagement ABU. Trials (c) and (f) were meant to encourage active participation but were not included in analyses.