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Intolerance of uncertainty and information-seeking behavior: Experimental manipulation of threat relevance☆

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ABSTRACT

Prospective intolerance of uncertainty (IU) involves fear and anxiety in *anticipation* of future uncertainty and is especially related to worry and generalized anxiety disorder (GAD). Individuals high in IU appraise uncertain situations as threatening and thus may engage in excessive information-seeking behavior to decrease uncertainty. This study aimed to examine the links between prospective IU and information-seeking. Participants ($N = 174$) high and low in prospective IU completed an ostensible aptitude test (threat stimulus), which was supposedly either excellent (high relevance condition) or poor (low relevance condition) at predicting future outcomes. Thus, the test itself presented an immediate threat, and the awaited test results generated uncertainty. Following the relevance manipulation, participants were given the opportunity to engage in information-seeking behavior by asking questions about the ostensible test and by requesting feedback about the test results. Results indicated that in the high-relevance condition, individuals high and low in IU evidenced similar levels of information-seeking behavior. Conversely, in the low-relevance condition, individuals low in IU evidenced less information-seeking than did individuals high in IU. Furthermore, cognitive appraisals of ambiguous situations were associated with the extent of information-seeking behavior. The implications of these findings for the treatment of GAD are discussed.

Most people dislike uncertain situations, and some individuals find uncertainty intolerable. Individuals reporting high intolerance of uncertainty (IU) respond more negatively to uncertain situations on emotional, behavioral, and cognitive measures (Buhr & Dugas, 2002; Dugas et al., 2004). For example, individuals high (versus low) in IU evidence higher levels of fear (Morriss et al., 2016), are more risk-aversive (Luhmann et al., 2011), and appraise ambiguous situations as more concerning (Koerner & Dugas, 2008). Higher IU is also a risk factor for several psychiatric disorders, including generalized anxiety disorder (GAD; Gentes & Ruscio, 2011), obsessive-compulsive disorder (OCD; Steketee et al., 1998), social anxiety disorder (Boelen & Reijntjes, 2009), depression (de Jong-Meyer et al., 2009), panic disorder, and agoraphobia (McEvoy & Mahoney, 2011). Understanding IU is more critical now than ever, as levels of IU have increased over recent years (Carleton et al., 2019). Although IU is a transdiagnostic risk factor, prospective IU involving fear and anxiety in *anticipation* of future uncertainty (as opposed to inhibitory IU associated with inhibition of action in response to uncertainty) is especially related to worry and GAD (Koerner et al., 2017; Shihata et al., 2017).

How to define IU has been a topic of theoretical interest in the past three decades (see Carleton et al., 2012 and Freeston et al., 2020 for reviews on how the IU definition has changed over the years). Several definitions of IU have been offered, with some emphasizing the *behavioral* disposition to react negatively to perceived uncertainty (e.g., Carleton, 2016). Still, most definitions indicate negative or inflexible beliefs about uncertainty and its implications as one of the fundamental factors of IU (e.g., Berenbaum et al., 2008; Freeston et al., 1994; Sexton & Dugas, 2009). Thus, when faced with uncertain or ambiguous situations,

individuals high in IU appraise such situations as threatening (Dugas et al., 2005). This is important for the study of IU as both general personality/emotion theories (Cervone, 2004; Lazarus, 1991) and cognitive theories of anxiety (Beck & Clark, 1997) suggest that appraisals, rather than beliefs/schemas, are more proximal causes of emotions and behavior (action tendencies). Consequently, IU should activate negative appraisals of uncertainty, which in turn would lead to anxiety, worry, and avoidance behavior. Research findings confirmed this by demonstrating that appraisals of ambiguous situations mediate the relationship between IU (beliefs about uncertainty) and worry (Koerner & Dugas, 2008).

Worry has been theorized to have various functions (Borkovec & Sharpless, 2004; Newman & Llera, 2011). One aspect of worry involves estimating the likelihood that the uncertain situation will result in future adverse outcomes (Szabó, 2009). If a person appraises the likely consequences of a (uncertain) situation as benign or irrelevant to oneself, anxiety and worry should no longer be present (Koerner & Dugas, 2008). To change one's own initially negative appraisals, the individual needs to engage in information seeking to obtain evidence incongruent with such appraisals. Woody and Rachman (1994) proposed that individuals with GAD, in particular, are in constant search for safety signals in the form of reassuring information. Research confirms that such individuals do seek more reassurance from others (Beesdo-Baum et al., 2012; Cougle et al., 2012; Singh et al., 2020). Furthermore, IU is predictive of *in vivo* checking behavior related to OCD (Sarawgi et al., 2013). In an experimental study, participants assigned to experience both high perceived IU (manipulated through false feedback) and high situational uncertainty (manipulated through a vignette about a fictitious STI) sought more information about the fictitious health risk than those with low perceived IU and/or low situational uncertainty (Rosen & Knäuper, 2009).

Notably, receiving information (safety signal) about an uncertain situation either does not reduce anxiety or results in only short-term relief due to the individuals' bias towards perceiving and interpreting threats in the environment (Butler & Mathews, 1983; 1987). For example, in one study, participants were told that they were about to watch emotionally upsetting film clips (Ranney et al., 2019). Those high (versus low) in prospective IU reported higher distress and worries in anticipation of watching the films regardless of whether they received detailed information or no information about the film clips. One potential explanation is that individuals high in IU may need more evidence to assess a given (uncertain) situation. For example, in one study, participants experiencing high levels of worry (theorized and found to result from high IU) demonstrated slower response times than did low worriers in a letter search task when the search target was absent (but not when the search target was present; Tallis, Eysenck, & Mathews, 1991). The authors interpreted this as indicative of a higher degree of evidence required to complete the task.

Besides needing more evidence, individuals high in trait anxiety often have difficulty accurately appraising the relevance of stimuli in their environment. Eysenck's (1992) hypervigilance theory postulates that anxious individuals attend to non-threatening task-irrelevant stimuli more than non-anxious individuals because of general hypervigilance. Mogg and Bradley (1998) build on this theory, positing that individuals high in trait anxiety demonstrate a lower threshold for threat appraisal. Thus, both anxious and non-anxious individuals may similarly appraise highly relevant, threatening stimuli, but only anxious individuals may appraise relatively innocuous, irrelevant stimuli as threatening. Consequently, a combination of a low threshold for appraising a situation as threatening (even when the situation is irrelevant) and a higher need for evidence may contribute to increased information-seeking in individuals high in trait anxiety, worry, and/or IU (Kahlor, 2007).

Such an increased need for evidence and the resulting excessive information-seeking behavior suggests that high IU individuals develop and maintain high levels of anxiety because of deficits in learning that a

given situation is safe – an idea proposed by the generalized unsafety theory of stress (GUTS; Brosschot et al., 2016). Much research supports this theory. For example, a meta-analysis showed that, in fear conditioning paradigms, patients who struggle with anxiety (relative to healthy controls) take longer to unlearn responding with fear to conditioned fear stimuli during the extinction phase (Duits et al., 2015). Similarly, individuals higher in IU demonstrate more difficulty learning safety from safety cues (Morriss et al., 2019; Morriss & van Reekum, 2019; Woody & Rachman, 1994). For example, in one conditioning study, neutral and mildly aversive auditory tones were paired with visual symbols half of the time to increase uncertainty (Morriss et al., 2019). During the extinction learning phase, unlike low IU participants, those high in IU continued to demonstrate heightened physiological arousal in response to the symbol previously paired with the aversive (versus neutral) tone. This finding suggests that extinction learning is disrupted in individuals high in IU. Consequently, high IU individuals remain in this default stress response, continuing to interpret uncertain situations as threatening.

In sum, high IU individuals appraise uncertain/ambiguous situations as threatening and thus experience worry and anxiety and engage in excessive information-seeking behavior in such situations. However, receiving information about the uncertain situation does not reduce stress and anxiety among these individuals. Given the role of information-seeking in maintaining anxiety (Woody & Rachman, 1994), this study aimed to further explore and elucidate the links between prospective IU and information-seeking behavior in response to a threat presented with and without a safety cue.

We also examined another behavior that is associated with IU but distinct from information-seeking. Assessing a different behavior could help determine whether our manipulations (described in the next section) would exert a unique influence on information-seeking or broadly affect other IU-related behaviors. We chose risk-taking as a comparison to information seeking, as individuals high in IU (e.g., Carleton et al., 2016; Luhmann et al., 2011) or high in anxiety (Giorgetta et al., 2012) are more risk-aversive relative to controls. Although high and low IU participants may differ in many behaviors, risk-taking (much like information-seeking) also occurs in a context of uncertainty whenever an individual does not know the probability of a given outcome. In this study, we administered the Balloon Analog Risk Task (Lejuez et al., 2002), which assesses people's propensity to take a risk when an outcome of the risky choice is unknown. Lastly, given that IU is conceptualized as a negative cognitive bias about uncertainty and that appraisals of ambiguous situations are more robustly related to IU than to worry, anxiety, or depression (Dugas et al., 2005), we examined whether a tendency to appraise ambiguous situations negatively is predictive of heightened information seeking.

1. Experimental manipulations of uncertainty and future-oriented nature of worry

Studies investigating IU have employed various methods to manipulate uncertainty and to measure distress. The nature of these experimental manipulations may substantially affect the external validity of research investigating IU and information-seeking behavior, and the personal relevance of these laboratory tasks may impact the results. The use of experimental stimuli that accurately represent participants' concerns, worries, and daily stressors is crucial to elucidating the nature of IU and its impact on psychological wellbeing. However, several studies exploring IU and response to threats depicting uncertainty use threatening stimuli that are less likely to be encountered in daily life (e. g., electric shocks; Nelson & Shankman, 2011; Chen et al., 2018). Other manipulations involve scenarios with relatively low base rates (e.g., losing or winning money in gambling [Ladouceur et al., 2000], contracting a sexually transmitted disease [Rosen & Knäuper, 2009]). Findings from such studies may fail to uncover critical IU-related processes if experimental tasks are not aligned with participants' day-to-day

worries.

In the study of IU, it is important to consider that worry as a strong correlate of IU is distinctly concerned with the future (Behar et al., 2005; Watkins et al., 2005) and particularly distal rather than immediate future. For example, a student concerned about failing a class may worry about later (exaggerated) consequences including the inability to find a job, not having financial means to support him/herself, and/or becoming homeless. In one study (Bredemeier et al., 2012), participants were asked to estimate the likelihood that 40 negative outcomes would occur within the next month, next year, or next 10 years. For the more distal (next year or 10 years) as opposed to the most proximal (next month) timeframe, events rated as highly likely were also rated as having high cost/consequences. That is, the interactive effect of likelihood and cost estimates was strongest for the more distal rather than proximal outcomes.

Oglesby and colleagues (2017) used a threatening stimulus in the form of an impromptu speech task. Given that high IU individuals evidence higher levels of social anxiety than their low IU colleagues (Boelen & Reijntjes, 2009), the speech task appears to be more ecologically valid. Participants were told either that (a) they would give a speech on a controversial topic (certain threat) or that (b) a coin toss would decide whether they would give a speech (uncertain threat). Participants were also informed that the speech would be video-recorded and reviewed by an independent judge. Contrary to predictions, participants higher in IU reported higher anticipatory state anxiety regardless of uncertainty about the speech. These findings suggest that those higher in IU demonstrate higher anxiety in response to all potential threats regardless of uncertainty level. However, it is crucial to note that the manipulation of uncertainty was related to an immediate threat rather than distal outcomes associated with the threat. Rather than worrying about the act of speaking itself, participants might have worried more about the later consequences of giving the speech (the broader personal implications of participants' poor speech-giving skills). These consequences would remain uncertain regardless of condition. Moreover, the investigators did not examine information-seeking behavior.

To optimally examine the nature of IU, worry, and information-seeking behavior, experimental manipulations should pertain to outcomes in the distant future. Yet, existing studies have typically examined IU and worry regarding threats in the immediate future (e.g., electric shock, upsetting video clips, speech giving tasks). Additionally, excessive information-seeking behavior may maintain or exacerbate stress and anxiety (Woody & Rachman, 1994). Understanding how *future* implications of a threat affect fear and information-seeking behavior in individuals high and low in prospective IU can contribute to understanding critical processes underlying IU-related disorders (e.g., GAD, OCD) and may guide treatment of these disorders.

2. Overview of the current study

The current study aimed to fill several gaps in the literature by using a novel paradigm to examine the interactive effects of trait IU and situational uncertainty on emotional states and information-seeking behavior. We sought to improve upon past research by creating situational uncertainty that would be both (1) relevant to participants' daily worries (ecologically valid) and (2) aligned with the *distant* future-oriented nature of worry. Considering that academic performance is one of the most common worries among university students (Dugas et al., 1995), we recruited a sample of undergraduate students and informed them, as part of a cover story, that they would complete a test of intellectual and emotional functioning (cf. de Bruin et al., 2006). The ostensible test itself was intended to pose an immediate threat whereas the *future implications* of the test results were intended to generate uncertainty and worry.

Participants were told that the test was either excellent (high relevance condition) or very poor (low relevance condition) at predicting future accomplishments and interpersonal outcomes. That is, instead of

manipulating uncertainty *per se*, we manipulated information about the relevance of the test results and their implications for participants' futures. The experimental condition informing participants that the test had poor predictive validity (low relevance) was intended to provide a safety signal that would lower the cost estimate of the test outcome making it less relevant. Following the manipulation, we measured information-seeking behavior by (1) asking questions about the ostensible test and (2) requesting feedback about the test results.

We expected that individuals low in trait prospective IU would seek more information if informed that the test was highly predictive of future outcomes (high relevance condition) as opposed to having poor predictive validity (low relevance). In contrast, we expected that participants high in trait prospective IU would seek equivalent amounts of information regardless of the test's supposed relevance. That is, consistent with the GUTS framework (Brosschot et al., 2016), we expected that those high in trait prospective IU would disregard the safety signal provided by the low relevance condition and evidence similar levels of information-seeking behavior across the conditions. This hypothesis is also consistent with Mogg and Bradley's (1998) position that individuals high in trait anxiety demonstrate a bias in appraising irrelevant, innocuous stimuli as more threatening. Because even non-anxious individuals could seek post-test feedback due to their general interest in the test results (cf. Dickson et al., 2017; Dickson & MacLeod, 2004), we assessed participants' motivation (interest and anxiety) to seek such feedback to account for these motivational factors. Moreover, we examined whether any interactive effect of the trait prospective IU and relevance condition would be unique to information-seeking behavior and thus not related to risk-taking behavior. Informing participants that the test is poor or excellent at predicting future outcomes should affect their information-seeking but not risk-taking. Lastly, because IU is conceptualized as a negative cognitive bias about uncertainty (Koerner & Dugas, 2008), we predicted that participants' cognitive appraisals of ambiguous situations (measured using the Ambiguous/Unambiguous Situations Diary; Davey et al., 1992) would be predictive of information-seeking behavior.

3. Method

3.1. Participants

Introductory Psychology students enrolled in a course credit research participation pool completed the Intolerance of Uncertainty Scale (IUS; Carleton et al., 2007), among other surveys, at the beginning of the semester. The mean on the IUS's prospective anxiety subscale was 18.68 ($SD = 6.29$), which is comparable to the mean obtained on an undergraduate sample ($M = 17.51$, $SD = 5.68$) and a community sample ($M = 18.54$, $SD = 6.50$) in another study (Carleton et al., 2012). Potential participants who scored at least one SD below (≤ 12; low trait IU) or above (≥ 25; high trait IU) the mean were eligible to participate. We recruited 205 participants for the investigation. Of these, 19 (9.3%) individuals who initially met the criteria for inclusion based on their IUS prospective anxiety subscale score no longer met these criteria on the day of the laboratory visit and were not included in the study. Another 12 (6.5%) participants who did not pass the manipulation check (see below) were excluded from the analyses. Thus, analyses were based on 174 participants (123 female, 51 male; $M_{age} = 19.1$, $SD = 2.07$) with low ($n = 84$; IUS ≤ 18; $M = 13.43$, $SD = 2.64$) or high ($n = 90$; IUS ≥ 19; $M = 26.00$, $SD = 4.40$) trait prospective IU scores. As a reference, the mean prospective IU score of our high IU group was similar to that of a clinical sample diagnosed with GAD ($M = 24.60$, $SD = 6.84$; Carleton et al., 2012). The sample was 26% ($n = 45$) White, 5% ($n = 9$) Black, 28% ($n = 48$) Asian, and 35% ($n = 61$) Latino/a; the remaining 6% ($n = 11$) chose to self-describe their race/ethnicity in an open-ended format.

3.2. Measures

All measures and tasks were programmed using MediaLab software (Jarvis, 2004) except for the Balloon Analog Risk Task, which was programmed using *E-Prime 2.0* software (Psychology Software Tools Inc, Pittsburgh, PA).

Intolerance of Uncertainty Scale-12 (IUS-12). The IUS-12 is a 12-item measure composed of two subscales that assess prospective anxiety (prospective IU) and inhibitory anxiety (inhibitory IU; Carleton et al., 2007). The prospective IU subscale contains seven items assessing fear and anxiety in anticipation of uncertainty, and it is uniquely associated with GAD and OCD. The IUS-12 has good retest reliability (Khawaja & Yu, 2010) and adequate convergent and discriminant validity (Carleton et al., 2007; McEvoy & Mahoney, 2011). The internal consistency of this subscale in the current sample was excellent ($\alpha = 0.92$), and its retest reliability (from the screening to the experimental session) was high ($r = 0.83$).

Penn State Worry Questionnaire (PSWQ). The PSWQ is a 16-item self-report measure designed to assess the frequency and intensity of worry (Meyer et al., 1990). Correlations between the PSWQ and measures of anxiety, depression, and emotional control support the PSWQ's convergent and discriminant validity (Brown et al., 1992). The PSWQ was administered to ensure that trait levels of worry were equivalent across randomly assigned conditions. The PSWQ variable would also be used as a covariate to examine the effects of IU on information seeking beyond any influence of trait worry. The internal consistency of the PSWQ in the current sample was excellent ($\alpha = 0.95$).

Beck Depression Inventory-II (BDI-II). The BDI-II is a 21-item self-report measure that assesses symptoms of depression over the past two weeks (Beck et al., 1996). All items are scored on a 4-point Likert scale with higher scores indicating more severe levels of depression. The BDI-II offers cutoff scores for minimal (0–13), mild (14–19), moderate (20–28), and severe (29–63) levels of depression. The convergent and discriminant validity of the BDI-II are good (Arnarson et al., 2008). Given the links between IU and depression (de Jong-Meyer et al., 2009), the BDI-II was administered to ensure that depression symptomatology was equivalent across randomly assigned conditions. Given that IU is associated with depression (Gentes & Ruscio, 2011), the BDI-II variable would also be used as a covariate to examine the effects of IU on information seeking beyond any influence of depression symptomatology. The internal consistency of the BDI-II in the current sample was excellent ($\alpha = 0.93$).

Positive and Negative Affect Schedule - Expanded Form (PANAS-X). Emotions were assessed with selected subscales from the PANAS-X, which has good convergent and discriminant validity (Watson & Clark, 1994). Participants reported, using a 5-point Likert scale (from 1 = *Not at all* to 5 = *Extremely*), the extent to which each of 20 adjectives described emotions they experienced "at this moment." Each adjective referred to one of four PANAS-X subscales: fear, hostility (anger), sadness, or serenity. The order of the adjectives was randomized.

Information-Seeking Task. Participants were told that they would be completing the Intellectual and Emotional Functioning Test (see Procedure, below). They then could seek information in two different ways. First, they were asked to write any questions they had about the (ostensible) test on a provided form and told that the principal investigator would answer all questions upon arrival. The number of questions written during this time served as one measure of information-seeking behavior. To provide each participant with time for writing questions, the experimenter left the room for exactly 5 min under the pretense of having to "prepare a few things." Second, they indicated (1) whether and how much "feedback about [their] performance" (*0–30 min*) they wanted to receive after completing the ostensible test and (2) whether they would like (*Yes/No*) the final test score to be presented on the screen; these outcomes served as additional measures of information-seeking behavior. Participants were informed that even if they requested the full, 30-min feedback, the experimental session would end 15

min before the end of the scheduled 2-h session; this ensured that participants' choices were not influenced by a potential scheduling conflict.

Additionally, to explore participants' reasons for the amount of post-test feedback they sought, they indicated their interest in and anxiety about receiving feedback about their test results (i.e., "When considering how much feedback you wanted about your performance …" (1) "… how *interested* were you in finding out your results?" and (2) "… how *anxious/concerned* were you about finding out your results?"). Participants rated these two items on a 5-point scale (1 = *Not at all* to 5 = *Extremely*).

Balloon Analog Risk Task (BART). The BART is a computer-based behavioral task designed to measure risk-taking (Lejuez et al., 2002). We implemented the task to explore any differences between risk-taking and information-seeking behavior, as only the latter behavior is uniquely associated with intolerance of uncertainty. The task begins with participants viewing a deflated onscreen balloon and two options: "Pump the balloon" and "Stop and collect points." The number of pumps for the current balloon and the total points accrued throughout the task are also displayed. In each trial, participants pump up the onscreen balloon, with each pump inflating the balloon by $1°$ in each direction and earning the participant 10 points. At any time, the participant can click the "Stop and collect points" option, which moves the accrued points for the balloon out of play, banking them for the end of the task. If the participant inflates the balloon to the point that it pops, all points gained for that balloon are lost. After accrued points are banked or the balloon pops, the trial ends, and the next trial begins. Participants are asked to inflate 20 balloons of varying maximum size (average = 64 pumps, maximum = 128 pumps). Participants are provided with no detailed information on when the balloons will pop, thus creating conditions of uncertainty. Participants' goal is to accrue as many points as possible. The dependent variable of interest is the mean number of pumps from non-popped balloons, with a higher number indicating greater risk-taking tendencies. The BART has good convergent validity (Lejuez et al., 2002), and acceptable retest reliability in those aged 18–35 ($r = 0.77$; White et al., 2008).

Ambiguous/Unambiguous Situations Diary (AUSD). The AUSD was used as a measure of participants' cognitive appraisals of ambiguous situations. The task has a journal entry format and consists of 28 fictitious diary entries (Davey et al., 1992). Participants are instructed to read every description as if it were an entry in their own diary and state their degree of concern for each item on a 5-point scale (from 1 = *Not at All Concerned* to 5 = *Extremely Concerned*). Higher scores indicate the tendency to appraise given situations as concerning (Rassin & Muris, 2005). Fourteen entries are worded ambiguously and include examples such as "While on my way out tonight, I was stopped in the street" and "I got my first paycheck from my Saturday job today. When I got home, I was surprised to see how much was in it." The remaining entries are worded unambiguously and include seven positive and seven negative items. Given our focus on the appraisal of ambiguous situations and to reduce participant burden, we used only six unambiguous scenarios as filler items (3 positive [e.g., "I went to Amanda's party last night. It was fun!"] and 3 negative [e.g., "I have been feeling ill all day. If I still feel like this tomorrow, I will have to go to the doctor"]). These six unambiguous entries were not used in analyses. Internal consistency of the participants' responses to the ambiguous entries was good ($\alpha = 0.87$).

Memory Test. As part of another research study, a two-part incidental memory test was administered precisely as described in the paper by Dugas et al. (2005). During the first part, 15 neutral (e.g., Above) and 15 uncertainty-related (e.g., Maybe) words were randomly presented on the screen one at a time for 10 s (see Dugas et al., 2005 for the list of all 30 words). After viewing each word, participants rated how familiar they were "with the meaning of the word just presented" using a 5-point Likert scale (from 1 = *Not at all* to 5 = *Extremely*). During the second part of the task, participants had 5 min to write in an open-ended format as many of the words as they remembered.

3.3. Procedure

Upon arrival at the laboratory, participants were randomly assigned to a low or high relevance condition and completed the informed consent procedure. A computer and other materials (e.g., an intelligence test) were placed on the desk to help create the illusion of a standardized task intended to measure intellectual and emotional ability. Participants were told that "we are investigating what improves or weakens the validity of a test" and that they would "complete the Intellectual and Emotional Functioning Test (IEFT)" (in actuality, the name of the test was made up for this study to help convey the cover story, and participants did not complete such a test). The experimenter also announced that according to research, the IEFT was "very poor" (low relevance condition) or "excellent" (high relevance condition) at "predicting people's future accomplishments [… and] future interpersonal outcomes." The experimenter further noted that the "purpose of our study is to examine what aspects of the [IEFT] make it so [weak/great] at predicting future outcomes."

Participants then engaged in the first part of the Information Seeking Task (see above for details) for 5 min. After the 5 min elapsed, the experimenter returned, thanked the participant for waiting, and collected the form on which participants could write their questions. The experimenter then started the computer program and left the participant alone while waiting in an adjacent room. Using the computer program, participants completed the second part of the Information Seeking Task by indicating how many minutes' worth of feedback they wanted and whether they wanted to be informed of their final test score. Subsequently, participants completed the BART, which was presented as the "Economic Decision Making Test" consistent with the cover story. They also completed the AUSD, which assessed their cognitive appraisal styles, and then answered questions about their reasons for the amount of feedback requested. Additionally, participants completed the memory task.[1] Lastly, they completed the PANAS-X, IUS-12, PSWQ, BDI-II, and provided demographic information. The manipulation of the relevance of the ostensible test would not be successful if participants misheard the information provided by the experimenter. Thus, a manipulation check involved participants indicating, using dichotomous response options, whether they believed "the IEFT is EXCELLENT …" or "POOR at predicting future outcomes." Each response option corresponded precisely to the information provided to participants in one of the experimental conditions. At the end of each session, the experimenter debriefed each participant explaining the actual purpose of the study. All participants received credit for their participation.

4. Results

Participants' self-reported trait worry (PSWQ), depression (BDI), and state emotions (anger, fear, sadness, serenity) are reported in Table 1[2] Separate IU Group × Relevance Condition analyses of variance (ANOVAs) revealed that, compared to participants with low prospective IU, individuals with high prospective IU reported higher levels of trait worry, $F(1, 170) = 194.18$, $p < .001$, $\eta_p^2 = 0.53$, and elevated symptoms of depression, $F(1, 170) = 73.46$, $p < .001$, $\eta_p^2 = 0.30$. No other main effects or interactions were significant (all $ps > .22$).

4.1. Emotional states

Two-way 2 (IU Group: high trait IU, low trait IU) × 2 (Relevance

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Table 1

Means (SDs) of self-reported trait worry, depression, and state emotions.

Condition: Group:	Low Relevance		High Relevance	
	Low IU	High IU	Low IU	High IU
Trait Symptoms				
PSWQ	36.88 (9.73)	58.19 (12.60)	36.20 (7.63)	60.63 (12.31)
BDI	5.38 (5.28)	14.02 (10.29)	5.82 (7.34)	17.09 (10.23)
Post-Manipulation Emotional States				
Anger	1.10 (0.43)	1.20 (0.53)	1.06 (0.14)	1.27 (0.42)
Fear	1.15 (0.23)	1.56 (0.77)	1.26 (0.43)	1.81 (0.73)
Sadness	1.16 (0.31)	1.78 (0.99)	1.20 (0.38)	1.85 (0.80)
Serenity	3.68 (0.88)	3.26 (1.18)	3.60 (1.10)	2.74 (1.15)
Emotions Related to Post-Test Feedback Requested				
Interest	2.83 (1.24)	3.30 (1.08)	3.18 (1.04)	3.70 (1.08)
Anxiety	1.80 (0.85)	2.64 (1.22)	2.52 (1.13)	3.23 (1.36)

Note. BDI = Beck Depression Inventory; IU = Intolerance of Uncertainty, prospective anxiety subscale; PSWQ = Penn State Worry Questionnaire.

Condition: high relevance, low relevance) between-subjects ANOVAs indicated significant main effects of IU Group on each of the four post-manipulation emotional states. Specifically, compared to controls, the high trait IU group reported elevated state anger, $F(1, 170) = 7.82$, $p = .006$, $\eta_p^2 = 0.04$, fear, $F(1, 170) = 32.99$, $p < .001$, $\eta_p^2 = 0.16$, and sadness, $F(1, 170) = 45.41$, $p < .001$, $\eta_p^2 = 0.21$, as well as decreased serenity, $F(1, 170) = 15.14$, $p < .001$, $\eta_p^2 = 0.08$. Results also indicated that participants in the high relevance condition reported higher levels of fear than did those in the low relevance condition, $F(1, 170) = 4.73$, $p = .031$, $\eta_p^2 = 0.03$. Thus informing participants that the ostensible test had high (as opposed to poor) predictive validity impacted participants' fear levels suggesting the relevance manipulation was successful. This main effect was not qualified by a significant IU Group × Relevance Condition interaction, $F(1, 170) = 0.76$, $p = .384$, $\eta_p^2 = 0.00$. No other main effects or interactions were significant (all $ps > .070$).

4.2. Information seeking behavior

Number of Questions Asked. Most participants (86.8%) did not write any questions. The remaining 23 participants wrote one ($n = 9$ [5.2%]), two ($n = 7$ [4.0%]), three ($n = 5$ [2.9%]), or four ($n = 2$ [1.1%]) questions about the test. The questions were reviewed to ensure they pertained the ostensible test or the test results. The low IU participants wrote an average of 0.21 per person, and the high IU individuals had an average of 0.31 per person. Furthermore, participants in the low relevance condition wrote an average of 0.25 per person, and those in the high relevance condition an average of 0.28 per person. A one-sample Kolmogorov-Smirnov test indicated that these data followed a zero-inflated Poisson distribution, $Z = 1.32$, $p = .061$. The Poisson regression analyses examined the number of questions asked based on three predictors: IU Group, Relevance Condition, and IU Group × Relevance Condition interaction. The full model was a significant improvement in fit over the null model, likelihood ratio (LR) $\chi^2(3) = 8.19$, $p = .042$. The two-way interaction was significant, $b = -1.66$, $SE = 0.69$, $Wald\ \chi^2 = 5.75$, odds ratio (OR) = 0.19, 95% CI [0.05, 0.74], $p = .016$. To explore whether this effect could be explained better by the presence of depression and/or trait worry rather than IU specifically, we performed a post hoc analysis adding the BDI-II and PSWQ as covariates. Results remained significant even with self-reported trait worry and symptoms of depression included in the model as covariates, $b = -1.75$, $SE = 0.69$, $Wald\ \chi^2 = 6.38$, odds ratio (OR) = 0.17, 95% CI [0.05, 0.68], $p = .012$. As evident in Fig. 1 and revealed by follow-up analyses, when informed that the ostensible test had low predictive validity (low relevance condition), high IU individuals were almost four times as likely to ask questions than were their low IU counterparts, $b = 1.34$, $SE = 0.55$, $Wald\ \chi^2 = 5.90$, OR = 3.83, 95% CI [1.30, 11.32], $p = .015$. In contrast, when told that the ostensible test had high predictive validity (high relevance condition), both IU groups asked a similar number of questions, $b =$
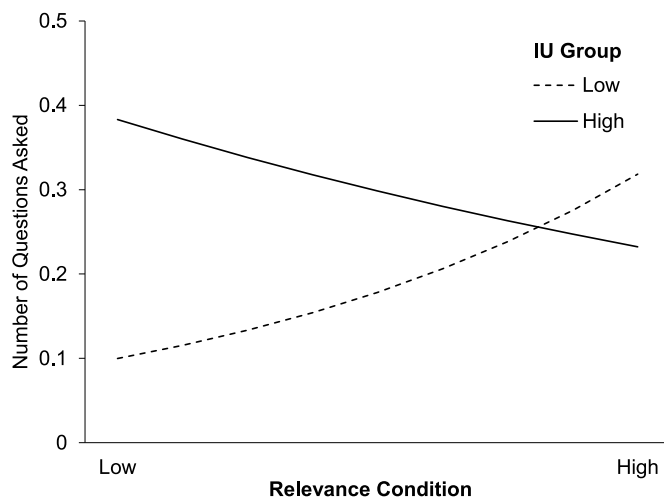
Fig. 1. Poisson log-linear regression lines representing the significant interaction between intolerance of uncertainty (IU) group and relevance condition on the number of questions asked.

-0.31, $SE = 0.41$, *Wald* $\chi^2 = 0.57$, OR $= 0.73$, 95% CI [0.33, 1.65], $p = .449$. In other words, low IU individuals engaged in information-seeking behavior when it was relevant but not when the situation did not warrant it. High IU individuals did not differentiate these contextual differences across the conditions.

Amount of Feedback Requested. Most participants (85.7%) requested either 0 (25.9%), 10 (19.0%), 15 (21.3%), or 30 (19.5%) minutes of post-test in-person feedback. Additionally, only 10 (5.7%) participants did not request their overall test score to be presented on the screen at the end of the session. Because both of these variables indexed the same construct (a request for post-test feedback), we *z*-transformed both variables and computed the mean for each participant. The resulting z scores represent the overall amount of feedback requested.

We first examined the interactive effects of IU group membership and threat relevance without accounting for participants' overall interest in test results. A two-way ANOVA examining the amount of feedback requested revealed that the high IU group ($M = 0.12$, $SD = 0.61$) requested more feedback than did the low IU group ($M = -0.12$, $SD = 0.92$), $F(1, 170) = 5.19$, $p = .024$, $\eta_p^2 = 0.03$. Similarly, those in the high relevance condition ($M = 0.11$, $SD = 0.67$) requested more feedback than did those in the low relevance condition ($M = -0.11$, $SD = 0.87$), $F(1, 170) = 4.30$, $p = .040$, $\eta_p^2 = 0.03$. The two-way interaction was not significant, $F(1, 170) = 1.24$, $p = .266$, $\eta_p^2 = 0.01$.

Exploratory Analysis. Table 1 (bottom) presents levels of interest in and anxiety about receiving post-test feedback across the groups. Two-way ANOVAs indicated that, compared to people low in IU, those high in IU reported more interest in, $F(1, 170) = 8.61$, $p = .004$, $\eta_p^2 = 0.05$, and anxiety about $F(1, 170) = 19.21$, $p < .001$, $\eta_p^2 = 0.10$, receiving feedback. Similarly, participants in the high (versus low) relevance condition had elevated scores on both variables: interest in feedback, $F(1, 170) = 5.04$, $p = .026$, $\eta_p^2 = 0.03$, and anxiety about feedback, $F(1, 170) = 13.90$, $p < .001$, $\eta_p^2 = 0.08$. None of the interactions were significant, all $ps > .71$.

The correlation between anxiety about and interest in feedback was moderate, $r(172) = 0.31$, $p < .001$, suggesting the two constructs are distinct but still significantly related. Thus, accounting for interest would also account for anxiety (cf. Miller & Chapman, 2001). Consequently, instead of controlling for interest as initially planned, we

created a variable representing relative levels of interest and anxiety by subtracting anxiety scores from interest scores.[3] These difference scores were then used to create two subgroups: In one subgroup ($n = 98$ of whom 48.0% were high IU individuals and 43.9% were in the high relevance condition), interest levels were higher than anxiety levels, whereas in the other subgroup ($n = 76$ of whom 56.6% were high IU individuals and 57.9% were in the high relevance condition), anxiety levels were as high or higher than interest levels. A chi-square analyses showed that the two subgroups were similarly likely to include participants with high vs low IU scores, $\chi(N = 174) = 1.27$, $p = .259$, or those in high vs low relevance condition, $\chi(N = 174) = 3.36$, $p = .067$.

As shown in Fig. 2, a three-way ANOVA examining the extent of post-test feedback requested revealed a significant three-way IU Group $\times$ Relevance Condition $\times$ Interest-Anxiety interaction, $F(1, 166) = 4.59$, $p = .034$, $\eta_p^2 = 0.03$. This three-way interaction remained significant even after controlling for self-reported trait worry and symptoms of depression, $F(1, 164) = 4.64$, $p = .033$, $\eta_p^2 = 0.03$. Follow-up analyses showed that, in the subgroup reporting stronger reliance on interest rather than anxiety in seeking post-test feedback, the amount of feedback requested did not differ as a function of the IU Group, $F(1, 94) = 0.06$, $p = .812$, $\eta_p^2 < 0.01$, the relevance condition, $F(1, 94) = 0.65$, $p = .422$, $\eta_p^2 = 0.01$, or the interaction between the two variables, $F(1, 94) < 0.01$, $p = .981$, $\eta_p^2 < 0.01$ (Fig. 2, left). However, among participants who were predominantly driven by anxiety rather than interest when seeking feedback, the results revealed a significant main effect of the IU Group, $F(1, 72) = 16.41$, $p < .001$, $\eta_p^2 = 0.19$, the relevance condition, $F(1, 72) = 11.82$, $p = .001$, $\eta_p^2 = 0.14$, and a significant two-way interaction, $F(1, 72) = 6.16$, $p = .015$, $\eta_p^2 = 0.08$ (Fig. 2, right); this interaction remained significant when controlling for self-reported trait worry and symptoms of depression, $F(1, 70) = 7.37$, $p = .008$, $\eta_p^2 = 0.10$. Analogous to the number of questions asked before the test, the amount of feedback requested differed as a function of the IU group in the low relevance condition but not in the high relevance condition. Specifically, the low IU participants requested less feedback than their high IU counterparts did when told that the test had poor predictive validity, $t(30) = -3.43$, $p = .002$, $d = -1.23$, 95% CI [-1.95, -0.49]. In contrast, when told that the test had an excellent predictive validity, the two IU groups requested a similar amount of feedback, $t(41) = -1.56$, $p = .125$, $d = -0.47$, 95% CI [-0.67, 0.09].

4.3. Risk-taking behavior

Our findings indicate that the interaction between IU group membership and the threat relevance to future outcomes is predictive of information-seeking behavior. However, a question remains whether these findings are unique to information-seeking behavior as opposed to other behaviors, such as general risk-taking behavior. To this end, we examined the effects of IU group membership and relevance condition on risky decision-making (i.e., the number of pumps on the Balloon Analogue Risk Task [BART]). The overall number of pumps was similar to that reported in prior studies (e.g., Lejuez et al., 2003). Compared to participants with low trait IU ($M = 42.12$, $SD = 15.86$), individuals with high trait IU ($M = 36.22$, $SD = 12.97$) were more risk-averse as evidenced by fewer pumps on the BART, $F(1, 170) = 6.95$, $p = .009$, $\eta_p^2 = 0.04$. Results did not indicate a main effect of relevance condition (low relevance: $M = 38.15$, $SD = 13.64$; high relevance: $M = 40.03$, $SD = 15.73$), $F(1, 170) = 0.54$, $p = .465$, $\eta_p^2 = 0.003$, nor an IU Group $\times$ Relevance Condition interaction, $F(1, 170) = 0.37$, $p = .547$, $\eta_p^2 = 0.002$. When including the interest-anxiety variable in the analysis, the three-way interaction was not significant, $F(1, 165) = 0.72$, $p = .397$, η_p^2

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[3] A two-way ANOVA showed that the these difference scores were not related to the IU Group, $F(1, 170) = 1.70$, $p = .193$, $\eta_p^2 < 0.01$, or the Relevance Condition, $F(1, 170) = 1.71$, $p = .193$, $\eta_p^2 < 0.01$. The two-way interaction was also non-significant, $F(1, 170) = 0.16$, $p = .689$, $\eta_p^2 < 0.01$.
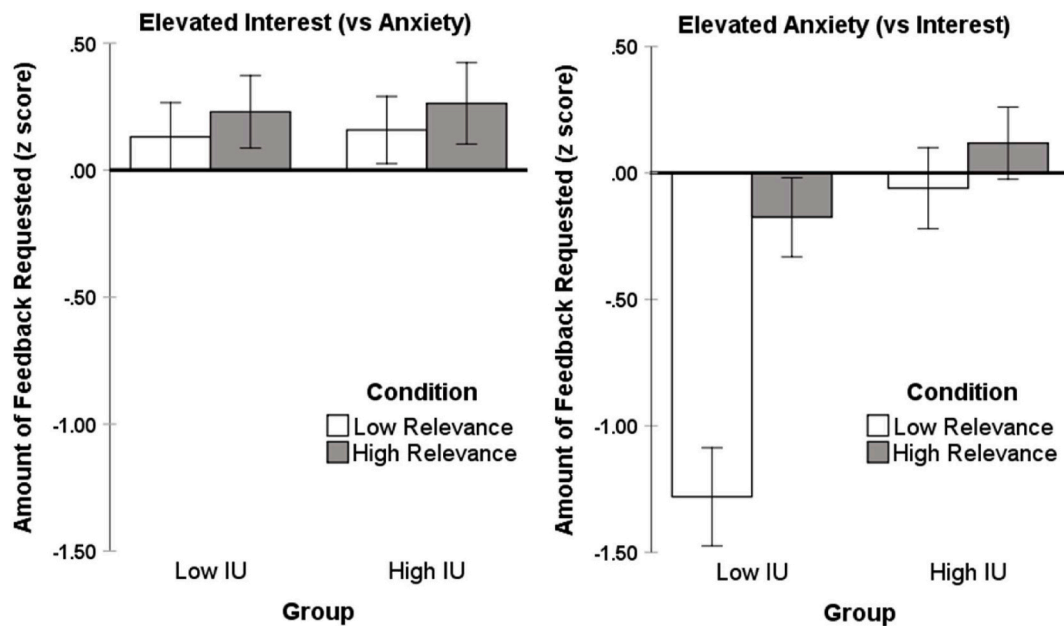
Fig. 2. Amount of feedback requested as a function of the intolerance of uncertainty (IU) group, the relevance condition membership, and relative reliance on interest versus anxiety in seeking feedback.
Notes: Each error bar represents one standard error of the mean.

$= 0.004$. Thus, any interactive effects were evident in regards to only the information-seeking behavior but not the general risk-taking behavior.

4.4. Cognitive appraisals

We also examined group differences in cognitive appraisals of ambiguous situations. A two-way ANOVA showed that individuals with high IU scores rated ambiguous situations as more concerning ($M = 2.97$, $SD = 0.64$) than did the low IU participants ($M = 2.36$, $SD = 0.54$), $F(1, 170) = 47.32$, $p < .001$, $\eta_p^2 = 0.22$. Neither the main effect of the relevance condition (low relevance: $M = 2.69$, $SD = 0.68$ vs. high relevance: $M = 2.67$, $SD = 0.66$) nor the interaction was significant, $ps > .579$.

Given that appraising ambiguous situations as threatening is associated with IU, we examined the relationship between these appraisals and the two measures of information-seeking behavior (number of questions asked about the test, extent of post-test feedback requested). Because the variable representing the number of questions asked had a zero-inflated distribution, we regressed this outcome variable on a single predictor, appraisals of ambiguous situations, using Poisson regression. The full model was a significant improvement in fit over the null model, likelihood ratio (LR) $\chi^2(1) = 6.73$, $p = .009$. Results indicated that the more concerning the ambiguous situations were for participants, the more questions they asked before the test, $b = 0.55$, $SE = 0.21$, $Wald \chi^2 = 6.94$, odds ratio (OR) $= 1.74$, 95% CI [1.15, 2.62], $p = .008$.

The correlation between appraisals and the extent of post-test feedback requested was not significant, $r(172) = 0.11$, $p = .166$. We again expected that accounting for the relative interest in the test results would clarify this relationship. Thus, we examined the moderating effects of the interest-anxiety variable on the association between appraisals of ambiguity and the requested amount of feedback. The overall model was significant, $R^2 = 0.11$, $F(3, 170) = 7.33$, $p < .001$, as was the interaction, $b = -0.36$, 95% CI [−0.71, −0.02], $t = -2.10$, $p = .037$. As depicted in Fig. 3, for participants who requested feedback largely because of their anxiety (rather than interest), greater propensity to appraise ambiguity as threatening was associated with a greater amount of feedback requested, $b = 0.36$, 95% CI [0.10, 0.62], $t = 2.78$, $p = .006$. However, for participants who reported that interest motivated them more than anxiety did in seeking feedback, appraisals of ambiguity were
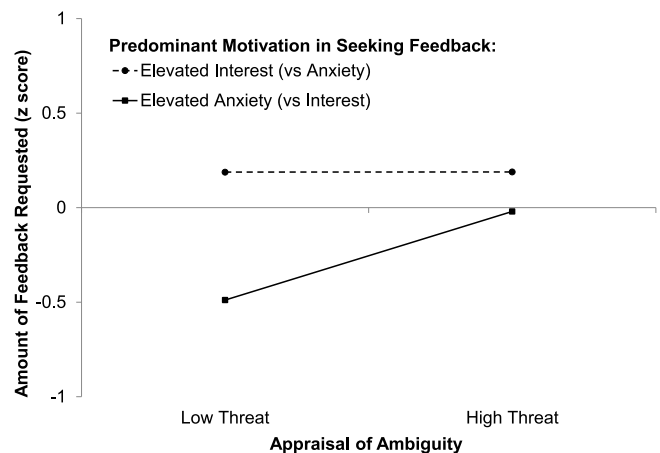

Fig. 3. Simple slopes between the amount of feedback requested and appraisals of ambiguous situations for elevated levels of interest (vs anxiety) or anxious (vs interest).

not associated with the amount of feedback requested, $b < 0.01$, 95% CI [−0.22, 0.22], $t = 0.01$, $p = .995$.

5. Discussion

This study investigated the interactive effects of prospective IU and threat relevance on two types of information-seeking behavior: the number of questions asked and the amount of post-test feedback requested. Although only a minority of participants asked any questions, manipulating how relevant the threatening stimulus (i.e., the test of intellectual and emotional functioning) was to participants' future affected the two IU groups differently in terms of the number of questions they asked. In the high relevance condition, the groups did not differ in information seeking; that is, if informed that the test was excellent (rather than poor) at predicting future outcomes, both groups asked a relatively high number of questions. In contrast, in the low relevance condition, individuals low in prospective IU asked

significantly fewer questions than did those high in prospective IU. Thus, when the situation was highly relevant, the high and low IU groups were indistinguishable from each other on this type of information-seeking behavior. Seeking information in highly relevant situations (e.g., career choice, health problems) is expected and even desired regardless of IU status. However, in situations of low relevance, the two IU groups differed in their behavior: Low IU individuals reduced their information-seeking, but their high IU counterparts did not modify this behavior to fit the context. High IU individuals engaged in excessive information seeking despite being informed that the situation (i.e., the test) had no bearing on their future. This is consistent with the perspective that some individuals respond to uncertainty with distress even when no threat is present or possible (Freeston et al., 2020).

With regard to the other type of information-seeking behavior: requests for post-test feedback, the interaction of prospective IU and threat relevance was not significant. One possibility is that requesting post-test feedback was likely driven not only by IU-related *anxiety* but also by a general *interest* in the results. People are generally eager to take online intelligence tests to learn their IQ scores. Consequently, we found that accounting for the relative levels of interest versus anxiety in seeking post-test feedback helped to explicate the combined effect of the IU group membership and threat relevance. Specifically, among participants who were motivated more by their anxiety rather than interest when seeking post-test feedback, the interaction of the IU group and threat relevance was indeed significant. In the high relevance condition, the two IU groups sought a similar amount of feedback, but in the low relevance condition, individuals low in prospective IU again sought less feedback than did their high IU counterparts.

Participants were generally quite interested in the test results, and thus even some low IU participants requested extensive post-test feedback, possibly due to their high levels of interest. Consequently, among individuals reporting greater interest in (than anxiety about) the feedback, the interactive effects of prospective IU and the threat relevance on the post-test feedback-seeking behavior did not emerge. That is, when highly interested in the test results, all groups sought similar levels of post-test feedback. This highlights the importance of assessing motivational processes when examining the links between psychopathology and behavior (e.g., Dickson et al., 2017). For example, undesirable behavior such as procrastination may be motivated by high anxiety about an activity or a low interest in the activity. Similarly, positive behavior may result from the approach- or avoidance-related motivation; a person may exercise to increase stamina or to avoid health problems (cf. Dickson & MacLeod, 2004). One question that may arise is to what extent participants could distinguish between their anxiety about and interest in the test results because stimuli that cause anxiety will also draw one's attention and potentially arouse interest. Correspondingly, these two variables were positively correlated, but the correlation was of medium strength ($r = .31$), indicating that these constructs were also relatively distinct in our sample.

In this study, we examined both information-seeking behavior and general risk-taking behavior. This allowed us to establish that the interactive effects of the IU group and the relevance manipulation were unique to the information-seeking behavior rather than being indiscriminate or ubiquitous. Indeed, risky decision-making (indexed by the BART) did not differ as a function of the relevance condition. Consequently, our finding that low prospective IU individuals sought different amounts of information depending on the test relevance manipulation cannot be attributed to differences in general risk-taking behavior. This further supports the idea that low IU individuals not only consider safety information but also selectively apply it to a pertinent situation (in this case, the test or its results as opposed to the risk-taking task).

The IU group membership was associated with different levels of all self-reported emotions. On the other hand, the relevance manipulation influenced fear levels but left other emotions unaffected. Being informed that the test participants were about to take was highly predictive (versus not predictive) of future outcomes increased fear in both IU

groups. Besides our direct manipulation check, these findings show that our manipulation successfully changed the relevance of the threat (i.e., the test) on an emotional level. Consequently, both IU groups evidenced elevated information-seeking behavior in the high relevance condition. However, although all participants reported lower fear levels in the low (versus high) relevance condition, the high IU group sought a similar amount of information regardless of the condition. One reason for this may be that, across the conditions, high IU participants reported higher negative emotions and lower serenity compared to low IU individuals.

We hypothesized that appraising ambiguity as threatening would be associated with the inclination to reduce the ambiguity through information-seeking behavior. Indeed, such cognitive appraisals were predictive of the number of questions asked about the test and, among participants motivated more by anxiety than interest, associated with the length of the post-test feedback requested. These findings are of clinical significance, suggesting that modifying cognitive appraisals may reduce excessive information-seeking behavior. Cognitive restructuring helps patients challenge negative appraisals of ambiguous situations and effectively reduces anxiety in individuals with GAD (e.g., Barlow et al., 1992). Research demonstrated that it also reduces checking behavior (a form of information-seeking) in a non-clinical sample (Ludvik & Boschen, 2015) and in individuals with OCD (Radomsky et al., 2020). Cognitive restructuring targeting IU specifically may question the accuracy and helpfulness of statements such as "I cannot cope with uncertainty" and "I need to have all of the information to avoid a catastrophic outcome." Considering that those high in IU engage in excessive information-seeking behavior in high-uncertainty but low-relevance situations, it may be optimal to focus cognitive restructuring on the relevance of situations. It may be helpful to have a therapy client consider the actual consequences of a given situation in a distant future (e.g., "what will it matter in 5 years?") and to question the usefulness of information seeking.

One novel treatment for GAD focuses entirely on behavioral experiments that challenge IU beliefs such as "uncertainty ruins everything" (Hebert & Dugas, 2019, p. 427). Hebert and Dugas (2019) provide several examples of behavioral experiments targeting IU beliefs; only one example targets information-seeking directly, in which a patient compares the outcome of three days of typical reassurance-seeking behavior with the outcome of three days not seeking reassurance. In this treatment, information-seeking is conceptualized as one of many "safety behaviors," which are described as "behavioral manifestations" of IU beliefs; these safety behaviors are not viewed as a primary mechanism in maintaining IU beliefs and anxiety, but rather viewed as a consequence of IU-related beliefs. This novel treatment has not been tested in any published randomized controlled trials, but preliminary data are promising with regard to GAD symptom reduction. Future randomized controlled trials may investigate this treatment's efficacy in reducing information-seeking, specifically in individuals with GAD. A dismantling study could also investigate whether a briefer treatment targeting only information-seeking beliefs and behaviors may be as efficacious as a full protocol of IU treatment (Hebert & Dugas, 2019) for patients high in information-seeking.

5.1. The novel approach to studying the relationship between IU and information-seeking

Our study advanced beyond prior research examining information-seeking behavior among high and low IU individuals in several essential ways. First, we employed a threatening stimulus relevant to students' daily concerns: assessment of intellectual aptitude (Dugas et al., 1995). Previous research primarily relied on stimuli such as electric shocks or losing money in a gamble that are rarely encountered by an average undergraduate student (e.g., Ladouceur et al., 2000; Nelson & Shankman, 2011). Although at least one previous study implemented an ecologically valid stressor: a speech task (Oglesby & Schmidt, 2017), it did not examine information-seeking.

The second innovation in our study involved the emphasis on the uncertainty as related to outcomes in the distant future – a crucial aspect given the future-oriented nature of worry (Bredemeier et al., 2012). Specifically, we held the probability of the immediate threat, the aptitude test, constant across the groups while using a manipulation that strictly concerned future outcomes, the ostensible predictive power of the test. This feature allows us to draw stronger conclusions about the effects of future-related uncertainty irrespective of the immediate threat. By contrast, prior studies employed experimental stimuli (as described in the preceding paragraph) involving immediate threat rather than threat-related future outcomes, a key feature of prospective IU (Koerner et al., 2017; Shihata et al., 2017).

Lastly, previous research manipulated uncertainty by varying the probability of a given negative event, whereas our novel approach was to manipulate the information about the relevance of the uncertain situation. Providing participants with such qualitatively different information allowed us to test the premises of the GUTS framework (Brosschot et al., 2016). The framework proposes that individuals high in IU evidence deficits in learning that a situation poses no actual or relevant threat. Accordingly, although these individuals engage in excessive information-seeking behavior to reduce uncertainty (Kahlor, 2007; Woody & Rachman, 1994), previous research showed that providing information about safety did not reduce their anxiety (e.g., Ranney et al., 2019). Our findings are also consistent with the GUTS account but present a caveat. High IU individuals explicitly confirm their knowledge (in a manipulation check) that a given situation is of low relevance, but their continued information-seeking behavior implies they disregard this information.

5.2. Limitations and future directions

The current study is not without limitations. First, even though the behavioral measures of information-seeking developed specifically for this study yielded the expected results, only 14% of participants wrote any questions about the test, and thus the results rely on a relatively small subset of participants. Although the mere opportunity to seek information might have lowered anxiety for some participants resulting in reduced information seeking, a substantial relief should come from obtaining information. We believe modifying these behavioral measures could improve their sensitivity. For example, allowing participants to ask questions orally rather than by writing them could increase the response rate. Moreover, few participants chose not to have the final test score displayed on the screen. Informing participants about a short waiting period before the score is generated could deter some (more tolerant of uncertainty) participants from requesting the score. Future studies should also assess information-seeking tendencies using natural observations of, for example, online searching or reassurance-seeking from friends and family (e.g., through analysis of text messages or social media interactions).

Second, to assess people's motivation for seeking feedback, we developed single-item tools assessing whether participants' sought information due to their interest in and/or anxiety about the test results. Although these single-item measures led to meaningful and expected moderating effects, future research should employ researcher-administered and/or multi-item measures to replicate these results and further differentiate these motivational constructs.

Third, we assessed general appraisals of ambiguity, and these appraisals were associated with information-seeking behaviors. However, it would be helpful to assess participants' appraisals of the experimental stimuli (e.g., the aptitude test, the importance of future outcomes) as such experiment-specific appraisals should be even more predictive of information seeking. Similarly, although our manipulation check confirmed that participants considered the test poor or excellent at predicting outcomes, future studies should also measure the extent to which participants experienced uncertainty due to this manipulation and how much such perceived uncertainty disturbed them emotionally.

Lastly, although the study's strengths included the use of behavioral measures, it also relied on self-report instruments, which have their drawbacks (e.g., Bartoszek & Cervone, 2020; Mauss & Robinson, 2009). It is noteworthy that the levels of negative emotions were relatively low compared to serenity, which was the highest-rated emotion. This may indicate that, although the manipulation did not activate intense negative emotional states, even small variations in negative emotions resulted in behavioral changes. Future research should aim to better understand the effects of this novel paradigm by incorporating other measures of cognitive, emotional, and behavioral constructs.

5.3. Conclusion

The current study supports the idea, in line with the GUTS framework, that individuals high in prospective IU (relative to individuals low in prospective IU) demonstrate a deficit in their ability to discern between relevant and irrelevant uncertain situations. Individuals high in prospective IU sought information about the test to reduce uncertainty regardless of whether the test was relevant to their future outcomes. Furthermore, we found that appraising ambiguity as more threatening was associated with greater information-seeking. Future studies should investigate how cognitive and behavioral therapies could target appraisals of ambiguous situations to reduce information-seeking in individuals high in IU. Novel treatments that incorporate interventions focused on discerning between relevant and irrelevant uncertain situations may also effectively reduce information-seeking in individuals high in IU or those diagnosed with GAD.

CRediT authorship contribution statement

Gregory Bartoszek: Conceptualization, Methodology, Software, Investigation, Validation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Project administration. **Rachel M. Ranney:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Irena Curanovic:** Formal analysis, Writing – original draft, Writing – review & editing. **Stephen J. Costello:** Formal analysis, Writing – original draft, Writing – review & editing. **Evelyn Behar:** Conceptualization, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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