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# Intolerance of Uncertainty Is Associated With Increased Threat Appraisal and Negative Affect Under Ambiguity but Not Uncertainty

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**Intolerance of Uncertainty (IU) has gained increasing interest as a vulnerability factor for worry in Generalized Anxiety Disorder and other emotional disorders. We extended the procedure of Grupe and Nitschke (2011) to compare threat processing in High IU ($n$ = 29) and Low IU ($n$ = 26) participants. Participants viewed four cues: two reference cues that preceded aversive pictures on 100% or 0% of trials, and a target cue that preceded aversive pictures on 50% of trials (Uncertain condition). Participants were instructed about these probabilities in advance. In addition, we surprised participants with a second target cue that also preceded aversive pictures on 50% of trials but that had not been mentioned in the instructions (Ambiguous condition). Results provided preliminary evidence that High IU participants showed greater online threat expectancy, postexperimental covariation estimates and negative mood for the target cues compared to the reference cues. The results also suggest that among high IU individuals, ambiguity, rather than uncertainty per se, may be a particularly powerful trigger for biased threat appraisal and negative affect. Clinically, the results suggest that patients with high IU may benefit from interventions to help them calibrate the degree of risk in situations involving ambiguous threat.**

*Keywords:* intolerance of uncertainty; ambiguity; threat appraisal; expectancy; covariation bias

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INTOLERANCE OF UNCERTAINTY (IU; Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994) has attracted significant interest as a vulnerability factor for the etiology of excessive worry and generalized anxiety disorder (Dugas, Gagnon, Ladouceur, & Freeston, 1998; Dugas & Robichaud, 2007). Emerging research has also underscored the association between IU and other anxiety disorders, such as social phobia (Boelen & Reijntjes, 2008), obsessive-compulsive disorder (Tolin, Abramowitz, Brigidi, & Foa, 2003), and posttraumatic stress disorder (Fetzner, Horswill, Boelen, & Carleton, 2013), as well as depression (McEvoy & Mahoney, 2011). IU has been broadly defined as "a cognitive bias that affects how a person perceives, interprets, and responds to uncertain situations on a cognitive, emotional, and behavioral level" (Dugas, Schwartz, & Francis, 2004, p. 835). This conceptualization implies that IU contributes to worry/GAD directly by promoting threat-consistent appraisals of uncertain information (see Dugas, Buhr, & Ladouceur, 2004, for summary). On the other hand, the principal measure of IU, the Intolerance of Uncertainty Scale (IUS; Freeston et al., 1994), appears to operationalize IU as the extent to which an individual finds uncertainty unacceptable (e.g., "it's unfair having no guarantees in life"), distressing (e.g., "unforeseen events upset me greatly"), or disruptive (e.g., "when

it's time to act, uncertainty paralyzes me"). It is not clear to what extent the IUS items directly target threat appraisal.

Nonetheless, there is some evidence that IUS scores are associated with memory and interpretative biases. For example, Dugas et al. (2005) found that individuals with high IU levels recalled a greater proportion of uncertain words (e.g., "unclear"), and they also reported being more concerned about ambiguous situations. Koerner and Dugas (2008) found that individuals with high IU levels reported a greater level of concerns across positive, negative, and ambiguous scenarios, with the strongest between-group difference found for ambiguous scenarios. Other studies have demonstrated that IU is associated with a tendency to seek more certainty cues before making decisions about moderate ambiguous tasks (e.g., Ladouceur, Talbot, & Dugas, 1997). Further, individual differences in IU have been shown to predict perception of uncertainty about outcome probability as unacceptable (de Bruin, Rassin, & Muris, 2006), and task-related state worry (Ladouceur, Gosselin, & Dugas, 2000).

While these findings highlight the cognitive and affective responses to uncertainty, no studies to date have directly examined the way in which high IU individuals calibrate the likelihood and cost of uncertain aversive outcomes. Fear conditioning and related paradigms provide a promising empirical framework for examining cognitive biases and affective responses in IU. Sarinopoulos et al. (2010) adapted the illusory correlation paradigm (Tomarken, Mineka, & Cook, 1989) to examine undergraduates' responses to threat, using distressing pictures from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) as the aversive outcome. Uncertainty was conveyed by a target cue that preceded aversive pictures 50% of the time. Responses were compared to two reference cues, one that always preceded an aversive picture and one that never did. Postexperimental estimates of the association between the uncertain cue and the aversive pictures were significantly higher than 50%, showing evidence for covariation bias. Grupe and Nitschke (2011) investigated threat appraisal under uncertainty by monitoring a priori and online expectancy ratings as well as postexperimental covariation estimates. Expectancy ratings for the uncertain cue were significantly greater than the true probability of 50%. Although they did not observe an overall covariation bias for the uncertain cue, the online expectancy ratings predicted postexperiment covariation estimates.

In the research conducted on IU to date, the terms uncertainty and ambiguity have been treated somewhat synonymously (e.g., de Bruin et al., 2006; Ladouceur et al., 1997). Indeed, an earlier body of literature on intolerance of ambiguity (IA) also sought to represent an individual's tendency to interpret ambiguous situations as threatening and to respond to novel and complex situations with discomfort and avoidance (Budner, 1962; Frenkel-Brunswik, 1949). Despite efforts to differentiate IA and IU (e.g., Greco & Roger, 2001; Grenier, Barrette, & Ladouceur, 2005), there has been little direct empirical research on the distinction. However, the broader literature on cognitive bias suggests that ambiguity rather than uncertainty may provide more favourable conditions for the observation of individual differences in threat appraisal. For example, MacLeod and Mathews (2012) reviewed a wide range of interpretive tasks that embody potential threat, concluding that "selective interpretation of ambiguity can contribute to heightened anxiety vulnerability and to clinically relevant patterns of anxiety symptoms" (p. 201). Within the decision-making literature, ambiguity has generally been defined as a complete lack of knowledge regarding an outcome, whereas uncertainty refers to a situation where the outcome is not known on a given trial but the probability of the outcome is known, such as tossing a coin (Camerer & Weber, 1992; Ellsberg, 1961; Lazarus & Folkman, 1984). It is well accepted in the anxiety literature that estimated probability is an important component of threat appraisal (Butler & Mathews, 1983; Reiss, 1991). However it is rare in a clinical situation for probability of threat to be known exactly. Therefore ambiguity might be a more common and clinically relevant situation to explore (Koerner & Dugas, 2008).

Accordingly, in the present research we extended the procedure developed by Grupe and Nitschke (2011) to test threat processing in high and low IU individuals under both uncertainty and ambiguity. We used two target cues, each of which was followed by the negative outcome (aversive IAPS picture) on 50% of trials. For one of these cues (Uncertain), participants were informed of the true 50% probability in the pre-experimental instructions, whereas for the other cue (Ambiguous), participants were given no information. Importantly, participants were not aware that there would be a fourth cue (Ambiguous). Like Grupe and Nitschke (2011), we compared the target cues to two instructed reference cues, one that was always followed by the aversive outcome and one that was never followed by the aversive outcome. We recorded online expectancy of the aversive outcome and skin conductance response during the anticipatory period of each trial. In addition, we obtained postexperimental covariation estimates of the relationship between each cue and the aversive outcomes, as well as retrospective