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Exaggerated interpretation bias for uncertain information as a predictor of anxiety-related symptoms: A new method of assessment for IU

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ABSTRACT

Background and objectives: Intolerance of uncertainty (IU), or fear of the unknown, is as an important transdiagnostic risk factor across anxiety-related conditions, namely generalized anxiety disorder (GAD), obsessive compulsive disorder (OCD), and social anxiety disorder (SAD). IU is typically indexed using self-report measures. Given the importance of multi-method assessments and the shortcomings associated with existing behavioral indices of IU, additional methods of assessment are needed. Emerging literature supports the use of interpretation bias (IB) paradigms to index constructs such as IU. However, only one study to date has examined the association between an IU-focused IB paradigm (IU-IB) and self-report IU and no research has investigated whether an IU-IB paradigm would be related to increased anxiety-related symptoms.

Methods: The current investigation examined the utility of an IU-IB paradigm across two separate samples wherein participants completed an interpretation bias task and self-report measures. Sample 1 included 86 participants (74.4% female; *M*age = 19.14) and sample 2 included 138 participants (79.7% female; *M*age = 18.88).

Results: Findings from Study 1 indicated a significant association between an exaggerated IU-IB and symptoms of GAD and OCD, and this relationship held after covarying for negative affect. Study 2 results indicated a significant relationship between an exaggerated IU-IB and symptoms of GAD, OCD, and SAD, after covarying for negative affect.

Limitations: The current study had a variety of limitations, including the use of cross-sectional data and an undergraduate sample.

Conclusions: These findings provide an important replication and extension of previous work and highlight the transdiagnostic utility of this IU-IB task.

1. Introduction

Anxiety-related conditions are among the most commonly occurring mental disorders among U.S. adults (i.e., lifetime prevalence rate of 28.8%) and represent an immense societal and individual burden (e.g., low SES, increased healthcare costs; Greenberg et al., 1999; Kessler, Ruscio, Shear, & Wittchen, 2009, pp. 21–35; NIMH, 2016a). Therefore, research aimed at developing a comprehensive understanding of the etiological and maintaining processes underlying these disorders is crucial. As such, intolerance of uncertainty (IU) has emerged as an important factor underlying the development and maintenance of anxiety-related conditions. IU is defined as "an individual's dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty" (Carleton, 2016a; 2016b). Individuals who are elevated in IU have a tendency to react negatively to uncertainty and believe that future uncertainty is threatening (Carleton, Norton, & Asmundson, 2007). Although IU has been correlated with a variety of psychological symptoms, its most notable relationship is with anxiety-related disorders. Specifically, IU has been robustly associated with symptoms of generalized anxiety disorder (GAD; e.g., Dugas, Buhr, & Ladouceur, 2004; Mahoney & McEvoy, 2012), social anxiety disorder (SAD; e.g., Boelen & Reijntjes, 2009; Mahoney & McEvoy, 2012), and obsessive compulsive disorder (OCD; e.g., Holaway, Heimberg, & Coles, 2006; Mahoney & McEvoy, 2012) across clinical and non-clinical samples. Within these disorders, individuals may experience increased

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anxiety as a result of heighten IU, which could result in excessive worry regarding future events (e.g., within GAD) and increased maladaptive behaviors such as avoidance (e.g., within SAD), checking, excessive cleaning (e.g., OCD). Given the robust associations between IU and anxiety-related symptoms, this construct is considered an important transdiagnostic risk factor for anxiety and related disorders (Carleton, 2016a; McEvoy & Mahoney, 2011).

IU is typically assessed using the Intolerance of Uncertainty Scale, Short Form (IUS-12; Carleton et al., 2007). The IUS-12 is a self-report questionnaire comprised of a total score and two subscales, prospective and inhibitory IU. The prospective subscale of the IUS-12 is often considered the more "cognitive" component of this construct referring to a desire for predictability. Inhibitory IU is thought to reflect uncertainty paralysis and be the more "behavioral" domain of IU. Although some discriminant validity regarding the IU subfactors and certain anxiety-related disorders has been found (e.g., Carleton et al., 2012; McEvoy & Mahoney, 2012), more recent work suggests that the bulk of the variance in IU is shared between the two subfactors and that they should be used together, not separately (Hale et al., 2016; Hong & Lee, 2015). Highlighting the importance of this construct, the IUS-12 is included as a self-report measure of the negative valence systems potential threat (anxiety) construct in the National Institutes of Mental Health (NIMH) Research Domain Criteria (RDoC) initiative (NIMH, 2016b). The NIMH RDoC is a research initiative that aims to integrate multiple levels of analysis (e.g., behavioral, self-report) when examining psychological disorders (NIMH, 2016b). The RDoC framework and focus are consistent with the psychological communities' recent call for psychological phenomena to be analyzed across multiple methods of assessment.

Despite the abundance of research on IU, the majority of work on IU has relied on self-report indices and research aimed at identifying additional indicators of IU is scarce. Behavioral indices of IU, such as the Beads Task (Jacoby, Abramowitz, Buck, & Fabricant, 2014; Ladouceur, Talbot, & Dugas, 1997), have been developed but associations between self-report IU and outcomes from the Beads Task and other behavioral indicators are inconsistent (Jacoby et al., 2014; Ladouceur et al., 1997; Sternheim, Startup, & Schmidt, 2011). The Beads Task is a probabilistic inference paradigm wherein participants are asked to draw colored beads from a jar (with beads predominately one of two colors) until they are certain enough to make a decision as to the color jar they are drawing from (e.g., "predominately black beads"). Given there is no feared negative outcome for answering incorrectly on traditional versions of this task, paradigms such as this one have been criticized for having low ecological validity. However, researchers have attempted to increase the ecological validity of the Beads Task and provided some evidence for ecological validity for this task within the context of a negative outcome due to poor performance (Jacoby, Abramowitz, Reuman, & Blakey, 2016). Further, paradigms such as the Beads Task strive to measure "state" IU (i.e., uncertainty in the moment) not "trait" or dispositional IU. Additional tasks have been developed and validated to measure IU, such as the NPU-threat task (Christian Grillon et al., 2008; Schmitz & Grillon, 2012). The NPU-threat task is a startle and threat-of-shock paradigm wherein participants are delivered shocks on a no-shock, predictable-shock, and unpredictable-shock schedule. Although this task involves feared negative outcomes (i.e., startle and shock), these types of tasks are time-consuming, difficult to administer (i.e., require special equipment), and potentially uncomfortable for the participant (i.e., startles and shocks administered throughout). Therefore, additional indices of IU, particularly in regards to trait IU, are needed.

One promising method of indexing IU outside of traditional self-report is through interpretation bias (IB) paradigms. An IB for threat is broadly defined as the tendency to interpret ambiguous information from the environment as negative (MacLeod & Mathews, 2012). An extensive body of literature has shown that anxious individuals have a tendency to interpret ambiguous information more negatively, suggesting the presence of an exaggerated IB for threatening information (Amir, Beard, & Bower, 2005; Eysenck, Mogg, May, Richards, & Mathews, 1991; Hallion & Ruscio, 2011). Further, prominent cognitive models of anxiety (e.g., Beck & Clark, 1997) posit exaggerated IBs to play a central and causal role in the development and maintenance of anxiety-related symptoms (Hallion & Ruscio, 2011; MacLeod & Mathews, 2012). These theories suggest a bottom-up process (i.e., unconscious and unintentional) wherein exaggerated IBs are thought to increase the frequency and intensity of negative/threatening thoughts, which in turn leads to an increase in negatively valenced emotions (e.g., anxiety, depression). In addition to their importance in the onset and maintenance of symptoms, IBs appear to be amenable to treatment. A variety of studies have shown that exaggerated IBs for threatening information can be mitigated (e.g., Oglesby, Allan, & Schmidt, 2017) through brief computerized paradigms (i.e., cognitive bias modification for interpretation biases (CBM-I); Hallion & Ruscio, 2011) and that these changes lead to reductions in symptoms of anxiety-related conditions (i.e., anxiety sensitivity, Capron & Schmidt, 2016; social anxiety symptoms, Amir et al., 2005).

In addition to research linking IBs and general anxiety symptoms, exaggerated IBs have been found in the context of uncertain situations. Oglesby, Raines, Short, Capron, and Schmidt (2016) examined IU-related IBs wherein participants were presented with ambiguous words/phrases (e.g., "Doctor called") and asked whether threatening (e.g., "I have a terrible disease) or neutral (e.g., "Appointment reminder") interpretations were related to the ambiguous phrase. Individuals high in IU endorsed more threatening/negative interpretations of ambiguous information when compared to those low in IU. Further, elevated IU was not significantly related to neutral interpretations of ambiguous words, therefore providing specificity to their IU-IB findings. However, this study did not evaluate whether an exaggerated IB for uncertain information was related to anxiety symptoms. In order to validate an exaggerated IB for uncertainty information as an additional method of assessment for IU, it is important to show that this measure is associated with theoretically related constructs, such as anxiety symptoms. This research would provide further validation of Oglesby et al. (2016)'s paradigm and findings and extend this work by providing convergent validity.

The current study had three main aims. First, the present study sought to further validate our IU-IB paradigm within a second sample and propose this paradigm as an additional method of assessment of IU. In study 2, we examined the association between self-report IU and IU-IB and hypothesized that elevated IU would be significantly associated with an exaggerated IU-IB based on the work of (Oglesby et al., 2016).[1] Second, given that Oglesby et al. (2016) did not examine the IU-IB task in relation to anxiety symptoms, we sought to extend their findings by examining the associations between IU-IB and anxiety-related symptoms. Based on previous work (Boelen & Reijntjes, 2009; Dugas et al., 2004; Holaway et al., 2006; Mahoney & McEvoy, 2012), we examined the association between IU-IB and symptoms of SAD, GAD, and OCD and hypothesized that an exaggerated IU-IB would be significantly associated with elevations in these anxiety-related symptoms after covarying for negative affect across both samples. Finally, we were interested in testing the incremental predictive power of IU-IB beyond the effects of IU self-report. Given the well-documented and robust relationship between IU and anxiety symptoms, and the strong association between IU self-report and IU-IB, we expected that IU-IB may fall out of significance when these indices were pitted against each other. However, these analyses were considered an essential step in understanding the nature of the relationship between IU, IU-IB, and anxiety symptomology.

[1] Study 1 utilized the same sample from XXXX et al., 2016; therefore, we did not re-examine the association between self-report IU and IU-IB within Study 1 for the current paper.

2. Study 1: methods

2.1. Participants

Participants included 86 undergraduate students recruited from a large southern university. Participant selection was based on individuals' responses to the Intolerance of Uncertainty Scale (IUS-12; Carleton et al., 2007). Half of the sample was selected for scoring 1.5 standard deviations above the non-clinical mean on the IUS-12 (Carleton et al., 2012), and the other half of the sample was unselected (i.e., not required to meet the IUS cut-off). This method was used to make certain that the sample would have a continuous range of IU symptoms. Participants were primarily female (74.4% female) with ages ranging from 17 to 35 (M = 19.14, SD = 2.48). 67.4% of the sample was Caucasian, 11.6% African American, 11.6% Asian, 1.2% American Indian, 3.5% Other (e.g., bi-racial), and 1.2% declined to respond.

2.1.1. Procedure

Participants were recruited via email and invited to complete a study investigating uncertainty and stress assessment in exchange for course credits. During the in-person study session, informed consent was obtained upon participant arrival to the lab, followed by a set of self-report questionnaires, including those used in the current analyses. Next, as part of a larger study, participants were randomized into one of three study conditions: certain threat, uncertain threat, and control condition. Participants randomized to the certain threat condition were informed that they would give a 3-min speech later on in the study. Participants randomized to the uncertain threat condition were instructed that they may be required to give a 3-min speech later on in the study, as determined by a coin flip. Lastly, individuals randomized to the control condition were informed that some participants will have to give a speech 3-min speech at the end of the study, but they are not part of this group.

After randomization but prior to completion of experimental condition, all participants completed an interpretation bias task along with additional study-specific exercises. After completing all tasks, participants were debriefed and awarded course credit for their contribution. Total study participation lasted approximately 1.5 h. All self-report measures described as part of this study were taken prior to the experimental manipulation, with the interpretation bias task being the only exception. All procedures were approved by the institution's institutional review board.

2.2. Measures

2.2.1. Self-report

2.2.1.1. Demographics. A complete demographics questionnaire was used to gather comprehensive participant information including age, race, ethnicity, living arrangements, and sexual orientation.

2.2.1.2. Intolerance of Uncertainty. The Intolerance of Uncertainty Scale, Short Form (Carleton et al., 2007) is a 12-item self-report measure used to assess intolerance of uncertainty. Questions evaluate an individual's ability to tolerate the uncertainty associated with ambiguous situations, his or her responses to uncertainty, and beliefs regarding the implications of uncertainty (Carleton et al., 2007). Items are rated on a 5-point Likert scale ranging from 0 (*Not at all characteristic of me*) to 5 (*Entirely characteristic of me*). The IUS-12 has demonstrated good internal consistency (α = 0.91) in previous research (Carleton et al., 2007), and in the current study sample, the IUS-12 demonstrated excellent internal consistency (α = 0.93).

2.2.1.3. Negative Affect. The Positive and Negative Affect Schedule (PANAS) is a 20-item self-report questionnaire used to measure negative affect. The PANAS assesses two global dimensions of affect, positive and negative (Watson, Clark, & Tellegen, 1988), by asking respondents to read various words that describe different feelings and emotions and rate the degree to which they felt that way on average. The PANAS negative and positive scales have demonstrated high internal consistency and stability of a 2-month period (Watson et al., 1988). Only the negative affect scale (PANAS-NA) was used in the present study and reliability analysis indicated that it demonstrated good internal consistency (α = 0.90).

2.2.1.4. Worry. The Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) is a 16-item self-report measure used to assess level of worry. Using a five-point Likert scale ranging from *Not at all* (1) to *Very* (5), respondents are asked to indicate the degree to which each statement applies to them. In previous research, the PSWQ has demonstrated high internal consistency and test-retest reliability (Davey, Hampton, Farrell, & Davidson, 1992). The PSWQ demonstrated good internal consistency in the current sample (α = 0.93).

2.2.1.5. Obsessive Compulsive Symptoms. The Obsessive-Compulsive Inventory Revised (OCI-R; Foa et al., 2002) is an 18-item self-report questionnaire used to measure obsessive-compulsive disorder (OCD) symptoms. Questions evaluate the extent to which respondents are distressed or bothered by symptoms of hoarding, checking, neutralizing, obsessing, ordering, and washing. The OCI-R has demonstrated good internal consistency, test–retest reliability, and convergent validity with other measures of OCD symptoms (Foa et al., 2002). Within the current study, reliability analysis indicated that the OCI-R demonstrated good internal consistency (α = 0.91).

2.2.1.6. Social Anxiety Symptoms. The Liebowitz Social Anxiety Scale (LSAS; Heimberg et al., 1999) is a 24-item scale that assesses an individual's fear and avoidance behaviors associated with various dimensions of social anxiety. In the current study, the LSAS was administered via self-report (as opposed to interview). However, previous work has found comparable psychometric properties for the self-report version of this measure (Fresco et al., 2001). The LSAS has demonstrated test–retest reliability, internal consistency, and convergent and discriminant validity in previous research (Baker, Heinrichs, Kim, & Hofmann, 2002), and in the present investigation, demonstrated good internal consistency (α = 0.97).

2.3. Study task

2.3.1. Interpretation Bias (IB) Task

A negative interpretation bias for uncertain information was measured using a modified Word Sentence Association Paradigm (WSAP; Beard & Amir, 2008). The WSAP was modified by the authors to include phrase and sentences pairs indicating uncertainty, whereas the original WSAP included phrase and sentence pairs illustrating social situations (Beard & Amir, 2008). Specifically, ambiguous phrases denoting uncertainty were created. The task also included one negative and one neutral interpretation of these phrases. Participants completed 80 trials comprised of four phases each. During the first phase, a fixation cross appeared on the computer screen for 500 ms to orient participants toward the screen and notify them that the trial was beginning. Next, an ambiguous prime (e.g. "Doctor called") appeared on the screen for 1000 ms. Following this, a sentence representing either a negative sentence/phrase (e.g. "I have a terrible disease") or a benign sentence/phrase (e.g., "Appointment reminder") appeared on the screen and remained until participants pressed the space bar to indicate they had finished reading the statement. On half the trials, the combination of the initial prime and sentence created a benign interpretation defined as a "neutral interpretation"; on the other half of the trials the combination creates a negative interpretation defined as an "uncertain/negative interpretation". Finally, participants were told to press "1" if

Table 1
Study 1 zero-order correlation, means, and standard deviations.

	1	2	3	4	5	6	M	SD
1. IU_IB	–	–	–	–	–	–	1.45	.22
2. IUS12_Total	-.45**	–	–	–	–	–	29.08	10.63
3. PANAS_NA	-.28*	.50**	–	–	–	–	20.53	7.76
4. PSWQ_Total	-.40**	.63**	.57**	–	–	–	53.05	13.42
5. OCI-R_Total	-.43**	.61**	.51**	.52**	–	–	14.72	11.78
6. LSAS_Total	-.30**	.61**	.71**	.63**	.59**	–	45.93	27.18

Note. IU_IB, Intolerance of Uncertainty Interpretation Bias Task; IUS12 Total, Intolerance of Uncertainty Scale-Short Form (IUS-12) Total Score; PANAS NA, Positive and Negative Affect Schedule-Negative Affect Subscale; PSWQ Total, Penn State Worry Questionnaire Total Score; OCI-R Total, Obsessive Compulsive Inventory-Revised Total Score; LSAS Total, Leibowitz Social Anxiety Scale Total Score. * = $p < .05$, ** = $p < .001$.

they thought the prime and sentence were related or "2" if they thought the prime and sentence were un-related. An interpretation bias for uncertain information was calculated by averaging participants' responses to uncertain/negative interpretations. Individuals whose average was closer to 1 when responding to the uncertain/negative interpretations (i.e., ambiguous prime + negative sentence/phrase) were said to have a negative interpretation bias for ambiguous information. An interpretation bias for neutral information was calculated and interpreted in the same way.

The phrase/sentence pairings were created by the authors from Oglesby et al. (2016). To validate these pairings, the primes and sentences used in the current study were rated by five independent judges who are published authors on IU. Judges rated the pairings from 1 (*not at all*) to 5 (*very*) in terms of how threatening and relevant to IU the prime/sentence pairings were. The mean threat rating for the neutral interpretation pairings was 1.55. The mean threat rating for the uncertain/negative interpretation pairings was 4.6. The mean IU relevance rating was 4.61.

3. Study 1: results

Preliminary analyses indicated that there were no threats or violations of normality, multicollinearity, or homoscedasticity (Berry, 1993; Tabachnick & Fidell, 2001). Next, the means, standard deviations, and zero-order correlations for all variables of interest were examined (Table 1). The IUS-12 total sample mean and standard deviation was lower than that found in clinical samples but higher than that found in undergraduate samples (i.e., $M = 29.08$ (current samle) versus $M = 37.01$–43.04 in clinical samples and $M = 27.52$ in undergraduate samples; Carleton et al., 2012; Khawaja & Yu, 2010). As reported in prior work (Oglesby et al., 2016), IUS-12 total scores were significantly correlated with IU-IB ($r = -0.45, p < 01$). Further, IUS-12 total scores and IU-IB were both significantly associated with (all p's ≤ 0.01) symptoms of worry, OCD, and social anxiety. Negative affect was also significantly associated (all p's ≤ 0.01) with IUS-12 total scores, IU-IB, and anxiety symptom scales (i.e., worry, OCD, social anxiety). As previously noted, participants were randomly assigned to three conditions as part of a larger study. However, a one-way ANOVA found no significant associations between IU-IB and the 3 conditions (F (2, 85) = 0.118, $p = .89$). Therefore, we did not include condition as a covariate in the following analyses.[2]

To test our primary hypotheses, a series of multiple regression analyses were conducted to assess the relationships between an IU-IB and symptoms of worry (as measured by the PSWQ total score), OCD (as measured by the OCI-R total score), and social anxiety (as measured by the LSAS total score) after covarying for negative affect (as measured by PANAS-NA). In the first model, symptoms of worry served as the dependent variable and negative affect and IU-IB were entered as predictors. Results indicated that the overall model was significant $F(2, 85) = 26.88$, $p < .001$, $r^2 = 0.39$). As expected, after covarying for negative affect ($\beta = 0.50$, $t = 5.63$, $p < .001$, $sr^2 = 0.23$), IU-IB was significantly associated with worry ($\beta = -0.26$, $t = -2.96$, $p = .004$, $sr^2 = 0.06$). In the second model, symptoms of OCD served as the dependent variable and negative affect and IU-IB were entered as predictors. Results indicated that the overall model was significant $F(2, 85) = 22.24$, $p < .001$, $r^2 = 0.35$). Consistent with prediction, after covarying for negative affect ($\beta = 0.43$, $t = 4.64$, $p < .001$, $sr^2 = 0.17$), IU-IB was significantly associated with OCD symptoms ($\beta = -0.31$, $t = -3.33$, $p = .001$, $sr^2 = 0.09$).[3] In our final model, symptoms of social anxiety served as the dependent variable and negative affect and IU-IB were entered as predictors. Results indicated that the overall model was significant $F(2, 85) = 45.09$, $p < .001$, $r^2 = 0.52$). However, after covarying for negative affect ($\beta = 0.68$, $t = 8.63$, $p < .001$, $sr^2 = 0.43$), results indicated that IU-IB was not significantly associated with social anxiety symptoms ($\beta = -0.11$, $t = -1.44$, $p = .15$, $sr^2 = 0.01$).

Next, to test the incremental predictive power of IU-IB, a series of multiple regression analyses were conducted to assess the simultaneous contribution of IUS-12 self-report and IU-IB when predicting symptoms of worry (as measured by the PSWQ total score), OCD (as measured by the OCI-R total score), and social anxiety (as measured by the LSAS total score). For all models, IUS-12 total scores and IU-IB were included as predictors. Each symptom measure was entered as the dependent variable in separate models. When predicting worry symptoms, the overall model was significant $F(2, 85) = 29.00$, $p < .001$, $r^2 = 0.41$). However, IU-IB was not significantly associated with worry ($\beta = -0.15$, $t = -1.55$, $p = .12$, $sr^2 = 0.02$) after accounting for IUS-12 total scores ($\beta = 0.56$, $t = 5.94$, $p < .001$, $sr^2 = 0.25$). In regards to OCD symptoms, the overall model was significant $F(2, 85) = 27.87$, $p < .001$, $r^2 = 0.40$). Further, results found that IU-IB ($\beta = -0.19$, $t = -1.94$, $p = .05$, $sr^2 = 0.03$) was robustly associated with symptoms of OCD after accounting for IUS-12 total scores ($\beta = 0.53$, $t = 5.54$, $p < .001$, $sr^2 = 0.22$). Finally, when predicting social anxiety symptoms, the overall model was significant $F(2, 85) = 24.14$, $p < .001$, $r^2 = 0.37$). However, IU-IB ($\beta = -0.03$, $t = -0.34$, $p = .73$, $sr^2 < 0.01$) was not significantly associated with symptoms of social anxiety, whereas IUS-12 ($\beta = 0.59$, $t = 6.03$, $p < .001$, $sr^2 = 0.28$) was.

4. Study 2: methods

4.1. Participants

Participants included 138 undergraduate students recruited from a large southern university. Participants are a subsample from a larger study and were selected based on elevated scores on the Intolerance of Uncertainty Scale (IUS-12; Carleton et al., 2007), the Distress Tolerance Scale (DTS; Simons & Gaher, 2005), and the Anxiety Sensitivity Index (ASI-3; Taylor et al., 2007). To be eligible, participants needed to be 1 standard deviation above the mean on only one of these measures. Participants were primarily female (79.7% female) with ages ranging from 17 to 23 ($M = 18.88$, $SD = 1.19$). 89.2% of the sample was Caucasian, 7.9% African American, 0.7% Asian, 1.4% Other (e.g., bi-racial), and 0.7% declined to respond. Primary diagnoses for participants included: no diagnosis (69%), SAD (12.1%), GAD (4.6%), depressive disorders (4%), specific phobia (3.6%), substance or alcohol use disorder (3.1%), other specified anxiety disorder (1.5%), obsessive-compulsive and related disorders (1.4%), and trauma and stressor-related disorders (0.7%).

[2] The reported pattern of results remains the same if condition is included as a covariate.

[3] Results do not change if the OCI-R hoarding specific items are removed.

4.2. Procedure

Eligible participants were contacted via email and invited to sign-up online to participate in the current study in exchange for course credits. Upon arrival to the lab, informed consent was obtained. Next, participants completed a clinician administer structured clinical interview (SCID-5; First, Williams, Karg, & Spitzer, 2015). Participants then completed a battery of self-report questionnaires including those used in the current analyses. Following the questionnaires, participants went on to complete an interpretation bias task. After completing all tasks, participants were debriefed, thanked for their time, and awarded any course credits they earned. Total participation took approximately 2.5 h and all procedures were approved by the university's institutional review board.

4.3. Measures

4.3.1. Clinician administered

4.3.1.1. Structured Clinical Interview for DSM-5 (SCID-5). All study participants were assessed using the SCID-5 (First et al., 2015). SCIDs were administered by trained clinical psychology graduate students who completed extensive training in SCID administration and scoring. Training components included the review of SCID training tapes, observation of live SCID administrations, and completion of practice assessments with other trained therapists. As part of the training process, interviewers received feedback until they demonstrated high reliability levels. To ensure diagnostic accuracy, a licensed clinical psychologist reviewed all completed SCIDs. Percentage agreement between clinical interviewers for a random sample of approximately 15% of these SCIDs resulted in high interrater reliability (kappa = .77; Schmidt, Capron, Raines, & Allan, 2014).

4.3.2. Self-report

4.3.2.1. Demographics. A comprehensive demographics questionnaire was used to assess numerous variables including age, race, ethnicity, living arrangement, and sexual orientation.

4.3.2.2. Intolerance of Uncertainty (IUS-12). Please see previous description of measure. In the present study, the IUS-12 demonstrated good internal consistency (α = 0.92).

4.3.2.3. Negative Affect (PANAS-NA). Please see previous description of measure. In the present study, the PANAS-NA demonstrated adequate internal consistency (α = 0.91).

4.3.2.4. Worry (PSWQ). Please see previous description of measure. In the present study, the PSWQ demonstrated good internal consistency (α = 0.92).

4.3.2.5. Obsessive Compulsive Symptoms (OCI-R). Please see previous description of measure. In the present study, the OCI-R demonstrated adequate internal consistency (α = 0.86).

4.3.2.6. Social Anxiety Symptoms (LSAS). Please see previous description of measure. In the present study, the LSAS demonstrated excellent internal consistency (α = 0.96).

4.4. Study task

4.4.1. Interpretation Bias (IB) Task

The IB task completed for this study followed procedures identical to those described in the Study 1.

5. Study 2: results

Preliminary analyses indicated that there were no threats or violations of normality, multicollinearity, or homoscedasticity (Berry, 1993; Tabachnick & Fidell, 2001). The means, standard deviations, and zero-order correlations for all variables of interest in the current sample are described in Table 2. Similar to study 1, the sample mean and standard deviation for IUS-12 scores was comparable to that found in other reports utilizing nonclinical samples and slightly lower than that found in clinical samples (Carleton et al., 2007; Khawaja & Yu, 2010). IUS-12 total scores were significantly correlated with IU-IB ($r = -0.46$, $p < 01$). In addition, IUS-12 total scores and IU-IB were both significantly associated with (all p's ≤ 0.001) symptoms of worry, OCD, and social anxiety. Lastly, negative affect was also significantly associated (all p's ≤ 0.001) with IUS-12 total scores, IU-IB, and anxiety symptom scales (i.e., worry, OCD, social anxiety).

Table 2
Study 2 zero-order correlation, means, and standard deviations.

	1	2	3	4	5	M	SD
1. IU_IB	–	–	–	–	–	1.53	.21
2. IUS12_Total	-.46**	–	–	–	–	28.31	10.35
3. PANAS_NA	-.33**	.60**	–	–	–	19.04	6.74
4. PSWQ_Total	-.37**	.69**	.60**	–	–	52.67	13.16
5. OCIR_Total	-.29**	.44**	.32**	.35**	–	10.21	8.40
6. LSAS_Total	-.42**	.45**	.51**	.45**	.22**	50.54	28.02

Note. IU_IB, Intolerance of Uncertainty Interpretation Bias Task; IUS12 Total, Intolerance of Uncertainty Scale-Short Form (IUS-12) Total Score; PANAS NA, Positive and Negative Affect Schedule-Negative Affect Subscale; PSWQ Total, Penn State Worry Questionnaire Total Score; OCI-R Total, Obsessive Compulsive Inventory-Revised Total Score; LSAS Total, Leibowitz Social Anxiety Scale Total Score. ** = $p < .001$.

To test our main hypotheses, a series of multiple regression analyses were conducted to assess the relationships between an IU-IB and symptoms of worry (as measured by the PSWQ total score), OCD (as measured by the OCIR total score), and social anxiety (as measured by the LSAS total score) after covarying for negative affect (as measured by PANAS negative affect). In the first model, symptoms of worry served as the dependent variable and negative affect and IU-IB were entered as predictors. Results indicated that the overall model was significant $F(2, 136) = 43.53$, $p < .001$, $r^2 = 0.39$). As expected, after covarying for negative affect (β = 0.54, $t = 7.57$, $p < .001$, $sr^2 = 0.26$), IU-IB was significantly associated with worry (β = −0.19, $t = -2.63$, $p = .009$, $sr^2 = 0.03$). In the second model, symptoms of OCD served as the dependent variable and negative affect and IU-IB were entered as predictors. Results indicated that the overall model was significant $F(2, 136) = 11.22$, $p < .001$, $r^2 = 0.14$). Consistent with prediction, after covarying for negative affect (β = 0.26, $t = 3.04$, $p = .003$, $sr^2 = 0.06$), IU-IB was significantly associated with symptoms of OCD (β = −0.21, $t = -2.42$, $p = .017$, $sr^2 = 0.04$) .[4] In our final model, symptoms of social anxiety served as the dependent variable and negative affect and IU-IB were entered as predictors. Results indicated that the overall model was significant $F(2, 136) = 32.07$, $p < .001$, $r^2 = 0.32$). Furthermore, after covarying for negative affect (β = 0.41, $t = 5.46$, $p < .001$, $sr^2 = 0.15$), results indicated that IU-IB was significantly associated with social anxiety symptoms (β = −0.28, $t = -3.71$, $p < .001$, $sr^2 = 0.07$).

Next, to test the incremental predictive power of IU-IB, a series of multiple regression analyses were conducted identical to that of study 1. When predicting worry symptoms, the overall model was significant $F(2, 136) = 61.95$, $p < .001$, $r^2 = 0.48$). However, IU-IB was not significantly associated with worry (β = −0.07, $t = -0.96$, $p = .34$, $sr^2 < 0.01$) after accounting for IUS-12 total scores (β = 0.66, $t = 9.44$, $p < .001$, $sr^2 = 0.35$). As for OCD symptoms, the overall model was significant $F(2, 136) = 17.50$, $p < .001$, $r^2 = 0.21$). Further, results found IU-IB (β = −0.11, $t = -1.29$, $p = .19$,

[4] Results do not change if the OCI-R hoarding specific items are removed.

$sr^2 < 0.01$) was associated with symptoms of OCD at trend level after accounting for IUS-12 total scores ($\beta = -0.26$, $t = -2.96$, $p = .004$, $sr^2 = 0.12$). Finally, when predicting social anxiety symptoms, the overall model was significant $F(2, 136) = 23.60$, $p < .001$, $r^2 = 0.26$). In addition, IU-IB ($\beta = -0.27$, $t = -3.18$, $p = .002$, $sr^2 = 0.06$) and IUS-12 ($\beta = 0.33$, $t = 3.98$, $p < .001$, $sr^2 = 0.09$) were both significantly associated with symptoms of social anxiety.

6. Discussion

Consistent with expectation, an exaggerated IU-IB was associated with elevated levels of self-reported IU within Study 2. These results are consistent with previous work finding an association between an exaggerated IU-IB and elevated levels of self-reported IU (Oglesby et al., 2016). Specifically, using the same paradigm employed in the current study, the authors found that individuals elevated in IU displayed an IB for uncertain information. Furthermore, our results are consistent with the findings of Dugas et al. (2005) and Koerner and Dugas (2008), wherein the authors found that individuals high in IU displayed elevated concern over ambiguous scenarios. Given the importance of replication and multi-method assessment of psychological phenomena, our findings provide an essential validation of our IU-IB paradigm and suggest that it could be used as an additional method of assessment for IU-related interpretations.

The current investigation was the first to examine the relationship between an exaggerated IU-IB and anxiety-related symptoms. Across both studies, our findings indicated a significant and robust relationship between an exaggerated IU-IB and symptoms of GAD and OCD. These results remained significant even after covarying for levels of negative affect. Associations between self-report IU and symptoms of GAD and OCD have been well documented in the literature (e.g., Dugas et al., 2004; Mahoney & McEvoy, 2012). However, no research to date has documented the presence of an uncertainty-specific IB among these disorders. This work is a critical extension of the existing literature and provides preliminary support for the convergent validity of our task. Specifically, these findings suggest that our IU-IB paradigm was associated with constructs theoretically related to IU in the existing literature, suggesting that our IU-IB task may be useful in clinical and research settings as a supplementary index of IU.

We also examined the incremental predictive power of IU-IB in relation to symptoms of GAD and OCD after accounting for IU self-report. Across both studies, IU-IB remained a robust predictor of OCD symptoms above and beyond IU self-report. However, IU-IB was not significantly associated with symptoms of worry once IU self-report was accounted for. These mixed findings are likely due to the strong and well documented association between the IUS-12 and symptoms of worry/GAD (i.e., IUS-12 accounts for a large amount of variance). However, these discrepant findings could be in part due to differences between the IUS-12 measure and our IU-IB indice. The IU-IB paradigm indexes negative interpretations of uncertainty, an important part of the IU construct. However, measures such as the IUS-12 (Carleton et al., 2007) may be more comprehensive and measure the construct of IU more fully. For worry and GAD symptoms, parts of the IU construct outside of negative interpretations for uncertainty, such as those included in the IUS-12 (e.g., feelings that you are unable to cope with uncertainty, fear regarding how you will act in the face of uncertainty) may be more important.

Consistent with hypotheses, Study 2 results found a significant association between an exaggerated IU-IB and symptoms of SAD after covarying for negative affect. Although the correlation between IU-IB and SAD symptoms was significant within Study 1, when negative affect was entered as a covariate this relationship was no longer significant. When examining the incremental predictability of IU-IB above IU self-report, results demonstrated this same pattern of findings (i.e., in study 1, IU-IB was not related; in study 2, IU-IB was significantly related). Differences in SAD symptom levels between the two samples could explain our divergent findings. Although neither LSAS total score sample means reached the clinical threshold (≥ 60; Rytwinski et al., 2009), the Study 2 sample mean was slightly greater in comparison to Study 1. Therefore, the differences between sample means in regard to social anxiety symptom is one potential explanation for our discrepant findings (i.e., it is possible that an exaggerated IU-IB is present among individuals with social anxiety symptoms approaching clinical significance, but not in individuals with slightly lower social anxiety symptoms). In addition, given the well-documented and robust association between negative affect and SAD symptoms and IU and the reduced variance in SAD symptom severity within Study 1, negative affect may have been too stringent of a covariate to see significant effects. Given our mixed findings, future work should investigate whether exaggerated interpretations of uncertainty are associated with elevated symptoms of SAD across clinically elevated samples after accounting for levels of negative affect.

Taken together, results from the current study have promising clinical implications. Clinicians often rely on traditional methods of assessment (e.g., self-report questionnaires) to identify IU within clinical populations. Although self-report measures are convenient and widely used, they are associated with certain limitations, such as intentional response bias. Further, individuals with low insight into their symptoms may have difficulty accurately completing these measures. In contrast, IB tasks require participants to quickly respond to ambiguous information in a short period of time. Therefore, IB-based assessments of IU may provide an effective adjunct to traditional methods of assessment and may allow for more accurate reporting. For example, clinicians could use this measure in conjunction with traditional self-report measures as a way of identifying high IU within their patients. Further, our IU-IB paradigm could be used to identify whether an individual displays a tendency to interpret uncertain information in a negative way, which could then be used as a potential target in treatment. Finally, the utilization of IB paradigms to detect IU and negative interpretations of uncertainty within clinical populations may allow clinicians the opportunity to employ early intervention techniques, which may decrease risk for the development of anxiety symptoms.

Despite the many well-established treatment modalities for anxiety and related disorders (see Chambless & Ollendick, 2001), numerous barriers (e.g., cost, accessibility, stigma; Schmidt & Keough, 2010) associated with the utilization of traditional therapy techniques remain. IU has been found to be malleable and amenable to treatment (Boswell, Thompson-Hollands, Farchione, & Barlow, 2013). In addition, emerging evidence supports the utilization of CBM-I paradigms to reduce exaggerated interpretation biases, such as an exaggerated IU-IB (Oglesby et al., 2016), and anxiety symptoms (Beard & Amir, 2008; Capron & Schmidt, 2016). Given the efficacy of CBM-I paradigms and the substantial barriers associated with traditional treatments, and that the current study provides support for the role of interpretation biases in anxiety symptoms, research on the implementation of CBM-I paradigms as a treatment for IU and anxiety-related psychopathology is needed. In addition, incorporating IU-focused CBM-I protocols into existing therapeutic techniques (e.g., cognitive behavioral treatments) for anxiety and related conditions may alleviate present symptoms and prevent the development of future conditions (Amir, Bomyea, & Beard, 2010; Hallion & Ruscio, 2011).

Limitations of the present study should be considered. Although our sample consisted of individuals elevated in risk factors related to anxiety, the current study did not utilize a clinical sample. Future work should attempt to replicate these findings among a clinical sample to identify the presence of an exaggerated IU-IB among individuals with anxiety-related psychopathology. In addition, the current study utilized cross-sectional data. Future research should attempt to replicate and investigate these findings within a longitudinal framework. Specifically, research investigating whether an individuals' tendency to interpret ambiguous information in a threatening manner leads to the future development or exacerbation of anxiety-related symptoms is warranted.

The current study assessed for the presence of limited anxiety-related symptoms; thus, future research should investigate the role of IU-IBs among additional anxiety-related symptoms, such as post-traumatic stress disorder and panic disorder. Although our study provides a promising second assessment of IU, we did not utilize a behavioral measure of IU. While IU-IB and condition were not significantly associated in study 1, it is possible that state IU as a result of the experimental manipulation could have confounded these results. However, this could also be seen as a strength of the study given that IU-IB was associated with trait IU (as measured by the IUS-12), but not state IU (as indicated in the experimental manipulation). In addition, results aiming to understand the incremental predictive power of IU-IB above and beyond IU self-report were mixed. Although somewhat expected, IU-IB was not as robust of a predictor as IU self-report. These results suggest that our IU-IB should not be used *instead* of IUS self-report, but in *conjunction with* IU self-report. Considering the important of multi-modal assessments, future work should attempt to replicate and extend these findings by examining these associations in relation to existing behavioral indices of IU, such as the Beads Task and the NPU-threat task (Jacoby et al., 2014; Ladouceur et al., 1997; Schmitz & Grillon, 2012).

Despite these limitations, the current study provides important information regarding the relationship between an exaggerated IU-IB and anxiety-related symptoms. Specifically, these findings add to the growing body of literature supporting the transdiagnostic nature of IU within anxiety conditions. In addition, the present investigation provides an important replication and extension of previous work and findings suggest the presence of an exaggerated IU-IB among individuals elevated in IU and certain anxiety-related symptoms. Our results also point to the potential utility of our IU-IB paradigm as an additional method of assessment for IU beyond traditional self-report methods.

Contributors

Author one wrote the majority of the introduction and discussion sections, as well as assisted with the methods and results sections. Author two assisted with writing the results section as well as assisting with the introduction and discussion sections. Author three wrote the methods section and conducted literature searches. Author four assisted with the introduction and discussion sections as well as proof reading and writing assistance. Author five provided critical feedback on all drafts of the manuscript. All authors contributed significantly to the manuscript and approved the final version being submitted.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbtep.2019.02.010.

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