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BRIEF REPORT

Intolerance of Uncertainty and Uncertainty-Related Attentional Biases: Evidence of Facilitated Engagement or Disengagement Difficulty?

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Abstract We first examined the association between intolerance of uncertainty (IU) and a possible uncertainty-related attentional bias, and second tested whether one or more specific attentional processes—facilitated engagement or disengagement difficulty—accounted for the association. Next, we examined whether this attentional bias was specific to IU or if it was attributable to anxiety, depression, or general distress. Students ($N = 104$) completed questionnaires and a visual search task (VST) with a lexical decision component. For the VST, participants were asked to determine whether a target stimulus that was embedded in a matrix of distracting stimuli was a word or nonword. Results were that IU correlated significantly with facilitated engagement toward, but not with disengagement difficulty from, uncertainty stimuli. IU, particularly the inhibitory dimension, continued to correlate significantly with facilitated engagement after controlling for anxiety, depression, or general distress. Conceptual and therapeutic implications of these results are discussed.

Keywords Anxiety · Attentional bias · Disengagement difficulty · Facilitated engagement · Intolerance of uncertainty

Intolerance of uncertainty (IU) is conceptualized as a dispositional fear of the unknown and appears to be a vulnerability that spans across anxiety disorders (Carleton 2012). Carleton proposed that an information-processing bias might be important for further explicating how IU relates to anxiety disorders, noting in particular that "the ability to tolerate uncertainty may be reflected in a bias towards classification of a novel stimulus as threatening, therein increasing autonomic arousal and facilitating perceptions of anxiety at strategic processing levels" (p. 938).

Extant literature supports such a possibility. For example, Dugas et al. (2005) showed through an incidental learning task that individuals with higher versus lower levels of IU had a tendency to recall words denoting uncertainty. Further, Krohne and Hock (2011) suggested that individuals with high IU engage in vigilant coping behavior, which is marked by an attentional bias for threat (e.g., uncertainty) as a way to minimize unwanted occurrences. Despite Krohne and Hock's suggestion, no known published study has examined whether IU is associated with an uncertainty-related attentional bias. Testing for such an association is an important step in better understanding whether IU relates to an information-processing bias.

When testing for such an association, it is necessary to explore its specificity and robustness. This is because IU correlates moderately with anxiety, depression, and general distress (McEvoy and Mahoney 2012), and each of these variables relates to an attentional bias for threat (Bar-Haim et al. 2007; Lonigan and Vasey 2009; Mogg and Bradley 2005). An observed association between IU and attentional bias therefore might be attributable to overlap with anxiety, depression, or general distress. If so, it is important to identify the specific variable that accounts for the association.

Moreover, it is important to examine what specific attentional processes account for an association between IU and an uncertainty-related attentional bias. Two processes are

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commonly described in the literature: facilitated engagement and disengagement difficulty. Facilitated engagement relates to threat stimuli being detected more quickly than non-threat stimuli; disengagement difficulty relates to relative difficulty disengaging attention from threat stimuli relative to non-threat stimuli (Cisler and Koster 2010). Cisler and Koster asserted that these two attentional processes have different neurobiological underpinnings. Namely, facilitated engagement likely is representative of a threat detection mechanism located within the amygdala and disengagement difficulty likely reflects impoverished top-down attentional control processes located within the prefrontal cortex. These two attentional processes might also affect functioning in distinct ways (e.g., facilitated engagement might indicate hypervigilance for threat; Pineles et al. 2009). It is thus important to account for both attentional processes when examining an IU-attentional bias association.

To address the above considerations, we examined whether IU is associated with an uncertainty-related attentional bias, while assessing whether facilitated engagement or disengagement difficulty accounts for that bias. We further examined whether an IU-attentional bias association was robust to the effects of anxiety, depression, or general distress. Based on putative links between IU and a bias for processing information denoting uncertainty (Carleton 2012; Dugas et al. 2005; Krohne and Hock 2011), we predicted that IU would correlate significantly with an index of an uncertainty-related attentional bias. We also saw enough evidence to predict that IU would correlate with both facilitated engagement and disengagement difficulty. First, Krain et al. (2008) found that IU was associated with heightened amygdala activity in response to uncertainty cues; based on Cisler and Koster's (2010) suggestion that the amygdala is an important neural region associated with facilitated engagement, this suggested an IU-facilitated engagement association. Second, Schienle et al. (2010) found that IU is associated with diminished prefrontal cortex activation in response to uncertainty cues; based on Cisler and Koster's assertion that impoverished regions of the prefrontal cortex underlie disengagement difficulty, we further predicted the IU-difficulty disengaging association.

We also predicted that anxiety, depression, and general distress each would significantly relate to an uncertainty-related attentional bias. This prediction was based on the previously reviewed findings that IU correlates significantly with each of these variables (McEvoy and Mahoney 2012), as well as findings that anxiety, depression, and general distress all relate to an attentional bias for threat (Bar-Haim et al. 2007; Lonigan and Vasey 2009; Mogg and Bradley 2005). However, we predicted that an IU-attentional bias association would be robust to the effects of each of these variables. This prediction was based on results from Dugas et al. (2005) indicating that the relation between IU and perceived threat of uncertain information was not attributable to either anxiety or depression. Results consistent with these predictions would support the purported role of an information-processing bias in the phenomenology of IU (Carleton 2012), as well as highlight the potential usefulness of attention bias modification interventions (Bar-Haim 2010) for reducing the impact of IU on emotional functioning.

Predictions were based on a unidimensional conceptualization of IU. However, Carleton et al. (2007) found that IU is marked by two dimensions labeled prospective (i.e., cognitive) and inhibitory (i.e., behavioral) IU. Research suggests that these two dimensions have distinct correlates; for the current study, we followed McEvoy and Mahoney's (2012) recommendation to account for both IU dimensions in planned analyses.

Method

Participants and Procedure

The initial sample consisted of 121 psychology students enrolled at a Midwestern U.S. University. Following the extant literature, participants who had elevated rates of incorrect responses on the VST were removed from study analyses (see below for precise details of the procedure). The reduced sample ($N = 104$) had a mean age of 19.1 ($SD = 1.4$) years, was 54 % female, and 39 % White/Caucasian (37 % Black/African-American, 10 % Hispanic/Latino, 9 % Asian, 4 % "Other" race/ethnicity, and 1 % chose not to report their race/ethnicity).

Questionnaires

Intolerance of Uncertainty Scale-12 Item Version (IUS-12; Carleton et al. 2007)

The IUS-12 is a 12-item version of the original 27-item Intolerance of Uncertainty Scale (IUS; Freeston et al. 1994). The IUS-12 assesses prospective (e.g., *Unforeseen events upset me greatly*) and inhibitory (e.g., *The smallest doubt can stop me from acting*) IU on a 5-point scale. The IUS-12 has demonstrated good psychometric properties in prior studies, including total scale convergence of .96 with the 27-item IUS (Carleton et al. 2007). The IUS scales (total: $M = 26.76$, $SD = 9.62$; prospective: $M = 17.39$, $SD = 6.17$; inhibitory: $M = 9.36$, $SD = 3.90$) showed good internal consistency in the present study (Cronbach's α values ranging from to .80–.90).

Penn State Worry Questionnaire (PSWQ; Meyer et al. 1990)

The PSWQ includes 16 items on a 5-point scale to assess the tendency to engage in excessive and uncontrollable worry. This measure has shown adequate psychometric properties in prior studies (e.g., Meyer et al. 1990). The PSWQ ($M = 45.84$, $SD = 13.59$) showed good internal consistency in the present study ($\alpha = .92$).

Center for Epidemiologic Studies-Depression Scale (CES-D; Radloff 1977)

The CES-D is a 20-item measure that assesses depression symptoms over the past week using a 4-point scale. This measure has shown adequate psychometric properties in prior studies (e.g., Santor et al. 1995). The CES-D ($M = 11.50$, $SD = 5.92$) showed good internal consistency in the present study ($\alpha = .84$).

Positive and Negative Affect Schedule (PANAS; Watson et al. 1988)

The PANAS asks respondents to indicate to what extent single-word descriptors capture how they felt on a 5-point scale. The PANAS scale of current interest—Negative Affect (NA)—consists of 10 items and has shown adequate psychometric properties in prior studies (e.g., Watson et al. 1988). PANAS-NA ($M = 14.00$, $SD = 5.32$) showed good internal consistency in the present study ($\alpha = .87$).

Visual Search Task (VST)

Questionnaires and the VST were completed on the same desktop computer. The VST was presented using DirectRT software (version 2006.1: Jarvis 2006). Both tasks required a computer keyboard for participant responses. The VST followed the methodology used by Pineles and colleagues (Pineles et al. 2009; Pineles et al. 2007). It consisted of two primary components (facilitated engagement and disengagement difficulty), with each component consisting of two blocks. The order in which each VST component was completed was counterbalanced across participants. See Fig. 1 for examples of VST trials.

In the facilitated engagement condition, two types of experimental trials were used. Specifically, either an uncertainty word target or a categorized neutral word target (household items) was placed in an array of non-word stimuli (i.e., unpronounceable letter strings with no semantic meaning). Additionally, to improve participant engagement, a third trial category was used in which a non-word target was placed in an array of non-word stimuli. Facilitated engagement for uncertainty stimuli is operationalized as faster responding to uncertainty targets in an array of non-word stimuli, relative to response times to categorized neutral targets in an array of non-word stimuli.

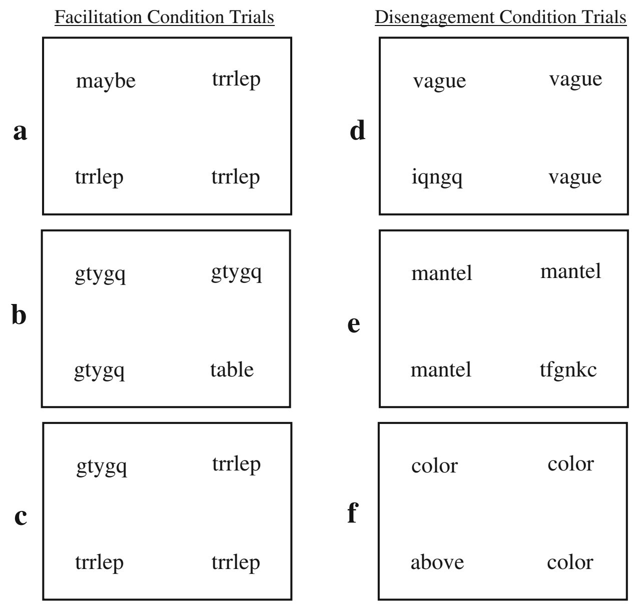

Fig. 1 Example visual search task trials. **a** uncertainty word target in array of non-word stimuli, **b** categorized (i.e., household items) neutral word target in array of non-word stimuli, **c** non-word target in array of non-word stimuli, **d** non-word target in array of uncertainty words, **e** non-word target in array of categorized neutral words, **f** uncategorized neutral word target in array of uncategorized neutral words

In the disengagement difficulty condition, two experimental trials were used in which a non-word target was placed in an array of (a) uncertainty words or (b) categorized neutral words. Again for the sake of engagement, a third trial category was used in which an uncategorized neutral word target was placed in an array of uncategorized neutral words. Disengagement difficulty from uncertainty stimuli is operationalized as slower responding to non-word targets in an array of uncertainty words, relative to response times to non-word targets in an array of categorized neutral words.

For both conditions, participants were informed that the goal of the task was first to identify, from four different strings of letters, the letter string that was different from the rest. Participants then were asked to decide whether the "oddball" letter string was an English word (i.e., lexical decision). Participants were instructed to respond by pressing the "/" key if the oddball target was an English word and the "z" key if the target was not an English word. Participants completed 10 practice trials with visual feedback (Correct or Incorrect) after each trial. Each trial began with the presentation of a fixation cross (+) in the center of the screen for 700 ms, after which four strings of letters appeared on the screen. Letter strings were spaced equally in a rectangular pattern. Stimuli remained on the screen until the participant responded, at which time the stimuli disappeared and the screen remained blank for 1000 ms before the start of the next trial. There were 30 trials in each block (10 trials from each category) and two blocks per condition. Trials were presented randomly within each block and the presentation of blocks was separated by a 30-second delay. For additional details about this methodology, refer to Pineles et al. (2009).

As noted, three types of word-stimuli were used: uncertainty, categorized (household) (e.g., *kettle*, *table*, *cabinet*, *clock*), and uncategorized neutral (e.g., *tower*, *errand*, *market*, *rattle*). The words denoting uncertainty were used by Dugas et al. (2005) and are presented in Table 1. The word category of household items was used to ensure that any observed effects were not the result of category bias. Words representing household items and uncertainty were matched on frequency of usage (Frances and Kucera 1982), length, and number of syllables. As noted, trials with uncategorized neutral words were used to keep participants engaged in the task, rather than losing interest because of an expectation that every oddball target would be a non-word. Trials with uncategorized neutral words were not used in analyses.

Procedure

In a private room, participants completed informed consent, questionnaires, and the VST. Participants then were debriefed and assigned partial course credit toward a research exposure requirement. All study procedures were approved by the University's institutional review board.

Preparation of Stimulus–Response Data

Approximately 12 % ($n = 14$) of participants inflated the mean number of error responses (9.2 % error rate across participants). As noted by Ratcliff (1993), having as few as 57 % (4/7) correct responses per cell may be adequate to provide valid RT data if enough correct responses remain. Given this liberal criterion, we chose a slightly more conservative a priori benchmark by retaining cases which had a minimum of 60 % (12/20) correct responses per cell. This criterion allowed for maximum data retention while maintaining the quality of RT data and resulted in an overall cut point of 20 % error trials for participants removed from the sample (14 %; $n = 17$). In addition, the average error rate fell from 9.2 % to 4.1 %. For the remaining sample, RTs for error trials were replaced by the mean of the particular RT cell, following Ohman et al. (2001). RTs less than 250 ms or greater than 3000 ms were identified as anticipatory responding or outliers, respectively, following Ratcliff.

Anticipatory responses were treated in the same manner as error responses; outliers were winsorized at +3 *SD* from the median for each specific trial (Ratcliff 1993). Two RT scores were calculated. Facilitated engagement was calculated by subtracting mean RTs to uncertainty targets in an array of non-word stimuli from RTs to categorized neutral targets in an array of non-word stimuli. Higher scores represent greater facilitated engagement toward uncertainty stimuli. Disengagement difficulty was calculated by subtracting mean RTs to non-word targets in an array of categorized neutral words from non-word targets in an array of uncertainty words. Higher scores represent greater difficulty disengaging from uncertainty stimuli.

Mean RTs were in a range consistent with those observed in research in which similar VST methodology was used (e.g., Pineles et al. 2009). The mean RT for all trials was 1404 ms ($SD = 277$). For facilitation trials, mean RTs for trials with either an uncertainty target or a categorized neutral target were $M = 1374$ ms ($SD = 293$) and $M = 1373$ ms ($SD = 284$), respectively. For disengagement trials, mean RTs for trials with a non-word target in either an array of uncertainty words or an array of categorized neutral words were $M = 1441$ ms ($SD = 313$) and $M = 1427$ ms ($SD = 294$), respectively.

Table 1 Uncertainty Stimuli used for the Visual Search Task (VST)

Word
Chance
Maybe
Perhaps
Random
Unclear
Uncertain
Unforeseen
Unknown
Unsure
Vague

Results

Correlations with Attentional Bias for Uncertainty Stimuli

Zero-order correlations among the study variables are presented in Table 2. As shown, only IU (total scale, prospective, inhibitory) correlated with facilitated engagement on the VST. However, tests of the strength of dependent correlations (Meng et al. 1992) revealed the magnitude of the correlation between IU (total scale, prospective, inhibitory) and facilitated engagement was not significantly stronger than the correlation between the other study variables and facilitated engagement (z-statistics ranged from 0.65 to 1.30, *ns*). None of the study variables correlated with disengagement difficulty on the VST.

Partial Correlations Between IU and Facilitated Engagement

Partial correlations between IU (total scale, prospective, inhibitory) and facilitated engagement on the VST while controlling for anxiety, depression, or general distress are presented in Table 3. As shown, only inhibitory IU consistently shared a significant correlation with facilitated engagement after controlling for each covariate.

Discussion

The present results provide the first known empirical evidence of an association between IU and a specific type of attentional bias for information denoting uncertainty. IU significantly positively correlated with facilitated engagement toward uncertainty stimuli, such that higher IU was associated with faster identification of uncertainty stimuli relative to neutral stimuli. Conversely, IU was not associated with difficulty disengaging from uncertainty stimuli. The relation between IU, particularly inhibitory IU, and facilitated engagement was generally robust to the effects of anxiety, depression, or general distress.

These results suggest that facilitated engagement is the specific underlying attentional process that accounts for the IU-attentional bias association. Cisler and Koster (2010) noted that, based on neurobehavioral research, a threat detection mechanism operating primarily at the level of automatic processing likely is responsible for facilitated engagement toward threat stimuli. They further suggested that the amygdala is the brain structure that likely corresponds to such a threat detection mechanism. Preliminary data support the importance of this structure in the processing of information denoting uncertainty, as IU is associated with heightened amygdala activity in response to uncertainty cues (Krain et al. 2008). The potentially automatic nature of an uncertainty-related attentional bias is consistent with Carleton (2012), who posited that IU is associated with the automatic tendency to classify novel information as threatening. The present results further suggest that IU might be associated with hypervigilance for information denoting uncertainty, as Pineles et al. (2009) asserted that evidence of facilitated engagement might be indicative of hypervigilance for threat information. Consistent with conclusions reached by Carleton, this hypervigilance for information denoting uncertainty might lead to continually high perceptions of threat and increased levels of arousal/anxiety.

The relation between IU and facilitated engagement for uncertainty-related information appears specific to IU, in that anxiety, depression, and general distress did not correlate with this attentional bias. Whereas the magnitude of the raw relation between IU and facilitated engagement was comparable in size to the raw relation between facilitated engagement and anxiety, depression, or general distress, partial correlation analyses highlighted the robustness of the relation between IU and facilitated engagement. More specifically, anxiety, depression, and general distress shared near-zero partial correlations with facilitated engagement after controlling for IU. However, IU, particularly inhibitory IU, continued to significantly correlate with facilitated engagement after controlling for anxiety, depression, or general distress. The IU-attentional bias relation thus does not appear attributable to the overlap with these variables.

Although it was predicted that anxiety, depression, and general distress would correlate with an uncertainty-related attentional bias, their non-significant relations with the

Table 2 Zero-order correlations among study variables

Variable	1	2	3	4	5	6	7
1. Intolerance of uncertainty scale-short form	–						
2. Intolerance of uncertainty scale-short form-prospective	.97**	–					
3. Intolerance of uncertainty scale-short form-inhibitory	.93**	.82**	–				
4. Penn state worry questionnaire	.68**	.69**	.59**	–			
5. Center for epidemiological studies-depression scale	.48**	.44**	.47**	.51**	–		
6. Positive and negative affect schedule-negative affect	.43**	.40**	.42**	.52**	.54**	–	
7. Facilitated engagement	.22*[a]	.20*[a]	.22*[a]	.12[a]	.09[a]	.13[a]	–
8. Disengagement difficulty	.02	.00	.07	.15	.03	−.09	−.01

$N = 104$. Italicized values reflect part-whole correlations. ** $p < .01$; * $p < .05$ (two-tailed). Superscripts denote statistically equivalent correlations in magnitude

Table 3 Partial correlations controlling for overlap with depression, anxiety, or general distress

Variable	Facilitated Engagement Partial *r*
Controlling for anxiety	
Penn state worry questionnaire	−.03
Intolerance of uncertainty scale-short form	.18
Penn state worry questionnaire	−.02
Intolerance of uncertainty scale-short form-prospective	.15
Penn state worry questionnaire	−.01
Intolerance of uncertainty scale-short form-inhibitory	.19^{+}
Controlling for depression	
Center for epidemiological studies-depression scale	−.01
Intolerance of uncertainty scale-short form	.20*
Center for epidemiological studies-depression scale	.01
Intolerance of uncertainty scale-short form-prospective	.17
Center for epidemiological studies-depression scale	−.01
Intolerance of uncertainty scale-short form-inhibitory	.21*
Controlling for general distress	
Positive and negative affect schedule-negative affect	.03
Intolerance of uncertainty scale-short form	.18
Positive and negative affect schedule-negative affect	.04
Intolerance of uncertainty scale-short form-prospective	.16
Positive and negative affect schedule-negative affect	.02
Intolerance of uncertainty scale-short form-inhibitory	.20*

$N = 104$. * $p < .05$; $^{+}$ $p = .05$ (two-tailed)

attentional bias indices are actually consistent with results from Nelson and Shankman (2011). These researchers found that IU, but not anxiety (i.e., worry), correlated with startle response, which is another automatic process putatively important to IU and anxiety disorders. The present results also converge with Nelson and Shankman's finding that inhibitory IU was the IU dimension most relevant to startle response. Nelson and Shankman found that low perceived control of anxiety-related events mediated the relationship between inhibitory IU and startle response. In the context of the present results, one possibility is that individuals with elevated inhibitory IU are hypervigilant for threat as a result of low perceived control over anxiety-related events. Future studies might test this possibility via examining whether perceived control mediates the IU-facilitated engagement association.

To the degree to which IU is uniquely related to facilitated engagement for information denoting uncertainty, then existing attention modification techniques (Bar-Haim 2010) that are used to reduce attentional biases for threat might not be particularly effective for reducing an uncertainty-related attentional bias. This possibility is based on preliminary data suggesting that difficulties disengaging from threat stimuli are a mechanism by which attention modification techniques for certain anxiety disorders operate (e.g., social anxiety; Heeren et al. 2011). To reduce automatic attentional biases, Mobini and Grant (2007) proposed that exposure-based interventions might be particularly effective, as these interventions appear to block further elaborative processing of threat stimuli. As such, future studies might seek to examine whether the relation between IU and uncertainty-related attentional bias is attenuated after completing exposures designed to decrease IU (Dugas and Robichaud 2007).

The present findings should be considered with the following limitations in mind. First, participants consisted of a sample of college students unselected for level of IU. Although this methodology is consistent with the current dimensional (non-taxonic) conceptualization of IU (Carleton, Weeks et al. 2012), it will be important for future research to ensure the present findings generalize to samples marked by individuals who consistently score higher on measures of IU, such as anxiety disordered samples (Carleton, Mulvogue et al. 2012). Second, although we used stimuli that Dugas et al. (2005) found to denote uncertainty, the study of attentional biases via word stimuli has been criticized (Bar-Haim et al. 2007). However, Bar-Haim et al. found no difference between the combined effect sizes in attentional biases when using word versus pictorial stimuli. As such, the choice of stimuli was not likely responsible for the magnitude of their observed attentional bias effect. Further, others advocate for the use of word stimuli when looking at attentional biases because these stimuli capture a wider range of experiences than do pictorial stimuli (Pineles et al. 2009). Overall, our method was viewed as appropriate for the current study.

A third limitation was that questionnaire administration was not counterbalanced and thus its completion before the VST might have affected observed relations with the attentional biases. However, this sequencing is unlikely to account for the relative specificity observed in these data, as relations between each questionnaire and attentional biases would presumably have been similarly affected by this methodology. Fourth, although the magnitude of our effect is consistent with the size of other attentional bias effects identified in the literature (e.g., Bar-Haim et al. 2007), the attentional bias observed in the present study was only modest in size. Finally, existing research suggests that the VST is a useful task in distinguishing between facilitated engagement and disengagement difficulty (Cisler et al. 2009). However, as noted by Cisler et al., the VST has been used less frequently relative to other tasks, such as the dot-probe, and the convergent validity of attentional bias tasks has yet to be sufficiently examined.

Future studies might thus seek to replicate the present results using alternative tasks. Along similar lines, future research may seek to more directly investigate the degree of automaticity in the attentional bias for uncertainty information by using a task with subliminally presented uncertainty stimuli.

Limitations notwithstanding, the present study provides an important step in further elucidating relations between IU and uncertainty stimuli. More specifically, it revealed that IU, particularly inhibitory IU, is associated with facilitated engagement toward information denoting uncertainty. Although questions remain surrounding the association between IU and attentional biases, advancements in our understanding of this association might lead to the development and use of treatment strategies that seek to reduce the impact of both IU and attentional biases on symptoms of anxiety and perhaps other forms of psychopathology.

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