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How is the Beads Task related to intolerance of uncertainty in anxiety disorders?

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ABSTRACT

Intolerance of uncertainty (IU) is a cognitive bias associated with anxiety disorders that has only been reliably measured using self-report instruments. The current study investigated relationships between a probabilistic inference task – the Beads Task – and self-report IU. Individuals with anxiety disorders (ANX) and non-anxious controls (NAC) completed self-report measures as well as the Beads Task at three levels of difficulty. The Beads Task successfully induced task-related uncertainty as the decision became more difficult. While the two groups did not differ on the observable performance related measures, the ANX group was significantly more distressed during the task than were the NACs. Moreover, among the ANX group, self-reported IU was correlated with draws to decision and distress during the task. The Beads Task appears to provoke distress associated with uncertainty for anxious individuals, rather than altering their behavioral responses; thus, clinical implications and avenues for future research are discussed.

1. Introduction

Intolerance of uncertainty (IU) has been defined as "a cognitive bias that affects how a person perceives, interprets, and responds to uncertain situations (i.e., ones in which the future outcome is indefinite) on a cognitive, emotional, and behavioral level" (Dugas, Schwartz, & Francis, 2004, p. 835; parentheses added). It specifically refers to "beliefs about the necessity of being certain, about the capacity to cope with unpredictable change, and about adequate functioning in situations which are inherently ambiguous" (Obsessive Compulsive Cognitions Working Group [OCCWG], 1997, p. 678). Individuals who are high in IU have a lower perceptual threshold of ambiguity, find uncertainty to be distressing, believe that uncertainty is negative, think it should be avoided, and have difficulty functioning in uncertain or ambiguous situations (Buhr & Dugas, 2002; Krohne, 1993). They also tend to apply ineffective problem solving strategies in uncertain situations, overestimate the possibility of unpredictable negative events, and make threatening interpretations of ambiguous information (Ladouceur, Talbot, & Dugas, 1997). Given the ubiquity of ambiguity and uncertainty in everyday life, individuals high in IU tend to experience heightened daily distress.

IU is considered an important domain of dysfunctional cognition associated with anxiety disorders. However, its role in obsessive-compulsive disorder (OCD; OCCWG, 1997) and generalized anxiety disorder (GAD; Dugas, Buhr, & Ladouceur, 2004), has received the most attention. In OCD, IU is one of the cognitive biases involved in the misinterpretation of unwanted intrusive thoughts that leads to the development and maintenance of obsessions and compulsions (OCCWG, 1997). Empirical studies with clinical and nonclinical samples consistently indicate a relationship between self-reported IU and OC symptoms (Boelen & Carleton, 2012; Calleo, Hart, Björgvinsson, & Stanley, 2010; Dugas, Gosselin, & Ladouceur, 2001; Holaway, Heimberg, & Coles, 2006; Jacoby, Fabricant, Leonard, Riemann, & Abramowitz, 2013; Mahoney & McEvoy, 2012; McEvoy and Mahoney, 2011, 2012; Tolin, Abramowitz, Brigidi, & Foa, 2003; Tolin, Worhunsky, & Maltby, 2006), even after controlling for depression, anxiety sensitivity, and worry (Steketee, Frost, & Cohen, 1998).

Similarly, theoretical models of GAD posit that the extreme worry represents an attempt to control the uncertainty associated with feared future situations (Dugas et al., 2004a; Freeston, Rhéaume, Letarte, & Dugas, 1994), and a large body of research supports a strong association between self-reported IU and worry in both undergraduate and clinical samples, even after controlling for various demographic and clinical factors (Boelen & Carleton, 2012; Buhr & Dugas, 2006; Dugas, Freeston, & Ladouceur, 1997; Dugas et al., 2001; Dugas et al., 2004a; Fergus & Wu, 2010; Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2012; Norton, Sexton, Walker, & Norton, 2005; Sexton, Norton, Walker, & Norton, 2003). More severe GAD symptoms are also associated with

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greater self-reported IU (Dugas et al., 2007). Finally, experimental manipulation of IU has been found to increase worry, which suggests a possible causal association between the two variables (De Bruin, Rassin, & Muris, 2006; Grenier & Ladouceur, 2004; Ladouceur, Gosselin, & Dugas, 2000; Rosen & Knäuper, 2009).

Although the majority of theoretical and empirical work on IU has focused on its association with OCD and GAD symptoms, IU is also associated with numerous other anxiety disorders, including panic disorder (Dugas et al., 2001 Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2011 Dugas et al., 2001 Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2011 McEvoy & Mahoney, 2011; Norton et al., 2005), health anxiety (Boelen & Carleton, 2012; Deacon & Abramowitz, 2008; Fergus & Valentiner, 2011; Norton et al., 2005), and social phobia (Boelen and Reijntjes (2009); Carleton, Collimore, & Asmundson, 2010; Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2012). Thus, it appears that IU represents a transdiagnostic cognitive vulnerability across the anxiety disorders (Carleton et al., 2012).

An important limitation of the existing research on IU, however, is that studies rely almost exclusively on two self-report measures of this construct, the Intolerance of Uncertainty Scale (IUS-12; Carleton, Norton, & Asmundson, 2007; Freeston et al., 1994 and the Perfectionism/Certainty subscale of the Obsessive Beliefs Questionnaire (OBQ-PC; OCCWG, 2001, 2005; both described further below).[1] While there is strong evidence for the validity of these scales as measures of IU (Carleton et al., 2007; OCCWG, 2001, 2005), the literature would benefit from methodologically varied measurement of this construct. The Beads Task, a probabilistic inference task that involves deciding from which jar a series of beads has been drawn, has been conceptualized as a behavioral measure of IU (Ladouceur et al., 1997): individuals who are high in IU are expected to require more pieces of information (i.e., more beads) before they feel certain enough to make a decision.

In the original Yes–No version of the Beads Task (Huq, Garety, & Hemsley, 1988; Phillips & Edwards, 1966), participants were shown two jars holding 100 beads of two different colors in a particular ratio (e.g., 85:15 red to blue vs. 85:15 blue to red). Participants were then told that beads were going to be drawn one by one with replacement from one of these two jars, and that each jar was equally likely to be chosen. The participant's task was to determine from which jar the beads were being drawn. They were told that they could request as many beads as necessary to decide, and were asked after each bead was drawn whether they required more draws, or if they had come to a decision. The sequence of beads in reality was predetermined using a random number generator and this order was used for all participants. In more difficult versions of the task, the ratio of different colored beads was closer to 1:1. The outcome measure was the number of beads participants requested before feeling "certain" about making a decision (i.e., draws to decision; DTD).

Ladouceur and colleagues (1997) were the first to examine how performance on the Beads Task is related to IU. With a non-clinical sample, these authors found a positive correlation between scores on the IUS and DTD in a moderately difficult version of the task, but not in a highly difficult version. Accordingly, they concluded that especially low and high levels of ambiguity (i.e., task difficulty) lead to low and high levels of uncertainty respectively regardless of IU, and that moderately ambiguous situations, in particular, would distinguish most clearly between individuals high and low in IU.

Although no studies to date have compared performance on the Beads Task across different anxiety disorders, several investigations suggest that individuals with OCD require more evidence before making decisions than do individuals with depression, phobias, and non-anxious controls (Fear & Healy, 1997; Foa et al., 2003; Milner, Beech, & Walker, 1971; Toffolo, Hout, Hooge, Engelhard, & Cath, 2013 Volans, 1976). Similar results have been found with individuals with high self-reported worry compared to those with low worry (e.g., Tallis, Eysenck, & Mathews, 1991). Most of these studies, however, suffered from methodological limitations such as very small sample sizes, the use of overly "easy" versions of the Beads Task (i.e., 85:15 ratios which might not have captured differences between those with high and low IU), and, most importantly, self-reported IU was never measured or correlated with Beads Task performance.

Time to decision is a second Beads Task outcome that has been examined, although with mixed results. While some studies have found that individuals with OCD (Fear & Healy, 1997) and high levels of worry (Metzger, Miller, Cohen, Sofka, & Borkovec, 1990) took more time to make an ambiguous decision compared to non-anxious controls, the majority of Beads Task studies have not reported time to decision. Finally, one study examining Beads Task performance in a sample of participants with eating disorders found that individuals with bulimia and anorexia nervosa were more distressed by the task than were non-clinical controls (Sternheim, Startup, & Schmidt, 2011). No studies of the Beads Task among individuals with anxiety disorders have reported distress evoked by the task, even though this would seem to be an important dependent variable to measure in order to assess IU.

Given the gaps and limitations of the existing work on IU, the present study aimed to elucidate the association between IU and these outcomes of the Beads Task (DTD, time, distress) in a clinical sample. Specifically, we first compared performance on the Beads Task-with three levels of difficulty/uncertainty-in a group of individuals with various anxiety disorders (ANX group) to a group of non-anxious controls (NAC group). We expected that all participants would request more beads, take more time to decide, and feel less certain and more distressed as the level of task difficulty increased (difficult > intermediate > easy). We also hypothesized significant differences between groups on the intermediate version of the task; specifically, we expected that compared to the NAC group, the ANX group would (a) request more beads, (b) take more time to decide, and (c) be more distressed following their decision. Second, we examined relationships between Beads Task performance and self-reported IU in our ANX group. We hypothesized that Beads Task-related outcomes would be positively associated with scores on both Self-Report Scales of IU (the OBQ-PC and IUS-12). Finally, we predicted positive associations between Beads Task outcomes and symptom measures of general distress, worry, and OCD.

2. Material and methods

2.1. Participants

Sixty-nine adults with anxiety disorders and 26 undergraduate students without any anxiety disorder diagnoses participated in the study.[2] Student participants (NACs) were recruited from

[1] The intolerance of uncertainty index (IUI; Carleton et al., 2010b; Gosselin et al., 2008) is a more recently developed measure of IU that has been less widely used in the literature. The IUI is more symptom-focused and was developed for use as a clinical outcome measure, whereas the IUS-12 and the OBQ-44 were both designed to be used in research with clinical and non-clinical populations. Thus, the latter two questionnaires are the focus of the current study.

[2] Of the 100 individuals who were screened for the study, 4 were ineligible based on the diagnostic interview (specifically 2 undergraduates met criteria for one or more anxiety disorders and two community members did not meet full diagnostic criteria). Additionally, one individual was excluded from data analysis because he emailed the principal investigator after the study saying that he realized he had misunderstood the rules of the Beads Task.

Introduction to Psychology classes at the University of North Carolina at Chapel Hill (UNC-CH) and received 1 h of research credit in exchange for their participation. Individuals with anxiety disorders (ANXs) were recruited from the community via letters distributed to local treatment providers, flyers posted locally, and advertisements. Of the ANX group, 36% ($n = 25$) met diagnostic criteria for social phobia, 32% ($n = 22$) for OCD, 4% ($n = 3$) for PTSD, 41% ($n = 28$) for GAD, and 25% ($n = 17$) for specific phobia.[3] Of the ANX group, 58% ($n = 40$) reported ever receiving treatment, and 36.2% ($n = 25$) reported receiving treatment currently. Of those reporting ever receiving treatment, 87.5% ($n = 35$) said they received both medication and therapy and 12.5% ($n = 5$) reported receiving therapy only. Demographic characteristics of the two samples are displayed and compared in Table 1. The ANX group was significantly older, more educated, and more female relative to the NAC group.

Table 1
Demographic characteristics by diagnostic group.

	NAC $n = 26$	ANX $n = 69$	Test for difference	Effect size
Age (years), *M* (*SD*)	18.86 (1.07)	31.65 (13.63)	$t(70) = 7.73^{**}$	$d = 1.84$
Years of education, *M* (*SD*)	14.16 (0.83)	16.90 (2.36)	$t(93) = 8.39^{**}$	$d = 1.74$
Gender, % female (*n*)	53.8 (14)	79.7 (55)	$\chi^2(1) = 6.36^{*}$	$\varphi = .26$
Race/ethnicity, % (*n*)			χ^2 (4) = 9.39	$\varphi_c = .31$
African, American or Black	3.8 (1)	14.5 (10)		
White	88.5 (23)	68.1 (47)		
Latino or Hispanic	7.7 (2)	1.4 (1)		
Asian	0 (0)	13.0 (9)		
Other or multiethnic	0 (0)	2.9 (2)		

* $p < .05$.
** $p < .001$.

2.2. Measures

2.2.1. Mini-International Neuropsychiatric Interview Version 5.0 (MINI; Sheehan et al., 1998)

The MINI is a structured diagnostic interview to determine DSM-IV Axis I diagnoses with adequate psychometric properties and a strong correlation with the SCID-IV (Sheehan et al., 1997). All participants were given the anxiety disorder modules of the MINI to determine diagnostic status.

2.2.2. Intolerance of Uncertainty Scale, Short Form (IUS-12; Carleton et al., 2007)

The IUS-12 is a shortened version of the original 27-item IUS (Freeston et al., 1994) that measures reactions to uncertainty, ambiguous situations, and the future (e.g., "Uncertain events upset me greatly"). We used this version in the current study because the 27-item version has several items that pertain specifically to GAD and might better account for symptoms of worry than those of other anxiety disorders (Carleton, Gosselin, & Asmundson, 2010; Gentes & Ruscio, 2011). Participants rate each item on the IUS-12 from 1 (*Not at all characteristic of me*) to 5 (*Entirely characteristic of me*). The measure consists of two subscales thought to represent approach and avoidance responses to uncertainty respectively (Birrell, Meares, Wilkinson, & Freeston, 2011): (a) Prospective IU (the cognitively focused dimension), measures desire for predictability, preferences for knowing what the future holds, anxiety about future uncertain events, and active engagement in seeking information to increase certainty, and (b) Inhibitory IU (the behaviorally focused dimension) measures avoidance and paralysis in the face of uncertainty. The IUS-12 has good psychometric properties in both clinical and non-clinical samples (Carleton et al., 2012, 2007; Helsen, Van, Vlaeyen, & Goubert, 2013; Jacoby et al., 2013; Khawaja & Yu, 2010; McEvoy & Mahoney, 2011). Internal consistency of the IUS-12 subscales in the present sample was excellent ($\alpha = .91$–$.92$).

2.2.3. Obsessive Beliefs Questionnaire-44 (OBQ-44; OCCWG, 2001, 2005)

This is a 44-item self-report instrument that measures dysfunctional (i.e., obsessive) beliefs hypothesized to underlie OCD symptoms. It contains three subscales: (a) threat overestimation and responsibility (OBQ-RT; 16 items), (b) perfectionism and need for certainty (OBQ-PC; 16 items), and (b) importance and control of thoughts (OBQ-ICT; 12 items). Individuals rate items on a Likert scale ranging from 1 (*Disagree very much*) to 7 (*Agree very much*). The instrument has good validity, internal consistency, and test-retest reliability (OCCWG, 2001, 2005). Internal consistency of the OBQ-44 subscales in the present sample was excellent ($\alpha = .93$–$.95$).

2.2.4. Dimensional Obsessive-Compulsive Scale (DOCS; Abramowitz et al., 2010)

The DOCS is a 20-item self-report measure that assesses the severity of the most consistently replicated OCD symptom dimensions in four subscales: (1) concerns about germs and contamination, (2) concerns about being responsible for harm, injury, or bad luck, (3) unacceptable thoughts, and (4) concerns about symmetry, completeness, and the need for things to be "just right". Each subscale begins with a general description of the symptom dimension and specific examples of representative obsessions and compulsions. Then within each symptom dimension, five items (rated 0–4) assess the following parameters of severity over the past month: (a) time occupied, (b) avoidance, (c) distress, (d) interference, and (e) difficulty disregarding obsessions and refraining from compulsions. The DOCS subscales have good to excellent reliability in clinical OCD, other anxiety disorder, and undergraduate samples. The measure also has good convergent, discriminant, and known groups validity. Internal consistency of the DOCS subscales in the present sample was excellent ($\alpha = .94$–$.95$).

2.2.5. Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990)

The PSWQ is a 16-item scale that measures the tendency to engage in excessive, uncontrollable, and generalized worry. The scale assesses the intensity and excessiveness of worry without regard to its specific content and represents a unidimensional construct. Participants rate items on a five-point Likert scale ranging from 1 (*Not at all typical*) to 5 (*Very typical*). Sample items include: "My worries overwhelm me" and "Once I start worrying I can't stop". The PSWQ has good internal consistency, reliability, and criterion-related validity in undergraduate and clinical samples (Brown, Antony, & Barlow, 1992; Meyer et al., 1990; Molina & Borkovec, 1994). Internal consistency of the PSWQ in the present sample was excellent ($\alpha = .95$).

2.2.6. Depression Anxiety and Stress Scale (DASS-21; Antony, Bieling, Cox, Enns, & Swinson, 1998; Lovibond & Lovibond, 1995)

The DASS-21 is a 21-item self-report measure of general depression, hyperarousal, and tension over the past week. It contains three seven-item subscales: depression (DASS-D), which measures dysphoric mood (e.g. sadness or worthlessness); anxiety (DASS-A), which measures symptoms of physical arousal, panic

[3] Note, these percentages do not add to 100% because individuals could be given more than one diagnosis.

attacks, and fear (e.g. trembling or faintness); and stress (DASS-S), which measures symptoms such as tension, irritability, agitation, and overreaction to stressful events. Participants rate items on a four-point Likert scale ranging from 0 (*Did not apply to me at all*) to 3 (*Applied to me very much, or most of the time*) and then total scores are multiplied by 2 in order to compare to full scale DASS-42 scores. The DASS-21 has an excellent factor structure and the subscales have good to excellent internal consistency (Antony et al., 1998). It also has good convergent and known groups validity. Internal consistency of the DASS in the present sample was excellent ($\alpha = .94$).

2.2.7. Beads Task (Huq et al., 1988; Phillips & Edwards, 1966)

The version of the Beads Task used in the current study was computerized and consisted of three levels of difficulty/uncertainty: (a) an easy or low uncertainty version consisting of 2 jars with a 85:15 blue to red vs. 85:15 red to blue ratio, (b) an intermediate uncertainty version consisting of 2 jars with a 60:40 purple to green vs. 60:40 green to purple ratio, and (c) a difficult or high uncertainty version consisting of 3 jars with a 44:28:28 orange to yellow to pink vs. 44:28:28 yellow to pink to orange vs. 44:28:28 pink to orange to yellow ratio. Following Sternheim et al. (2011)'s methodology, the maximum possible number of beads that could be requested before making a decision was 30.

The sequences of beads in the three conditions (easy, intermediate, and difficult) are listed below. The first 20 beads from the easy and intermediate conditions are modeled after Garety et al. (2005). The rest of the sequences were determined using a random number generator.

Low uncertainty condition (easy) – 85 red (R): 15 blue (B)
Mostly red – RRRBRRRBRRRBRRRBRRRRRBRRRBRRRR
Intermediate uncertainty condition (intermediate) – 60 purple (P): 40 green (G)
Mostly purple – PGGPPGPPPGPPPPGGPGGPPGGPGGPPPP
High uncertainty condition (difficult) – 44 orange (O): 28 yellow (Y): 28 pink (P)
Mostly orange – POOYYPOYOYYPOPOOPPOYPOYOOOPYYO

Because of the possibility of memory biases and deficits (e.g., Deckersbach, Otto, Savage, Baer, & Jenike, 2000), and decreased memory confidence in some anxiety disorders (e.g., Tolin et al., 2001), all participants were able to see the beads from previous trials displayed at the bottom of their computer screen in order to eliminate any possible influence of memory on the Beads Task.

The experimenter recorded (a) the number of beads the participant selected before making a decision (i.e., draws to decision, DTD), (b) time taken to reach the decision, and (c) accuracy of the participant's decision. Participants also completed a series of three questions (at the end of each version of the task) by dragging their cursor along a visual analogue scale on the computer screen that ranged from 0 (*Not at all*) to 100 (*Very much*). The questions were: (a) "how certain are you about your decision?", (b) "how distressed do you feel right now?", and (c) "how important is it for you to get the answer right?" (which was used to check that participants were engaged in the task).

2.3. Procedure

The study was described to all participants as a 1 h experiment investigating "probability and decision-making". Participants were informed that they would be given an interview by a trained research assistant; asked to answer questions on the computer about thoughts, feelings, and behaviors; and that they would complete a probability decision-making task on the computer with the help of the research assistant.

All participants were tested individually in the laboratory. The experimenter first obtained informed consent, and then administered the anxiety disorder modules of the MINI. Using the computer program Qualtrics, participants then completed a demographic survey and the study measures described above. Finally, participants completed the Beads Task—initially a practice version (in order to learn the probabilistic rules of the task), and then the three different experimental versions (in a counterbalanced order)—with the aid of the experimenter (since the presence of an experimenter has been found to increase reliability of the task; Fear & Healy, 1997). At the end of the visit, participants were debriefed. Students received 1 h of credit toward the research requirement of Introduction to Psychology, and individuals with anxiety disorders received $10 as compensation for their time.

3. Results

3.1. Missing data

There was a small percentage of missing self-report data, so we began by analyzing the patterns of missing values. Given the relatively low fraction of missing information both within variables (<2%) and within participants (≤5%) as well as the high relative efficiency of our estimates for variables with missing data (>99%) we chose to use single imputation to estimate our missing data.

Table 2
Means and standard deviations on self-report study measures by diagnostic group.

	NAC $n = 26$	ANX $n = 69$	Independent samples t-test	Cohen's d
IUS-12				
Prospective IU	12.77 (3.98)	22.91 (6.04)	$t(68) = 9.50^{*}$	2.30
Inhibitory IU	6.30 (1.81)	13.34 (4.95)	$t(93) = 10.14^{*}$	2.10
DOCS				
Contamination	1.27 (1.49)	4.86 (4.88)	$t(91) = 5.47^{*}$	1.15
Responsibility for harm	1.04 (1.46)	7.00 (4.43)	$t(92) = 9.86^{*}$	2.06
Unacceptable thoughts	1.08 (1.88)	6.75 (5.35)	$t(93) = 7.66^{*}$	1.59
Symmetry	1.04 (1.64)	5.33 (4.59)	$t(93) = 6.72^{*}$	1.39
OBQ-44				
Responsibility/threat	45.04 (17.82)	70.65 (20.11)	$t(93) = 5.70^{*}$	1.18
Perfectionism/certainty	53.32 (18.29)	75.77 (20.93)	$t(93) = 4.82^{*}$	1.00
Importance/control of thoughts	27.88 (11.71)	40.86 (17.71)	$t(68) = 4.14^{*}$	1.00
PSWQ	39.26 (15.09)	66.24 (10.32)	$t(93) = 7.78^{*}$	1.61
DASS	11.23 (9.55)	49.20 (24.11)	$t(93) = 10.99^{*}$	2.28

* $p < .001$.

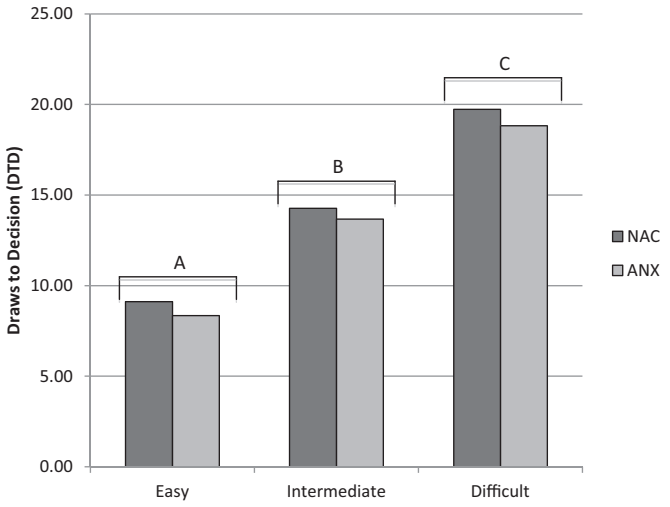

Fig. 1. Draws to decision by diagnostic group for each version of the Beads Task. *Note.* Different uppercase superscripts represent significant task version differences ($p < .05$).

3.2. Group comparisons on self-report measures

Group mean scores on the self-report measures of symptoms and cognitions, along with the results of independent samples *t*-tests examining group differences, appear in Table 2. As expected, the ANX group had significantly higher scores on all cognitive and symptom measures compared to the NAC group, with moderate to large effect sizes.

3.3. Group comparisons on Beads Task performance

3.3.1. Preliminary analyses

First, analyses were conducted to examine participant accuracy on the three versions of the Beads Task and perceived importance of the task overall. There was a 100% accuracy rate on the easy version of the task, and 95% ($ns = 90$) accuracy rates on both the intermediate and the difficult versions. On average, participants indicated that it was moderately important to answer correctly on the Beads Task ($M = 43.58$, $SD = 29.98$).

Second, as a manipulation check we examined whether individuals experienced less certainty after completing more difficult versions of the Beads Task, and whether there were group differences on certainty on the three task versions. A 3 (task version) × 2 (group) mixed ANOVA on ratings of certainty after completing the task revealed a main effect of task difficulty, $F(2, 186) = 88.27$, $p < .001$, $\eta_p^2 = .49$. Post-hoc paired samples *t*-tests revealed that participants reported being significantly less certain after completing the difficult version ($M = 47.97$, $SD = 22.72$) compared to the intermediate version ($M = 61.38$, $SD = 21.57$), $t(94) = 7.22$, $p < .001$. In addition, participants reported being significantly less certain after completing the intermediate version compared to the easy version ($M = 75.39$, $SD = 20.38$), $t(94) = 7.59$, $p < .001$. Thus, as expected, the more difficult the task version, the more uncertain participants felt after deciding. There was no main effect of diagnostic group on certainty, $F(1, 93) = 2.35$, $p = .13$, $\eta_p^2 = .03$. There also was no task version by diagnostic group interaction, $F(2, 186) = .41$, $p = .66$, $\eta_p^2 = .01$.

3.3.2. Draws to decision

Fig. 1 shows the mean DTD on the Beads Task by group for the easy, intermediate, and difficult task versions. To examine the hypothesized group differences (ANX > NAC), we computed a 3 (task version) × 2 (group) ANOVA with DTD as the dependent variable. This analysis revealed a main effect of task difficulty, $F(2, 186) = 91.22$, $p < .001$, $\eta_p^2 = .50$. As is clear from Fig. 1, post-hoc paired samples *t*-tests revealed that participants requested more beads on the difficult version of the task than on the intermediate version, and on the intermediate, than the easy version ($ps < .001$). There was no main effect of diagnostic group, $F(1, 93) = .30$, $p = .58$, $\eta_p^2 = .01$. There also was no task version by group interaction, $F(2, 186) = .02$, $p = .98$, $\eta_p^2 = .01$.

3.3.3. Time[4]

Fig. 2 shows the mean time (in seconds) that elapsed before making a decision on the Beads Task by group for the easy, intermediate, and difficult task versions. A 3 (task version) × 2 (group) ANOVA with time to decision as the dependent variable revealed a main effect of task difficulty, $F(2, 186) = 64.52$, $p < .001$, $\eta_p^2 = .41$. As can be seen in Fig. 2, post-hoc paired samples *t*-tests revealed that participants took more time to decide on the difficult, than on the intermediate version of the task; and on the intermediate than on the easy version ($ps < .001$). There was no main effect of group, $F(1, 93) = .29$, $p = .59$, $\eta_p^2 < .01$. There also was no task version by diagnostic group interaction, $F(2, 186) = .68$, $p = .51$, $\eta_p^2 = .01$.

3.3.4. Distress

Fig. 3 shows the mean distress level reported by participants after making a decision by Beads Task level and by group. A 3 (task version) × 2 (group) ANOVA revealed a main effect of task difficulty on distress, $F(2, 186) = 8.61$, $p < .001$, $\eta_p^2 = .09$. As is clear from Fig. 3, post-hoc paired samples *t*-tests revealed that participants were more distressed by the difficult version than the intermediate version ($p = .005$), and more distressed by the intermediate version than the easy version ($p = .002$). There was also a main effect of group, $F(1, 93) = 20.31$, $p < .001$, $\eta_p^2 = .18$; the ANX group was significantly more distressed after completing the Beads Task than the NAC group. There also was a task version by diagnostic group interaction, $F(2, 186) = 3.03$, $p = .04$, $\eta_p^2 = .03$, such that the ANX group reported increasingly more distress as the task became more difficult, while the NAC group remained consistently non-distressed across the three task versions.

3.4. Pearson's correlations between Beads Task performance and self-report measures

3.4.1. IU and other cognitive variables

We computed correlations (within the ANX group) between the primary Beads Task variables and the self-report cognition measures (OBQ-PC and IUS-12) for each version of the Beads Task. A Bonferroni corrected alpha of .01 was used to correct for multiple tests within each task version (.05/5). The magnitude of correlations ranged from .01 to .40. This analysis revealed that DTD on the intermediate Beads Task version was moderately positively associated with IU as measured by the OBQ-PC, $r(69) = .36$, $p < .01$, but not as measured by the IUS-12 subscales. Time to decision was not associated with any self-report measures of IU. Self-reported distress levels following the intermediate and difficult Beads Task versions, however, were moderately positively associated with scores on the OBQ-PC (intermediate: $r(69) = .34$, $p < .01$;

[4] Two participants were identified who had time scores on the intermediate version of the Beads Task that were >3 SDs above the mean. ANOVA analyses were computed both with and without these two outliers, and removing the outliers did not change the significance of the results; thus, to be conservative, the outliers were retained for analyses.

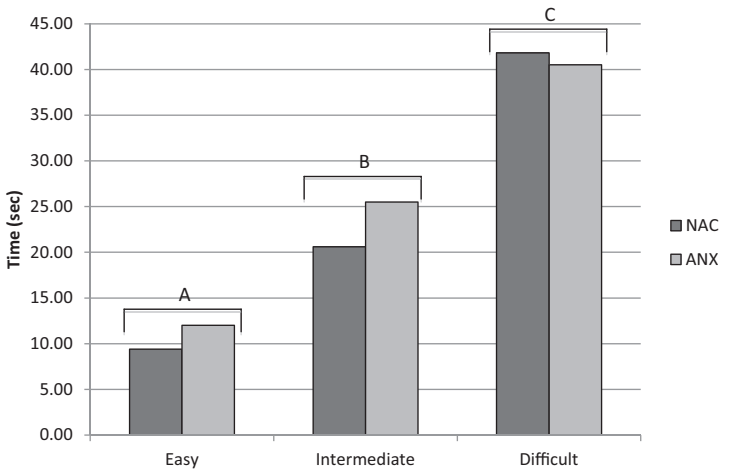

Fig. 2. Time to decision by diagnostic group for each version of the Beads Task.
Note. Different uppercase superscripts represent significant task version differences ($p < .05$).

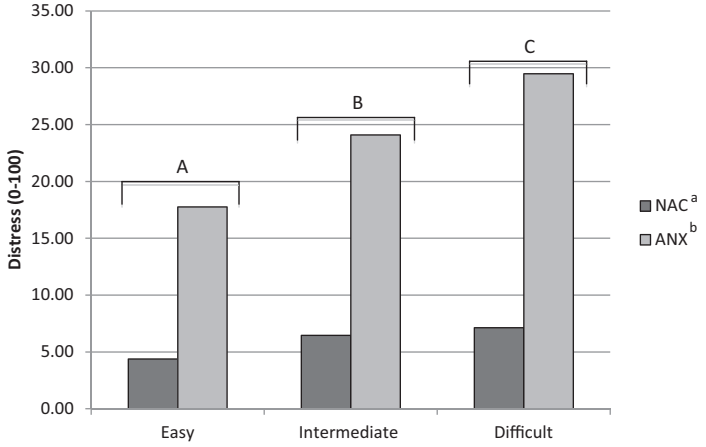

Fig. 3. Level of distress by diagnostic group for each version of the Beads Task.
Note. Different uppercase superscripts represent significant task version differences ($p < .05$). Different lowercase superscripts represent significant diagnostic group differences ($p < .05$)

difficult: $r(69) = .40$, $p < .01$) and the OBQ-RT (intermediate: $r(69) = .36$, $p < .01$; difficult: $r(69) = .35$, $p < .01$).[5] No other correlations were significant at the Bonferroni corrected alpha level.

3.4.2. Anxious symptoms

We also computed correlations (within the ANX group) between the primary Beads Task variables and the self-report symptom measures for each version of the Beads Task. A Bonferroni corrected alpha of .008 was used to correct for multiple tests within each task version (.05/6). The magnitude of correlations ranged from 0 to .33. Distress on the difficult Beads Task version was moderately positively associated with scores on the PSWQ, $r(69) = .32$, $p < .01$, and DASS, $r(69) = .33$, $p < .01$. No other correlations were significant at the Bonferroni corrected alpha level.

[5] Given that our ANX sample may have co-occurring difficulties with depression, we ran partial correlations between in vivo distress and the cognition measures controlling for depression scores (DASS-D). Self-reported distress following the intermediate and difficult Beads Task versions remained moderately positively associated with scores on the OBQ-RT (intermediate: $r(66) = .35$, $p < .01$; difficult: $r(66) = .34$, $p < .01$) and OBQ-PC (intermediate: $r(66) = .31$, $p < .01$; difficult: $r(66) = .36$, $p < .01$), even after controlling for DASS-D.

4. Discussion

Researchers have repeatedly highlighted the importance of identifying cognitive processes that span anxiety disorders for the purpose of developing transdiagnostic models and treatments for these problems (e.g., Barlow, Allen, & Choate, 2004). IU is one such process that appears to be associated with various anxiety disorders; yet to date, only self-report instruments are available for studying this construct. In vivo tasks, such as the Beads Task, that induce uncertainty in the laboratory could therefore provide novel methods for examining IU, such as testing theories about its involvement in anxiety disorders. Such a task could also be extremely useful as a paradigm for assessing the effects of cognitive and behavioral interventions on IU.

In the current study, participants appeared to follow the task instructions, and indicated that identifying the correct jar was moderately important to them. In addition, as expected, the more difficult versions of the task were associated with less certainty in decisions, suggesting that the task did induce uncertainty as it became progressively more difficult. Moreover, once participants reached a decision, there were no diagnostic group differences in how certain they felt about this decision, which is in line with previous studies suggesting that individuals with high IU are able to reach comparable levels of certainty to those low in IU; this level

of certainty simply requires more information for those with high IU (Ladouceur et al., 1997).

In examining diagnostic group differences on Beads Task performance, although participants requested more beads and took more time to decide as the Beads Task became more difficult, contrary to our prediction these outcomes did not demonstrate known groups validity, as there were no group differences on DTD or time to decision on any of the three versions. This is in contrast to previous findings that individuals with OCD and with elevated worry required more evidence before making decisions than individuals with other psychological disorders and NACs (Fear & Healy, 1997; Fitch & Cougle, 2013; Foa et al., 2003; Milner et al., 1971; Toffolo et al., 2013; Volans, 1976) and take more time to reach their decisions (Fear & Healy, 1997; Metzger et al., 1990). Notably, although statistically significant, the differences observed in previous studies between diagnostic groups were quite small, e.g., ≤1 bead (Fear & Healy, 1997; Huq et al., 1988). Thus, the current study adds to the literature and calls into question whether behavioral responses on the Beads Task paradigm as it was used in the current study are useful in differentiating those with anxiety disorders from NACs.

In analyses examining distress after having decided, participants were more distressed following their decision the more difficult the Beads Task version. Furthermore, in line with our hypotheses, individuals with anxiety disorders were significantly more distressed after completing the task than were NACs. In fact, it appeared that while the ANX group reported increasingly more distress as the task became more difficult, the NAC group remained non-distressed across the three task versions. This finding suggests that it is one's emotional response to the Beads Task, as opposed to the observed behavioral responses (i.e., DTD, time to decision), that best distinguishes individuals with anxiety disorders from non-anxious individuals.

Also as hypothesized, among individuals with anxiety disorders, self-reported IU as measured by the OBQ-PC was associated with DTD on the intermediate Beads Task version. The fact that neither IUS-12 subscale was associated with DTD was surprising given the relatively strong associations reported in previous studies using non-clinical participants (i.e., *rs* = .28–43; Ladouceur et al., 1997), but is in line with the null findings from a more recent study with eating disorder patients (Sternheim et al., 2011). We found that self-reported IU was not associated with time to decision, but was positively associated with level of distress after having decided on the intermediate and difficult versions of the task (again as measured by the OBQ-PC but not the IUS-12).

Why was the OBQ-PC but not the IUS-12 associated with Beads Task performance? While both self-report measures assess uncertainty-related cognitions and are strongly correlated, they are not completely redundant (*r* = .61 in the current study). Indeed, these measures were developed by different teams of researchers (the OBQ-44 coming from the OCD literature and the IUS-12 coming from the GAD literature) who conceptualized and defined IU in slightly different ways. While the IUS-12 items measure the variety of ways that people "react to the uncertainties of life", the OBQ-PC assesses perfectionism/certainty as "attitudes or beliefs that people sometimes hold". As Gentes and Ruscio (2011) suggested, when similar items are compared on these two measures, the OBQ tends to be worded more severely than the IUS. Finally, the IUS-12 simply measures uncertainty cognitions while the empirically derived OBQ-PC subscale measures both uncertainty and perfectionism (which were determined to be a single construct using factor analytic methods).

Although we did not have hypotheses examining other subscales of the OBQ in relation to the Beads Task, the OBQ-RT was also correlated with distress on the intermediate and difficult task versions. This subscale measures perception of threat; thus, it is not surprising that it would be associated with subjective distress. Future studies, however, should further examine responsibility cognitions and perceptions of threat as they relate to the Beads Task. In addition, distress on the difficult task version was moderately positively associated with symptom measures of distress and worry, but not the OCD symptom dimensions. In this mixed anxiety disorders sample, it appears that more general measures of distress and worry are related to in vivo distress on this task, rather than OCD-specific measures. Future research should examine the relationship between OC symptom dimensions and the Beads Task in a more homogenous sample of patients with OCD in order directly test whether disorder-specific symptoms relate to uncertainty-induced distress in these samples.

The findings from the current study also have potential clinical implications for the treatment of patients with anxiety disorders. That the ANX group differed from the NAC group in their perceived distress in response to an uncertain situation, rather than in their actual behavioral responses, could be used in the psychoeducational component of cognitive-behavioral therapy for anxiety disorders. Specifically, individuals with anxiety frequently perceive and describe themselves as "unable" to function in uncertain situations; however, it appears from this study that while they perform just as well; they appear to be more distressed by uncertainty.

The findings of this study raise several avenues for future research in the area of IU. First, the Beads Task itself could be altered based on the current findings. Although there was a range in distress levels across individuals, the mean level of distress was relatively low overall (and we received informal feedback from some participants upon debriefing that they were not distressed by the task). Thus, incentives for identifying the correct answer (e.g., money; Ladouceur et al., 2000; Luhmann, Ishida, & Hajcak, 2011), or more aptly for anxiety disorders, pairing a negative stimulus with incorrect answers (e.g., a mild electric shock; Nelson & Shankman, 2011), might amplify the distress participants feel when making their decision. Future work could also design IU-related tasks that are more personally relevant to the participant's specific concerns, such as whether one correctly turned off the stove or what an unexplained raise in heart rate means, in order to maximize external validity. To date no studies have used an idiographic approach to stimuli selection with the Beads Task.

Furthermore, future research might explore additional self-report constructs that may better explain Beads Task performance. Need for cognitive closure (Webster & Kruglanski, 1994), for example, which is related to IU (Berenbaum, Bredemeier, & Thompson, 2008), is defined as the desire for "*an* answer on a given topic, *any* answer...compared to confusion and ambiguity" (Kruglanski, 1990). It may be that certain individuals have a decision-making style that involves requesting more and more information in order to feel certain, whereas others use a more avoidant technique and make a quick decision in order to avoid the uncertainty itself. Indeed, in a previous study, individuals with high trait anxiety requested fewer pieces of information on a variety of uncertainty-inducing tasks, and the authors concluded that these individuals made hasty decisions with the goal of reducing uncertainty, even at the expense of correctness (Bensi & Giusberti, 2007). Thus, future research measuring need for closure and obtaining qualitative data as to how participants made their decision would help the development of future tasks.

The present study has a number of limitations that should be considered. First, only the anxiety disorder modules of the MINI were administered, thus it is unknown what co-occurring conditions participants were struggling with (e.g., depression). Second, the NAC group was significantly younger, more male, and had significantly fewer years of education than the ANX group.

However, we had no a priori reason to believe that age, gender, or years of education would be related to performance on the Beads Task. Third, the OBQ-PC subscale includes items assessing both IU and perfectionism. Accordingly, it is possible that the perfectionism items were driving the correlation with Beads Task variables, and thus future studies should include a separate measure of perfectionism. Finally, the sample was primarily Caucasian, which may limit the generalizability of the results to other racial/ethnic groups. The literature to date suggests that there are no racial or ethnic differences in IU (Norton, 2005), although more research in this area is certainly needed.

5. Conclusions

In summary, the current study examined a probabilistic inference task, the Beads Task, and its relationships with self-report IU in an anxiety disorder sample. While the Beads Task successfully induced task-related uncertainty as the probabilistic decision became progressively more difficult, there were no diagnostic group differences using either of the observable performance related measures (DTD and time to decision). However, individuals with anxiety disorders were significantly more distressed after completing the task than non-anxious controls, suggesting that it is one's emotional response to the Beads Task as opposed to one's observed behavioral responses that has diagnostic validity. Among the anxiety disorder group, participants' general cognitive bias of IU (as measured by the OBQ-PC but not the IUS-12) was moderately associated with DTD (on the intermediate task version) and in vivo distress after having decided (on both the intermediate and difficult versions), but not time taken to reach a decision. Thus, it appears that this task seems to succeed in certain circumscribed ways, with admitted limitations, and should be adapted and improved in future studies with anxious individuals.

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