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"What if I make a mistake?": Examining uncertainty-related distress when decisions may harm oneself vs. others

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ABSTRACT

Intolerance of Uncertainty (IU) is a key construct in the development and maintenance of obsessive-compulsive disorder (OCD). Recent research has examined the Beads Task as a behavioral measure of IU in which an incorrect decision is tied to an aversive outcome. The current study aimed to increase ecological validity of the Beads Task as an analog for decisional uncertainty in OCD. Specifically, we investigated whether the aversive outcome's "victim" impacted associations between IU and distress during decision-making. Undergraduates (N = 85) completed the Beads Task either alone or with a confederate partner. They were told that errors on the task would either lead to themselves (solo condition) or their "partner" (partner condition) having to complete the Cold Pressor Task (CPT). As hypothesized, participants in the partner condition experienced the Beads Task as significantly more distressing and important than those in the solo condition. Furthermore, self-report prospective IU was associated with distress about harm befalling oneself and perceived importance of the decision (solo condition), whereas inhibitory IU was associated with distress about harm befalling others (partner condition). Clinical implications for addressing uncertainty using exposure and response prevention, and future research of decision-making in the context of responsibility for harm are discussed.

1. Introduction

Intolerance of Uncertainty (IU) is a transdiagnostic cognitive vulnerability factor in the development and maintenance of anxiety-related disorders including obsessive-compulsive disorder (OCD; Obsessive Compulsive Cognitions Working Group [OCCWG], 1997) that affects how one experiences, interprets, and responds to situations that are ambiguous or have indefinite future outcomes (Dugas, Schwartz, & Francis, 2004; OCCWG, 1997). Whereas most individuals feel "certain enough" that situations are safe in the absence of clear-cut danger cues, those with elevated IU inflate the importance of not knowing "for sure" whether a feared outcome *may* occur at some point in the future (e.g., the possibility of illness from contamination) and experience a great deal of discomfort over this sense of uncertainty.

More specifically, individuals with elevated IU: (a) have a lower perceptual threshold of ambiguity (e.g., situations that seem "certain enough" to most may be perceived as unclear; Ladouceur, Talbot, & Dugas, 1997), (b) make threatening interpretations of ambiguous information (e.g., via uncertainty-based reasoning: "if I feel uncertain, there must be danger"; e.g., Reuman, Jacoby, Fabricant, Herring, & Abramowitz, 2015), and (c) find uncertainty to be distressing, unmanageable, and something to be avoided (e.g., Buhr & Dugas, 2002). As a result of this distress, individuals with high IU have difficulty functioning in uncertain or ambiguous situations (e.g., applying ineffective problem solving strategies; Jacoby, Abramowitz, Buck, & Fabricant, 2014), and those with OCD engage in compulsive rituals (e.g., checking, reassurance seeking) with the aim of reaching a sense of certainty. Given the ubiquity of uncertainty in daily life, high IU can lead to heightened daily distress and unnecessary (and personally costly) reassurance-seeking behaviors.

IU can be broken down into two sub-components (Birrell, Meares, Wilkinson, & Freeston, 2011; Carleton, Norton, & Asmundson, 2007; McEvoy & Mahoney, 2011). *Prospective IU* refers to desire for predictability and knowing what the future holds, anxiety about future uncertain events, and active engagement in seeking information to increase certainty (e.g., distress about whether one might contract a sexually transmitted infection from using a public restroom and urges to visit the doctor repeatedly to obtain test results). *Inhibitory IU* is characterized by avoidance and paralysis in the face of uncertainty (e.g., feeling incapable of moving forward until one is sure that a

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spouse's airplane has safety landed).

Empirical studies consistently indicate a relationship between self-reported IU and obsessive-compulsive (OC) symptoms (e.g., Calleo, Hart, Björgvinsson, & Stanley, 2010; Jacoby, Fabricant, Leonard, Riemann, & Abramowitz, 2013; Tolin, Abramowitz, Brigidi, & Foa, 2003), and that these relationships are strongest with obsessions concerning responsibility for harm (doubting) and checking compulsions (e.g., Abramowitz, Nelson, Purdon, Antony, & Summerfeldt, 2007; Tolin, Brady, & Hannan, 2008). Certain studies also indicate that the prospective IU dimension is uniquely related to OC symptoms (Carleton, Gosselin, & Asmundson, 2010; McEvoy & Mahoney, 2011), yet this remains unclear (Mahoney & McEvoy, 2012).

One limitation of the existing research on IU, however, is that studies have relied almost exclusively on self-report measures of this construct (e.g., the Intolerance of Uncertainty Scale, IUS-12; Carleton et al., 2007). Although these instruments demonstrate strong psychometric properties, they are designed to be trait measures that capture participants' self-reported stable beliefs about uncertainty. Consequently, they do not, lend themselves well for use as dependent variables for studies seeking to examine predictors and moderators of *state* IU (i.e., feelings of IU-related distress captured in the moment). More recent research, therefore, has begun to evaluate laboratory paradigms as in vivo measures of IU by examining the relationship between self-reported IU and performance on behavioral tasks involving uncertainty or ambiguity (e.g., Carleton et al., 2016; Jensen, Kind, Morrison, & Heimberg, 2014). These tasks have the advantage of experimentally inducing uncertainty in the laboratory and capturing participants' cognitive, emotional, and behavioral responses to actual ambiguous scenarios (e.g., decisions made during a laboratory gambling task; Luhmann, Ishida, & Hajcak, 2011).

One such behavioral measure is the *Beads Task* (Huq, Garety, & Hemsley, 1988; Phillips & Edwards, 1966), a probabilistic inference task in which participants are shown two jars on a computer screen. Each jar contains 100 beads of two different colors in a particular ratio (e.g. 85:15 red beads to blue beads vs. 85:15 blue to red). Participants are told that beads will be drawn one by one with replacement from one of the jars (the sequence of beads is predetermined using a random number generator), and that each jar is equally likely to be chosen. The participant's task is to determine from which jar the beads are being drawn (e.g., the mostly red jar or the mostly blue jar). Participants are told that they can request as many beads as necessary to correctly decide. IU is expected to be positively associated with: (a) the number of beads requested before feeling "certain" about making a decision (i.e., draws to decision; DTD), (b) the time taken to make a decision (i.e., decision time), and (c) self-reported distress during the task.

Indeed, two studies reported a positive association between self-report IU and DTD using both a non-clinical sample (Ladouceur et al., 1997) and a clinical sample of individuals with anxiety disorders (Jacoby et al., 2014); a separate team reported null findings in participants with eating disorders (Sternheim, Startup, & Schmidt, 2011). Jacoby et al. (2014) also found that self-reported IU was correlated with distress during the Beads Task among individuals with anxiety disorders, and distress level on this task distinguished participants with anxiety from non-anxious controls. Relationships between IU and decision time have generally not been found. Additional studies exist measuring performance on the Beads Task and other similar probabilistic reasoning tasks, with mixed findings across studies as to whether individuals with OCD require more, less, or comparable evidence to non-anxious comparison groups (e.g., Fear & Healy, 1997; Grassi et al., 2015; Volans, 1976); however, methodologies across studies differ making comparisons of these results difficult, and none of these studies measured self-report IU.

Furthermore, in the context of OCD (and anxiety disorders more generally), IU typically focuses on the possibility of a feared negative consequence (e.g., "I might have left the oven on and now the house could burn down!"; Nelson & Shankman, 2011). Yet, in the studies reviewed above, there were no negative consequences for an incorrect decision on the Beads Task. To address this ecological validity issue, Jacoby, Abramowitz, Reuman, and Blakey (2016) modified the paradigm to make it more similar to the experience of someone with OCD by linking an incorrect decision on the Beads Task to the threat of an unpleasant experience that participants would seek to avoid: completing the Cold Pressor Task (CPT; i.e., submerging one's dominant hand in a cooler of ice water for as long as is tolerable). This modified version also maximized uncertainty of the decision by using a completely ambiguous version of the Beads Task with 50/50 probabilistic ratios. Findings indicated that adding the CPT amplified in vivo distress, perceived task importance, and uncertainty during the Beads Task decision-making process relative to previous studies (Jacoby et al., 2014).

However, whereas some individuals with OCD struggle with uncertainty regarding negative consequences befalling *themselves*, others feel especially responsible for preventing harm befalling *others* (e.g., "What if the fire also damages my neighbor's home? It will be my fault!"; Rachman, 2002; Salkovskis, 1985). Yet, no studies to date have used an in vivo IU paradigm to examine how individuals respond to the possibility of being responsible for harm befalling someone else. Indeed, existing studies that have examined the impact of enhanced responsibility by using designs in which participants are presumably responsible for ham to others (e.g., a confederate receiving an electric shock; Arntz, Voncken, & Goosen, 2007; Boschen & Vuksanovic, 2007; Parrish & Radomsky, 2006), did not directly differentiate the impact of responsibility for oneself relative to others (i.e., the control condition was a "no responsibility" group). Furthermore, none of these studies included measures of self-reported IU.

Accordingly, the present study aimed to further examine the Beads Task as an analog for decisional uncertainty in the context of OCD by linking decisions to an aversive future outcome (i.e., the CPT) that participants were either attempting to avoid for themselves or for another person. Specifically, we compared the traditional (i.e., solo) version of the Beads Task to a "partner version" in which the study participant's performance on the Beads Task was linked to the possibility of an aversive outcome for another person (i.e., a confederate). The primary study aim was to investigate whether a difference in the "victim" of the aversive outcome (oneself or someone else) impacted uncertainty-related distress during the decision-making process involved in the Beads Task. We hypothesized that task distress and importance would be elevated when participants were responsible for an aversive outcome befalling someone else (vs. themselves; Rachman, 2002; Salkovskis, 1985).

Our secondary aim was to examine associations between IU and OC symptoms with Beads Task outcomes across these two versions. Given that there have been some mixed findings as to whether one of the two dimensions of IU is uniquely associated with OC symptoms (McEvoy & Mahoney, 2011), we examined whether prospective and inhibitory IU would be differentially associated with Beads Task outcomes for each of the two versions (i.e., solo and partner). We also investigated the extent to which OC symptom dimensions (especially the dimension involving doubting obsessions and checking compulsions; Abramowitz et al., 2007) and general depression, anxiety, and stress were associated with Beads Task outcomes for these two task versions.

2. Method

2.1. Participants

Eighty-seven undergraduate students recruited from Introduction to Psychology classes at a large southeastern university participated in this study. We elected to use a non-clinical sample for the present study given that the majority of individuals in the general population experience unwanted intrusive thoughts similar in content to clinical obsessions (e.g., Radomsky et al., 2014) and that are associated with

the same developmental and maintenance factors (for a review, see Abramowitz et al., 2014). Research also indicates that IU has a dimensional latent structure (Carleton & Weeks, 2012). Accordingly, the study of IU and OC symptoms in non-clinical samples has the potential to inform the mechanisms involved in the maintenance of clinically severe OCD.

Data from two participants were removed from data analysis: one indicated during the debriefing that they speculated deception in the study design, and the other's data were lost due to a computer error. Accordingly, 85 participants were included in the final sample: 42 in the solo condition and 43 in the partner condition. The sample was primarily female (67.1%, n = 57), White (81.2%, n = 69; 9.4% Black or African American, 4.7% Asian, 2.4% bi- or multi-racial, and 2.4% other), non-Latino (89.4%, n = 76), and right-handed (92.9%, n = 79), with a mean age of 18.89 years (SD = .90; range 18–22), which is comparable to the demographics of the university's Introduction to Psychology participant pool at large.

2.2. Measures

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

The IUS-12 is a self-report measure capturing reactions to uncertainty, ambiguity, and the future and consisting of two subscales: (a) *Prospective IU* measures discomfort due to future unknowns and information gathering to increase certainty (e.g., "I always want to know what the future has in store for me"), and (b) *Inhibitory IU* measures avoidance and paralysis in the face of uncertainty (e.g., "When I am uncertain I can't function very well"). Participants rate each item from 1 (*Not at all characteristic of me*) to 5 (*Entirely characteristic of me*). The IUS-12 has good psychometric properties in both clinical and non-clinical samples (Carleton, Mulvogue, et al., 2012; Carleton et al., 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 very good (αs = .86–.87).

2.2.2. 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: (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." After a general description of the symptom dimension with representative examples, five items (rated 0–4) assess the following parameters of severity of obsessions and compulsions 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 both clinical 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 good (α = .75–.90).

2.2.3. 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 psychological distress containing three seven-item subscales: Depression (DASS-D; i.e., dysphoric mood), Anxiety (DASS-A; i.e., physiological arousal and fear); and Stress (DASS-S; i.e., 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 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 (Helsen, Van den Bussche, Vlaeyen, & Goubert, 2013; Antony et al., 1998). It also has good convergent and known groups validity. Internal consistency of the DASS subscales in the present sample was good (α = .75–.90).

2.3. Procedure

Participants were recruited for a study about how individuals "make decisions under pressure" via the Psychology Department's participant pool using the SONA software for scheduling lab appointments. All participants were informed that they would be asked to answer questions on the computer about thoughts, feelings, and behaviors, and that they would complete a "cold water challenge" and a computer-based decision-making task with the help of the experimenter. Individuals were told that they would be randomly assigned to complete the study either alone or with a partner. A female confederate completed the study along with participants in the partner condition and was introduced as another Psychology 101 student.

All participants were tested in the laboratory between November 2015 and October 2016. The experimenter first obtained informed consent and notified participants whether they had been assigned to complete the experiment alone or with a partner. In the partner condition, the confederate was covertly alerted when the actual participant arrived so that they appeared for the experiment a few minutes later. During the consent process, a study coordinator also assessed for the following exclusion criteria: (a) color-blindness, (b) history of hypertension, peripheral vascular disease, cold urticaria, cold sensitivity, or Raynaud's syndrome, and (c) open cuts or lesions on the hands. Participants then completed a demographic survey and the self-report study measures described above using the computer program Qualtrics. In the partner condition, confederates also completed the surveys on Qualtrics at an adjacent computer with a privacy partition between the computers.

2.3.1. The Cold Pressor Task (CPT)

Next, all participants completed the CPT, which is one of the most common experimental methods of pain induction (e.g., Franklin et al., 2010; Klatzkin, Mechlin, Bunevicius, & Girdler, 2007; Russ et al., 1992). A water circulator attached inside the cooler maintained an even distribution of the water temperature (and prevented the water near the participant's hand from warming up). Participants were asked to submerge their dominant hand (up to the wrist) in a cooler of 5 °C ice water (M = 4.79, SD = .95) and were instructed to remove their hand from the water when the discomfort became "too intense for you to take." Upon removing their hand, they were asked to rate their discomfort/pain level on a scale from 0 (*No pain or discomfort*) to 10 (*Worst pain / discomfort you can imagine*). Although the CPT is painful/uncomfortable, this discomfort is temporary and does not result in any longer-term adverse consequences. Experimenters recorded the time latency from CPT onset until the participant removed his or her hand (referred to as "endurance time"), a commonly-used measure of pain tolerance (e.g., Klatzkin et al., 2007; Mechlin, Morrow, Maixner, & Girdler, 2007). Participants were allowed to keep their hand in the water for a maximum of two minutes (after which point the hand becomes numb from the ice water).

In the partner condition, the confederate participated in the CPT after the study participant. All confederates were instructed to submerge their hands for approximately 30 s in the ice water, and the experimenter provided confederates with the feedback that their endurance time was 34 s (in order to standardize the amount of time participants thought the confederate could tolerate the cold water). Confederates were instructed to report their discomfort/pain level as an "8," and were trained to state: "Oh man, that's really cold! I hope I don't have to do that again." Participants and confederates were then informed that they would be randomly assigned (like the flip of a coin) to either complete the decision-making task, or to wait while their partner completed the task (and be the one to repeat the cold water challenge

following incorrect answers). Although this assignment appeared to be random, the participant was always assigned to perform the Beads Task while the confederate was selected to be the one who would need to repeat the CPT.

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

Finally, participants completed a practice version of the Beads Task (in order to learn the rules) followed by two different computerized experimental versions of the task (in a counterbalanced order), in the presence of an experimenter (as this has been found to increase reliability of the task; Fear & Healy, 1997). Each version contained 2 jars with 50:50 probabilistic ratios, but participants were not informed of the ratio of beads inside the jar. Instead, they were misled to believe that there was one jar filled with beads that were mostly one color and a second jar filled with beads that were mostly the other color (e.g., a mostly purple jar vs. a mostly green jar). The maximum possible number of beads that could be requested before deciding was 50. The sequences of beads in the two conditions were determined using a random number generator and are listed below:

Version 1: **50 Purple (P): 50 Green (G)**

GPPGPPGPGGGPGGPGGGPGGGPGGPGPPPPGGPPGPGGPPGGPPPGPPG

Version 2: **50 Red (R): 50 Blue (B)**

RBRRBBRBBRBRBRBBRRBRRBRBBRBRRBRRBBRBRBRRBRBRRBBBRR

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

In explaining the rules of the task, the experimenter also emphasized the importance of answering correctly on the Beads Task. Specifically, participants in the *solo condition* were told that if they answered incorrectly, they would have to re-submerge their hand in the ice water for 20 s, plus 2 additional seconds for every bead they chose while making their decision (the amount of time was tracked on the computer screen). Participants were told that they would not have to re-submerge their hand in the ice water at all if they answered correctly. Thus, they were instructed to consider the tradeoff between the number of beads they chose to see and their accuracy as they were deciding. Participants in the *partner condition* were told that if they answered incorrectly their partner (i.e., the confederate) would have to re-submerge her hand into the ice water for 20 s, plus 2 additional seconds for every bead they chose to see while making their decision; thus, the participant was given responsibility for protecting their partner from harm. The confederate was instructed to wait in an adjoining room while the participant completed the Beads Task.

During the task, the experimenter recorded: (a) the number of beads the participant selected before deciding (i.e., DTD), (b) time taken to reach the decision, and (c) the participant's decision itself (i.e., which jar they thought the beads were coming from). Also, at the end of each version of the task, but before learning whether or not they answered correctly (and whether they or their partner would need to repeat the CPT), participants also completed a series of three in vivo questions using a visual analog scale (VAS) ranging from 0 (*Not at all*) to 100 (*Very much*): (a) “How certain are you about your decision?”, (b) “How distressed do you feel in this moment?”, and either (c) “How important is it for you to get the answer right and avoid having to put your hand in the ice water?” (solo version) or “How important is it for you to get the answer right and avoid your partner having to put his or her hand in the ice water?” (partner version).

In reality, since there was no right or wrong answer, after completing each Beads Task version and responding to the follow-up questions, all participants were informed that they answered correctly on both experimental versions of the task, and thus no participants (or confederates) repeated the CPT. At the end of the visit, participants were debriefed and informed of the mild deception involved in the study. In exchange for their participation, participants received one hour of credit toward the research requirement of Introduction to Psychology.

2.4. Data analysis plan

We used the following statistical approach to test our hypotheses. We first computed descriptive statistics for our self-report measures of cognitions and symptoms (IUS-12, DOCS, and DASS-21 subscales), as well as Beads Task outcomes. We also conducted a preliminary check for systematic demographic or psychological differences between groups. Next, to address the first study aim, we conducted independent samples *t*-tests to compare Beads Task outcomes (i.e., DTD, time to decision, distress, importance, and certainty) between the solo and partner conditions. Finally, to address the second study aim, we calculated Pearson's correlations between the Beads Task outcome variables and the self-report cognition and symptom measures to examine how trait levels of IU (IUS-12 Prospective and Inhibitory IU subscales), OC symptom dimensions (DOCS subscales), and general psychological distress (DASS-21) were related to in vivo Beads Task performance for the two task versions.

3. Results

3.1. Descriptive statistics of study measures

3.1.1. Self-report measures

Means, standard deviations, range, skewness, and kurtosis values for the self-report study measures appear in Table 1. The sample's mean and range on these measures were comparable to those from previous studies using undergraduate samples (e.g., Carleton et al., 2007). The distributions of the DASS depression and anxiety subscale scores were somewhat positively skewed (skewness: DASS-D = 1.87, DASS-A =

Table 1
Means and standard deviations on study measures (N = 85).

	Mean (*SD*)	Range	Skewness	Kurtosis
IUS-12				
Prospective IU	20.24 (5.69)	8–33	−.04	−.41
Inhibitory IU	9.73 (4.02)	5–21	.79	−.05
DOCS				
Contamination	2.95 (2.05)	0–7	.13	−.94
Harm	3.28 (2.89)	0–12	.85	−.02
Unacceptable Thoughts	3.40 (2.86)	0–11	.66	−.51
Symmetry	3.02 (3.12)	0–13	1.06	.59
DASS-21				
Depression[a]	6.87 (7.80)	0–40	.53	.01
Anxiety[a]	5.67 (5.66)	0–34	.01	−.33
Stress	11.39 (8.17)	0–34	.63	−.29
CPT				
Endurance time (sec)	53.09 (34.91)	8.49–120	.87	−.37
Pain level (0–10)	5.88 (1.35)	3–9	.01	−.75
Beads Task				
DTD (0–50)	21.65 (12.87)	1–50	.56	−.53
Time to decision (sec)[a]	60.68 (48.02)	3.32 – 220.84	−.41	.42
Distress (0–100)	49.06 (25.78)	3.50–100	.14	−1.02
Importance (0–100)	65.01 (26.90)	5–100	−.34	−.95
Certainty (0–100)	39.04 (19.40)	2.50 – 84.00	.04	−.83

Note. IUS-12 = Intolerance of Uncertainty Scale-12; DOCS = Dimensional Obsessive Compulsive Scale; DASS-21 = Depression Anxiety and Stress Scale-21; CPT = Cold Pressor Task; DTD = Draws to Decision.

[a] The mean and range for DASS scores and Beads Task time to decision are actual values; skewness and kurtosis for these variables are for the square root- and log transformed values respectively. All subsequent analyses involving these measures used transformed values.

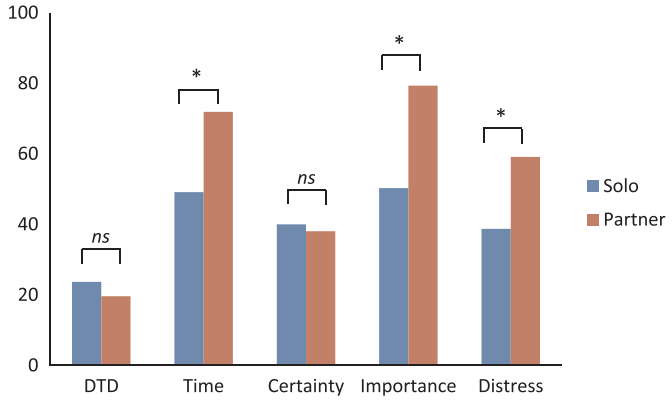

Fig. 1. Beads Task outcomes for solo and partner versions.

1.88) and platykurtic (kurtosis: DASS-D = 3.88, DASS-A = 6.39). As a result, we square root transformed these subscales, which resulted in a more symmetric distribution. None of the other measures displayed problematic levels of skewness or kurtosis (Tabachnick & Fidell, 2013).

3.1.2. Cold Pressor Task outcomes

Table 1 also contains descriptive information about participant performance on the CPT. On average, participants kept their hand in the ice water for almost a minute (with a wide range of individual performances). Participants also found the ice water to be moderately painful/uncomfortable. These performance measures were comparable to our findings from a previous study (Jacoby et al., 2016).

3.1.3. Beads Task outcomes

Mean performance outcomes on the Beads Task are shown in Table 1. Decisions were fairly evenly distributed for both the Purple-Green (46% purple vs. 54% green) and Red-Blue (63% red vs. 37% blue) task versions. Given that the sequence of beads for both versions was generated using a random number generator in order to represent 50:50 probabilistic ratios, and because primary outcomes (i.e., DTD, time to decision, distress) were comparable across the two task versions, we averaged performance on the two versions for subsequent analyses. As can be seen, participants indicated feeling relatively uncertain of their decision. They stated that it was moderately important to answer correctly and that they were moderately distressed by the task. The distribution of Beads Task decision time was positively skewed (skewness = 1.55) and platykurtic (kurtosis = 2.34). As a result, we log transformed decision time, which resulted in a more symmetric distribution.[1]

3.2. Comparisons of solo versus partner conditions

3.2.1. Preliminary analyses

First, appropriate independent samples *t*-tests and chi-square tests were conducted comparing the solo and partner conditions on demographic (i.e., age, race, ethnicity, grade, and handedness), self-report measures (i.e., IUS-12, DASS-21, and DOCS subscale scores), and CPT performance measures (i.e., temperature, endurance time, and perceived discomfort). There were no systematic differences between groups on any of these measures; $ts < .95$, $ps > .35$; $\chi^2 < 3.70$, $ps > .06$.

3.2.2. Beads Task outcomes

Beads Task outcomes for both conditions are presented in Fig. 1. As can be seen, participants in the partner condition perceived answering correctly on the Beads Task to be significantly more important ($M = 79.36$, $SD = 20.11$) than did those in the solo condition ($M = 50.31$, $SD = 25.10$), $t(83) = -5.90$, $p < .001$, $d = 1.29$. Similarly, participants in the partner condition experienced significantly more distress before learning whether or not they answered correctly in the Beads Task ($M = 59.14$, $SD = 23.58$) than did those in the solo condition ($M = 38.75$, $SD = 24.03$), $t(83) = -3.95$, $p < .001$, $d = .87$. Individuals in the partner condition also took significantly longer to reach a decision ($M = 71.93$, $SD = 57.49$) than did those in the solo condition ($M = 49.16$, $SD = 32.70$), $t(67) = -2.25$, $p = .03$, $d = .49$; however, after time to decision was log-transformed to account for the skewness of the data (as previously described) this effect disappeared, $t(83) = -1.33$, $p = .19$. There were no significant differences between the solo and partner conditions on DTD (23.71 vs. 19.64 respectively) or certainty (40.02 vs. 38.08), $ds < .31$.

3.3. Associations between Beads Task performance and self-report measures

3.3.1. Preliminary analyses

First, preliminary correlation analyses among the self-report measures in the entire sample indicated that IUS-12 total scores were significantly, weakly positively associated with DOCS ($r = .34$, $p = .002$) and DASS-21 total scores ($r = .44$, $p < .001$). DOCS and DASS-21 total scores were also significantly, weakly positively correlated with one another ($r = .29$, $p = .008$).

3.3.2. Correlations in solo and partner Beads Task conditions

Pearson correlations between the Beads Task outcomes and self-report measures are presented in Table 2. A Bonferroni corrected alpha of .005 was used to correct for multiple comparisons for the examination of IUS-12 subscales and Beads Task outcomes (.05/10). As can be seen, for the solo condition, both perceived importance of the decision and distress in anticipation of potential harm befalling oneself were moderately, positively associated with the prospective but not inhibitory IU subscale of the IUS-12. Distress was also weakly positively associated with DASS-Anxiety, but not DASS-Depression, DASS-Stress, or any of the DOCS symptom dimensions. Time to decision was weakly, positively associated with inhibitory IU (but no other measures), and this association did not survive Bonferroni correction. DTD and certainty were not associated with any self-report measures.

For the partner condition, as can be seen, distress about harm potentially befalling one's partner was weakly, positively correlated with inhibitory but not prospective IU (or any symptom measures); the association between inhibitory IU and distress, however, did not survive Bonferroni correction. Time to reach a decision, was also weakly positively associated with DASS-Depression and DASS-Stress. The DOCS-Unacceptable Thoughts subscale was also weakly positively associated with DTD on the Beads Task. Certainty and importance of one's decision was not associated with any self-report measures.

4. Discussion

4.1. New insights

The current study aimed to improve the ecological validity of the Beads Task as an experimental analog for the decision-making process that occurs in OCD in the context of IU. The merits of this experimental approach are that unlike designs that pair positively reinforcing incentives for identifying a correct answer during the decision-making process (e.g., money), the present study linked incorrect answers on the Beads Task with an aversive stimulus (i.e., the threat of freezing cold ice water). This experimental procedure allowed us to better understand how individuals make decisions when there is a feared outcome they are seeking to avoid, a process that becomes maladaptive for individuals with clinical anxiety. Furthermore, building off previous work using this task (Jacoby et al., 2016), we modified the procedures such

[1] While we used the standard log transformation for time to decision, we used a square root transformation for the DASS subscales since scores on the DASS include scores of 0 and the log(0) is undefined.

Table 2
Correlations between Beads Task measures and self-report measures.

Beads Task Outcome Measure	IUS-P	IUS-I	DOCS-C	DOCS-H	DOCS-UT	DOCS-S	DASS-D	DASS-A	DASS-S
Solo version (n = 42)									
DTD	−.08	−.01	.14	.05	.07	.13	−.16	−.06	.04
Time	.25	.32*	−.05	.10	.09	.17	.15	.13	.17
Certainty	−.08	−.23	.12	−.01	.08	.11	−.05	−.17	.02
Importance	.45**	.10	.11	.06	.22	−.01	.13	.25	.10
Distress	.48**	.25	.25	.20	.29	.12	.14	.35*	.14
Partner version (n = 43)									
DTD	−.08	.01	−.12	−.13	.38*	−.05	.18	.20	.10
Time	.17	.20	−.01	.15	.02	−.03	.35*	.23	.30*
Certainty	.03	−.10	.14	−.12	.11	.02	−.10	.01	−.04
Importance	.24	.23	.07	.10	.16	.19	.12	.17	.13
Distress	.24	.31*	.07	.03	.19	.24	.14	.25	.24

Note. IUS = Intolerance of Uncertainty Scale, Prospective IU and Inhibitory IU subscales; DOCS = Dimensional Obsessive Compulsive Scale, Contamination, Harm, Unacceptable Thoughts, and Symmetry subscales; DASS = Depression Anxiety and Stress Scale; DTD = Draws to Decision.
* $p < .05$.
** $p < .005$ (Bonferroni corrected).

that participants were held responsible for making correct decisions amidst ambiguity that impacted either the wellbeing of themselves or others in order to better understand decisional distress for those with OCD who feel especially responsible for preventing harm to other people (Rachman, 2002; Salkovskis, 1985).

4.2. Principal findings

In line with our hypotheses, we found that when participants were held responsible for making decisions that could lead to adverse outcomes for someone else, they reported that the decision was very important, endorsed moderate distress, and these ratings were significantly elevated relative to participants completing the task on their own (with a large effect size). Participants in the partner condition also took more time to reach a decision than did those in the solo condition; although once time was transformed to account for the positive skew in the data, this difference disappeared.[2] There was no difference on DTD or degree of uncertainty between the two groups, as participants in both conditions reported being relatively uncertain of their Beads Task decision.

These results provide evidence that our modification to the Beads Task has ecological validity as an analog for the experience of someone with obsessional fears of responsibility for harm befalling someone else. In other words, it appears that the "victim" who stands to get hurt *does* make a difference in terms of the subjective experience of the individual making the decision and potentially contributes to delays in decision-making. Given the importance of beliefs about responsibility for preventing harm to others in conceptual models of OCD (Rachman, 2002; Salkovskis, 1985), this suggests the Beads Task paradigm offers the opportunity to understand how responsibility for harm impacts uncertainty-related distress in an experimental context. Given that our sample consisted of unscreened undergraduates and structured diagnostic interviews were not administered, future research is needed to examine these constructs in larger clinical samples (e.g., patients with OCD) in order to see the extent to which these findings generalize.

We also found that when attempting to avoid a negative outcome for oneself, one's beliefs about the desire for knowing what the future holds and active engagement in seeking information to increase certainty (i.e., prospective IU) were associated with feeling that the decision was more important and experiencing more distress before learning the outcome. When one's success with the Beads Task, was linked to a negative outcome for *someone else*, however, beliefs about avoidance and paralysis in face of uncertainty were associated with decisional distress. This suggests that different core beliefs underlie uncertainty-related distress regarding responsibility for harm to oneself versus others, which may explain some of the mixed findings regarding the specificity of associations between IU dimensions and OC symptoms that have been documented with self-report trait measures (e.g., Mahoney & McEvoy, 2012; McEvoy & Mahoney, 2011).

Given that difficulties with decision-making have been implicated in the etiology of OCD as well as a predictor of treatment outcome (Cavedini, Gorini, & Bellodi, 2006; Olley, Malhi, & Sachdev, 2007; Vandenbroucke & Gabriëls, 2012), if these findings were to generalize to patient samples, a better understanding of this intersection between responsibility for harm and IU could inform our understanding of the maintenance (and perhaps treatment) of OCD. For example, if individuals who endorse actively seeking information to resolve uncertainty experience the most distress in contexts in which they fear harm to themselves, this may indicate the emphasis of *response prevention* techniques to target these problematic checking/reassurance seeking behaviors. Alternately, if individuals who describe themselves as more avoidant when making decisions feel more paralyzed by distress when they are afraid of harming others, *exposure* to uncertainty may be a more important procedure to target this specific fear. Yet it is important to acknowledge that because the current study did not use a clinical sample or treatment analog design, future research using clinical samples would be necessary to test this possibility.

In the solo condition, inhibitory IU was also associated with taking more time to reach a decision. While it makes intuitive sense that beliefs about uncertainty-related paralysis would be linked to observable delays in decision-making, this finding should be interpreted with some caution given that other studies have not found this association between time and self-report IU (Jacoby et al., 2014, 2016) and this relationship did not retain statistical significance after applying a Bonferroni correction. Among those who completed the partner task version, elevated depressive and stress symptoms were both associated with taking more time to reach a decision; however, since these association was not hypothesized and have not been demonstrated in previous work (in fact, in one study, DASS-Depression was weakly *negatively* associated with DTD; Jacoby et al., 2016), they should also be interpreted with caution.

Anxiety symptoms were associated with distress during the solo version of the task, which replicated results from an earlier study with a clinical sample in which worry symptoms were associated with task distress (Jacoby et al., 2014). Our finding that OC symptoms were generally not associated with Beads Task performance (except for unacceptable thoughts symptoms, which were weakly positively associated with DTD) is consistent with a previous study using a clinical

[2] This may indicate that this result prior to transformation was driven by a few individuals who took a longer time to decide than was typical. Thus, this relationship would be interesting to examine in clinical samples that may take longer to decide.

sample (Jacoby et al., 2014) and suggests that the Beads Task captures more general forms of in vivo distress, rather than any specific obsessive-compulsive content. Future research could build on previous work (Fitch & Cougle, 2013) to design IU-related in vivo tasks that are more personally relevant to OC-specific concerns.

4.3. Challenges faced

Challenges faced in this research include the multiple facets of deception involved (i.e., that the ratio of beads in the jars were in reality 50/50, that participants would always be assigned to complete the Beads Task, and that the study partner was a lab member confederate). Although we did conduct a debriefing interview in order to probe for participant skepticism of the design, these interviews were post-hoc and may have been influenced by the demand characteristics of participants enrolled in a psychology course. A second challenge to this work is being able to measure and understand not only Beads Task outcomes, but also the *process* of how participants make decisions. For instance, while certain individuals may have a decision-making style that involves requesting more and more information in order to feel certain, others might use a more avoidant technique and make a quick decision in order to avoid uncertainty itself. Such nuances were not captured in the current study design.

4.4. Solutions

To address the challenge of deception, in addition to the debriefing interviews used in the current study, we believe that our inclusion of an in-the-moment assessment of the degree to which participants felt it was important to answer correctly before learning whether or not their answer was correct was an even more meaningful way to probe for study believability (and we were encouraged by the high ratings of perceived importance in the present study).

In addition, in future studies we wish to expand the interview process following participant decision-making in order to better understand *how* they reached their decisions and weighed the trade-off between requesting more beads in order to enhance their accuracy (and keep either themselves or their partner "safe" from harm), while also minimizing the associated increase in the CPT duration for themselves/their partner if they were to answer incorrectly. Additionally, self-report measures of decision-making styles have been developed which more specifically capture participant assessment of their process of decision-making (Leykin & DeRubeis, 2010). Such measures could be utilized for future research in order to see whether certain self-reported styles map onto Beads Task performance (e.g., do those who identify as having a "vigilant" decision-making style request more beads than those with an "avoidant" style? Does the degree to which someone endorses having an "anxious" decision-making style correlate with decisional distress during the Beads Task?). Furthermore, need for cognitive closure (i.e., the desire for reaching any solution rather than remaining in a state of confusion and ambiguity; Webster & Kruglanski, 1994) is a closely related concept to IU (Berenbaum, Bredemeier, & Thompson, 2008) that also could be included in future studies.

4.5. Limitations and future directions

Overall, associations between cognitive and self-report measures with behavioral and emotional outcomes (especially during the partner version of the task) were relatively modest in magnitude, and thus the construct validity of the Beads Task as an instrument measuring IU in this study was limited. As previously mentioned, our data were collected using a non-clinical, undergraduate sample, and future studies should utilize clinical samples of patients with OCD to elucidate whether Beads Task outcomes are associated with OCD characteristics in a clinical sample. Additionally, there is room for improvement in terms of identifying additional constructs that may predict one's Beads Task performance. Specifically, measures of responsibility (e.g., the Responsibility Attitude Scale; Salkovskis et al., 2000) may better account for distress during the partner condition and should be examined in future studies. Moreover, as others have noted (Carleton, 2012), the inclusion of psychophysiological measures (i.e., skin conductance, heart rate) during the decision-making process could augment the in vivo self-report indices traditionally captured during the Beads Task.

Furthermore, our participants were college-educated and primarily Caucasian, which may limit the generalizability of the results to more diverse socio-economic and racial/ethnic groups. However, previous research does suggest that IU has a dimensional latent structure, which provides opportunities for studying IU-related distress in community samples (Carleton & Weeks, 2012), and to date suggests that there are no racial or ethnic differences in IU (Norton, 2005). Yet future research on this topic with more diverse clinical samples is very much encouraged. Additionally, as this was the initial exploratory study using this paradigm and our sample size was powered on the primary aim of the study (i.e., to be able to compare mean differences on Beads Task outcomes between the two versions), future studies should power their sample size to be able to directly compare the magnitude of correlations in the solo versus the partner conditions (i.e., moderator analyses).

Additional avenues for future investigation would be to examine decision-making outcomes when participants are completing the study with a confederate stranger versus a familiar partner (e.g., a roommate, significant other), as has been adopted in research on reassurance seeking (Neal & Radomsky, 2015). Indeed, clinical experience indicates that patients with OCD are often most concerned with negative outcomes befalling loved ones (even more so than strangers). Or designs could manipulate the degree to which the confederate appears "vulnerable," since both theoretical (Rachman, 1998) and experimental (Berman, Wheaton, & Abramowitz, 2012) work suggests that more significance and importance is attached to responsibility for harming more vulnerable or helpless individuals. Indeed, in the present study, the confederate was framed to be a relatively vulnerable victim, as participants were led to believe that confederates were only capable of submerging their hands for 34 s (versus the participant average of 53 s) and that they experienced a pain level of 8 / 10 during the CPT (versus the participant average of a 6 / 10). Future studies, could manipulate the performance of the confederate (e.g., endurance time, subjective distress) to see if this impacts participant Beads Task performance (e.g., DTD, importance, distress).

5. Conclusions

In summary, the current study examined relationships between self-report IU and performance on an updated version of the Beads Task. By linking decisions to an aversive future outcome (i.e., the CPT) that participants were attempting to avoid either for themselves or for another person, this version was designed to increase ecological validity of the task as an analog for decisional uncertainty in the context of OCD. When participants were making a decision that would impact someone they thought was another study participant, they reported being significantly more distressed about whether or not harm would come to this individual and considered the decision to be significantly more important as compared to when these decisions would impact only themselves. Moreover, beliefs about the need to know what the future holds and active behaviors aimed to increase uncertainty (i.e., prospective IU), were associated with distress about harm befalling oneself and perceived importance of the decision (i.e., the solo condition), whereas the tendency to avoid and feel paralyzed in the face of uncertainty (i.e., inhibitory IU), was associated with distress about harm befalling others (i.e., the partner condition).

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