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Predictive Validity of Explicit and Implicit Threat Overestimation in Contamination Fear

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Abstract

We examined the predictive validity of explicit and implicit measures of threat overestimation in relation to contamination-fear outcomes using structural equation modeling. Undergraduate students high in contamination fear ($N = 56$) completed explicit measures of contamination threat likelihood and severity, as well as looming vulnerability cognitions, in addition to an implicit measure of danger associations with potential contaminants. Participants also completed measures of contamination-fear symptoms, as well as subjective distress and avoidance during a behavioral avoidance task, and state looming vulnerability cognitions during an exposure task. The latent explicit (but not implicit) threat overestimation variable was a significant and unique predictor of contamination fear symptoms and self-reported affective and cognitive facets of contamination fear. On the contrary, the implicit (but not explicit) latent measure predicted behavioral avoidance (at the level of a trend). Results are discussed in terms of differential predictive validity of implicit versus explicit markers of threat processing and multiple fear response systems.

Keywords

contamination fear; overestimation of threat; looming vulnerability; implicit associations

1. Introduction

Threat overestimation, marked by exaggerated beliefs about the probability and costs of negative events (Taylor et al., 2010), has been hypothesized to play a role in the origin and maintenance of contamination fear (Connolly, Lohr, Olatunji, Hahn, & Williams, 2009). In line with this hypothesis, individuals high (versus low) in contamination fear can generate more reasons why contamination-relevant situations are harmful and fewer reasons why they are safe (Olatunji, Connolly, Lohr, & Elwood, 2008). Moreover, in a study of covariation bias, individuals with high levels of contamination fear underestimated the pairing of contamination-related and neutral stimuli, perhaps indicative of a decreased likelihood of foreseeing a neutral or safe outcome following contact with “contaminated” stimuli (Connolly et al.).

Though often studied as a unitary predictor of obsessive-compulsive symptoms, threat overestimation is a multifaceted construct (e.g., Mortiz & Jelink, 2009). In addition to probability and cost biases related to encountering potential threats, threat overestimation

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³Participants also rated the degree to which imagining each scene made them anxious, though this question was not analyzed owing to its likely shared variance with emotional vulnerability, a criterion variable.

also includes a bias toward looming vulnerability, defined as the propensity to conceptualize threat as dynamic and the risk of harm as rapidly increasing (Riskind & Rector, 2007). Looming vulnerability cognitions predict symptom severity in OCD patients (Riskind & Rector) and contamination fear in a subclinical OCD sample (Riskind, Abreu, Strauss, & Holt, 1997), and are thus included as part of the current study's assessment of threat overestimation in contamination fear.

Threat overestimation may also be multifaceted in the sense of being instantiated both explicitly (available to conscious introspection and control) and implicitly (residing outside conscious control). While multiple studies have examined explicit predictors of contamination fear-related outcomes, none to our knowledge has explored *implicit* predictors. The expected predictive role of implicit associations tied to threat overestimation and contamination fear follows from cognitive models of anxiety, which emphasize the automatic nature of anxious responding, especially the uncontrollable processing of threat information (McNally, 1995). Given that implicit associations are thought to reflect relatively uncontrollable associations stored in memory (see Teachman & Woody, 2004), they may predict contamination fear outcomes. There is also some preliminary evidence in healthy samples that maladaptive beliefs tied to OCD can be assessed using implicit associations (Teachman & Clerkin, 2007; Teachman, Woody, & Magee, 2006).

Measuring explicit and implicit aspects of threat overestimation may allow us to examine variance in contamination fear outcomes that is not assessed through the use of either method alone. Though the two measures are often related, collapsing them into a unitary construct is not as informative as treating them as separate but complementary constructs (Nosek & Smyth, 2007). As Roefs and colleagues (2011) state, implicit measures "have the potential to reveal aspects of the dysfunctional beliefs that explicit measures cannot reveal and to predict behaviors that explicit measures do not predict" (p. 150). Thus, the current study examines the differential predictive validity of explicit and implicit associations relevant to threat overestimation.

A number of studies have found explicit threat overestimation measures to positively correlate with contamination-fear symptoms, state cognitions, subjective distress, and behavior; though none has examined all of these variables in the same study. For example, contamination-fearful (versus non-fearful) participants had higher scores on a measure of looming vulnerability (Riskind et al., 1997), and on a measure of cognitions related to the likelihood and severity of becoming contaminated (Deacon & Olatunji, 2007; see also Tolin, Worhunsky, & Maltby, 2004, for related results in an OCD sample). Contamination-fearful persons also reported higher state anxiety and exhibited more behavioral avoidance during contamination-related behavioral avoidance tasks (BATs; Deacon & Olatunji, though this latter relationship was fully mediated by self-reported disgust sensitivity).

The predictive ability of implicit measures in a contamination fearful sample has not been previously tested to our knowledge. Though evidence suggests that implicit associations can also be correlated with subjective distress (Teachman, Smith-Janik, & Saporito, 2007; Teachman & Woody, 2003) and explicit cognitions (Steinman & Teachman, 2011; cf. de Jong, van den Hout, Rietbroek, & Huijding, 2003; Swanson, Rudman, & Greenwald, 2001), the literature has produced mixed findings. This suggests that the strength of the relationships may be disorder- or association-dependent, and/or may vary based on different moderators, such as the social desirability of the evaluation (see Nosek, 2005). Nevertheless, there is growing empirical support that implicit measures can be unique predictors of clinical outcomes, including symptom severity and other indicators relevant to contamination fear. Recently, in a non-clinical sample, an implicit measure of disgust sensitivity was found to predict avoidance on BATs measuring disgust across a variety of domains, independently of

self-reported anxiety and disgust propensity (Nicholson & Barnes-Holmes, 2012). Similarly, in a sample of individuals with pathological skin picking, an implicit measure of distraction tendencies in response to pictures of skin irregularities predicted unique variance in post-treatment severity of skin picking, beyond that accounted for by a self-report measure of skin picking severity given prior to treatment (Schuck, Keijsers, & Rinck, 2012).

Akin to threat overestimation, be it explicitly or implicitly measured, contamination fear can also be examined as a multifaceted construct. In their multisystem framework of emotion, Lang, Cuthbert, and Bradley (1998) highlight multiple response systems (e.g., behaviors, feelings) that can be involved in the expression of fear (see also Lang, 1968; Rachman, 1978), and they note that desynchrony among these systems is common. Therefore, to capture multiple components of contamination fear, we examine: 1) self-reported contamination fear symptoms, 2) subjective distress tied to contamination concerns, including fear (Rachman & Hodgson, 1980) and disgust (Olatunji, Lohr, Sawchuk, & Tolin, 2007), 3) cognitions tied to state overestimation of threat (Dorfan & Woody, 2006), and 4) avoidance as a behavioral indicator of contamination fear (Olatunji et al.).

We examine implicit and explicit measures tied to threat overestimation as simultaneous predictors of the multiple components of contamination fear among individuals high in contamination fear to learn whether different forms of pathological fear responses are uniquely predicted by explicit versus implicit biases. While it is widely established that cognitive threat biases are related to the expression of fear, there is little work determining if different forms of cognitive bias (e.g., explicit versus implicit) predict distinct components of the fear response, which is the focus of the current investigation. Understanding what factors differentially predict various facets of contamination fear problems may be important for determining distinct targets of therapy based on idiographic fear profiles. For example, if behavioral avoidance is better predicted by implicit (versus explicit) measures of threat overestimation, then cognitive bias interventions that specifically target maladaptive implicit associations (versus the focus on explicit cognitions with traditional cognitive restructuring) may be needed to decrease avoidant behavior.

Dual-process models of attitude-behavior relations (e.g., Strack & Deutsch, 2004), and the related double dissociation hypothesis (see Asendorpf et al., 2002; Roefs et al., 2011), theorize that implicit measures wield relatively greater predictive validity when the resources required for cognitive control are low or task responses are difficult to consciously control, whereas explicit measures are thought to have greater predictive validity when cognitive control resources are high or task responses are readily controllable. Though this study does not directly test dual process models, they are useful for generating hypotheses about potential differences in implicit versus explicit predictive validity. In particular, dual process models suggest that explicit threat overestimation should predict markers of contamination fear that are available to conscious introspection and amenable to conscious control, which would include the self-reported symptoms, cognitive, and affective contamination fear responses in the current study.

Prediction of behavioral avoidance is less obvious. While performance on all of the outcome measures is controllable to some extent, we expected behavioral avoidance to be less controlled due to the presence of state anxiety during the task. Evidence suggests that under conditions of elevated state anxiety, certain kinds of behaviors are relatively less controllable, due to the depletion of cognitive control resources (see Eysenck, Derakshad, Santos, & Calvo, 2007). For example, individuals who show a restrained pattern of eating have been shown to eat more food when performing a high cognitive-load task than when performing a low cognitive-load task (Ward & Mann, 2000), and to increase their food intake in a laboratory setting when under conditions of increased state anxiety (Polivy,

Herman, & McFarlane, 1994). Additionally, under conditions of heightened state anxiety due to an upcoming speech task, individuals with elevated trait social anxiety drink more alcohol than when they are not told about an upcoming speech (Kidorf & Lang, 1999). Together, these examples suggest that overriding certain motivated behaviors will be more difficult when resources are depleted, as occurs during state anxiety. Thus, to the extent that avoidance is a less controlled contamination fear response, dual process models suggest it should be predicted by implicit threat overestimation. However, given that participants have time to adjust their approach/avoidance behavior, potentially allowing for some strategic override, explicit threat overestimation may also be a predictor.

2. Method¹

2.1. Participants

Participants ($N = 56$) were undergraduates who were recruited from the university's psychology department participant pool who were invited to participate if they scored higher than the mean of a diagnosed OCD sample on the Padua Inventory–Washington State University Revision–Contamination Fear Subscale (PI-WSUR-C; Burns, Keortge, Formea, & Sternberger, 1996)². This symptom cutoff is in line with numerous other studies that have used high contamination fear samples (e.g., Deacon & Maack, 2008; Deacon & Olatunji, 2007; Olatunji, Sawchuk, Lohr, & de Jong, 2004). Our sample did not include participants low in contamination fear because these data were collected as part of a larger study that involved an intervention for contamination-fearful individuals (see Green & Teachman, 2012, and footnote ¹). Individuals took the PI-WSUR-C online at a time of their choosing, as part of a larger battery of unrelated questionnaires that were given in random order. They were not told how their responses would affect study eligibility. Participants in the study were compensated with course credit or pay (\$20 for two hours). The sample reported a mean age of 18.7 ($SD = .94$), and race as 41.1% Caucasian, 19.6% African American/Black, 17.9% Hispanic/Latino, 10.7% Asian, 5.4% Middle Eastern, and 3.6% bi-racial (1.8% did not report race).

2.2. Materials

2.2.1. Measures of threat overestimation

Participants completed the *Contamination Cognitions Scale* (CCS; Deacon & Maack, 2008), which assesses probability judgments of contamination from common objects (e.g., elevator buttons), as well as cognitions tied to how “bad” this contamination would be (costs) were it to occur. This measure has been shown to have good internal consistency across four time points, with Cronbach's alpha ranging from .95 to .99, as well as excellent test-retest reliability (.94) over a 1-week period (Deacon & Maack; Cronbach's alpha in current sample = .97). The scale was modified from the original in that the response options were divided into blocks of 10s (e.g., participants could respond with 0, 10, 20, etc.). Participants' responses were averaged across the 26 items, and scores ranged from 0 to 100.

Participants also completed a measure of looming vulnerability cognitions using the *Looming of Contamination Toronto Scale* (LOC; Riskind & Rector, 2007), which has good internal consistency (Cronbach's alpha = .95; Riskind & Rector). Participants read about and

¹These data were collected as part of a larger two-session study designed to manipulate implicit contamination fear associations (see Green & Teachman, 2012). For the current study, we collapsed across experimental conditions because the experimental manipulation was unsuccessful. Only measures relevant to the current hypotheses are included. A full listing of the other measures and procedures included in the study is available from the first author.

²The PI-WSUR has been shown to have good internal consistency (Cronbach's alpha = .85) and test-retest reliability (0.72) over a 6–7 month period in an unselected sample (Burns et al.; Cronbach's alpha in current sample = .67).

imagined themselves in three contamination-relevant scenarios (e.g., being in a public bathroom). They then rated the degree to which they imagined the contamination in each scenario as spreading (Cronbach's alpha for these items in current sample = .80) and the level of threat as increasing versus remaining constant (Cronbach's alpha for these items in current sample = .72)².

2.2.2. Implicit measure of safety-danger associations

The *Brief Implicit Association Test* (B-IAT; Sriram & Greenwald, 2009) was used to assess implicit associations tied to the relative danger versus safety (Jones & Menzies, 1997) of ambiguously contaminated objects. Reliability on this measure has been shown to vary according to the stimuli that are used (Cronbach's alpha range: .55 – .94; Sriram & Greenwald). The task reflects overestimation of threat because the objects are not clearly contaminated, so connecting the objects with danger indicates a tendency to infer threat even when threat is not objectively present. The B-IAT is a modified version of the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) in which individuals must quickly classify various types of stimuli into superordinate level categories. Unlike the IAT, which requires a relative comparison between two explicitly labeled target categories, the B-IAT only requires the explicit labeling of one target category (potential contaminants, in this case) and two descriptive attribute categories (dangerous or safe, in this case). Items from another category appear as unlabeled background stimuli.

The target category label selected to represent the potential contaminants was “Everyday Objects,” so as not to directly prime contamination fears. The everyday object images were public toilets and exemplars from two categories that the participant had rated as the most “germy” out of a list of 20 objects commonly perceived as potentially dirty (e.g., doorknobs, hairbrushes). Independent raters ($N=14$) previously rated each picture for degree of contamination on a Likert-type scale ranging from 1 (*Not at all contaminated*) to 7 (*The most contaminated I can imagine something being*). All everyday object category means (e.g., the mean rating for all doorknob images) fell in the ambiguously contaminated realm, receiving ratings between 2 and 5, with no single image within a category receiving a mean rating above 5.7. The attribute categories were labeled “Dangerous” (stimuli included “Dangerous,” “Perilous”, and “Risky”) and “Safe” (stimuli included “Safe,” “Protected,” and “Secure”). Given the difficulty of selecting relevant control stimuli that could not potentially be seen as contaminated, we used images of the same everyday objects in an unrecognized, scrambled form as background stimuli, allowing us to control for the color composition of each image.

The B-IAT included five blocks, three of which were used for practice in categorizing the stimuli and were not analyzed. In one critical block (4 practice trials and 36 test trials) the participant was told to classify “Everyday Objects” and “Dangerous” stimuli together using one key, and to reject any other stimuli using another key (in this example, the other stimuli would be the scrambled images and “Safe” words). In the other critical block (4 practice trials and 36 test trials), the task was to classify “Everyday Objects” and “Safe” stimuli together using one key and to reject any other stimuli (scrambled images and “Dangerous” words) using another key. The difference in overall classification time between these two critical blocks (order was counterbalanced) was taken as a measure of the relative strength of associations between contamination-related images and safety or danger. This is based on the idea that people can classify stimuli more quickly if the category pairing is consistent with their automatic associations between the constructs (Greenwald et al., 1998).

2.2.3. Measures of contamination fear outcomes

Contamination fear symptoms—Participants completed the Vancouver Obsessional Compulsive Inventory-Contamination Subscale (VOCI-CS; Thordarson et al., 2004). In a sample of individuals with OCD, this measure has been shown to have excellent internal consistency (Cronbach's $\alpha = .92$) and test-retest reliability (.96) over a span of approximately 1.5 months (Thordarson et al.; Cronbach's α in current sample = .87).

Subjective distress—After participants were given a general description of the BAT steps, they rated their anticipatory fear and disgust levels for the task using a 0–100 verbal analogue Subjective Units of Distress Scale (SUDS; Wolpe, 1990) ranging from 0 (*no fear*) to 100 (*most fearful you can imagine being, like panic*). Immediately following the task, participants used the same scale to provide ratings of their peak fear and disgust levels during the task.

State cognition—After a brief exposure task during which they were asked to touch the adhesive portion of a seemingly used bandage, participants completed a 7-item State Looming Vulnerability (SLV; Schmidt, Simpson, & Teachman, 2010) questionnaire designed for the current study to assess their state contamination looming appraisals during the exposure task (e.g., “To what extent did you feel that the threat of contamination was changing or morphing?”; Cronbach's α in current sample = .90).

Behavioral avoidance—Participants engaged in a behavioral avoidance task (BAT) involving a public toilet in a single stall bathroom. The task was divided into six steps, which progressively invited greater contact with the toilet. Higher scores indicate less avoidance. The steps were as follows: (1) touch the toilet flusher with one's dominant hand, (2) touch the top of the toilet pipe (the metal piece directly behind the top of the seat) with both hands, (3) touch the outside of the toilet bowl on the sides (not the seat itself) with both hands, (4) rub the palms of one's hands all over one's forearms, (5) touch the toilet seat with the palms of both hands, and (6) rub the palm side of both hands across one's cheeks and forehead. Participants were told that they could end the task at any time and that it was not a test of courage.

2.3. Procedure

Following informed consent, participants rated the degree of “germiness” of public toilets and the objects that they thought were the most contaminated from a list of common items. These objects comprised the idiographic stimuli used in the B-IAT. They next completed a measure of contamination fear symptoms (VOCI-CS). During a second lab visit two days later, participants provided baseline levels of fear and disgust (SUDS) and completed the B-IAT to measure contamination-related implicit associations. They then did the toilet BAT and bandage exposure tasks, followed by a measure of their state looming vulnerability cognitions (SLV). After being allowed to wash their hands, participants completed a measure of trait looming vulnerability (LOC) and contamination cognitions (CCS). Participants were then fully debriefed and thanked.

3. Results

3.1. Data scoring and reduction

The B-IAT data were scored according to the algorithm developed by Greenwald, Nosek, and Banaji (2003) for the IAT. A D score was calculated, representing the difference in mean response time across critical blocks divided by the standard deviations across blocks. Following the recommendations of Greenwald et al., we excluded data if the individual's

error rate was more than 30% overall, or if an individual took less than 300 ms to respond to more than 10% of trials. On the basis of these criteria, one individual's B-IAT data were cut.

3.2. Modeling procedure

Structural equation modeling (SEM) was used to examine threat overestimation, measured explicitly and implicitly, as a predictor of contamination-related symptoms, subjective distress, state cognition, and behavior (see Bornstein & Benasich, 1986; Geweke & Singleton, 1980; and Holbert & Stephenson, 2002, for discussion of applicability of SEM to relatively smaller sample sizes). See Table 1 for means and standard deviations of the measures used to assess these constructs. Explicit cognitive predictors were combined into a "true score" latent factor consisting of three indicators that loaded significantly onto the factor (see Figures 1–4): 1) likelihood- and severity-related contamination cognitions (CCS total score), reflecting probability and cost biases, 2) cognitions related to the degree to which the threat of contamination is escalating in a given situation (mean item score across scenarios on LOC), and 3) cognitions related to the degree to which contaminants are rapidly spreading in a given situation (mean item score across scenarios on LOC). The latent factor was created to more broadly sample the domain of explicit threat overestimation and to decrease the effect of measurement error and intra-individual variability by including only the shared variance across the indicators. Similarly, a latent factor representing the "true" implicit score was created. Participants' responses to the 36 test trials in both critical blocks were parceled into three subsets (e.g., test trials 1, 4, 7, etc. were grouped together into one parcel; test trials 2, 5, 8, etc. were grouped into another parcel). These three parcels served as indicators for the latent implicit factor. Lastly, a latent factor was created for the subjective distress outcomes using the anticipatory and peak fear and disgust ratings in response to the toilet BAT. Single indicators were used for the other variables: contamination-related symptoms were measured with the VOCI-CS, behavior was measured by avoidance in the toilet BAT, and state cognition by the SLV scale.

Four models (one for each contamination-outcome measure) were fit in Amos using full maximum likelihood methods to treat incomplete data as missing at random (Little & Rubin, 1987). For each baseline model, paths connecting the explicit and implicit cognitive predictors to the contamination-related outcome were freely estimated, as was the relationship between the explicit and implicit cognitive predictors. See Figures 1–4 for each baseline model with standardized coefficients noted and significant coefficients indicated by an asterisk.

To test the relationship between the cognitive predictors and contamination-related outcomes, each baseline model was compared to multiple, nested structural regression models (see McArdle & Hamagami, 1996) in which the path connecting the implicit (Models 1–4b) or explicit (Models 1–4c) cognitive predictor to a contamination-outcome measure was constrained to be 0. This methodology allows for alternative hypotheses to be considered systematically by examining the change in chi-squared value, with lower values indicating better fit (Jöreskog & Sörbom, 1979). A non-significant change in fit between a baseline model and its nested model indicates that one cannot reject the null hypothesis of non-significant path estimates, whereas a significant change in fit implies that the model fit is significantly improved by estimating the relationship between the cognitive predictor and the contamination-related outcome measure. See Table 2 for the goodness-of-fit indices and the change in fit between each baseline and nested model.

For descriptive purposes, the absolute model fit for each model was also examined according to the root-mean-square error of approximation index (RMSEA; less than 0.08 can be considered an acceptable fit, according to Browne & Cudeck, 1993; lower numbers are better), the comparative fit index (CFI), and the normed fit index (NFI). Values on the

CFI and NFI range from 0 to 1 (higher numbers are better), with values of about 0.90 indicating an acceptable fit (Hu & Bentler, 1999).

The latent explicit variable was a significant and unique predictor of contamination fear symptoms, subjective distress, and state cognitions, but not of behavioral avoidance. Only the implicit measure predicted behavioral avoidance at the level of a trend ($p = .067$). Notably, the difference between the standardized regression weights for the path from the explicit latent factor to the behavioral avoidance indicator and for the path from the implicit latent factor to the behavioral avoidance indicator was not significant ($p = .182$), suggesting there was not a significant difference in the magnitude of implicit vs. explicit prediction of avoidance (both were small effects; see Figure 3).

The absolute fit indices indicated mostly adequate fit for all baseline models, with the exception of the model predicting subjective distress (which may have lower fit indices due to the larger number of parameters estimated). The nested comparisons showed a significant loss of fit for models in which the path from the explicit (but not implicit) cognitive factor was constrained to 0 when predicting symptoms, subjective distress, or state cognitions (see Models 1–3c), as well as a significant loss of fit for the model in which the path from the implicit (but not explicit) latent factor to the behavior outcome was constrained to 0 (see Model 4b). (Note, the finding that the coefficient for the path between the implicit latent measure and behavioral avoidance only trended toward significance, while the nested model comparison revealed a significant loss in model fit when that path was set to 0, presumably occurred because shifting the one parameter led to other effects in the model; e.g., altering other variables' variances or covariances. Thus, the effects show the same link between the implicit and behavioral measures, just slight variations in significance level.)

4. Discussion

We examined multiple facets of threat overestimation, explicitly and implicitly, as predictors of four contamination fear-related outcomes: symptoms, subjective distress, state cognitions, and behavioral avoidance. As hypothesized, and in keeping with prior findings (Deacon & Olatunji, 2007; Riskind et al., 1997), contamination-related symptoms were predicted by the latent explicit threat overestimation factor. Further, explicit threat overestimation predicted state looming vulnerability cognitions, in line with findings from Tolin et al. (2004), and predicted subjective distress, in keeping with the findings of Deacon and Olatunji. Moreover, these prior distress findings were extended to include a state measure of disgust in addition to anxiety, and to include both anticipatory and peak affect ratings.

Regarding the prediction of behavioral avoidance, prior studies have often found significant, small to moderately sized correlations between IAT effects and behavior (e.g., McConnell & Leibold, 2001; Rudman & Glick, 2001), but null findings certainly do occur (e.g., Karpinski & Hilton, 2001). Our examination in the domain of contamination fear matched this mixed picture in that the relationship between our implicit measure and behavioral avoidance was only significant at the level of a trend and did not differ significantly from the relationship between explicit threat overestimation and behavior.

The lack of a significant association in the current study between explicit measures and avoidance does stand in contrast to prior findings of a significant relationship between contamination cognitions and avoidance (e.g., Deacon & Olatunji, 2007) and looming vulnerability cognitions and avoidance (Riskind, Wheeler, & Picerno, 1997). A potential explanation for this discrepancy lies in the measurement of avoidance across these studies. Deacon and Olatunji measured avoidance using three contamination-related BATs, which were summed to create a single measure. Riskind and colleagues measured anticipated

avoidance by how close participants would be willing to stand to a “filthy” toilet for five minutes, though participants never actually saw the filthy toilet or were asked to stand by it. In the current study, we measured avoidance with a single BAT involving one contamination-related object. Given the heterogeneity of contamination concerns, it may be that a stronger relationship emerged in those studies where a variety of contamination-related objects were included, or where participants were able to impose their own imagery on a hypothetical “filthy” toilet. The second possible explanation concerns the current study’s restricted range of contamination fear, which may have obscured a significant relationship between the explicit measures and avoidance. Deacon and Olatunji, as well as Riskind and colleagues, included participants both high and low in contamination fear, whereas the current study only included the former. Nevertheless, the desynchrony among response domains is in keeping with Lang and colleagues’ (Lang et al., 1998) multisystem framework of emotion, according to which various response domains may be expressed independently. To borrow Lang’s phrase, these results suggest that neither contamination fear nor threat overestimation lend itself to a “lump theory” (Lang, 1970).

To our knowledge, this study provides the first evaluation of the unique predictive validity of implicit and explicit measures of threat overestimation in a contamination-fearful sample. Our findings are in line with prior research that has found implicit and explicit measures to assess distinguishable yet complementary components of attitudinal constructs (see Nosek & Smyth, 2007). Certainly, one possible explanation for our findings is that they are due to shared method variance (i.e., the latent explicit threat overestimation variable, which was comprised of self-reported questionnaire scores was significantly associated with the three dependent variables, which were also self-report-based). However, an alternative or perhaps additional way to conceptualize our findings is that controllability lies on a continuum and that it is easier to control responses under certain conditions than under others. Therefore, the pattern of distinct implicit versus explicit prediction may reflect a difference in controllability between the avoidance task and the self-report measures. As previously discussed, implicit measures are thought to be less amenable to conscious control, which, according to dual process models and the related double dissociation hypothesis, makes them more predictive of behaviors exhibited under conditions of decreased control (see Asendorpf et al., 2002; Roefs et al., 2011). While participants were given as much time as they wanted to advance through the BAT, task performance is still arguably less controlled than the self-report measures, given participants completed the task under conditions of heightened state anxiety, and approach likely required overcoming the strong avoidance motivation typically associated with contamination fear (Rachman, 2004). In keeping with dual-process models (e.g., Strack & Deutsch, 2004), implicit measures would be expected to have more predictive validity under such circumstances, though it will be important in future research to measure the controllability of performance on the behavioral task more directly.

Our results should be examined in light of several limitations. First, our sample is smaller than most samples on which SEM is used. However, according to Holbert and Stephenson (2002), “One should not rule out the use of SEM with fewer [participants], but variables must be reliably measured, the structural models should be simple, and the limitations of the analyses must be documented” (p. 536). In light of these recommendations, we created separate models for each dependent variable to reduce the number of parameters estimated in any given model. Furthermore, all measures in the model had adequate psychometric properties, with the exception of our implicit measure, which had relatively lower internal consistency (though the psychometrics were relatively good for implicit reaction time tasks of this nature; see Fazio & Olson, 2003). Nonetheless, given the relatively small sample size, parameter estimates may be less stable than they would have been with a larger sample. Second, our study only included individuals who were highly contamination fearful. While this was a result of the data having been collected for a separate study, it is notable that the

use of a restricted range made for a more rigorous test of relationships between variables, strengthening confidence that the observed significant relationships are robust. Third, the B-IAT is a relatively new measure, which, to our knowledge, has not previously been used in a contamination-fearful sample, so further validation is required.

Nevertheless, these results have significant clinical and theoretical implications. The fact that implicit danger associations uniquely predicted behavioral avoidance suggests there may be value in altering implicit associations (e.g., through therapy or cognitive bias modification; see Clerkin & Teachman, 2010). As Lang (1971) notes, the multiple response domains involved with experiencing and expressing an emotion can function independently and, consequently, can each be shaped by environmental contingencies. Moreover, our findings support the targeting of looming vulnerability cognitions in treatment for individuals with contamination fear, in line with the recommendations of Riskind and Rector (2007).

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Figure 1.

Rectangles depict measured variables; circles represent latent factors. Curved arrows indicate error terms for each variable. Single-headed arrows indicate structural parameters. Double-headed arrow indicates covariations between two variables. LOC = Looming of Contamination Toronto Scale; CCS = Contamination Cognitions Scale; BIAT = Brief Implicit Association Test; Bias Scores 1–3 = parceled D scores; VOCI = Vancouver Obsessional Compulsive Inventory. *Note.* The figure shows the significant parameter estimates for Model 1a.

Figure 2.

LOC = Looming of Contamination Toronto Scale; CCS = Contamination Cognitions Scale; B-IAT = Brief Implicit Association Test; Bias Scores 1–3 = parceled D scores; BAT = Behavioral Avoidance Task. Ant. = Anticipatory. *Note.* The figure shows the significant parameter estimates for Model 2a.

Figure 3.

LOC = Looming of Contamination Toronto Scale; CCS = Contamination Cognitions Scale; B-IAT = Brief Implicit Association Test; Bias Scores 1–3 = parceled D scores; SLV = Sense of Looming Vulnerability. *Note.* The figure shows the significant parameter estimates for Model 3a.

Figure 4.

LOC = Looming of Contamination Toronto Scale; CCS = Contamination Cognitions Scale; B-IAT = Brief Implicit Association Test; BAT = Behavioral Avoidance Task. *Note.* The figure shows the significant parameter estimates for Model 4a.

Table 1

Means and Standard Deviations of Predictors and Outcome Measures

<u>Explicit and Implicit Cognitive Predictors</u>		
	<i>M</i>	<i>SD</i>
Likelihood and Severity Ratings (CCS)	43.28	20.67
Escalating Threat Cognitions (from LOC)	3.51	1.33
Rapid Spread of Contamination Cognitions (from LOC)	3.75	1.33
D Score (Danger B-IAT)	-.16	.34
<u>Contamination-Related Outcome Measures</u>		
Symptoms (VOCI – CS)	16.27	10.84
Anticipatory Disgust (Toilet SUDS)	47.30	25.86
Anticipatory Fear (Toilet SUDS)	26.59	23.91
Peak Disgust (Toilet SUDS)	58.54	28.25
Peak Fear (Toilet SUDS)	34.96	31.56
State Cognition (SLV)	18.27	9.43
Behavior (Toilet Avoidance)	3.04	2.10

Note. CCS = contamination cognitions scale; LUC = Looming of Contamination Toronto Scale; B-IAT = Brief Implicit Association Test; VOCI-CS = Vancouver Obsessive Compulsive Index – Contamination Subscale; SUDS = Subjective Units of Distress Scale; SLV = State Looming Vulnerability Scale questionnaire.

Table 2

Fit Statistics of the Three Competing Nested Models

Model	χ^2	df	χ^2/df	$\Delta\chi^2$	df	NFI	CFI	RMSEA
Symptoms (Fig. 1)								
1a: Baseline	13.40	12				.89	.99	.05
1b (implicit set to 0)	13.62	13	.22	No		.89	.99	.03
1c (explicit set to 0)	17.80	13	4.40	yes		.85	.95	.08
Subjective Distress (Fig. 2)								
2a: Baseline	71.53	32				.79	0.86	.15
2b (implicit set to 0)	71.69	33	.16	No		.79	0.86	.15
2c (explicit set to 0)	83.38	33	11.85	Yes		.76	0.82	.17
State Cognition (Fig. 3)								
3a: Baseline	8.08	12				.94	1.00	.00
3b (implicit set to 0)	8.11	13	.03	No		.94	1.00	.00
3c (explicit set to 0)	24.22	13	16.14	Yes		.81	0.89	.13
Behavior (Fig. 4)								
4a: Baseline	4.39	12				.96	1.00	.00
4b (implicit set to 0)	8.23	13	3.84	Yes		.93	1.00	.00
4c (explicit set to 0)	5.42	13	1.03	No		.95	1.00	.00

Note. The $\Delta\chi^2$ on df column indicates whether the alternate model is significantly different from the baseline model at the $P < .05$ level, based on the chi-square distribution with the relevant df. NFI = normed fit index; CFI = comparative fit index; RMSEA = root-mean-square error of approximation. For models 1–4 b, “implicit set to 0” means the path from the implicit latent factor was set to 0. For models 1–4 c, “explicit set to 0” means the path from the explicit latent factor was set to 0.