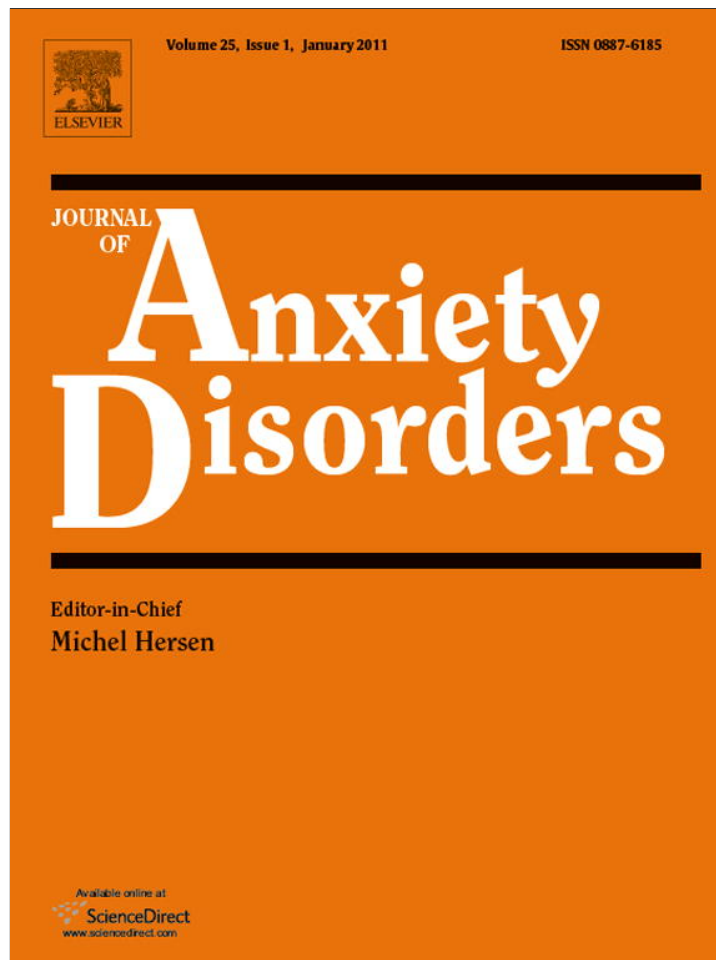


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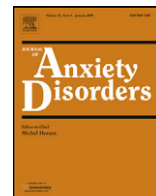
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## Unique affective and cognitive processes in contamination appraisals: Implications for contamination fear

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### ABSTRACT

A large body of evidence suggests an important role of disgust in contamination fear (CF). A separate line of research implicates various cognitive mechanisms in contamination fear, including obsessive beliefs, memory biases, and delayed attentional disengagement from threat. This study is an initial attempt to integrate these two lines of research and examines whether disgust and delayed attention disengagement from threat explain unique or overlapping processes within CF. Non-clinical undergraduate students ( $N=108$ ) completed a spatial cueing task, which provided measures of delayed disengagement from frightening and disgusting cues, and a self-report measure of disgust propensity (DP). Participants also completed a chain of contagion task, in which they provided contamination appraisals of an object as a function of degrees of removal from an initial contaminant. Results demonstrated that DP predicted greater initial contamination appraisals, but a sharper decline in estimations across further degrees of removal from the contaminant. Delayed disengagement from disgust cues uniquely predicted sustained elevations in contamination estimations across further degrees of removal from the contaminant. These results suggest that DP and delayed disengagement from disgust cues explain unique and complimentary processes in contamination appraisals, which suggests the utility of incorporating the disparate affective and cognitive lines of research on CF.

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Contamination fear (CF) refers to “an intense and persisting feeling of having been polluted, dirtied, or infected, or endangered as a result of contact, direct or indirect, with an item/place/person perceived to be soiled, impure, dirty, infectious, or harmful” (Rachman, 2006, p. 9). CF is most obviously linked with obsessive–compulsive disorder (OCD), where obsessions are related to germs, disease, and/or general uncleanliness, and compulsions are typically related to washing rituals (Rachman, 2004, 2006). CF may also be relevant for understanding other disorders, such as sexual assault-related posttraumatic stress disorder (Herba & Rachman, 2007) and health anxiety (Olatunji, 2009).

Research investigating the mechanisms relevant for understanding heightened CF generally falls into two conceptually distinct areas. On the one hand, much research has been focused on the role of disgust in CF (Cisler, Olatunji, & Lohr, 2009a; Woody & Teachman, 2000). Disgust is a basic emotion theorized to motivate

the avoidance of contact with, and ingestion of, noxious substances (Oaten, Stevenson, & Case, 2009; Rozin & Fallon, 1987). Evidence supporting an important role of disgust in CF comes from studies demonstrating (1) positive correlations between self-report measures of disgust and contamination fear (Moretz & McKay, 2008; Olatunji, Sawchuk, Lohr, & de Jong, 2004; Olatunji, Williams, et al., 2007), (2) increases in disgust propensity (DP) prospectively predict increase in CF (David et al., 2009; Olatunji, 2010), (3) greater avoidance and self-reported disgust during exposure to disgust-related objects among individuals with heightened CF (Deacon & Olatunji, 2007; Olatunji, Lohr, Sawchuk, & Tolin, 2007; Tsao & McKay, 2004), and (4) greater anterior insula activation, a neural region implicated in disgust processing, during exposure to disorder-relevant stimuli and disgust stimuli among individuals with contamination-related OCD (Lawrence et al., 2007; Phillips et al., 2000; Shapira et al., 2003). Further, research has consistently demonstrated that the relationship between disgust and contamination fear remains when controlling for general negative affectivity or trait anxiety (Moretz & McKay, 2008; Olatunji, Williams, et al., 2007; Tsao & McKay, 2004). This body of research provides strong evidence for a role of disgust in CF.

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On the other hand, much research has also focused on the role of various cognitive mechanisms in CF. One line of research in this regard has been research investigating obsessive beliefs in OCD, which refer to beliefs about the importance of controlling thoughts, perfectionism, intolerance of uncertainty, and overestimation of threat (OCCWG, 1997; Obsessive Compulsive Cognitions Working Groups [OCCGW], 1997, 2005; Rachman, 1997). This research suggests that overestimation of threat is strongly linked with contamination-related OCD (Tolin, Woods, & Abramowitz, 2003; Tolin, Brady, & Hannan, 2008). Another line of research suggests memory biases in CF. For example, Radomsky and Rachman (1999) found that individuals with contamination-related OCD were better able to remember which neutral objects had been touched with a contaminated object compared to a control group. Another line of research suggests attentional biases towards threat in CF (Armstrong & Olatunji, 2010; Foa, Ilai, McCarthy, & Shoyer, 1993; Najmi & Amir, 2010), with particular evidence for difficulty disengaging attention from threat cues (Cisler & Olatunji, 2010). These lines of research provide support for the importance of several cognitive mechanisms in understanding CF, though it is important to note that the degree to which these different cognitive mechanisms are distinct versus overlapping has yet to be elucidated.

It seems important and timely to begin to integrate these disparate lines of research into coherent explanations of CF. One relevant question in this pursuit is the degree to which affective (i.e., disgust) mechanisms and cognitive mechanisms explain unique versus overlapping processes in CF. One hypothesis regarding this question is that the relative primacy of the affective and cognitive mechanisms might differ depending on the characteristics of the stimulus. The laboratory-based studies discussed above employed objects and situations that are considered normative disgust elicitors with more apparent probability for contagion, such as bedpans and soiled tissues. Given that these objects are normative disgust elicitors with apparent contagion probability, it would be expected that individual differences in disgust propensity mediate reactions towards them (e.g., Rozin, Haidt, & McCauley, 1999). Normative disgust elicitors, however, are not the only types of objects that elicit marked disturbance among individuals with contamination-related OCD; instead, a much broader range of objects and situations elicit strong reactions from these individuals, such as touching stairway handrails, elevator buttons, door handles, money, and public telephones. In contrast to normative disgust elicitors, these objects and situations do not have obvious contamination-related properties and it seems unlikely that individual differences in disgust will explain a majority of the variance in marked disturbance towards these items. Rather, it may be the case that cognitive mechanisms, such as threat overestimation or difficulty disengaging attention from threat, explain the majority of variance towards these types of objects. While it is acknowledged that a strict dissociation between cognitive and affective processes does not seem tenable (e.g., they likely operate in tandem to mediate reactions towards any type of object), the relative importance of the affective or cognitive mechanisms may differ as a function of the type of object. This analysis makes two testable predictions: disgust may be more important in mediating reactions towards objects with more apparent and direct contagion properties (e.g., normative disgust elicitors), whereas the cognitive mechanisms implicated in CF may be more important in mediating reactions towards objects that have only indirect and distal contagion probability (e.g., elevator buttons may only become contaminated if someone sick sneezes on them).

The goal of the present study was to provide an initial test of these hypothesized unique roles of disgust and cognitive processes in CF. DP was chosen as the specific affective mechanism to investigate, given the wealth of previous research linking

heightened DP with CF (Moretz & McKay, 2008; Olatunji et al., 2004; Olatunji et al., 2006; Olatunji, Williams, et al., 2007). Difficulty disengaging attention from threat cues was chosen as the specific cognitive mechanism to investigate, given the growing body of research linking delayed attentional disengagement from threat cues with CF (Armstrong & Olatunji, 2010; Cisler & Olatunji, 2010). Further, difficulty disengaging attention may map directly onto the hypothesized process, such that an individual with contamination-based OCD may fixate on an elevator button, for example, because of difficulty removing (i.e., disengaging) attention from the alleged danger cue. As such, difficulty disengaging attention from threat seems a promising initial cognitive mechanism with which to test the hypothesized model.

One challenge to investigating the unique contributions of DP and delayed attentional disengagement is using a measure of CF sensitive enough to reflect variations in both candidate mechanisms. One viable measure is the chain of contagion task (Tolin, Worhunsky, & Maltby, 2004). In Tolin and colleagues' task, participants identified the most contaminated object in the building and rated how contaminated it was from 0 to 100%. The experimenter then rubbed a new pencil on the object, and the participant rated how contaminated the pencil was from 0 to 100%. The experimenter then rubbed another new pencil on the previous pencil, and the participant rated how contaminated the new pencil was from 0 to 100%. This process was repeated for 12 pencils; i.e., 12 degrees of removal from the initial contaminant. Tolin and colleagues found that individuals with contamination-related OCD demonstrated greater initial elevations as well as greater sustained elevations across the pencils relative to other anxiety disorder and non-anxious control groups. This methodology is useful for testing the hypothesized unique roles of affective and cognitive mechanisms because it systematically manipulates the contagion properties of the stimulus. That is, pencils 1 and 2, for example, have more direct contact with the contaminant and it might be expected that DP predicts contamination appraisals of these pencils. By contrast, pencils 11 and 12, for example, have only distal and indirect contact with the initial contaminant and difficulty disengaging attention from the initial threat cue might predict contamination appraisals of these objects. Accordingly, Tolin et al.'s (2004) chain of contagion task appears to be a viable means of testing whether the affective and cognitive mechanisms differentially explain variance in contamination appraisals of objects as a function of degrees of removal from the initial contaminant.

The present study tested the hypothesized roles of unique affective and cognitive mechanisms in CF by examining whether DP and delayed disengagement from threat predicted unique sources of variance in the chain of contagion task (Tolin et al., 2004). We hypothesized that DP would explain variance in pencils with more direct contact with the initial contaminant, but be less relevant for explaining variance in pencils with only indirect contact with the initial contaminant. By contrast, we predicted that delayed disengagement from threat would explain variance in pencils with only distal and indirect contact with the initial contaminant. Our previous study (Cisler & Olatunji, 2010) found delayed disengagement from both fear and disgust cues among high CF individuals at 500 ms, but not 100 ms, stimulus presentation. Both fear and disgust cues were used in the present study to examine whether relations with the chain of contagion task were specific to either delayed disengagement from disgust or fear stimuli. Stimulus duration was also manipulated to be either 100 or 500 ms. Manipulating stimulus duration differentiates early versus late stages of information processing, which provides a test of whether relations with the chain of contagion task are specific to early versus late processing biases.

## 1. Method

### 1.1. Participants

108 non-clinical participants (85 females) were recruited from undergraduate courses. Mean age was 19.3 (SD = 1.2) and 85% were Caucasian. This initial study with a non-clinical sample will provide justification for future research with clinical samples.

### 1.2. Tasks

#### 1.2.1. Spatial cueing task

The spatial cueing task presents two empty boxes on the right and left of a central fixation cross. A cue (i.e., stimulus picture) is displayed in one of the boxes for either 100 or 500 ms. The cue then disappears and either a '/' or 'X' probe is displayed in one of the boxes. The participant is instructed to press the key (i.e., '/' or 'X') corresponding to the correct stimulus as quickly as possible without making errors. One-third of trials were invalid: the probe appeared in the location opposite of the cue. Two-thirds of trials were valid: the probe appeared in the location of the cue. More valid compared to invalid trials results in the participant using the cue as a predictive marker of the likely position of the probe (Fox, Russo, & Dutton, 2002). The cue was frightening, disgusting, or neutral on an equal number of trials. The cue was displayed for 100 or 500 ms on an equal number of trials. There were three initial practice trials, and 216 experimental trials. This methodology was also used in Cisler and Olatunji (2010).

Based on prior research specifically implicating delayed disengagement from threat in CF and DP (Armstrong and Olatunji, 2010; Cisler & Olatunji, 2010; Cisler et al., 2009) and the present hypotheses specifically focused on delayed disengagement, only delayed disengagement indices from the spatial cueing task were used in the present analyses.<sup>1</sup> As is common in attentional bias research (e.g., Koster, Crombez, Vershuere, Van Damme, & Wiersema, 2006; Mogg, Holmes, Garner, & Bradley, 2008), bias scores were created to index disengagement: RTs on neutral invalid trials were subtracted from RTs on disgust invalid trials and fear invalid trials to create disengagement from disgust and fear bias scores, respectively. Higher values reflect greater difficulty disengaging from the emotional cues relative to the neutral cues. These bias scores were created separately for 100 and 500 ms trials, providing 4 total disengagement indices: 2 (disgust versus fear bias)  $\times$  2 (100 ms versus 500 ms stimulus duration).

#### 1.2.2. Chain of contagion task

The chain of contagion task was modeled after the task used by Tolin and colleagues (2004). Participants were first presented with a white bedpan filled with a mixture of apple juice and dog hair. Participants were asked how contaminated they estimate the bedpan to be from 0 to 100%. The experimenter then opened a new box of 12 pencils and explained to the participant that the pencils are new and have just been opened for the first time. The experimenter then took out a pencil and rubbed it thoroughly on the outer and inner rim of the bedpan for 10 s, being careful to not let the pencil touch the fluid. The experimenter then asked the participant how contaminated they estimated the pencil to be from 0 to 100%. The experimenter then took out a new pencil and rubbed it thoroughly on the previous pencil for 5 s and then asked the participant how contaminated they estimated the pencil to be from 0 to 100%. This process was repeated for 12 pencils.

### 1.3. Stimuli

Neutral, disgusting, or frightening pictures used in the spatial cueing task were selected from the International Affective Pictures System (IAPS; Lang, Bradley, & Cuthbert, 1999). Participants were asked to rate how disgusting and frightening they found each picture at the end of the experiment. The disgust pictures were rated as more disgusting than the neutral ( $t = 40.21, p < .001$ ) and frightening ( $t = 18.26, p < .001$ ) pictures. The frightening pictures were rated as more frightening than the neutral ( $t = 23.47, p < .001$ ) and disgusting ( $t = 5.61, p < .001$ ) pictures.

### 1.4. Questionnaire

The disgust propensity (DP) subscale of the disgust propensity and sensitivity scale-revised (van Overveld, de Jong, Peters, Cavanagh, & Davey, 2006) is an 8 item self-report measure designed to assess the frequency of disgust experiences. Subjects endorse the frequency with which they experience the content described in the items on a 5 point Likert scale (0 = "never" to 5 = "always"). For example, item 10 is 'I experience disgust'. This measure has been found to correlate with other measures of disgust propensity (Cisler et al., 2009b; van Overveld et al., 2006) and with symptoms of disgust-related anxiety disorders (Olatunji, Lohr, et al., 2007; Olatunji, Williams, et al., 2007). Internal consistency in the present study was .82.

### 1.5. Latent growth modeling

Latent growth modeling (LGM; Duncan, Duncan, & Strycker, 2006; Willet & Sayer, 1994) is an application of structural equation modeling used to examine patterns of change over time in repeated measurement designs. Intra-individual patterns of change are represented by an intercept latent factor and slope latent factor(s). The intercept latent factor represents the initial level of the variable being measured when the first measurement point is coded as 0 in the shape factors, as is the case in the present model. The intercept is a constant: paths from the intercept latent factor to the measured variables are fixed at a common value (e.g., 1). The slope latent factor(s) represent the shape of the change (i.e., growth) in the measured variable over the measurement period. Shape of growth is typically measured with a linear slope latent factor, in which the paths from the linear slope factor to the measured variables are fixed to increase (or decrease, depending on the direction of growth) at a linear rate (e.g., 0, 1, 2, 3, etc.). However, non-linear patterns of growth can also be modeled by adding quadratic (with regression paths equaling the square of the corresponding linear factor path) and cubic (with regression paths equaling the cube of the corresponding linear factor path) latent shape factors when appropriate. Relevant variables can be added to the model to predict these intercept and slope latent factors.

Fit indices to test the LGM were the  $\chi^2$  test, comparative fit index (CFI), and root mean square error of approximation (RMSEA). CFI values above .95 suggest good fit (Hu & Bentler, 1999), RMSEA values below .08 suggest adequate fit, and values below .06 suggest good fit (Brown & Cudek, 1993; Hu & Bentler, 1999). Akaike's information criterion (AIC; Akaike, 1987) was used to compare fit between non-nested models, with lower levels suggesting better fit. AIC values penalize model complexity and therefore favor more parsimonious models.

LGM was conducted in the present study using AMOS 16.0 software (Arbuckle, 2007). Missing data were estimated using maximum likelihood procedures. While structural equation modeling typically requires large sample sizes, recent research suggests that LGM can provide robust estimates with much smaller sample sizes (Muthen & Muthen, 2002).

<sup>1</sup> Inclusion of the facilitated attention indices did not change interpretation of the findings reported in this manuscript. A full report of analyses including all indices of attentional bias from the spatial cueing task is available upon request from the first author.

**Table 1**  
Descriptive statistics of study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
(1) Pencil 1	–	.87	.73	.62	.55	.48	.43	.39	.36	.33	.32	.30	–.06	–.02	–.06	–.03	.28
(2) Pencil 2		–	.93	.84	.76	.70	.65	.60	.56	.53	.51	.48	–.04	–.01	–.07	–.03	.20
(3) Pencil 3			–	.96	.90	.85	.80	.76	.72	.68	.66	.63	–.04	.01	–.09	–.03	.10
(4) Pencil 4				–	.98	.94	.90	.86	.83	.79	.77	.74	.01	.07	–.05	–.06	.06
(5) Pencil 5					–	.99	.96	.93	.90	.87	.85	.82	.01	.13	–.02	.08	.03
(6) Pencil 6						–	.98	.97	.94	.92	.90	.87	.02	.16	–.02	.08	.02
(7) Pencil 7							–	.99	.97	.96	.94	.91	.01	.17	–.01	.08	.02
(8) Pencil 8								–	.99	.98	.96	.94	.04	.19	.02	.11	.02
(9) Pencil 9									–	.99	.98	.96	.05	.17	.02	.10	.01
(10) Pencil 10										–	.99	.98	.06	.17	.02	.10	.01
(11) Pencil 11											–	.99	.07	.15	.02	.09	.01
(12) Pencil 12												–	.07	.14	.04	.08	.02
(13) Disgust disengagement 100 ms													–	.14	.46	.18	.23
(14) Disgust disengagement 500 ms														–	.30	.49	.19
(15) Fear disengagement 100 ms <sup>a</sup>															–	.42	.22
(16) Fear disengagement 500 ms <sup>a</sup>																–	.14
(17) Disgust propensity																	–
Mean	77	63	52	43	37	32	28	25	23	21	19	18	–1.2	14.7	12.4	11.1	14.8
SD	26	27	29	30	31	31	30	30	30	30	29	29	41.7	38	2.2	2.3	4.7

*r* values > .19 significant at  $p < .05$ .

<sup>a</sup> Refers to square root-transformed variable, but untransformed *M* and *SD* are displayed to ease interpretation.

## 1.6. Procedure

Participants were recruited from introductory psychology courses who learned of the experiment from a course website listing available experiments in which to participate in return for course credit. Participants were first provided with written and oral informed consent. The study was approved by the University Institutional Review Board. The order of the spatial cueing and chain of contagion tasks was counterbalanced. Participants completed the questionnaire on the computer as the first part of the spatial cueing task.

## 2. Results

### 2.1. Preliminary analyses

#### 2.1.1. RT data preparation

RT data were cleaned by first removing errors, then removing RTs that were 2.5 standard deviations or more above the individual's mean or less than 200 ms (e.g., Fox, Russo, Bowles, & Dutton, 2001; Koster et al., 2006). Three participants' RT data were removed from analyses due to excessively elevated mean RTs (i.e., greater than 3 SDs above sample mean). The number of RT data removed was low (i.e., on average, analyses were run on 95% of participant's RT data).

#### 2.1.2. Descriptive statistics

Table 1 presents descriptive data on the study variables. All variables demonstrated acceptable skewness and kurtosis, except for disengagement from fear cues at 100 and 500 ms stimulus presentation duration (skewness = 2.51; kurtosis = 19.10). Disengagement from fear was transformed by taking the log of the original value, which reduced skewness (–1.10) and kurtosis (12.42).

### 2.2. LGM analyses

#### 2.2.1. Parameters of the latent growth curve model and testing appropriate model fit

Contamination appraisals from pencil 1 to pencil 12 were included as observed variables that defined the growth model. Residuals of adjacent pencils were allowed to covary, given the strong likelihood of shared method variance across adjacent pencils

(i.e., correlations between adjacent pencils ranged from .87 to .99<sup>2</sup>), and this procedure is common in LGM analyses (Byrne & Crombie, 2003; Kline, 2005). Latent variables were the intercept and shape factors and their residuals were allowed to covary. The intercept and shape latent factors (described next) were specified as predictors of the observed pencil variables. DP and disengagement from fear and disgust bias scores at 100 and 500 ms were observed predictor variables of the latent intercept and shape factors. DP was also specified as a predictor of disengagement from fear and disgust bias scores. Fig. 1 displays the LGM model.

Preliminary analyses demonstrated that contamination estimations across the pencils fit a linear,  $F(1, 107) = 304.26$ ,  $p < .001$ , quadratic,  $F(1, 107) = 121.73$ ,  $p < .001$ , and cubic,  $F(1, 107) = 27.31$ ,  $p < .001$ , shape. A preliminary model was tested with only an intercept (with fixed regression weights of 1 across the 12 pencils) and linear slope (with fixed regression weights descending from 0 to –11 across the 12 pencils; i.e., modeling decreases in contamination appraisals across the pencils) latent factors and revealed a poor fit:  $\chi^2(112) = 707.87$ ,  $p < .001$ , CFI = .862, RMSEA = .223 (90% CI = .21–.24), AIC = 823.87. Model fit improved and demonstrated a marginal fit to the data when a quadratic shape latent factor (with fixed regression weights equaling the square of the regression weights from the corresponding path in the linear slope) was included:  $\chi^2(103) = 342.312$ ,  $p < .001$ , CFI = .945, RMSEA = .15 (90% CI interval = .13–.16), AIC = 476.31. Finally, model fit improved further and demonstrated a good fit to the data when a cubic shape latent factor (with regression weights equaling the cube of the regression weights from the corresponding path in the linear slope) was included:  $\chi^2(93) = 170.27$ ,  $p < .001$ , CFI = .982, RMSEA = .088 (90% CI = .067–.11), AIC = 324.27.

Accordingly, there are four parameters of the chain of contagion task that delayed disengagement from threat and DP might predict. A significant positive relationship between the predictors

<sup>2</sup> These elevated correlations between adjacent pencils are likely due to the fact that appraisals of one pencil are partially dependent on appraisals of the previous pencil. That is, if a participant appraises one pencil as 60% contaminated, then the next pencil logically cannot be greater than 60%. This interdependency between variables measured repeatedly over time is common and one means of statistically accounting for this in LGM is by allowing the residuals of the observed variables to covary (Byrne and Crombie, 2003; Kline, 2005), which was done in the present analyses.

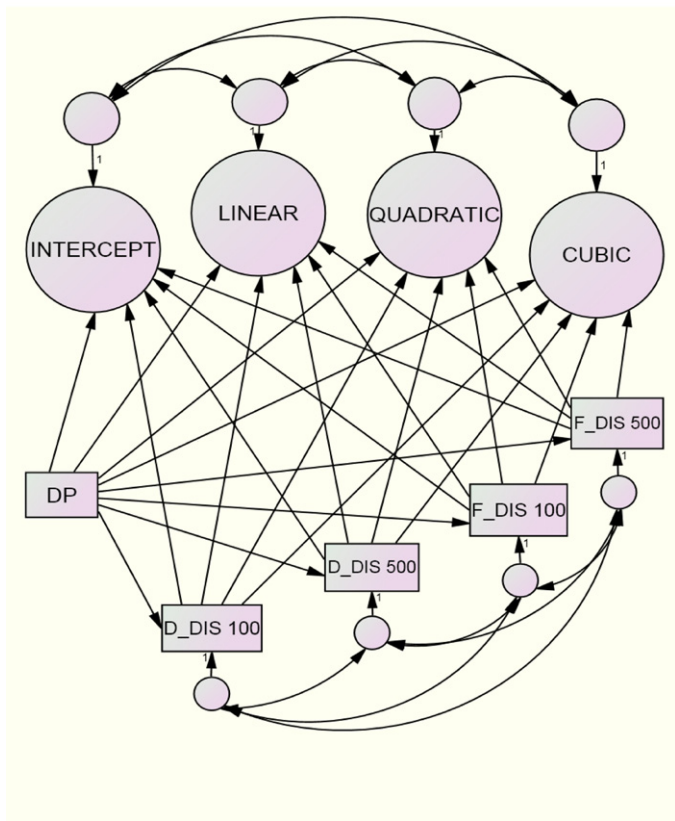


Fig. 1. Graphical illustration of the initial omnibus LGM.

and the intercept suggests that initial levels of the growth curve (i.e., appraisals of pencil 1) increase as a function of greater values in the predictor. Given that growth was modeled as a *decline* (i.e., decreasing contamination appraisals across the pencils), a significant positive relationship between the predictor and the shape factors indicates that higher levels of the predictor lead to faster rates of decline. By contrast, a negative relationship between a predictor and the shape factors indicates that higher levels of the predictor lead to *slower* rates of decline.

2.2.2. Examining predictors of the LGM parameters

After specifying an LGM model that fit the data well, the parameters of interest were examined. A summary of the major results is provided in Table 2. As can be seen, DP significantly positively predicted the intercept, linear slope, and quadratic shape, but not the cubic shape. Delayed disengagement from disgust cues at 500 ms was significantly *negatively* related to the linear slope, but was not significantly related to other parameters of the LGM. Delayed disengagement from disgust at 100 ms, delayed disengagement from fear cues at 100 ms, and delayed disengagement from fear

cues at 500 ms were not related to any parameters of the LGM (all  $p$ s > .22). DP was significantly positively related to disengagement from disgust cues at 100 ms ( $\beta = .25, p = .02$ ), disengagement from fear cues at 100 ms ( $\beta = .23, p = .02$ ), marginally significantly positively related to disengagement from disgust cues at 500 ms ( $\beta = .17, p = .07$ ), but not related to disengagement from fear cues at 500 ms ( $p = .19$ ).

Given that only disengagement from disgust cues at 500 ms was related to parameters of the LGM, a more parsimonious model was then tested by removing the other non-significant disengagement bias indices from the model. This model provided a good fit to the data:  $\chi^2(63) = 130.86, p < .001, CFI = .985, RMSEA = .092$  (90% CI = .067–.12), AIC = 230.86. DP continued to significantly positively predict the intercept ( $\beta = .28, p = .006$ ), linear slope ( $\beta = .27, p = .009$ ), and quadratic shape ( $\beta = .22, p = .046$ ). Delayed disengagement from disgust cues at 500 ms continued to significantly *negatively* predict the linear slope ( $\beta = -.29, p = .005$ ). DP was marginally significantly related to delayed disengagement from disgust cues at 500 ms ( $\beta = .18, p = .06$ ). The effect of DP and delayed disengagement from disgust at 500 ms on contamination appraisals in the chain of contagion task is displayed in Fig. 2.

3. Discussion

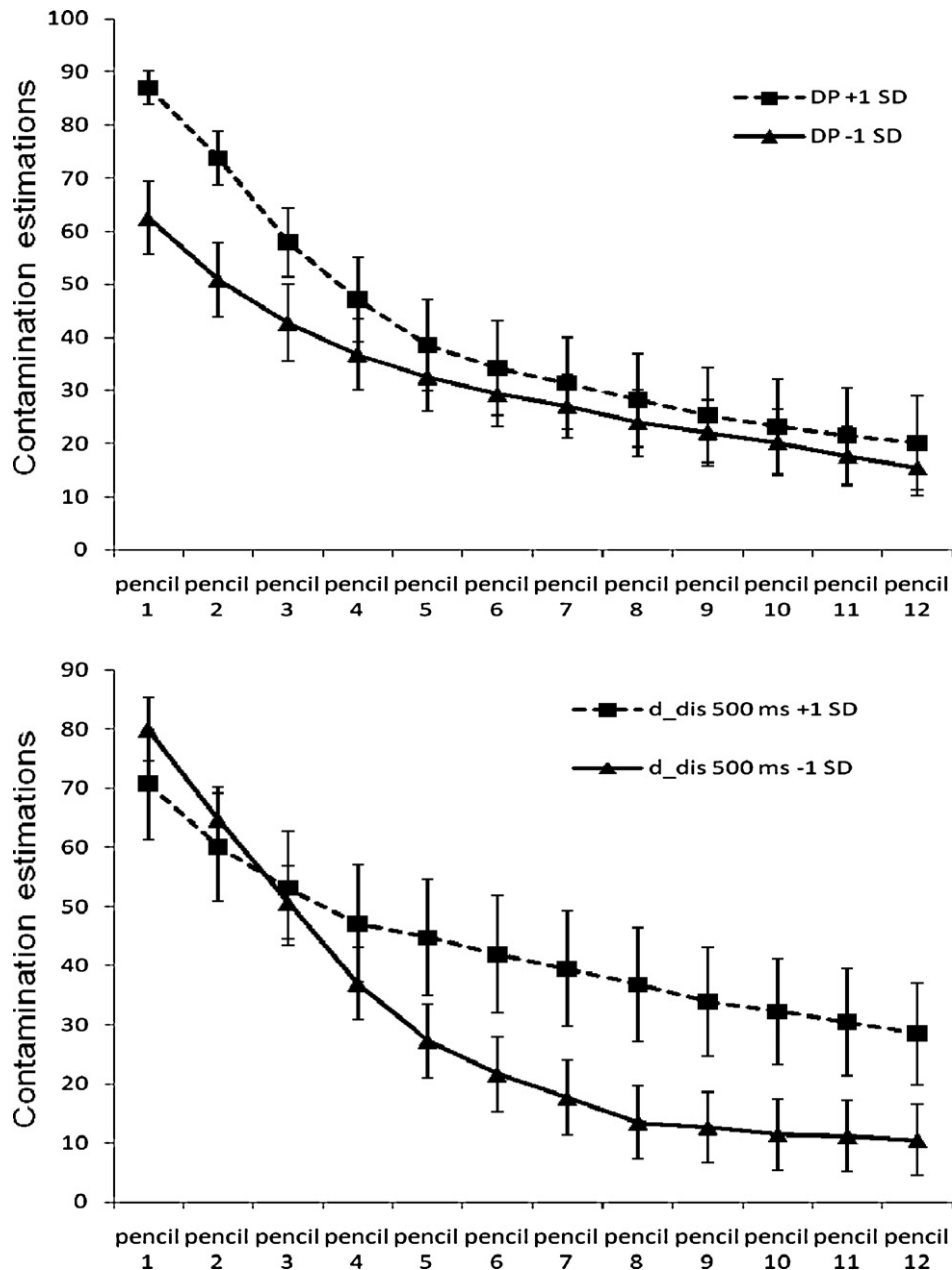
Results of the present study suggested that DP and delayed disengagement from disgust at 500 ms explained unique aspects of the chain of contagion task. Higher DP predicted elevated initial contamination appraisals (i.e., the intercept), but also predicted a greater decline in appraisals across the pencils (i.e., the linear slope) that occurred at a faster rate (i.e., the quadratic slope). By contrast, delayed disengagement from disgust cues at 500 ms only predicted sustained elevations across the task (i.e., negatively predicted the slope). There was no evidence that delayed disengagement from disgust cues at 100 ms, or fear cues at 100 or 500 ms, were related to the chain of contagion task.

The present results provide preliminary evidence that DP and delayed disengagement from disgust cues explain unique and complimentary aspects of contamination appraisals. First, DP predicted initial contamination appraisals, which suggests that greater propensity to respond with disgust, a putatively affective mechanism, is associated with greater appraisals of objects directly contacted by a contaminant. However, DP also predicted greater declines in appraisals across the pencils, which suggests that DP is not sufficient for explaining elevated contamination appraisals of objects with only distal and indirect contact with contaminants. By contrast, disengagement from disgust cues was the only parameter that negatively predicted the slope. As illustrated in Fig. 2, this negative relationship indicates that greater difficulty disengaging attention from disgust cues is associated with less of a decline in contamination appraisals; that is, disengagement from disgust cues uniquely predicts higher contamination appraisals of objects with distal and indirect contact with the initial contaminant. Finally, delayed disengagement from disgust was not associated with contamination appraisals of initial pencils, which further suggests that

Table 2 Standardized path coefficients from the omnibus LGM model.

Predictor	Intercept	LGM parameter		
		Linear slope	Quadratic slope	Cubic slope
Disgust propensity	.31*	.28*	.22*	.18
Disgust disengagement 100 ms	-.04	-.03	.04	.08
Disgust disengagement 500 ms	-.12	-.28*	-.22	-.16
Fear disengagement 100 ms	-.15	-.04	-.09	-.16
Fear disengagement 500 ms	.02	-.01	.04	.10

\*  $p < .05$ .



**Fig. 2.** Means (and standard error bars) of contamination appraisals across the pencils at one standard deviation above and below the sample means of DP (top portion) and disgust disengagement bias score at 500 ms (bottom portion). d\_dis 500 ms = disengagement from disgust at 500 ms bias score; +1 SD = one standard deviation above mean; -1 SD = one standard deviation below mean.

DP and delayed disengagement from disgust cues are each necessary to understand CF.

One explanation for the pattern of findings is that DP and delayed disengagement from disgust map directly onto the processes mediating performance in the chain of contagion task. Observing the experimenter rub a pencil on the bedpan is likely a highly salient experience that elicits a disgust response. This disgust response is likely heightened among high DP individuals and motivates elevated contamination estimations. However, the salience of this initial disgusting experience, and the degree of disgust elicited, likely attenuates across degrees of removal; thus, the effect of DP on contamination appraisals may weaken across degrees of removal. Difficulty disengaging attention from disgust cues, however, may maintain salience of the initial disgusting experience via sustained attention. Prolonged salience of the disgust cue consequently may sustain contamination appraisals across degrees of removal. The

finding that the effect of disgust disengagement indices was specific to 500 ms stimulus duration may suggest that the deficit is specific to later stages of processing. This could implicate either (1) strategic processing, such that attention is purposefully/strategically maintained onto disgust cues, or (2) poor attentional control processes, such that attention is maintained onto disgust cues due to poor recruitment of executive processes needed to shift attention (cf., Cisler & Olatunji, 2010). Future research will be needed to rule out these competing hypotheses. Additionally, the present results were also only correlational in nature, which leaves the possibility that the current relations between both DP and disengagement are spurious to other unmeasured variables. Future research is clearly needed to further elucidate precisely how these mechanisms relate to the unique elevations in contamination appraisals.

The present findings are consistent with the large body of prior research implicating DP in CF (David et al., 2009; Olatunji, 2010;

Olatunji et al., 2004). The present findings are also consistent with the growing body of research implicating difficulty in attentional disengagement in CF (Armstrong and Olatunji, 2010; Cisler & Olatunji, 2010), and that DP is linked with greater disengagement from disgust cues (Cisler, Olatunji, Lohr, & Williams, 2009). Beyond providing evidence for any one independent mechanism in CF, this study represents an initial attempt to integrate the lines of research implicating disgust and the various cognitive mechanisms (Armstrong and Olatunji, 2010; OCCGW, 2005; Radomsky & Rachman, 1999) in CF. This study is limited in that the specific mechanisms investigated may not necessarily generalize to all other candidate mechanisms in CF. With that limitation explicitly stated, the present results suggest the utility and increased explanatory power of integrating affective and cognitive explanations of CF. The present study suggests that affective and cognitive mechanisms may explain unique processes within CF. Heightened disgust reactivity may mediate contamination appraisals of directly contaminated objects, such as toilets, bodily products, used tissues, blood, etc. Poor attentional control from disgust cues may mediate appraisals of objects with distal and indirect contact with contaminants, such as stairway handrails, elevator buttons, public telephones, money, door handles, etc. It also must be noted that the chain of contagion task is limited to contamination appraisals, so the degree to which the present findings extend to other aspects of CF (e.g., avoidance, safety, and compulsive behaviors) is not necessarily clear. It would be interesting to conduct another similar experiment but ask participants to put each pencil in their mouth. If a participant rates a pencil as highly contaminated, but is willing to put the pencil in his or her mouth, the contamination appraisals may not be very relevant for explaining other processes in CF.

There may be clinical implications of this line of research. The finding that disgust propensity is linked with contamination appraisals may be clinically-relevant, given that disgust has been linked with slowed extinction relative to fear (Olatunji, Forsyth, & Cherian, 2007). This might necessitate longer exposure sessions for contamination-based OCD relative to other subtypes of OCD. The finding of delayed disengagement from disgust might implicate attentional training procedures in the treatment of contamination-based OCD. Indeed, emerging research implicates attention retraining, in which individuals are trained to disengage attention from threat, as efficacious independent treatments for anxiety disorders generally (Amir et al., 2009), and contamination-based OCD specifically (Najmi & Amir, 2010). It might be useful to test a combination of exposure plus attention retraining compared to either procedure alone in the treatment of contamination-based OCD.

The present study has limitations that temper conclusions. First, the sample was comprised of non-clinical students. It may be the case that different relations are found between contamination appraisals, DP, and attentional disengagement among diagnosed individuals. However, it may also be the case that only using diagnosed individuals might lead to a restricted range of responding that may artificially inflate or deflate the observed relations. Similarly, the use of only students might preclude generalization to non-student samples. Second, the relations identified between DP, disgust disengagement, and CF are only correlational. Future research is needed to test experimental manipulations of DP and disgust disengagement in the chain of contagion task. For example, one useful design might manipulate the presence of a disgust prime and also manipulate an attentional allocation instruction and examine their effect on the chain of contagion task. Third, the sample was relatively small to employ structural equation modeling, which necessitates replication with larger samples. However, LGM can provide robust parameter estimates with relatively smaller sample sizes (Muthen & Muthen, 2002). Fourth, the spatial cueing task was used as the measure of attentional bias, and the degree to which the results from this task generalize to other measures

of attentional bias (e.g., dot probe task) remains unclear. Fifth, to our knowledge, this is only the second study to employ the chain of contagion task (Tolin et al., 2004), and the task's psychometric properties (e.g., validity, reliability, etc.) are unknown. It is essential for future research to replicate the present findings using additional measures of attentional bias and additional measures of CF. Sixth, the assessment of DP was limited to the disgust propensity subscale of the DPSS-R. It is necessary to replicate the present findings using a more objective measure of DP, such as avoidance during disgust-related tasks. Based on the present findings, it would be expected that greater avoidance during disgust-related tasks should predict elevated initial contamination appraisals. Future research along these lines will help elucidate the emotional and cognitive processes that underlie CF.

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