

Mental Contamination in Obsessive-Compulsive Disorder: Associations With Contamination Symptoms and Treatment Response

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The most common symptom of obsessive-compulsive disorder (OCD) is contamination fear. Feelings of contamination can be provoked through contact with a physical contaminant, referred to as contact contamination (CC), as well as in the absence of one, referred to as mental contamination (MC). Prior research indicates that CC and MC are distinct, and MC may interfere with treatment for CC. However, no study to date has examined how MC may be associated with responses to physical contaminants and treatment response for CC. This study examined the relationships between CC and MC in a sample of individuals with elevated contamination symptoms ($N = 88$), half of whom met diagnostic criteria for OCD. Participants engaged in three sessions of exposure and response prevention (ERP) for CC and completed self-report measures and behavioral tasks

assessing CC and MC at pretreatment, posttreatment, and follow-up. As hypothesized, at pretreatment, MC was positively associated with reactivity to physical contaminants, even after participants washed their hands. ERP for CC was associated with unique changes in CC and MC across self-report and behavioral measures, and greater pretreatment MC predicted greater posttreatment CC, though this effect was evident in only one of two CC measures. Additionally, specificity analyses indicated changes in MC were independent of changes in disgust propensity, a related construct. Pretreatment disgust propensity also predicted treatment outcome, though the addition of pretreatment disgust propensity as a covariate reduced the relationship between pretreatment MC and posttreatment CC to nonsignificance. Results suggest MC plays an important role in the manifestation and treatment of CC symptoms and may represent a manifestation of disgust proneness. Theoretical and clinical implications are discussed.

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Keywords: obsessive-compulsive disorder; contact contamination; mental contamination; compulsive washing; exposure and response prevention

OBSESSIVE-COMPULSIVE DISORDER (OCD) is characterized by recurrent and unwanted thoughts, images, or impulses that provoke anxiety (i.e., obsessions), as well as behavioral efforts (e.g., repetitive behaviors, mental rituals, avoidance) aimed to neutralize this anxiety (American Psychiatric Association, 2013). OCD has a lifetime prevalence of about 2.3% in the United States (Ruscio, Stein, Chiu, & Kessler, 2010) and causes significant distress and impairment. Evidence-based treatment for OCD consists of exposure and response prevention (ERP; Foa, Yadin, & Lichner, 2012), in which individuals expose themselves to their feared obsessions and prevent themselves from engaging in compulsions that would otherwise decrease their anxiety. Although ERP is effective for many individuals who engage in treatment, on average, 25% of patients do not respond to individualized ERP treatment (Fisher & Wells, 2005). These findings underscore the need to investigate underlying factors that may be associated with treatment response in OCD in order to improve treatment outcome.

The most common symptom of OCD is contamination fear (Rachman, 2004), which is characterized by a fear of coming into contact with a person or item that is perceived to be harmful (Rachman, 2004, 2006), as well as efforts to wash or clean in order to decrease the potential threat derived from the contaminant. Feelings of contamination can be provoked through contact with, and in the absence of, a physical contaminant. To this end, researchers have more recently identified a set of symptoms known as “mental contamination” (MC), which is characterized by feelings of internal dirtiness that occur in the absence of a physical contaminant (Rachman, 2004). Specifically, individuals with MC may experience feelings of disgust by simply thinking about dirty, contaminated, immoral, or undesirable people, things, or events, which can then contribute to an urge to wash similar to that observed in contact contamination (CC). MC received significant attention due to its association with traumatic events, such as sexual assault (Fairbrother & Rachman, 2004; Herba & Rachman, 2007), though more recent research has examined the role of MC in OCD.

Interestingly, in one of the first studies to systematically examine MC in OCD, Coughtrey, Shafran, Knibbs, and Rachman (2012) found that 46.3% of individuals with OCD symptoms endorsed MC, 61.21% of individuals with a fear of contamination endorsed both CC and MC, and 15.52% of those with contamination fears endorsed only MC, providing evidence that MC may be a relatively common phenomenon within OCD. Additionally, recent investigations have indicated that MC and

CC are closely related, yet importantly distinct, constructs (Melli, Bulli, Carraresi, & Stopani, 2014; Melli, Bulli, Carraresi, Tarantino, Gelli, & Poli, 2017). Specifically, though both MC and CC involve fears of dirtiness, they differ in regard to the trigger or source of those fears, as well as the effectiveness of washing compulsions in removing feelings of dirtiness (Rachman, 2004). Moreover, some theorists have suggested that because MC is more cognitive in nature, it may require a more cognitively based treatment approach, which is in contrast with the current primarily behavioral approach for contamination symptoms (Coughtrey, Shafran, Lee, & Rachman, 2013; Radomsky, Rachman, Shafran, Coughtrey, & Barber, 2014). However, no study to date has investigated whether ERP is associated with meaningful changes in MC and whether MC interferes with treatment of CC. Given that MC shares significant overlap with CC, it may be that ERP does indeed target both constructs. Moreover, MC occurs in the absence of a tangible contaminant, which may make it more difficult to target using traditional exposure exercises involving contact with contaminants (Rachman, 2006; Coughtrey et al., 2013). It may be that MC reflects a more severe presentation of symptoms given that individuals with MC experience feelings of dirtiness with and without physical contaminants. As such, they may experience greater and more persistent reactivity to stimuli characterized by obsessive and ruminative thought that is less amenable to treatment (Coughtrey et al., 2012; Salkovskis & Westbrook, 1989). Indeed, prior work suggests internal stimuli, such as rumination and feelings of incompleteness, may interfere with optimal treatment response for OCD (Moulding, Aardema, & O'Connor, 2014; Summerfeldt, 2004). Taken together, MC may reduce with ERP, though it may require further clinical attention if CC symptoms do not remit.

Understanding the role of MC in treatment first requires the accurate measurement on the construct, and as such, researchers have started to develop both self-report and behavioral measures. Radomsky and colleagues (2014) developed the Vancouver Obsessive Compulsive Inventory—Mental Contamination (VOCI-MC) scale as a self-report measure of MC. In the development study, the authors administered the VOCI-MC to individuals with OCD with contamination symptoms, individuals with OCD without contamination symptoms, individuals with other anxiety disorders, and healthy controls. The VOCI-MC demonstrated excellent internal consistency across all groups ($\alpha = .93-.97$) and discriminated between those with OCD with contamination symptoms and all other groups. In addition to the VOCI-MC, Lee and colleagues (2013) developed a behavioral task in which participants are asked to

imagine a bowl of vomit and then rate various emotional states, including internal dirtiness. The sample comprised unselected undergraduate students, and results indicated that the task did indeed induce increased disgust and internal dirtiness, and OCD symptoms were associated with greater reactivity during the MC task. Notably, though other tasks of MC have been developed, such as the “nonconsensual kiss” paradigm (Fairbrother & Rachman, 2004), the task developed by Lee and colleagues (2013) is more closely related to OCD, as opposed to trauma symptoms and/or general guilt evoked in other tasks.

Though the aforementioned measures are an important start to the systematic study of MC, no study to date has examined the relationships between the VOI-MC and the behavioral task developed by Lee and colleagues (2013) to determine task validity. Moreover, the task has only been administered in unselected samples, and as such, it is unclear as to the impact of the task in a sample of individuals with elevated symptoms. Finally, it remains unclear as to how MC may be related to in vivo responses to CC tasks. Specifically, it is theorized that MC may result in a persistent urge to wash even when physical contaminants are removed (Coughtrey et al., 2012); however, there is a lack of empirical investigations testing this hypothesis. Understanding the role of MC in CC is imperative to improving our understanding of how MC may be related to symptom severity and treatment response.

Taken together, there is a growing area of research regarding the role of MC in OCD. However, the extant literature is limited as it remains unclear as to the relationship between MC and (a) in vivo responses to physical contaminants and (b) treatment response for contamination fears. This study, therefore, examined the relationships between CC and MC in a sample of individuals with elevated contamination symptoms, half of whom met diagnostic criteria for OCD. The specific aims of the current study were as follows. The first aim was to examine the validity of the MC task developed by Lee and colleagues (2013) in a sample of individuals with primary contamination symptoms. The second aim was to investigate the relationship between responses to CC and MC tasks. In line with the theory regarding the relationship between MC and CC (Rachman, 2004, 2006; Radomsky et al., 2014), we hypothesized that feelings of internal dirtiness due to the MC task would be associated with increased fear and urge to wash after touching a physical contaminant and after washing one’s hands. The third aim was to examine the extent to which ERP for CC was associated with unique changes in CC and MC. We hypothesized that ERP for CC would be associated with significant and independent changes in MC and

CC, even when accounting for changes in CC and MC, respectively. The fourth aim was to examine the extent to which MC was a significant predictor of treatment outcome for CC. We hypothesized that individuals with greater MC at pretreatment would exhibit greater CC symptoms at posttreatment and follow-up.

We also conducted analyses of specificity to assess the role of disgust propensity in explaining the hypothesized effects. MC was positively related to disgust propensity in multiple studies (Carrarsi, Bulli, Melli, & Stopani, 2013; Melli et al., 2014; Olatunji, 2010) and may have conceptual overlap with the construct. Thus, we examined whether changes in MC were accounted for by changes in disgust propensity and whether pretreatment MC predicted greater CC symptoms following treatment when covarying for pretreatment disgust propensity. Given that individuals prone to the experience of disgust are also generally more likely to experience internal feelings of dirtiness when thinking of dirty or disgusting things, consideration of disgust propensity in our analyses would help position MC in the context of this related literature. Notably, this study utilized a multimethod approach, such that we assessed CC and MC using self-report and behavioral measures of both constructs in order to assess overall symptom severity and in vivo responses. Moreover, we used multiple measures of contamination in order to assess the multifaceted nature of this construct. We specifically included two scales that assess the presence of CC and MC fears, as well as a more global measure of overall contamination symptoms that provides an overall measure of severity encompassing distress, impairment, compulsions, and avoidance.

Method

PARTICIPANTS

The sample comprised 88 undergraduate psychology students (72.7% female) with elevated obsessive-compulsive symptoms, as evidenced by a score on the VOI (Thordarson et al., 2004) of at least 21 (corresponding to the top 5% for a student sample) and a fear rating of at least 50 out of 100 on the CC assessment (see below). Of the sample, 46.6% ($n = 41$) met diagnostic criteria for OCD based on the Mini International Neuropsychiatric Interview (MINI; Sheehan et al., 1998). Students completed the study as partial fulfillment for course credit and were recruited from the undergraduate subject pool from June 2014 to April 2017, which consisted of 4,976 students in total. The mean age of the sample was 19.03 ($SD = 1.79$). Of the sample, 60.2% self-reported as White, 17.0% as African

American, 18.2% as Hispanic, 3.4% as Asian or Pacific Islander, and 1.1% as other (e.g., biracial).

CLINICAL INTERVIEW

Mini International Neuropsychiatric Interview (MINI)

The MINI (Sheehan et al., 1998) is a semistructured clinical interview that was used to assess the presence of OCD. The MINI was administered by trained research assistants. All interviews were audio recorded and an independent interviewer reviewed a random selection ($n = 18$) to assess reliability and diagnostic accuracy. The average percentage agreement was 94.4% and kappa was .87 (range = .62–1.00), reflecting high overall agreement between raters.

SELF-REPORT MEASURES

Vancouver Obsessive Compulsive Inventory (VOCI)

The VOCI (Thordarson et al., 2004) is a 55-item self-report measure of obsessive-compulsive symptoms, avoidance behavior, and obsessive-compulsive-related personality traits. Participants are asked to use a 5-point scale to rate the extent to which various statements describe them. For the current study, only the Contamination subscale was used as a measure of CC symptoms (e.g., “I am excessively concerned about germs and disease”). The VOCI—Contamination (VOCI-C) subscale exhibited good internal consistency in the current sample ($\alpha = .89$).

Vancouver Obsessive Compulsive Inventory—Mental Contamination (VOCI-MC)

The VOCI-MC (Radomsky et al., 2014) is a 20-item self-report measure of MC. Participants use a 5-point scale to answer questions about MC, such as “I often feel dirty inside my body” and “Some people look clean, but feel dirty.” In the current sample, the VOCI-MC demonstrated excellent internal consistency ($\alpha = .94$).

Dimensional Obsessive Compulsive Scale (DOCS)

The DOCS (Abramowitz et al., 2010) is a 20-item self-report measure of obsessive-compulsive symptoms. The DOCS comprises four subscales that reflect four empirically supported symptom dimensions, including germs and contamination, responsibility for harm, unacceptable thoughts, and the need for symmetry and completeness. The current study used only the Germs and Contamination subscale to measure obsessions, compulsions, avoidance behavior, and distress and interference due to symptoms related to contamination. The DOCS—Contamination (DOCS-C) subscale exhibited good internal consistency in the current sample ($\alpha = .84$).

Disgust Propensity and Sensitivity Scale (DPSS-R)

The DPSS-R (Olatunji, Cisler, Deacon, Connolly, & Lohr, 2007) is a 12-item self-report measure of

disgust propensity, defined as the frequency with which an individual experiences disgust, and disgust sensitivity, defined as an individual’s reactivity to disgust. Participants are asked to use a 5-point scale to rate the extent to which they agree with statements regarding their experience of disgust (e.g., “I avoid disgusting things”). The current study only used the Disgust Propensity subscale given that prior research has primarily focused on the relationship between contamination and disgust propensity (Carrarsi et al., 2013; Melli et al., 2014; Olatunji, 2010). The DPSS-R Disgust Propensity subscale exhibited adequate internal consistency in the current sample ($\alpha = .78$).

BEHAVIORAL TASKS

Contact Contamination (CC) Task

The CC task (Cogle, Goetz, Fitch, & Hawkins, 2011) is a behavioral task that has been used in previous studies to assess CC symptoms (Cogle, Wolitzky-Taylor, Lee, & Telch, 2007; Cogle et al., 2011; Najmi, Tobin, & Amir, 2012). Participants are instructed to place their hands in a container filled with a mixture of dirt, dead insects, and human hair. After touching the mixture, participants were then given the opportunity to wash their hands for as long as they would like. Participants were asked to use a scale from 0 (*none*) to 100 (*extreme*) to rate their subjective fear and urge to wash before the start of the task, as well as after touching the mixture and washing their hands. Specifically, before the start of the task, participants were asked to rate how fearful they felt, as well as the strength of their urge to wash their hands in that moment. Participants were again asked the same set of questions after coming into contact with the contaminant (i.e., dirt mixture) and after washing their hands. Fear immediately following contact with the contaminant was used to assess eligibility.

Mental Contamination (MC) Task

The MC task (Lee et al., 2013), used in the current study, has been used in prior studies to assess MC symptoms. Participants are instructed to imagine a bowl of vomit for 1 minute, and are then asked to describe the vomit in detail in order to enhance their engagement in the task. Participants were asked to use a scale from 0 (*none*) to 100 (*extreme*) to rate their subjective internal dirtiness before and after the task. Specifically, participants were asked to rate the extent to which they felt dirty inside their bodies.

TREATMENT

Exposure and Response Prevention (ERP)

The ERP (Foa et al., 2012) is an evidence-based treatment for OCD (Abramowitz, 1997) in which

individuals confront feared situations and avoid engaging in associated rituals. For the current study, we administered an analogue to ERP in which participants were repeatedly exposed to contamination-related stimuli during three sessions. Each exposure session occurred 4–7 days apart and during each session, participants were asked to complete seven trials in which they placed their hands in the mixture of dirt, dead insects, and human hair (described above) for 6 minutes. Participants completed self-report measures regarding their emotional response to the dirt mixture after every other trial (i.e., Trials 1, 3, 5, and 7). Following completion of all seven trials, participants were urged to avoid washing their hands for at least 1 hour following the exposure period. All participants completed the ERP-based treatment protocol regardless of diagnostic status.

PROCEDURE

Participants were recruited from introductory psychology classes at a large university in the southeastern United States. During the first appointment (i.e., pretreatment), participants completed a battery of self-report questionnaires, a clinical interview, and behavioral tasks. Participants who met eligibility requirements were then provided the rationale for ERP and subsequently engaged in their first treatment session. During the second and third appointments, participants engaged in two additional sessions of ERP. During the fourth appointment (i.e., posttreatment), participants completed the same battery of self-report questionnaires and behavioral tasks as they did during the first appointment. Finally, 2 weeks after the fourth appointment (i.e., follow-up), participants were e-mailed the battery of self-report questionnaires to complete. Following completion of the study protocol, participants were provided with information for community mental health resources. All procedures were approved by the university’s Institutional Review Board. See Figure 1 for a full study outline.

DATA ANALYSES

The data were first screened for violations of assumptions. Univariate outliers were identified by those that fell outside of the range of the median plus or minus two interquartile ranges. One outlier, a pretreatment VOICI-C score, was identified and transformed to the value equal to two interquartile ranges below the median.

Independent samples *t* tests were used to assess pretreatment differences between (a) those with and without an OCD diagnosis and (b) those who did and did not complete treatment. Correlation analyses were used to assess relationships between pretreatment self-report and behavioral measures.

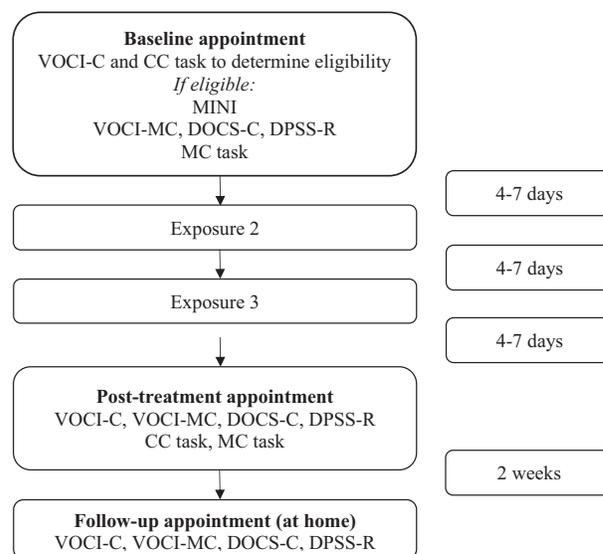


FIGURE 1 Study outline. Note. VOICI-C = Vancouver Obsessive Compulsive Inventory—Contact Contamination subscale; CC = contact contamination; MINI = Mini International Neuropsychiatric Interview; VOICI-MC = Vancouver Obsessive Compulsive Inventory—Mental Contamination subscale; DOCS-C = Dimensional Obsessive Compulsive Scale—Germs and Contamination subscale; DPSS-R = Disgust Propensity and Sensitivity Scale—Revised—Disgust Propensity subscale; MC = mental contamination.

Paired samples *t* tests were used to assess changes in internal dirtiness before and after the MC task induction. Multiple regression analyses were used to examine the relationship between pretreatment responses to the CC task and the MC task. Repeated measures ANOVAs were used to assess change in all variables of interest. Additionally, in order to assess the specificity of treatment effects, repeated measures ANCOVAs were used to assess changes in CC, when controlling for residual change in MC, and vice versa. Residual change was calculated by regressing follow-up scores on pretreatment scores. Multiple regression analyses were used to examine the extent to which pretreatment self-report and behavioral MC measures predicted posttreatment self-report and behavioral CC measures, when controlling for pretreatment measures. Primary analyses were conducted in individuals who completed all measures at all time points (*n* = 65) and intent-to-treat analyses using multiple imputation were also conducted to account for noncompleters (*n* = 23).

Results

DESCRIPTIVE STATISTICS AND CORRELATION ANALYSES

The means and standard deviations for all self-report measures and behavioral tasks at pretreatment, posttreatment, and follow-up are displayed

Table 1
Descriptive Statistics and Change in Variables of Interest

Self-report measures	Pretreatment	Posttreatment	Follow-up	<i>F</i>	<i>p</i>	η^2
VOCI-C	36.25(9.02)	25.03(10.38)	22.61(10.34)	78.40	<.001	.71
VOCI-MC	39.95(18.04)	32.17(16.89)	26.17(17.94)	24.74	<.001	.44
DOCS-C	9.40(3.62)	6.91(3.34)	6.11(3.58)	24.75	<.001	.44
DPSS-R	16.83(3.87)	14.56(4.91)	12.11(4.88)	45.27	<.001	.59
Behavioral tasks	Pretreatment	Posttreatment				
CC task						
Fear pre-HW	72.92(16.37)	30.92(26.56)		152.75	<.001	.71
Urge pre-HW	91.38(14.35)	52.62(28.46)		125.30	<.001	.66
Fear post-HW	32.46(25.44)	18.91(22.40)		19.63	<.001	.24
Urge post-HW	38.31(29.13)	18.75(24.33)		36.17	<.001	.37
MC task						
Internal dirtiness	55.63(29.70)	32.03(27.15)		45.92	<.001	.42

Note. VOCI-C = Vancouver Obsessive Compulsive Inventory—Contact Contamination subscale; VOCI-MC = Vancouver Obsessive Compulsive Inventory—Mental Contamination subscale; DOCS-C = Dimensional Obsessive Compulsive Scale—Germs and Contamination subscale; DPSS-R = Disgust Propensity and Sensitivity Scale—Revised—Disgust Propensity subscale; CC = contact contamination; HW = hand wash; MC = mental contamination.

in Table 1. An examination of means indicated that the current sample was comparable to other samples comprising individuals with primary OCD contamination symptoms. Specifically, pretreatment VOCI-C ($M = 36.25$) and DOCS-C ($M = 9.40$) were comparable to those in samples comprising individuals with OCD with primary contamination symptoms (VOCI-C $M = 30.60$, DOCS-C $M = 11.30$; Melli et al., 2014; Radomsky et al., 2014). Pretreatment VOCI-MC scores ($M = 39.95$) were higher than prior studies with individuals with OCD with primary contamination symptoms ($M = 25.10$; Melli et al., 2014) and individuals with OCD with any contamination symptoms ($M = 30.57$; Radomsky et al., 2014). There were no significant pretreatment differences between those who did and did not complete treatment on all self-report and behavioral measures, $ps > .07$.

At pretreatment, of those who completed treatment, individuals with an OCD diagnosis ($n = 31$) reported significantly greater scores on the DOCS-C ($t = -2.78$, $p = .007$, Cohen's $d = .69$) than those without OCD. No other pretreatment differences between these groups emerged.

See Table 2 for correlations between pretreatment self-report and behavioral measures. The VOCI-MC was strongly associated with all self-report measures, and with internal dirtiness during the MC task. Additionally, VOCI-MC was moderately associated with fear and urge to wash after the hand wash in the CC task. Finally, internal dirtiness during the MC task was associated with fear and urge to wash before and after the hand wash in the CC task.

MC TASK VALIDITY ANALYSES

At pretreatment, paired samples t tests indicated that internal dirtiness ($t = -4.67$, $p < .001$) significantly increased from pre- to post-MC task induction, suggesting the task was successful in inducing MC. Additionally, as displayed in Table 2, pretreatment internal dirtiness during the MC task was significantly associated with VOCI-C ($r = .53$, $p < .001$), VOCI-

Table 2
Correlations Between All Measures at Pretreatment

	1	2	3	4	5	6	7	8
1. VOCI-C	—							
2. VOCI-MC	.80	—						
3. DOCS-C	.71	.75	—					
4. DPSS-R	.67	.74	.46	—				
5. CC task fear pre-HW	.17	.20	.16	<i>.30</i>	—			
6. CC task urge to wash pre-HW	.47	<i>.39</i>	<i>.30</i>	<i>.39</i>	.52	—		
7. CC task fear post-HW	.27	<i>.39</i>	<i>.33</i>	<i>.32</i>	<i>.33</i>	<i>.23</i>	—	
8. CC task urge to wash post-HW	<i>.28</i>	<i>.36</i>	<i>.24</i>	<i>.27</i>	<i>.24</i>	<i>.29</i>	.72	—
9. MC task internal dirtiness	.53	.69	.51	.68	<i>.41</i>	<i>.28</i>	.60	.48

Note. VOCI-C = Vancouver Obsessive Compulsive Inventory—Contact Contamination subscale; VOCI-MC = Vancouver Obsessive Compulsive Inventory—Mental Contamination subscale; DOCS-C = Dimensional Obsessive Compulsive Scale—Germs and Contamination subscale; DPSS-R = Disgust Propensity and Sensitivity Scale—Revised—Disgust Propensity subscale; CC = contact contamination; HW = hand wash; MC = mental contamination. Bolded rs significant at $p < .001$; underlined rs significant at $p < .01$; italicized rs significant at $p < .05$.

MC ($r = .69, p < .001$), DOCS-C ($r = .51, p < .001$), and DPSS-R Disgust Propensity ($r = .68, p < .001$).

MC PREDICTING REACTIVITY TO CC AT PRETREATMENT

Multiple regression analyses were used to determine the relationship between internal dirtiness during the MC task and fear and urge to wash throughout the CC task. When controlling for pretask fear, internal dirtiness during the MC task was a significant predictor of fear after touching the mixture ($\beta = .27, t = 2.18, p = .03$) and after washing one's hands ($\beta = .40, t = 4.08, p < .001$). When controlling for pretask urge to wash, internal dirtiness during the MC task was a significant predictor of urge to wash after washing one's hands ($\beta = .38, t = 3.58, p = .001$), but not directly after touching the mixture ($\beta = .20, t = 1.68, p = .10$).

ANALYSES OF CHANGE IN OUTCOMES ACROSS TREATMENT

Repeated measures ANOVAs indicated there were significant decreases in all self-report measures across assessment intervals. There were also significant decreases in response to behavioral tasks from pre- to posttreatment. All ANOVA statistics are displayed in Table 1.

Next, we assessed whether changes in CC and MC were independent of each other. When controlling for residual change in VOICI-C, repeated measures ANCOVAs indicated there was a significant decrease in VOICI-MC, $F(2, 62) = 10.87, p < .001, \eta_p^2 = .26$. Likewise, when controlling for residual change in VOICI-MC, repeated measures ANCOVAs indicated there was a significant decrease in VOICI-C, $F(2, 62) = 14.55, p < .001, \eta_p^2 = .32$.

Finally, we assessed whether changes in MC were independent of disgust propensity. When controlling for residual change in DPSS-R Disgust Propensity, repeated measures ANCOVAs indicated there was a significant decrease in VOICI-MC, $F(2, 62) = 13.35, p < .001, \eta_p^2 = .30$.

ANALYSES OF BASELINE PREDICTORS OF OUTCOME

We conducted multiple regression analyses to determine the relationships between (a) pretreatment and posttreatment self-report measures and (b) pretreatment and follow-up self-report measures. As displayed in Table 3, pretreatment VOICI-MC was a significant predictor of greater posttreatment and follow-up DOCS-C, but not VOICI-C. In order to assess specificity, we conducted the same set of analyses with pretreatment DPSS-R Disgust Propensity as an added covariate. When including DPSS-R Disgust Propensity, VOICI-MC was no longer asso-

Table 3
Multiple Regression Predicting Posttreatment and Follow-Up VOICI-C and DOCS-C

	$F^2\Delta$	β	t
VOICI-C-Post			
VOICI-C-Pre	.48	.50	3.40**
VOICI-MC-Pre	.02	.24	1.63
VOICI-C-FU			
VOICI-C-Pre	.32	.43	2.48*
VOICI-MC-Pre	.01	.17	1.00
DOCS-C-Post			
DOCS-C-Pre	.33	.31	2.06*
VOICI-MC-Pre	.06	.36	2.37*
DOCS-C-FU			
DOCS-C-Pre	.18	.15	.91
VOICI-MC-Pre	.06	.36	2.18*

Note. VOICI-C = Vancouver Obsessive Compulsive Inventory—Contact Contamination subscale; DOCS-C = Dimensional Obsessive Compulsive Scale—Germs and Contamination subscale; Post = posttreatment; Pre = pretreatment; VOICI-MC = Vancouver Obsessive Compulsive Inventory—Mental Contamination subscale; FU = follow-up.

** $p < .01$, * $p < .05$.

ciated with posttreatment and follow-up DOCS-C scores, $ps > .21$, and DPSS-R Disgust Propensity was also not a significant predictor, $ps > .27$. DPSS-R Disgust Propensity was significantly associated with posttreatment VOICI-C (when entered with VOICI-MC), $\beta = .36, t = 2.85, p = .01$.

We also conducted multiple regression analyses to assess relationships between pretreatment and posttreatment behavioral measures. When accounting for pretreatment fear and urge to wash ratings during the CC task, pretreatment internal dirtiness during the MC task was not significantly associated with posttreatment CC task ratings, $ps > .06$.

Diagnostic Status

When controlling for relevant pretreatment variables, OCD diagnosis did not interact with any pretreatment self-report or behavioral measures to predict posttreatment measures, $ps > .18$.

INTENT-TO-TREAT ANALYSES

The analyses outlined above were repeated in the intent-to-treat sample using multiple imputation analyses with 20 iterations (Rubin, 2004) to estimate posttreatment and follow-up measures for treatment noncompleters. The overall pattern and significance of results remained unchanged.

Discussion

The current study examined the relationships between self-report and behavioral CC and CC in a sample of individuals with elevated contamination symptoms, half of whom met diagnostic criteria for OCD. Overall, results indicated that MC may need

to be considered in the manifestation and treatment of contamination-based OCD.

Our first aim was to examine the validity of an MC behavioral task in a sample of individuals with clinically significant OCD symptoms. Results were consistent with those of Lee and colleagues (2013), such that there was a significant increase in disgust and internal dirtiness due to the task. Moreover, disgust and internal dirtiness were associated with self-report measures of CC and MC. These results provide evidence for construct validity and support the use of this task in the sample of individuals with elevated symptoms. Given that research regarding MC is increasing, this task may be useful in an experimental context, could provide a sensitive index of change, and allow for a comprehensive assessment of the phenomena.

Our second aim was to examine the relationship between in vivo responses to MC and CC tasks in order to elucidate the relationship between MC and responses to physical contaminants. As hypothesized, internal dirtiness due to the MC task was associated with increased fear after touching the dirt mixture and after washing one's hands. Additionally, internal dirtiness was a significant predictor of urge to wash even after washing one's hands. To our knowledge, this is the first study to investigate how MC predicts in vivo responses to CC. Our findings suggest that individuals with MC may experience increased and persistent reactivity to physical contaminants because they are experiencing greater internal feelings of becoming contaminated. Moreover, results suggest MC contributes to persistent fear and urge to wash even after removing the physical contaminant through washing. It may be that MC interferes with the extent to which washing leads to feelings of cleanliness, leading to more persistent compulsive behavior. Importantly, future research should aim to replicate these findings and to extend them within a longitudinal framework to determine the temporal precedence of these constructs. However, the current study suggests that obsessions and compulsions may interact differentially in the presence of MC, as opposed to CC.

Our third aim was to examine the impact of three sessions of ERP for contamination fears on both CC and MC symptoms, and to determine the extent to which such changes were independent of one another. As hypothesized, self-report measures of CC and MC exhibited significant decreases over the course of treatment, and these changes were maintained 2 weeks after the completion of treatment. Moreover, results suggested that changes in self-report measures of CC and MC were independent of each other, such that changes in CC did not

simply reflect changes in MC, and vice versa. These results are consistent with prior research suggesting that CC and MC are related, but distinct, constructs (Melli et al., 2014, 2017). Notably, ERP was associated with changes in both forms of contamination according to both self-report and behavioral measures, such that reactivity to MC and CC induction tasks significantly reduced throughout treatment. The use of a multimethod approach provides further evidence for the validity of these findings, and provides a more ecologically valid assessment of both constructs. Taken together, our results suggest that ERP for CC is indeed associated with significant reductions in MC.

Our fourth aim was to examine the extent to which MC at pretreatment was associated with treatment response (i.e., CC symptoms at posttreatment and follow-up) in order to assess the extent to which MC may interfere with treatment for CC. As hypothesized, increased pretreatment MC was a significant predictor of posttreatment and follow-up CC, though this finding was only present in one of the two self-report measures, and not behavioral measures. This discrepancy may provide important information regarding methods of measurement. MC, as measured by the VOICI-MC, was a significant predictor of the DOCS, but not the VOICI-C. Notably, the VOICI-C is a more limited measure of contamination symptoms. Individuals are asked to rate the extent to which various statements apply to them, but the VOICI does not provide an exhaustive list of symptoms and does not capture distress and impairment associated with symptoms. Moreover, the VOICI-C specifically measures contamination fears, but does not thoroughly assess the severity of compulsions. In contrast, the DOCS is a more comprehensive measure that assesses overall symptom severity based on distress, impairment, avoidance, and time spent engaged in obsessions and compulsions, thereby more closely reflecting diagnostic criteria and indicators most relevant to treatment providers. Therefore, the fact that the VOICI-MC was a significant predictor of posttreatment and follow-up DOCS, but not VOICI-C, may indeed provide further support for the hypothesis that MC is associated with less change in overall symptoms, rather than the reduction of one's perception that contamination fears apply to them. For example, individuals with elevated MC may continue to experience increased washing and cleaning duration, even if their fear of external contaminants has decreased. Taken together with pretreatment results in the current study, perhaps MC contributes to the persistence of symptoms as reactivity to physical contaminants is reduced, but the internal sense of dirtiness remains. Additionally,

our results may suggest that overall MC, rather than reactivity to a specific imagined contaminant, is most relevant when considering potential barriers to treatment. Overall, results suggest that though ERP for CC is associated with significant reductions in MC, pretreatment levels of MC may be associated with poorer treatment outcome, though these results should be interpreted with caution given differences in effects across measures.

In addition to our primary hypotheses, we also assessed the impact of disgust propensity on the observed relationships between CC and MC, given prior research implicating disgust propensity in contamination symptoms (Olatunji, 2010) and the established relationship between the two constructs (Carraresi et al., 2013; Melli et al., 2014; Olatunji, 2010). In the current sample, MC and disgust propensity were strongly correlated ($r = .74$), providing further support for the previously established relationship. Nonetheless, our results indicated that changes in MC were independent of changes in disgust propensity, suggesting ERP is associated with unique changes in both constructs. The current study also found that disgust propensity was associated with poorer treatment outcome, such that pretreatment disgust propensity significantly predicted a posttreatment CC measure (VOCI-C). Moreover, when considering the predictive value of pretreatment disgust propensity on posttreatment measures of CC, pretreatment MC was no longer a significant predictor. Taken together, it may be that ERP is associated with significant changes in both disgust propensity and MC, but that disgust propensity is a stronger predictor of overall outcome. Indeed, prior research has shown MC cross-sectionally mediates the relationship between disgust propensity and contamination fears, suggesting that MC may be a mechanism by which disgust propensity contributes to contamination fears (Melli et al., 2014). It may be that individuals prone to disgust reactions are also more prone to internal feelings of dirtiness or contamination, even in the absence of a tangible contaminant. However, further longitudinal research is needed to elucidate the relationship between disgust propensity and MC, as well as the impact of both constructs on the etiology and maintenance of contamination fears.

It should be noted that the current study protocol consisted of only three sessions of an analogue to ERP, whereas clinical treatment trials of ERP for OCD typically consist of 10–16 sessions (Abramowitz, Foa, & Franklin, 2003). The shorter length of our protocol suggests that even just a few sessions of contamination-related exposure can result in a significant reduction of washing and cleaning behaviors.

However, it may also suggest that our findings regarding MC reflect our shorter exposure protocol. Specifically, it may be that MC requires greater treatment sessions to achieve optimal reduction. Further research should explore optimal treatment dose for contamination symptoms.

The current study's findings should be interpreted in light of limitations and subsequent avenues for future research. First, all participants received the same treatment, and as such, it is unclear as to whether effects are specific to ERP or to receiving treatment in general. Future research should compare the effects of ERP and an alternative treatment modality to determine the specificity of these effects. Second, the sample consisted primarily of individuals who were undergraduates, White, and female, thereby limiting the generalizability of the findings to other populations. Therefore, research should examine the role of MC in contact contamination in other samples. Third, we did not assess the presence of other psychiatric diagnoses nor OCD symptom types and therefore cannot provide information regarding comorbidity. Future research should collect more thorough diagnostic data to determine the potential impact of psychiatric comorbidity and OCD symptomology on the relationship between CC and MC. Additionally, the VOCI-MC does not assess the specific stimuli that may be most distressing to individuals. As such, it is unclear as to the relevance of the behavioral tasks used in the current study to participants' symptoms. Future research may therefore benefit from the development of a more refined measure of MC. Finally, the task used to assess CC before and after treatment was also used as the exposure task, which limited our ability to establish generalizability of treatment gains. However, we found substantial reductions in contamination symptoms across behavioral and self-report measures, which suggests ERP did indeed contribute to meaningful symptom reduction.

Despite these limitations, the current study is strengthened by the use of a large sample, and the use of a multimethod approach to the assessment of contamination symptoms. Taken together, our findings suggest MC may need to be considered in the manifestation and treatment of CC symptoms. Specifically, MC may be associated with increased reactivity to physical contaminants and poorer treatment outcome for CC, though the latter effect was evident only in one of two CC measures. As such, clinicians should consider assessing and treating MC in individuals with contamination-based OCD.

Conflict of Interest Statement

The authors declare no conflict of interest.

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RECEIVED: November 12, 2017

ACCEPTED: March 12, 2018

AVAILABLE ONLINE: 16 March 2018