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Scrupulosity and contamination OCD are not associated with deficits in response inhibition

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ABSTRACT

Background and objectives: Prior research has indicated a number of neuropsychological deficits in patients with OCD consistent with the cortico-striato-thalamo-cortical model of the disorder. Response inhibition (RI), defined as the inability to inhibit a prepotent response, has been identified as a possible candidate endophenotype for OCD. However, the results from previous studies of RI in OCD patients have been mixed, suggesting the possibility that some OCD dimensions may be associated with deficits in RI while others may not. The present study aimed to examine RI using a Go/No-Go (GNG) task in two OCD symptom dimensions, one of which, scrupulosity, has never been subject to neuropsychological investigation.
Methods: A total of 63 individuals, consisting of scrupulous OCD (n = 26), contamination OCD (n = 18) and non-psychiatric controls (n = 19) completed study measures. Controlling for depression symptoms, no significant performance differences were found between the groups on the GNG test, indicating no deficits in RI among contamination or scrupulous OCD.
Results: Results are consistent with several prior studies of RI in OCD that found no differences as compared to non-psychiatric controls, especially on GNG tests, and with more recent suggestions that RI may not constitute a clinical significant impaired domain in OCD.
Limitations: Limitations included a primarily highly educated and Causasian sample.
Conclusions: Additional conclusions include careful consideration of the RI measures selected for future studies, as well as the need for further investigation into the neuropsychological and neurobiological nature of scrupulous OCD.

1. Introduction

Obsessive-Compulsive Disorder (OCD) is a burdensome neuropsychiatric disorder with a lifetime prevalence rate of approximately 2.3% (Ruscio, Stein, Chiu, & Kessler, 2010). Imaging studies implicate the frontal-striatal circuitry in the pathophysiology of OCD (Pauls, Abramovitch, Rauch, & Geller, 2014), supporting the prevailing cortico-striato-thalamo-cortical (CSTC) model of OCD (Saxena & Rauch, 2000). A complementary substantial body of neuropsychological research, yielding an overall moderate degree of deficits across several neuropsychological domains (Abramovitch, Abramowitz, & Mittelman, 2013; Shin, Lee, Kim, & Kwon, 2014), is characterized by highly inconsistent results (Kuelz, Hohagen, & Voderholzer, 2004). In fact, a recent meta-analysis of neuropsychological test performance in adult OCD revealed statistically significant heterogeneity across most neuropsychological domains that was unaccounted for by clinical, demographic, or factors associated with neuropsychological test administration (Abramovitch et al., 2013).

One of the most highly researched neurocognitive domains in the OCD literature is response inhibition (RI), defined as the ability to inhibit a pre-potent response (Logan, Cowan, & Davis, 1984). The ever-growing interest in RI in OCD stems primarily from imaging studies indicating the prominent role of prefrontal regions, especially the orbitofrontal cortex, in the pathophysiology of OCD (Evans, Lewis, & Iobst, 2004). In fact, RI has frequently been suggested as a candidate endophenotype for OCD (Chamberlain, Blackwell, Fineberg, Robbins, & Sahakian, 2005; Menzies et al., 2007). However, as a whole, research on RI in OCD reveals inconsistent, and heterogeneous results (Abramovitch et al., 2013; Kuelz et al., 2004).

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Indeed, review of the OCD literature across the three major test paradigms assessing RI reveals that whereas the majority of studies assessing RI using the Stop Signal Task (SST) report significantly reduced performance in OCD samples compared to controls (Chamberlain et al., 2005; Penades et al., 2007; de Wit et al., 2012), only a minority of studies assessing RI using go/no-go (GNG) tests or continuous performance tests (CPT) report differences between OCD and control samples (Abramovitch, Dar, Schweiger, & Hermesh, 2011; Ghisi, Bottesi, Sica, Sanavio, & Freeston, 2013; Penades et al., 2007; da Rocha, Alvarenga, Malloy-Diniz, & Correa, 2011). Indeed, a large number of studies report comparable number of commission errors on GNG and CPT tests among OCD individuals compared to controls (Bohne, Savage, Deckersbach, Keuthen, & Wilhelm, 2008; Krishna et al., 2011; Lee, Chiu, Chiu, Chang, & Tang, 2009; Page et al., 2009; Thomas, Gonsalvez, & Johnstone, 2014; Tolin, Villavicencio, Umbach, & Kurtz, 2011; Ursu, Stenger, Shear, Jones, & Carter, 2003; Watkins et al., 2005), despite evidence for aberrant brain activity while performing RI tasks in OCD (e.g., Page, et al., 2009).

OCD is a heterogeneous disorder that includes various particular clinical presentations including contamination, checking, hoarding, symmetry and ordering and repugnant obsessions (Abramowitz & Jacoby, 2014). It has been speculated that different OCD dimensions – that hypothetically may be associated with different neurocognitive deficiencies - may partially account for variability between neuropsychological studies described above (Abramovitch et al., 2013). Preliminary evidence suggests that some OCD dimensions may be associated with distinct neural correlates (van den Heuvel et al., 2009; Mataix-Cols et al., 2004). Subsequent preliminary neuropsychological studies reported distinct neuropsychological deficits associated with OCD symptom dimensions. For example, Hashimoto et al. (2011) examined neuropsychological correlates of symptom dimensions in a sample of 63 adults with OCD. The authors found that the aggressive/checking dimension was associated with poorer performance only on the trail making test, while the symmetry/ordering dimension was associated with poorer performance on the trail making test and logical (verbal) memory test. Interestingly, the contamination/cleaning dimension was associated with better performance on the latter two tests. Another study reported that deficits in nonverbal memory in OCD may be associated with the checking dimension, but not with contamination/washing (Cha et al., 2008).

A limited number of studies investigated the association between RI and symptom dimensions in OCD. This limited body of literature indicates that there are no performance differences on RI tasks between OCD dimensions, as measured by GNG tests (Khanna & Vijaykumar, 2000; Penades et al., 2007). In fact, OCD symptom dimensions were not found to be differentially associated with performance on other tasks of RI, such as the Stroop and the Stop Signal tasks (Hashimoto et al., 2011; Penades et al., 2007). However, one study found that the checking dimension is associated with a significantly higher number of commission errors on a GNG test than the washing dimension (Omori et al., 2007). In another study using an analogue sample, Lee, Chiu et al. (2009), Lee, Yost, and Telch (2009) compared two groups of individuals with symptoms of OCD, using a novel classification of OCD symptoms. Their model does not discriminate between symptom dimension based on content, but by dichotomizing obsessions into autogenous (e.g., sexual, aggressive) and reactive (e.g., contamination, symmetry). Although the authors did not find differences on classic GNG outcome measures, they did find that the autogenous obsessions sample had a significant larger attenuated response inhibition (ARI; Lee, Yost, et al., 2009). ARI is an outcome measure involving RI and set shifting; it is the difference in average response time during a baseline block and a subsequent block for which the target go and no-go stimuli are reversed, thus encompassing both cognitive flexibility/set shifting and RI. As a whole, it appears that small number of studies available reveal inconsistent results concerning the association between RI and OCD symptom dimension, with a trend towards no association.

The aim of the present study is to examine RI using a GNG task in two OCD symptom dimensions, one of which –scrupulosity– has never been subject to a neuropsychological investigation. Scrupulosity, a relatively under-researched dimension in OCD, encompasses obsessions and preoccupation with religious and moral concerns (Abramowitz & Jacoby, 2014). Scrupulosity is often grouped with sexual and aggressive obsessions in a single unacceptable thoughts symptom dimension; however, it is perhaps better thought of as a category of core fear rather than a discrete symptom dimension (Siev & Huppert, in press). For example, a scrupulous individual may fear potentially sinful sexual obsessions (that could be categorized in the unacceptable thoughts dimension) or may engage in excessive checking (that could be categorized in the checking and responsibility for accidental harm dimension) to ensure he performed a religious ritual precisely. Although understudied, approximately 5% of individuals in Western cultures with OCD have primary scrupulosity (Foa & Kozak, 1995; Tolin, Abramowitz, Kozak, & Foa, 2001), and the presence of scrupulosity predicts poor treatment outcome in several studies (e.g., Alonso et al., 2001; Ferrão et al., 2006; Mataix-Cols, Marks, Greist, Kobak, & Baer, 2002; Rufer, Grothusen, Maβ, Peter, & Hand, 2005). The second OCD dimension examined in the present study is contamination concerns (also referred to as 'washing' or 'cleaning'). In the context of neuropsychological investigations, this symptom dimension is of particular interest since some studies report intact neuropsychological performance compared to controls (Cha et al., 2008; Nakao et al., 2009), and others report that contamination OCD is associated with better performance on several neuropsychological tasks (Hashimoto et al., 2011; Omori et al., 2007). Individuals with contamination concerns are an appropriate comparison group for this reason. In addition, scrupulosity is assumed to be autogenous and contamination obsessions are reactive (Lee & Kwon, 2003), and Lee, Chiu et al. (2009), Lee, Yost, and Telch (2009) compared individuals with autogenous and reactive symptoms using the same task used herein. In sum, the rationale to examine RI in scrupulous individuals derives from the facts that no studies to date have examined the neuropsychology of scrupulosity; scrupulosity is purported to belong to the group of autogenous obsessions, which may be related to RI deficits; and the extant literature on RI in OCD is characterized by mixed results, which may be a function of symptom subtype.

In the present study, we examined rates of commission errors as the primary RI outcome measure, and also evaluated ARI as a secondary measure of RI and set shifting. In light of previous findings, we predicted that individuals with contamination concerns would not differ from healthy controls on measures of RI. Lee, Chiu et al. (2009), Lee, Yost, and Telch (2009) found differences on ARI but not commission errors between individuals with autogenous and reactive symptoms using an analogue sample. We therefore expected that scrupulous individuals might demonstrate greater impairment on the measure of ARI, although not commission errors.

2. Materials and methods

2.1. Participants

The study sample consisted of 67 individuals meeting inclusion criteria for one of three study groups: scrupulous OCD (n = 29), contamination OCD (n = 19) or healthy controls (n = 19). We

initially enrolled 77 individuals; however, nine participants were found ineligible (four of the participants did not meet criteria for OCD severity (their symptoms were sub-clinical), two participants' primary obsessional fear was not scrupulous or contamination-related, one participant did not meet inclusion criteria because they had both primary scrupulous and contamination-related OCD symptoms, one participant was experiencing current alcohol abuse, and one participant had a primary diagnosis of seasonal affective disorder rather than OCD) and one participant voluntarily withdrew from the study. The majority of participants (n = 74) were recruited through an OCD clinic situated in a major teaching hospital in the Northeastern United States. A smaller number of participants (n = 3) were recruited through an anxiety disorder clinic affiliated with a large private university serving the greater local community. Of the 67 individuals who were eligible and completed the study, data from four of the participants were excluded from analyses after initial inspection of the data determined their responses were significant outliers (e.g., more than three standard deviations above the mean, suggesting random responding or misunderstanding the instructions), leaving a sample of 63 individuals (scrupulous OCD, n = 26; contamination OCD, n = 18; healthy controls, n = 19).

Inclusion into either the scrupulous OCD or contamination OCD groups required a diagnosis of OCD based on DSM-IV criteria that was established through semi-structured interviewing (Structured Clinical Interview for DSM-IV-Patient Version; First, Spitzer, Gibbon, & Williams, 2002), as well as a clinician-administered Yale-Brown Obsessive Compulsive Scale (Y-BOCS; Goodman, Price, Rasmussen, Mazure, Delgado, et al., 1989; Goodman, Price, Rasmussen, Mazure, Fleischmann, et al., 1989) score of 16 or higher. Interviewers obtained OCD participants' top three primary obsessions via the Y-BOCS checklist. Participants who described either scrupulous or contamination obsessions as their primary obsessions were included in their respective OCD groups. Participants with primary contamination obsessions could not have scrupulous obsessions among their top three obsessions; however, participants with primary scrupulous obsessions could have secondary or tertiary contamination concerns.[1] Participants without a current DSM-IV psychiatric diagnosis were included as healthy controls. All participants were (a) age 18 or older, (b) fluent in English and (c) willing to provide informed consent. Participants were excluded from the study if they met criteria for (a) any comorbid psychotic or bipolar disorder, (b) current substance abuse or dependence, (c) organic mental or developmental disorders, or (d) currently endorsed homicidality or suicidality. Participants in the healthy control group were excluded if they had lifetime OCD. In fact, only one healthy control participant met lifetime criteria for a DSM-IV disorder (past alcohol dependence).

2.2. Measures

Demographics form. The demographics form is a short self-report form designed for purposes of this study. The form collects relevant demographic information including age, race, ethnicity, marital status and highest level of education completed, as well as current and past psychiatric medications taken.

Structured Clinical Interview for DSM-IV-Patient Version (SCID-P; First et al., 2002). The SCID-P is a rater-administered, semi-structured interview that assesses for the presence of current and lifetime DSM-IV diagnoses. The measure was administered by a trained doctoral level clinician.

Yale-Brown Obsessive Compulsive Checklist and Scale (Y-BOCS; Goodman, Price, Rasmussen, Mazure, Delgado, et al., 1989; Goodman, Price, Rasmussen, Mazure, Fleischmann, et al., 1989). The Y-BOCS Checklist is a rater administered checklist of all major OCD obsessions and compulsions including but not limited to: doubting/checking, scrupulosity, contamination/washing, symmetry/ordering and hoarding. The Y-BOCS scale is a 10-item clinician administered measure of OCD severity, with a score of 16 or higher indicating clinically significant symptoms of OCD. The measure has shown good psychometric properties (Goodman, Price, Rasmussen, Mazure, Delgado, et al., 1989; Goodman, Price, Rasmussen, Mazure, Fleischmann, et al., 1989). Cronbach's alpha for the total Y-BOCS score in this sample was 0.97.

Depression Anxiety Stress Scales – 21-item version (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is a 21-item self-report measure designed to assess for the presence of depression, anxiety, and stress symptoms with the use of three respective subscales. Each subscale (e.g., depression, anxiety, stress) consists of seven items that are scored on a Likert scale of 0 (did not apply to me at all) to 3 (applied to me very much or most of the time), rated within the past week. Total subscale scores were calculated by summing the scores for the relevant items on each subscale and then doubling that score in order to make the score comparable to the original 42 item scale (Antony, Bieling, Cox, Enns, & Swinson, 1998). Higher scores are indicative of more severe symptomatology. The DASS has demonstrated strong reliability and good validity (Brown, Chorpita, Korotitsch, & Barlow, 1997; Lovibond & Lovibond, 1995). In the present study Cronbach's alphas for the DASS depression, anxiety and stress subscales were 0.93, 0.70 and 0.88, respectively.

Visual Go/No-go Task (GNG). The visual go/no-go task (Lapierre, Braun, & Hodgins, 1995) is a measure of response inhibition, defined as the ability to inhibit intended responses and learned associations. The goal of the task is for participants to press a button immediately upon detecting a target stimulus. The stimulus can appear anywhere on the screen and does so at variable interstimulus intervals. First, participants practice detecting the appearance of a square (50 trials). Second, they detect the appearance of a square but do not respond to the appearance of a cross of similar size (50 trials). Finally, they detect the appearance of the cross (i.e., previous distracter) and refrain from responding to the presence of the square (i.e., previous target) (50 trials). The main outcome measures used were, mean reaction time for correct responses, commission errors (responding to a 'no-go' stimulus), omission errors (failure to respond to a 'go' stimulus), and mean ARI (Lee, Yost, et al., 2009). The ARI is calculated by subtracting the average response time in the second block from the average response time in the third block – a block where instructions regarding 'go' and 'no-go' stimuli are reversed. As opposed to commission errors, which assess response inhibition, ARI assesses inhibitory control under reversal/set shifting condition (Lee, Yost, et al., 2009), where a larger ARI indicates increased deficiency.

2.3. Procedure

Participants who were screened for initial inclusion/exclusion criteria over the phone and appeared to meet study entrance criteria were invited for a one-time 3 h visit to complete study procedures. All participants first underwent a series of semi-structured diagnostic interviews administered by an experienced doctoral level clinician, including interviews assessing OCD symptoms and severity. After completing the diagnostic battery, participants then were administered a number of computerized tasks of

[1] Initially, scrupulous participants were excluded for having secondary or tertiary contamination concerns. However, in light of difficulties with recruitment, we decided that it would be more ecologically valid and the results more generalizable to include participants with primary scrupulosity even with secondary or tertiary contamination symptoms.

attention including the GNG. When completing the visual go/no-go task, participants were required to press a button immediately upon detecting a target stimulus.

3. Results

The study sample (N = 63) was predominantly Caucasian (n = 58, 92.1%), and consisted of more women (n = 35, 55.6%) than men (n = 28, 43.90%). The mean age of the sample was 33.41 (SD = 12.69). A minority of the sample, (n = 3, 4.8%) identified as Hispanic/Latino. The sample predominantly identified as single (n = 41, 65.1%), with 28.6% married and 6.3% divorced. The sample was also well educated: 66.7% had a college degree and 19.0% had post-college graduate education. 55.5% of the sample was working full or part-time, 15.9% were students, 12.8% were unemployed, and 15.9% were categorized as other (For a detailed breakdown of demographics by participant group refer to Table 1). The majority of the sample identified their religious affiliation as Catholic (n = 31, 49.2%). The rest of the sample identified their religious affiliations as Protestant (n = 9, 14.3%), Jewish (n = 3, 4.8%) and Hindu (n = 2, 3.2%). A portion of the total sample did not identify with a particular religion (n = 13, 20.6%) and consisted of 7 (11.1%) scrupulosity participants, 4 (6.3%) contamination participants and 2 (3.2%) healthy controls. In addition, 8% of the sample identified their religion as other. For the scrupulosity group alone, 12.7% (n = 8) identified as Catholic, 11.1% (n = 7) as Protestant, and 1.6% as Jewish (n = 1). (See Table 2 for breakdown of religious affiliation by participant group). A series of chi-square and one-way ANOVA analyses revealed no significant differences between groups (contamination OCD, scrupulosity OCD and healthy controls) on any demographic variables including, age, gender, race, ethnicity, religious affiliation, or educational status.

In the scrupulous OCD group, comorbid diagnoses occurred at the following percentages, Major Depressive Disorder (23.1%), Panic Disorder with Agoraphobia (0%), Social Anxiety Disorder (34.6%), Post-Traumatic Stress Disorder (3.8%), and Generalized Anxiety Disorder (19.2%). In the contamination OCD group, comorbid diagnoses occurred at the following percentages, Major Depressive Disorder (14.3%), Panic Disorder with Agoraphobia (5.6%), Social Anxiety Disorder (27.8%), Post-Traumatic Stress Disorder (0%), and Generalized Anxiety Disorder (11.1%).

In the overall OCD sample, 75% (33 out of 44) participants were taking psychotropic medications. In the scrupulous OCD group, 77% (20 out of 26) participants were taking psychotropic medications and in the contamination group 66.7% (12 out of 18) participants were taking psychotropic medications. The percentage of individuals within the scrupulous OCD group who reported taking the following medications included: antidepressants (57.7%), anti-psychotics (15.3%), anti-anxiety (27%), anti-convulsants (3.8%) and stimulants (3.8%). The percentage of individuals within the contamination OCD group who reported taking the following medications included: antidepressants (55.6%), anti-psychotics (5.6%), anti-anxiety (38.9%) and anti-convulsants (5.6%).

For the entire sample of participants with OCD, the total Y-BOCS score represented moderate degree of severity (M = 22.84, SD = 3.82). The two clinical groups did not differ on their Y-BOCS scores (see Table 3). DASS-21 averages for the two OCD groups were: Depression (M = 12.74, SD = 10.08), Anxiety (M = 6.78, SD = 5.41), Stress (M = 16.45, SD = 18.11). A series of one-way ANOVAs between groups found significant differences on all three subscales including depression, anxiety, and stress (See Table 3). Post-hoc analyses using Tukey's test revealed that the scrupulous OCD group had significantly higher levels of depression as compared to the contamination OCD group and healthy controls, both of which did not differ on their depression scores. The three groups also significantly differed on levels of anxiety, with the scrupulosity OCD group having significantly higher scores than both the contamination OCD and healthy control groups and the contamination OCD group having significantly higher levels of anxiety than the healthy control group. The OCD groups did not differ from one another on the stress subscale, but both of these groups scored significantly higher on levels of stress than the healthy controls (see Table 3).

Table 1
Sample demographics.

Demographic	SO (N = 26)	CO (N = 18)	HC (N = 19)	% Total sample
Racial background				
Caucasian	39.7	28.6	23.8	92.1
African American	1.6	0.0	1.6	3.2
Asian or Asian Am.	0.0	0.0	3.2	3.2
More than one race	0.0	0.0	1.6	1.6
Sex				
Female	19.0	19.0	17.5	55.60
Male	22.2	9.0	12.7	43.90
Ethnicity				
Hispanic/Latino	1.6	0.0	3.2	4.8
Non-Hispanic/Latino	39.7	28.6	27.0	95.3
Marital status				
Single	25.4	15.9	23.8	65.1
Married	15.9	7.9	4.8	28.6
Divorced	0.0	4.8	1.6	6.3
Highest level of ed.				
Post-graduate	7.9	6.3	4.8	19.0
College	25.4	17.5	23.8	66.7
High school	1.6	1.6	0.0	3.2
Other	6.3	3.2	1.6	11.1
Employment status				
Full-time	12.7	15.9	19.0	47.5
Part-time	1.6	1.6	4.8	8.0
Student	9.5	4.8	1.6	15.9
Unemployed	3.2	4.8	4.8	12.8
Other	14.3	1.6	0.0	15.9

Table 2
Religious affiliation.

Religious affliliation	SO (N = 26)	CO (N = 18)	HC (N = 19)	% Total sample
Catholic	12.7	17.5	19.0	49.2
Protestant	11.1	1.6	1.6	14.3
Jewish	1.6	1.6	1.6	4.8
Hindu	0.0	0	3.2	3.2
No religion	11.1	6.3	3.2	20.6
Other	4.8	1.6	1.6	8.0

3.1. Response inhibition data

A univariate ANCOVA controlling for DASS-depression scores[2] revealed no significant differences between any of the groups on mean response time for any GNG task block (see Table 4). Univariate ANCOVAs controlling for depression, revealed no differences between groups in commission and omission errors in Blocks 2 and 3 of the task (see Table 4). Finally, an ANCOVA controlling for

[2] We opted to control only for depressive symptoms and not anxiety for two reasons. First, depression has shown to impact executive functioning in OCD (Basso, Bornstein, Carona, & Morton, 2001). Second, while OCD is not considered an anxiety disorder in the DSM-5, elevated symptoms of anxiety are integral to OCD symptomatology, and thus partializing out anxiety would be removing some of the variance that may actually be part of the disorder. We also conducted separate analyses controlling for both depressive and anxiety symptoms, however the results remained insignificant.

Table 3
Sample characteristics.

Measure	SO (N = 26)		CO (N = 18)		HC (N = 19)		ANOVA		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*	Sig	Eta-squared
YBOCS	22.04	4.06	24.00	3.18	NA	NA	2.94	0.09	0.07
DASS depression	$16.46^{a,b}$	9.30	7.37^{a}	8.85	1.32^{b}	1.74	22.08	0.00	0.42
DASS anxiety	$8.39^{a,b}$	6.03	$4.44^{a,c}$	3.26	$0.84^{b,c}$	1.54	16.80	0.00	0.36
DASS stress	18.46^{a}	7.89	13.56^{b}	7.75	$2.31^{a,b}$	2.60	32.34	0.00	0.52

Note. Y-BOCS = Yale-Brown Obsessive Compulsive Scale; DASS = Depression Anxiety Stress Scale; NA = Not Available.
Note. SO = Scrupulous Obsessive-Compulsive Disorder; CO = Contamination Obsessive-Compulsive Disorder; HC = Healthy Controls.
Note: Same superscripts (a, b, c) indicate significant differences of $p < 0.001$ using Tukey's post-hoc test.

depression also failed to find any significant differences on the ARI coefficient between the groups (see Table 4).

In order to examine the association between OCD severity and RI, Pearson's correlations were conducted between the total Y-BOCS score and the total number of commission errors in the entire OCD sample, and separately within the scrupulous and contamination OCD samples. There was no significant correlation between the number of commission errors and the total Y-BOCS score across the entire OCD sample ($r = -0.16$, $p = 0.31$). When broken down by OCD group, there was no significant correlation within the scrupulous OCD sample ($r = 0.07$, $p = 0.62$). However, within the contamination OCD sample, a significant strong negative correlation was found between the number of commission errors and the total Y-BOCS score ($r = -0.55$, $p = 0.02$), indicating that within the contamination group, more severe OCD symptoms were associated with fewer commission errors. No other neuropsychological indices were found to significantly correlate with the Y-BOCS (i.e., omission errors and reaction time indices). In addition, given that no difference was found between the OCD and control groups on reaction time indices, we ruled out the possibility that OCD participants were deliberately slow to respond in order to avoid errors.

4. Discussion

The aim of the present study was to assess RI in scrupulous and contamination OCD compared to non-psychiatric controls using a GNG task. In accordance with our first hypothesis, no difference was found between individuals with contamination OCD and non-psychiatric controls on all GNG indices (reaction time, commission errors, omission errors, and ARI), controlling for depression severity. These results are in accord with previous studies reporting intact neuropsychological task performance compared to controls (Cha et al., 2008; Nakao et al., 2009), or even better performance on neuropsychological tasks associated with the contamination/washing dimension (Hashimoto et al., 2011). In fact, our results indicate that the number of commission errors on block 3 of the GNG test was negatively correlated with OCD symptom severity in the contamination OCD group.

Most studies examining RI using a GNG test have not found performance differences between OCD and control samples. In fact, a recent meta-analysis of neuropsychological test performance in adult OCD found an overall small effect size of $d = 0.33$, indicating small degree of underperformance among OCD samples compared to controls (Abramovitch et al., 2013), and this effect size had a confidence interval with an upper limit that approaches zero ($CI_U = -0.61$, $CI_L = -0.04$). However, our results are consistent with the possibility that unlike other OCD symptom dimensions, contamination OCD may be associated with enhanced performance on some neuropsychological tests. It has been suggested that this effect may be due to a unique neural substrate associated with contamination/washing symptoms (Hashimoto et al., 2011) reported in several studies (van den Heuvel et al., 2009; Mataix-Cols et al., 2004). More speculatively, while it has been established that checking compulsions are associated with distrust in memory (Radomsky, Gilchrist, & Dussault, 2006), it has also recently been suggested that repetitive checking may cause attenuation of cognitive functions, including memory, working memory and executive functions (Harkin & Kessler, 2011; Harkin, Rutherford, & Kessler, 2011). Given that the checking symptom dimension is associated with greater deficient performance in neuropsychological tasks compared to contamination/washing OCD (e.g., Cha, et al., 2008; Jang et al., 2010; Omori et al., 2007), it is possible that washing compulsions may not be associated with the same mechanism that has been hypothesized to impact cognitions as seen in checking rituals (Harkin et al., 2011; van den Hout & Kindt, 2003).

There were no performance differences in RI between participants with scrupulous OCD and non-psychiatric controls. To our

Table 4
Go/no-go performance across three groups.

Measure	SO (N = 26)		CO (N = 18)		HC (N = 19)		*F*	Sig	Eta-squared
	M	*SD*	*M*	*SD*	*M*	*SD*			
Block 1 average correct RT	330.15	73.33	342.10	63.90	329.92	34.98	0.39	0.68	0.01
Block 2 average correct RT	438.12	67.72	464.48	47.48	437.85	52.38	1.77	0.19	0.06
Block 2 omission error#	0.04	0.20	0.06	0.24	0.11	0.46	0.04	0.96	0.00
Block 2 commission error#	1.88	1.77	1.61	1.34	1.63	1.83	0.01	0.81	0.01
Block 3 average correct RT	463.40	66.76	483.37	78.48	458.72	59.10	0.99	0.38	0.03
Block 3 omission error#	0.00	0.00	0.00	0.00	0.00	0.00	–	–	–
Block 3 commission error#	1.66	1.12	1.77	0.94	1.37	1.00	0.19	0.83	0.01
ARI	25.28	33.86	18.90	50.61	20.87	28.57	0.07	0.93	0.00

Note. RT = Response time; ARI = Attenuated Response Inhibition.
Note. SO = Scrupulous Obsessive-Compulsive Disorder; CO = Contamination Obsessive-Compulsive Disorder; HC = Healthy Controls.

knowledge, there is no prior neuropsychological research on scrupulosity, let alone RI, and there are no imaging studies of individuals with scrupulosity from which to draw hypotheses regarding neuropsychological function associated with this symptom type. Using an analogue sample, Lee, Chiu et al. (2009), Lee, Yost, and Telch (2009), however, found that individuals with autogenous OCD symptoms scored higher than did those with reactive OCD symptoms on ARI. Although autogenous obsessions are purported to include religious obsessions as well as sexual and aggressive ones (i.e., the unacceptable thoughts symptom dimension; Lee & Kwon, 2003), measures used to classify symptoms as autogenous or reactive do not measure scrupulous symptoms adequately (Siev, Steketee, Fama, & Wilhelm, 2011). In addition, Siev et al. (2011) found differences between religious and sexual obsessions in cognitive styles such that the former were associated with styles thought to be characteristic of both autogenous and reactive groups. Therefore, rather than being at odds with Lee, Chiu et al. (2009), Lee, Yost, and Telch (2009), the present results may instead indirectly reflect the fact that scrupulosity is not necessarily autogenous rather than reactive. Rather, scrupulosity represents a category of core fear (Siev & Huppert, in-press) that can be associated with any symptom dimension. Symptoms can be autogenous (e.g., intrusive blasphemous images) or reactive (e.g., checking related to religious ritual performance).

It is also important to point out that despite a modest sample, the effect sizes (eta-squared) presented in Table 4 are approaching zero, indicating virtually no differences and supporting the null findings.

Our results highlight the need to select neuropsychological tasks carefully, especially in OCD samples. For example, whereas the majority of studies did not report an increased number of commission errors on GNG and CPT tests, the majority of studies utilizing the SST report significantly deficient performance in OCD. This may be due to the different neurochemical and neuroanatomical correlates associated with these tests (Eagle, Bari, & Robbins, 2008). This effect could also stem from the level of difficulty and cognitive load associated with specific tests. This has been reported in studies assessing performance of OCD samples on the N-back task, a task of working memory where task demand and cognitive load increases from 1-back to 3 back. One study reported comparable performance on 1-back trails but deficient performance on 2-back trials on a verbal N-Back tasks in OCD individuals compared to controls (Kashyap, Kumar, Kandavel, & Reddy, 2013). Similarly, OCD samples were reported to perform comparable to controls on 1-back and 2-back trials but not on 3-back trials on spatial N-Back tasks (de Vries et al., 2014; van der Wee et al., 2003). This has been reported in studies assessing performance of OCD samples on the N-back task, a task of working memory where task demand and cognitive load increases from 1-back to 3 back. One study reported comparable performance on 1-back trails but deficient performance on 2-back trials on a verbal N-Back tasks in OCD individuals compared to controls (Kashyap et al., 2013). Similarly, OCD samples were reported to perform comparable to controls on 1-back and 2-back trials but not on 3-back trials on spatial N-Back tasks (de Vries et al., 2014; van der Wee et al., 2003). Thus, OCD in general may be associated with underperformance in more complex and higher load tasks, and hypothetically with a differential level of performance between OCD dimensions. Consequently, it is important to carefully select tasks as well as interpret results from specific in-task trials, and to incorporate examination of OCD dimensions.

This investigation has several notable strengths. First, it is the first to examine neuropsychological correlates of scrupulosity. Second, the OCD groups were diagnosed on the basis of a comprehensive clinical assessment conducted by experienced doctoral-level clinicians. Moreover, participants were identified as scrupulous or contamination on the basis of a clinical interview and identification of their primary obsessional fear, rather than by correlating symptoms on an OCD self-report measure in a single sample. There are also several study limitations. First, the sample was almost entirely Caucasian, and it remains to be determined whether the results generalize to other racial and ethnic groups. Second, the sample was highly educated. It is possible that cognitive performance would differ in a less educated sample. Third, although participants with primary contamination obsessions did not have scrupulous obsessions among their top three obsessions, scrupulous participants were permitted to have secondary or tertiary contamination concerns. Fourth, given that response inhibition has been proposed as a potential endophenotype for OCD (Menzies et al., 2007), the lack of assessment for OCD in the first-degree relatives of healthy controls would have been useful and is a limitation of the present study.

5. Conclusion

The present study reveals no RI deficits as measured by a GNG test in individuals with scrupulosity and contamination OCD compared to healthy controls. These results are in accordance with the majority of studies examining RI using the GNG and CPT paradigms, and with recent suggestions that RI may not constitute a clinically significant impaired domain in OCD. However, given the different results reported when examining RI using the SST, more research is needed to clarify this controversial issue, especially with regard to OCD dimensions. Moreover, there is a lack of neuropsychological and brain imaging studies associated with scrupulous OCD, a prevalent OCD symptom dimension.

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