Cognitive flexibility differentiates young adults exhibiting obsessive-compulsive behaviors from controls

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ABSTRACT

The National Institute of Mental Health has proposed a shift toward classifying clusters of disorders on the basis of underlying biomarkers and neurological correlates. The present study sought to determine whether cognitive flexibility represents one such construct underlying obsessive-compulsive behaviors (OCBs), a cluster of behaviors characteristic of OCD and other body-focused repetitive behaviors (BFRBs), including trichotillomania, pathological skin picking, nail biting, and tic disorders. One-hundred and twenty-four undergraduate students completed the Depression Anxiety and Stress Scales, Padua Inventory—Washington State University Revision, Massachusetts General Hospital—Hairpulling Scale, Skin Picking Scale, and an Intradimensional/Extradimensional Shift (IDED) Test. Analyses were performed using a subsample of participants who met criteria for inclusion in the OCB group and a control group ($N=56$). Results indicated that young adults in the OCB group demonstrated significantly poorer performance on the IDED compared to controls. However, hierarchical regression analyses revealed that increased deficits in cognitive flexibility failed to predict worsened OCB severity—as assessed via a composite score. These results suggest that while cognitive flexibility differentiates those exhibiting OCBs from controls, it does not appear to be related to OCB severity. Future research is needed to replicate these results in larger clinical samples.

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1. Introduction

Obsessive-compulsive behaviors (OCBs) are repetitive, habitual, compulsive behaviors characteristic of obsessive-compulsive disorder (OCD) and other psychiatric disorders including body-focused repetitive behaviors (BFRBs; e.g., trichotillomania (TTM), pathological skin picking, and nailing biting), generalized anxiety disorder (GAD), tic disorders, eating disorders, substance abuse, impulsive control, as well as autism spectrum disorders. It is estimated that between 0.60% and 2.64% of adults will develop at least one of these disorders in their lifetime (Keuthen et al., 2010; Kim et al., 2011; Schlander et al., 2011; Galimberti et al., 2012; Knight et al., 2012; Roberts et al., 2013) and can result in significant impairment in day-to-day functioning. For example, the bald spots, tissue damage, and skin lesions that may result from TTM and pathological skin picking, the stereotyped behavior patterns associated with autism spectrum disorders (Levy and Perry, 2011), and the excessive doubting and ritualized behaviors characteristic of OCD and GAD can lead to a variety of negative outcomes including embarrassment, pain, poor health outcomes, interpersonal, and occupational difficulties (Arnold et al., 2001; Stein et al., 2010; Mackenzie et al., 2011). Recently, the National Institute of Mental Health (NIMH) proposed the Research Domain Criteria (RDoC) initiative to shift from the current classification of disorders on the basis of presenting signs and symptoms toward an emphasis on classifying clinical phenomena by shared biomarkers and neurological correlates between clusters of disorders (Insel et al., 2010). Despite the high prevalence of disorders characterized by OCBs, few studies have examined the relationship between potential neurocognitive factors and shared behavioral phenotypes amongst these disorders. To address the lack of research in this domain, the current study seeks to examine the relationship between cognitive flexibility and OCBs (i.e., obsessions, compulsions, hair pulling, and skin picking) in young adults as compared to controls.

Cognitive flexibility is defined as the ability to switch attention from one task to another or change behaviors after receiving negative feedback and has been linked to many psychiatric disorders including attention-deficit/hyperactivity disorder (ADHD; Sergeant et al., 2003; Willcutt et al., 2005; Rommelse et al., 2007), obsessive-compulsive and related disorders (e.g., OCD, TTM, pathological skin picking; Deckersbach et al., 2000; Okasha et al., 2000; Kuelz et al., 2004; Bohne et al., 2005; Chamberlain et al., 2005; Bannon et al., 2006; Chamberlain, et al., 2006; Lawrence et al., 2006; Chamberlain et al., 2007a; Chamberlain et al., 2007b; Britton et al., 2010; Odlaug et al., 2010; Ornstein et al., 2010), anorexia nervosa and bulimia nervosa (Tchanturia et al., 2004; Gillberg et al., 2007; Tchanturia et al., 2011; Galimberti et al., 2012), and depression (Marazziti et al.,

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2010; Meiran et al., 2011; Lee et al., 2012), among others. From a clinical perspective, cognitive flexibility may be particularly beneficial in helping to explain the development of OCBs. For example, patients presenting with symptoms of OCD—a disorder characterized by OCBs —may exhibit persistent, repetitive hand washing despite negative feedback such as bleeding and chapped hands. Similarly, patients who pull their hair or pick their skin continue to do so despite the resulting bald spots, bleeding, scarring, and negative social feedback. Evidence from neuroimaging studies of OCD and TTM suggests that performance on tests of cognitive flexibility may be mediated by the dorsolateral prefrontal cortices and frontal–striatal circuitry (Britton et al., 2010; Snorrason et al., 2012). These same brain regions have been implicated as potential areas of dysfunction in disorders characterized by OCBs. For example, a study of patients with OCD found that performance on tests of cognitive flexibility is associated with decreased frontal–striatal circuitry (Britton et al., 2010). The small number of neuroimaging studies in TTM have produced mixed findings (Snorrason et al., 2012), though there is evidence for abnormalities in the striatum, several cortical regions (both linked to cognitive flexibility deficits) and the amygdalo–hippocampal complex (Swedo et al., 1991; Grachev, 1997; O'Sullivan et al., 1997; Keuthen et al., 2007; Chamberlain et al., 2008; Chamberlain et al., 2010; Lee et al., 2010). These findings suggest that—from a biological and phenotypic perspective—cognitive flexibility may represent an important construct for understanding the etiology of OCBs.

Apart from inhibitory control, cognitive flexibility represents the neurocognitive domain that has received the greatest degree of empirical attention among OCBs and yet has also produced the most discrepant findings. Some studies have found that participants with OCD have impaired performance on tasks of cognitive flexibility (Deckersbach et al., 2000; Okasha et al., 2000; Kuelz et al., 2004; Bannon et al., 2006; Lawrence et al., 2006; Britton et al., 2010) while others find they perform similarly to healthy controls (Abbruzzese et al., 1995; Abbruzzese et al., 1997; Moritz et al., 2001, 2002). Though less prevalent, research examining cognitive flexibility in patients with TTM (Stanley et al., 1997; Bohne et al., 2005; Chamberlain et al., 2006; Chamberlain et al., 2007a; Grant et al., 2011; Grant et al., 2012) and pathological skin picking (Odlaug et al., 2010; Grant et al., 2011) have yielded mixed findings though the majority of these studies do appear to support the importance of cognitive flexibility in understanding the etiology of these disorders. A potential explanation for the discrepant findings from studies of cognitive functioning in OCBs, as noted above, may be the absence of a standardized method of assessing cognitive flexibility. For example, cognitive flexibility has been assessed using both computerized and paper-and-pencil methods of assessment, including the Object Alternation Test (Bohne et al., 2005), Trails B (Stanley et al., 1997), the computerized IDED task (Chamberlain et al., 2006; Britton et al., 2010; Odlaug et al., 2010; Grant et al., 2011; Grant et al., 2012), and the Wisconsin Cart Sorting Test (Ornstein et al., 2010). The multitude of potential methods for assessing cognitive flexibility, and the resultant lack of standardization creates difficulty in comparing results across studies. In addition, unstandardized approaches may lead to an increased potential for experimenter error or bias. The current study will attempt to remedy this limitation by utilizing a standardized, automated set-shifting task to examine cognitive flexibility in a more reliable manner and utilizing a novel, transdiagnostic approach to these behaviors.

The RDoC has placed, as a central tenant of its goal, an emphasis on examining relationships between differing units of analysis (i.e., behavioral tasks of cognitive flexibility, self-report of repetitive or ritualistic behavior) within broader constructs (i.e., habit behaviors). In this vein, the RDoC endeavors to be transdiagnostic in relation to its stated goals. Given this fact and the aforementioned relationship posited to exist between cognitive flexibility and OCBs, the primary aim for the current study is to investigate whether greater cognitive

flexibility deficits—assessed using a computerized measure—exist among young adults exhibiting OCBs (i.e., symptoms of OCD, TTM, or skin picking) compared to controls. To our knowledge, all prior research has sought to examine the role of cognitive flexibility within discrete disorders (i.e., OCD, subclinical symptoms of OCD, etc.), rather than utilizing a transdiagnostic approach. We predict that participants classified as part of the OCB group—via creation of a composite OCB variable—will exhibit greater deficits in cognitive flexibility compared to controls. This novel approach also provides the opportunity to explore a potential cumulative load hypothesis. That is, a secondary aim of this study is to identify whether poorer performance on a task of cognitive flexibility predicts worsened OCB severity—as assessed using a composite score obtained via the summation of standardized scores from three validated measures of OCD, hair pulling, and skin picking. We hypothesize that as the severity of cognitive flexibility deficits becomes greater, the severity of OCBs will also become greater (Chamberlain et al., 2005).

2. Methods

2.1. Participants

Data were obtained from an ongoing study designed to examine the link between neurocognitive functioning and repetitive behavior problems among college students. Participants were recruited via the SONA Experiment Management System website at Kent State University (KSU). Participants consisted of current KSU students (N=132) enrolled in psychology courses who were required to participate in ongoing research projects to receive course credit in entry-level psychology courses. Participants were required to be at least 18 years of age and provide complete data on all measures utilized in statistical analyses relevant to this study's primary and secondary aims. Of the 132 participants, 124 met these criteria and were used to construct subgroups (see description of subgroup construction in Data Analytic Plan). Demographic characteristics for the entire sample (N=124) as well as the two subgroups constructed for the purpose of this study are provided in Table 1.

2.2. Measures

2.2.1. Depression Anxiety and Stress Scales (DASS-21; Lovibond and Lovibond, 1995)

The DASS-21 is a 21-item version of the original 42-item self-report designed to measure depression, anxiety, and tension/stress. Items are scored from 0 to 3, with higher scores indicating increased frequency of symptoms. The DASS-21 consists of three subscales assessing depression (α=0.86), anxiety (α=0.76), and stress (α=0.77). The scale has frequently been used in college student populations and has been shown to have high reliability and adequate divergent and discriminant validity (Ng et al., 2007).

2.2.2. Padua Inventory—Washington State University Revision (PI-WSUR; Burns, 1995)

The Padua Inventory—Washington State University Revision is a 39-item self-report measure of the degree of disturbance caused by obsessions and compulsions (α=0.94 in the current sample). The scale consists of several subscales measuring contamination obsessions and washing compulsions, dressing/grooming compulsions, checking compulsions, obsessional thoughts of harm to self or others, and obsessional impulses to harm self or others. Items are scored on a range from 0 ("not at all") to 4 ("very much"). The scale has been used in diverse populations and displays good psychometric properties (Burns et al., 1996).

2.2.3. Massachusetts General Hospital—Hairpulling Scale (MGH-HS; Keuthen et al., 1995)

The MGH is a 7-item self-report that assesses repetitive hair pulling (α=0.97). The MGH measures the severity of hair pulling, degree of resistance and control over hair pulling, and actual hair pulling. Items range from scores of 0 to 4, with higher scores indicating increased symptom severity. The MGH has been found to be internally consistent, demonstrate good test-retest reliability, significant convergent and divergent validity, and sensitivity to change in hair pulling symptoms (O'Sullivan et al., 1995).

2.2.4. Skin Picking Scale (SPS) (Keuthen et al., 2001)

The SPS is a 6-item self-report scale assessing skin picking behaviors (α=0.95). Scale items measure the frequency of skin picking urges, intensity of urges, time spent on picking, interference due to picking, and distress and avoidance related to skin picking. Examinees are instructed to rate items on a 0–4 scale, with higher values indicating more severe symptoms. The SPS has been found to be a valid and reliable measure of skin picking severity (Keuthen et al., 2001).

Table 1
Demographic characteristics of samples.

Characteristic	Full sample (N=124)	OCBs (n=28)	Control (n=28)
Gender			
Male	37 (29.8%)	9 (32.1%)	7 (25.0%)
Female	87 (70.2%)	19 (67.9%)	21 (75.0%)
Age	20.5 (S.D.=2.70)	20.8 (S.D.=2.0)	20.3 (S.D.=2.9)
Class year			
Freshman	46 (37.1%)	8 (28.6%)	13 (46.4%)
Sophomore	18 (14.52%)	3 (10.7%)	–
Junior	29 (23.4%)	8 (28.6%)	7 (25.0%)
Senior	29 (23.4%)	8 (28.6%)	7 (25.0%)
Other	2 (1.6%)	1 (3.6%)	1 (3.6%)
Ethnicity			
Caucasian	90 (72.6%)	21 (75.0%)	19 (67.9%)
African American	18 (14.5%)	3 (10.7%)	5 (17.9%)
American Indian/Alaska Native	2 (1.6%)	1 (3.6%)	1 (3.6%)
Asian	7 (5.6%)	2 (7.1%)	1 (3.6%)
Other	7 (5.6%)	1 (3.6%)	2 (7.1%)
DASS depression total	7.5 (S.D.=7.1)	9.6 (S.D.=7.2)	5.4 (S.D.=6.1)
DASS anxiety total	6.8 (S.D.=6.1)	12.3 (S.D.=7.3)	5.3 (S.D.=5.1)
DASS stress total	11.7 (S.D.=7.0)	15.8 (S.D.=7.2)	11.1 (S.D.=7.7)[*]
PI-WSUR total	20.3 (S.D.=17.3)	37.8 (S.D.=24.4)	9.4 (S.D.=5.5)[***]
MGH total	1.1 (S.D.=3.9)	4.4 (S.D.=7.1)	0 (S.D.=0)[**]
SPS total	2.9 (S.D.=4.7)	9.1 (S.D.=6.1)	0.2 (S.D.=0.7)[***]
Cog. flex. composite total	7.1 (S.D.=8.6)	7.8 (S.D.=8.1)	4.8 (S.D.=7.0)
# Errors block 6	0.52 (S.D.=0.7)	0.68 (S.D.=0.8)	0.46 (S.D.=0.5)
# Errors block 8	6.6 (8.5)	7.1 (S.D.=8.3)	4.4 (S.D.=7.0)

Note. P values for group differences.

  * $P < 0.05$.
  ** $P < 0.01$.
  *** $P < 0.001$.

2.2.5. Intradimensional/Extradimensional Shift (IDED) Test (Sahakian and Owens, 1992)

The IDED is a computerized analog of the Wisconsin Card Sorting test and is a test of cognitive flexibility. In this task, the examinee is presented with two images. Each image contains a color-filled shape and white lines. The examinee chooses one of the images and receives feedback as to whether they were correct or incorrect, based on an unknown rule. The examinee is then presented with two new images, required to choose the correct image based on the feedback received in the previous trial, and again receives feedback as to their correctness. The examinee is considered to have established the rule after 6 consecutive correct responses. The number of trials required for the test-taker to reach 6 consecutive responses is considered one block. The rule then changes without the test taker's knowledge, requiring them to mentally "switch" to the novel rule and respond according to feedback. At block 6, the intradimensional set shift occurs. In blocks 1–6, the rule is based on the pink, color-filled shape. Which pink shape is correct varies throughout the different blocks, but it is always based on the shape dimension. At block 6 a novel set of shapes is presented and the examinee must apply the previous rule of shape to the novel shapes. Block 8 constitutes the extradimensional shift stage. At block 8, the examinee again is presented with novel shapes and lines, however, unlike in previous blocks, the rule depends on the line dimension rather than the shape dimension. Examinees are required to switch from the shape dimension rule they previously adhered to in the previous blocks, and apply a new line dimension rule. A final test block appears after block 8 to test acquisition of the new line dimension rule. In this block, examinees are rewarded for choosing the pattern with the line that was previously incorrect in the preceding block.

2.3. Procedure

Students elected to participate in the study by reading information posted on the Kent State University SONA Experiment Management System website and selecting a timeslot for participation. Upon arrival to the laboratory, participants were consented and asked to first complete a demographic questionnaire and several self-report questionnaires. The demographic questionnaire was used to obtain information in relation to age, race, psychological and medical history, and other historical information as well as including items in relation to number of times per week students reported biting their nails, picking their skin, and pulling out their hair (for non-cosmetic reasons). Participants were then instructed to complete a variety of self-report questionnaires, including the DASS, PI-WSUR, MGH-HS, and SPS, respectively. The latter three measures were chosen due to their reliable and valid assessment of disorders characterized by OCBs (see Section 2.2) as well as their use in prior research within young adult populations. Following completion of self-report questionnaires, participants completed several neurocognitive tasks from the Cambridge Neuropsychological Test Automated Battery

(CANTAB), including the IDED task, on a tablet computer. As part of a broader study, five additional CANTAB tasks were administered. However, because these tasks did not measure cognitive flexibility, they were not included in the current analyses.

3. Data analysis

3.1. Primary aim

To examine this study's primary aim—whether cognitive flexibility deficits exist among college students exhibiting OCBs—non-parametric (Mann–Whitney) tests were performed. The dependent variable was a cognitive flexibility score. This variable consisted of the sum of the number of errors to reach criterion at blocks 6 and 8 (assessing intradimensional and extredimensional set shifting, respectively). The grouping variable consisted of participants in the control group or OCB group. Informed, in part, by methods used to determine group membership in previous research examining neurocognitive functioning in subclinical OCD in a college student sample (Mataix-Cols et al., 1999), criteria for membership in the OCB group were a score of 1.0 or greater on a composite OCB severity measure created for the purposes of this study. This composite score was created via the summation of standardized scores—obtained from the larger sample of 124 participants—on the MGH-HS, SPS, and PI-WSUR. Creation of the OCB group was based upon theoretical rationale (i.e., overlapping neurobiology) highlighted in prior research with correlations amongst the measures ranging from weak ($r=0.15$, $p=0.09$ [MGH-SPS]) to moderate ($r=0.31$, $p < 0.001$ [PIWSUR-MGH]). Creation of the composite variable resulted in a sample of 28 young adults constituting the OCB group. Twenty-eight controls were randomly selected from the remaining participants exhibiting composite OCB severity scores less than −1.0. Independent samples t-test analyses revealed statistically significant differences between groups on OCB measures (see Table 1). Prior to conducting the analysis, potential covariates [i.e., age ($r= -0.10$, $p=0.46$), gender ($r= -0.06$, $p=0.67$), and medication status ($r= -0.09$, $p=0.51$)] were examined and revealed no need to control for confounding influences

on cognitive flexibility. In addition, an intelligence proxy variable was calculated—by coding for demographic variables including gender, education level, race, occupation, age, and geographic region of residence (Barona et al., 1984)—and examined as a potential covariate, but was not found to be correlated with cognitive flexibility. Subsequently, assumptions related to *t*-test analyses were examined and revealed that assumptions relating to normality were not met. As such, non-parametric tests (Mann–Whitney *U* test) were employed.

3.2. Secondary aim

Prior to conducting analyses related to our secondary aim, existing literature was examined to determine potential variables that may be related to OCB severity and therefore represent plausible variables to control for in our regression analyses. Correlation analyses were performed for potential covariates of age, gender, medication status, depression, anxiety, and stress (Basso et al., 2001; Moritz et al., 2001; Lawrence et al., 2006; Chamberlain et al., 2007a; Britton et al., 2010; Snorrason et al., 2010; Masi et al., 2013). An alpha correction ($p=0.017$) was performed to account for the large number of potential predictor variables ($n=6$). Based upon these analyses, only anxiety ($r=0.52$, $p < 0.001$; assessed using the DASS Anxiety subscale score) and stress ($r=0.36$, $p=0.007$; assessed using the DASS Stress subscale scale score) demonstrated statistically significant relationships to OCB severity. To examine the potential cumulative load effect of cognitive flexibility deficits, cognitive flexibility was utilized as a predictor of OCB symptom severity in a hierarchical regression analysis within the 56-participant sample described previously. The anxiety and stress variables were entered into step 1 and the cognitive flexibility variable (described above) was entered in block 2. The outcome variable was the composite OCB severity variable (described above). Before examining our final regression model, assumptions related to the conduct of regression were examined; all assumptions were met.

4. Results

4.1. Independent samples T-test

Results showed a significant difference in cognitive flexibility between the control and OCB groups, Mann–Whitney $U=243.5$ ($z=-2.5$), p=0.014. Analyses indicated that participants in the OCB group made more errors on the cognitive flexibility task ($M=7.8$, S.D.$=8.1$) versus participants in the control group ($M=4.8$, S.D.$=7.0$) and suggests a small to medium-sized effect (Cohen's $d=0.43$). Follow-up analyses revealed no statistically significant differences between groups with respect to Intradimensional set shifting (Block 6; $p=0.380$) but did reveal a trend towards a statistically significant difference on Extradimensional set shifting (Block 8; Mann–Whitney $U=686.5$, $p=0.063$). More specifically, participants in the OCB group exhibited more errors on Block 8 ($M=7.1$, S.D.$=8.3$) than controls ($M=4.4$, S.D.$=7.0$) and yielding a small to moderate effect size (Cohen's $d=0.41$).

4.2. Hierarchical regression

Results showed that a final regression model explained 26.3% of the variability in OCB severity (Adjusted $R^2=24.5\%$; see Table 2). Anxiety was a statistically significant predictor of OCB severity ($\beta=0.49$, $p < 0.001$). Stress was not ($p=0.239$) and was therefore removed from the final regression model. The addition of the cognitive flexibility variable (i.e., blocks 6 and 8; $\beta=0.07$, $p=0.37$) did not significantly improve model fit. These findings suggest that diminished cognitive flexibility is not predictive of greater OCB severity.

Table 2
Hierarchical multiple regression of obsessive-compulsive behaviors (OCBs) predicted by anxiety and cognitive flexibility deficits ($N=56$).

	B	SEB	β	R^2	ΔR^2
Step 1				0.249***	
Anxiety	0.17	0.03*	0.49		
Step 2				0.254***	0.01**
CF	0.02	0.02	0.07		

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

5. Discussion

Consistent with the purpose of the RDoC initiative—to classify psychological disorders on the basis of shared biomarkers and neurological correlates amongst clusters of disorders—the current study sought to examine the possibility that cognitive flexibility represents one such construct underlying several disorders characterized by OCBs. Analyses indicated that young adults with symptoms of OCBs—specifically OCD-like behaviors, skin picking, and hair pulling—present with significantly greater cognitive flexibility deficits compared to controls. Despite these group differences, results indicated that greater deficits in cognitive flexibility did not predict greater OCB severity. These findings represent a significant addition to extant literature by highlighting the importance of cognitive flexibility differentiating those who do and do not exhibit OCBs yet may be insufficient to predict the severity of OCBs in young adults.

Findings from the current study elucidate several important implications for understanding OCBs in young adults. First, young adults exhibiting OCBs appear to perform significantly worse on a computerized task of cognitive flexibility compared to those who exhibit these behaviors to a significantly lesser extent and supports prior work examining cognitive flexibility within discrete disorders such as OCD, TTM, SP, and others (Deckersbach et al., 2000; Kuelz et al., 2004; Odlaug et al., 2012). These results, in conjunction with prior work, support the importance of cognitive flexibility for understanding the pathophysiology of OCBs at both a clinical and subclinical level. Further, the present study's findings implicate extradimensional, rather than intradimensional, set shifting, as the facet to cognitive flexibility that most differentiates young adults with OCBs from controls. As such, interventions developed and designed to target specific cognitive deficits found amongst this population may seek to target extradimensional set shifting specifically. While intriguing, the findings also point to the importance of continued research utilizing larger, clinical samples—both via transdiagnostic and discrete disorders approaches—and multiple assessment formats (i.e., computerized, paper-pencil, disorder/cluster –specific and ecologically valid paradigms). What is more, the present study's findings in regards to the relationship between cognitive flexibility and OCB severity suggest that multiple areas of cognitive functioning must be examined to better understanding the pathogenesis of OCBs.

Cognitive flexibility did not predict OCB symptom severity. Taken within the context of our group-based results, these findings suggest that cognitive flexibility alone may be insufficient in explaining why some people exhibit more severe OCBs. Thus, while cognitive flexibility may be one important factor in understanding the development of OCBs, it may be of less importance for understanding the (de)escalation of OCBs symptoms. It is likely that multiple neurocognitive, as well as psychosocial, risk factors function together to lead to the development and maintenance of OCBs symptoms. Therefore, additional research examining the relationship between cognitive flexibility, other neurocognitive domains

(i.e., memory, attention, inhibitory control, etc.), as well as psychosocial/environmental (i.e., family functioning, stress, etc.) risk factors, within both clinical and nonclinical population is warranted.

Despite the noteworthy findings described previously, several limitations to the present study should be noted. One such limitation is the utilization of self-reports as measures of OCBs. Participants were required to estimate how many times per week they perform certain behaviors, which could be difficult for participants to remember. While a noteworthy limitation, this form of self-report has been used in prior research and is an efficient, reliable, and valid way to measure OCBs in a large sample. Future research, however, may consider the use of clinician-administered measures to facilitate more accurate estimations of the frequency and severity of OCB performance. To our knowledge as well, no single measure exists designed to reliably and validly assess OCBs in a transdiagnostic fashion among adults as exists for working in pediatric populations (i.e., Child Behavior Checklist-Obsessive Compulsive Scale; Hudziak et al., 2006; Storch et al., 2006). As such, the utilization of separate measures for separate symptoms was necessary. Second, the use of convenience sampling from a college student population resulted in a relatively homogenous sample (i.e., mainly female, Caucasian college students in their freshman year) that could decrease the generalizability of findings. This limitation is common in studies utilizing college student populations, however (Peterson, 2001), and highlights the need for replication in clinical populations.

Despite the inability of cognitive flexibility to predict OCB severity, cognitive flexibility was found to significantly differentiate those who do and do not engage in OCBs. This finding represents an important contribution to the RDoC initiative to identify biomarkers and neurocognitive correlates underlying clusters of disorders and provides support for past research examining etiological factors implicated in disorders characterized by OCBs. An additional benefit of the current study is the utilization of a standardized assessment method, which facilitates comparison across repetitive behavior disorders and decreases the opportunity for experimenter error and bias. Future research should endeavor to examine this relationship in a larger, clinical sample by utilizing similar standardized assessment techniques. Though cognitive flexibility is an important factor in understanding OCBs, it is likely one of many neurocognitive correlates influencing this phenotype across disorders. Cognitive flexibility, as well as other neurocognitive correlates (e.g., impulse control) should continue to be examined in future research. Knowledge of the neurocognitive correlates underlying OCBs will facilitate a better understanding of factors related to the phenotypic presentations of OCBs and will inform how to best treat these behaviors in the future.

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