An Examination of Executive Functioning in Young Adults Exhibiting Body-Focused Repetitive Behaviors

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Abstract: Body-focused repetitive behaviors (BFRBs), including hair pulling, nail biting, and skin picking are repetitive, habitual, and compulsive in nature. Although characteristic of disorders such as trichotillomania and skin picking disorder, BFRBs are associated with other psychiatric conditions as well. To date, research has failed to examine neurocognitive risk factors, particularly executive functioning, implicated in BFRBs utilizing a transdiagnostic approach. The present study recruited 53 participants (n = 27 demonstrating BFRBs and n = 26 randomly selected controls) from a larger sample of young adults. Participants completed an automated neurocognitive test battery including tasks of cognitive flexibility, working memory, and planning and organization. Results revealed that participants in the BFRB group demonstrated significantly poorer cognitive flexibility (d = 0.63) than controls. No differences were noted in other neurocognitive domains. However, planning and organization demonstrated a significant relationship with various BFRB severity measures. Implications, limitations, and avenues for further research are discussed.

Key Words: Body-focused repetitive behaviors, executive functioning, nail biting, skin picking, hair pulling

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Body-focused repetitive behaviors (BFRBs), including hair pulling, nail biting, and skin picking, represent a cluster of highly comorbid maladaptive repetitive behaviors not preceded by obsessive thoughts (Stein et al., 2008; 2010). Although most characteristic of disorders such as trichotillomania (TTM) and skin picking disorder, BFRBs are also associated with body-dysmorphic disorder, autism spectrum disorders, and stereotypic movement disorders. Due to their high prevalence rates (Teng et al., 2002), proposed biological overlap (Bienvenu et al., 2009; Novak et al., 2009), and significant risk for impairment, research focused on the identification of factors responsible for the development and maintenance of BFRBs is essential.

What research is available in relation to cognitive functioning in BFRBs has focused largely on TTM. Given the hypothesized biological overlap among these disorders (see Bienvenu et al., 2009), this line of inquiry may be relevant for understanding the pathogenesis of other BFRBs. These studies have found evidence for impaired performance on tasks of nonverbal memory, executive functioning, spatial processing, and divided attention (Keuthen et al., 1996; Rettew et al., 1991) with poorer performance correlated with worsened symptom severity (executive functioning; Keuthen et al., 1996). More recently, a study comparing patients who met diagnostic criteria for either TTM or obsessive-compulsive disorder (OCD) with healthy controls found increased perseveration on a task of cognitive flexibility (Bohne et al., 2005). In contrast, other studies in both the TTM (Chamberlain et al., 2006a; Grant et al., 2011) and pathological skin picking (Grant et al., 2011; Odlaug et al., 2010) realms have failed to find cognitive flexibility deficits. Another study examining neurocognitive functioning in comorbidity-free patients with TTM or OCD and healthy controls (Chamberlain et al., 2007) found deficits in spatial working memory in TTM patients, whereas various other cognitive functions (*i.e.*, learning, affective processing, decision-making, impulsivity) were found to be intact, suggesting ambiguity as to the specific domain in which executive functioning deficits exist among adults exhibiting BFRBs.

Despite the prior work briefly reviewed above, research seeking to elucidate the pathophysiology of BFRBs is generally lacking. What research does exist has focused primarily upon individual disorders rather than as a cluster of highly comorbid behaviors. The latter approach to which may yield a more significant impact on the field's understanding of behaviors associated with a variety of psychiatric disorders. The current study seeks to address this gap in the literature by examining executive functioning (*i.e.*, cognitive flexibility, spatial planning, working memory) among young adults exhibiting BFRBs (*e.g.*, nail biting, skin picking, or hair pulling) compared to controls. We hypothesize young adults exhibiting BFRBs will display poorer performance on these tasks. A second, exploratory aim is to examine whether decreased performance on tasks measuring executive functioning correlates with BFRB severity. In line with limited prior research (Keuthen et al., 1996), we predict a negative correlation between executive functioning and BFRB severity.

METHODS

Participants

Participants described herein were recruited as part of a larger study examining neurocognitive functioning in young adults and was approved by the Kent State University (KSU) Institutional Review Board. In total, 161 respondents were recruited through undergraduate psychology courses at KSU. Inclusion in the current study required the participant to be 18 years of age and have complete data on all outcome and key demographic variables. In total, 56 participants were selected for analyses, including 28 individuals demonstrating BFRBs (*i.e.*, skin picking, nail biting, hair pulling) and 28 randomly selected healthy controls (see *Data Analytic Plan* for a detailed description regarding the ascertainment of these subgroups). These sample sizes were subsequently reduced further—27 and 26, respectively—upon identification of 3 participants currently taking medications for use in the treatment of seizures which, in turn, may have skewed results. Participant demographics are presented in Table 1.

Measures

Repetitive behaviors were assessed using the Massachusetts General Hospital Hair Pulling Scale (MGH; Keuthen et al., 1995), Skin Picking Scale (SPS; Keuthen et al., 2001), and Nail Biting Scale (NBS). The NBS is a 6-item version of the SPS designed for use in the current study. Within the present sample, the NBS demonstrated excellent internal consistency (α = 0.90), suggesting its reliable use for purposes of this study. In addition to behavioral measures, potential symptoms of comorbidity were assessed using the Depression Anxiety and Stress Scale (DASS; Lovibond and Lovibond, 1995). Lastly, participant neurocognitive functioning was measured utilizing the Cambridge Neuropsychological Test Automated Battery (CANTAB, Cambridge Cognition Limited, 2011). Specific tasks within this battery include

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TABLE 1. Demographic Characteristics of the Sample

	Full Sample, n = 161	BFRB Group, n = 27	Healthy Controls, n = 26
Age (y), mean (SD)	20.3 (2.5)	20.7 (2.2)	20.1 (2.6)
Gender, n (%)			
Female	115 (71)	18 (66.7)	17 (65.4)
Male	46 (28.4)	9 (33.3)	9 (34.6)
Ethnicity, n (%)			
White/Caucasian	121 (74.7)	21 (77.8)	18 (69.2)
Black/African-American	22 (13.6)	3 (11.1)	4 (15.4)
Other	18 (11.1)	3 (11.1)	4 (15.4)
Current Medications, n (%)			
Any psychotropic medication	27 (16.7)	7 (25.9)	—
Stimulants	7 (4.3)	2 (7.1)	—
Adderral		1 (50)	—
Vyvanse		1 (50)	—
Other psychotropics/neur. med	22 (13.6)	5 (18.5)	—
Benzodiazepine (*i.e.*, Xanex)		2 (40)	—
Antidepressant (*i.e.*, Wellbutrin)		1 (20)	—
SSRI (*i.e.*, Zoloft)		3 (60)	—
MGH total score	.94 (3.5)	3.9 (7.3)	0.2 (0.8)
Hair pulling frequency (per week)	2.1 (8.5)	9.5 (18.8)	0.1 (0.3)
SPS total score	2.8 (4.47)	7.9 (5.6)	1.2 (2.5)
Skin picking frequency (per week)	11.0 (42.0)	39.2 (95.1)	2.1 (4.2)
NBS total score	3.7 (4.8)	7.9 (5.7)	2.4 (3.2)
Nail biting frequency (per week)	12.1 (26.8)	31.4 (45.0)	5.5 (9.3)
Comorbid Psychiatric Symptoms			
DASS—Depression Score	3.6 (3.5)	4.7 (3.5)	3.8 (3.4)
DASS—Anxiety Score	3.2 (3.0)	5.4 (3.3)	3.1 (3.6)
DASS—Stress Score	5.9 (3.8)	8.0 (3.8)	3.6 (3.6)

Note: After adjusting for number of comparison (n = 3; $p \le 0.016$), analyses comparing BFRB and control groups with respect to comorbid psychiatric symptoms revealed no statistically significant group differences.

the Intra/Extra Dimensional Set Shift (IDED; designed to assess rule acquisition and attentional set shifting), Stockings of Cambridge (SOC; designed to assess spatial planning and motor control), and Spatial Span (SSP; designed to assess working memory capacity and frontal lobe functioning). All measures utilized for purposes of the current study maintain strong psychometric properties.

Procedures

Upon receipt of written consent, participants completed a demographics questionnaire, the MGH, NBS, SPS, and several additional measures of psychiatric symptoms. After completion of self-reports, participants completed a neurocognitive battery. Upon culmination of all study components, subjects were thanked for their time and received course credit.

Data Analytic Plan

Potential covariates were examined including age, depression, anxiety, stress, OCD symptoms, gender, and medication status with none being significantly related ($p \le 0.007$; n = 7 comparisons) to outcomes of interest. The independent variables under examination in the present study consisted of participants in a control or BFRB group. Informed by prior research (Mataix-Cols, 1999), membership in the BFRB group required a score (1) 2 standard deviation above the mean—obtained from the larger sample of 161 participants—on either the NBS, SPS, or MGH and (2) > 95th percentile in relation to self-reported frequency of nail biting, skin picking, or hair pulling (ascertained via the demographics questionnaire; n = 28). Selection of a control group (n = 28) was based upon a random selection—via SPSS—of the remaining 133 participants. As noted previously, 3 participants (from this sample of 56) were subsequently removed due to their use of epileptic medications. Pearson correlations were examined with respect to the relationship between clinical outcomes (severity) and cognitive functioning within the BFRB group. An alpha-level of 0.05 was used to determine statistical significance.

RESULTS

Intra/Extra-Dimensional Task (IDED)

Participants in the BFRB group exhibited significantly more errors on Blocks 6 and 8 (Table 2) combined ($M = 10.0$, $SD = 10.1$) than the control group ($M = 5.0$, $SD = 5.7$; $p = 0.031$). Follow-up analyses revealed statistically significant differences between group with respect to Block 8 (Extradimensional Shift), $t(40.84) = -2.21$, $p = 0.033$, but not Block 6 (Intradimensional Shift; $p = 0.784$). No statistically significant differences were exhibited between groups with respect to reversal learning ($p = 0.666$). Correlational analyses revealed no statistically significant relationships between BFRB severity and IDED outcomes, although a negative, moderate trend ($r = -0.32$, $p = 0.13$) was noted with respect to the relationship between NBS scores and reversal learning (Table 3).

TABLE 2. Differences in Executive Functioning Between BFRB and Control Groups

Outcome	BFRB Group (n = 27)	Control Group (n = 26)	Effect Size (d)
Intra/Extra-Dimensional (IED)			
Rev. learning (errors blocks 7+9)	3.6 (6.4)	4.3 (6.3)	−0.11
Cog. flexibility (errors blocks 6+8)	10.0 (10.1)*	5.0 (5.7)	0.61
Spatial Span Length	7.1 (1.1)	7.3 (1.3)	−0.17
Stockings of Cambridge (SOC)			
Mean Initial Think Time 2 Moves	1318.4 ms (1038.4)	1300.3 ms (726.1)	0.02
Mean Initial Think Time 3 Moves	3863.7 ms (3369.5)	3869.8 ms (2834.1)	0.00
Mean Initial Think Time 4 Moves	4648.0 ms (3359.8)	5818.5 ms (4690.2)	−0.29
Mean Initial Think Time 5 Moves	6253.0 ms (4564.9)	6218.6 ms (4289.9)	0.01
Mean Subsequent Think Time 2 Moves	20.8 ms (79.3)	79.3 ms (228.8)	−0.34
Mean Subsequent Think Time 3 Moves	566.2 ms (1827.6)	147.2 ms (511.1)	0.31
Mean Subsequent Think Time 4 Moves	714.4 ms (1095.6)	747.6 ms (1085.1)	−0.03
Mean Subsequent Think Time 5 Moves	440.6 ms (599.3)	476.3 ms (586.7)	−0.06

*$p < 0.05$.

TABLE 3. Pearson Correlations Examining the Relationship Between Executive Functioning and Body-Focused Repetitive Behavior Outcomes

Outcome Measures	NBS	MGH	SPS	Nail Biting Frequency	Hair Pulling Frequency	Skin Picking Frequency
Rev. Learning	**−0.32[a]**	−0.13	0.09	−0.20	−0.02	0.09
Cognitive Flexibility	−0.30	0.14	0.02	0.11	0.19	−013
Spatial Span Length	0.04	0.13	0.15	−0.29	0.03	−0.03
MITT-2 Moves (SOC)	−0.17	−0.22	0.26	0.12	−0.19	−0.24
MITT-3 Moves (SOC)	−0.13	−0.29	0.28	0.14	0.28	−0.12
MITT-4 Moves (SOC)	−0.14	**−0.36[a]**	0.26	0.18	**−0.36[a]**	−0.02
MITT-5 Moves (SOC)	−0.27	0.12	−0.02	0.02	0.05	−0.17
MSTT-2 Moves (SOC)	−0.13	**0.56****	**−0.32[a]**	−0.10	**0.43***	−0.10
MSTT-3 Moves (SOC)	−0.17	−0.19	**0.36[a]**	−0.10	−0.18	0.03
MSTT-4 Moves (SOC)	**−0.30[a]**	−0.20	−0.01	0.08	−0.14	0.08
MSTT-5 Moves (SOC)	**−0.38[a]**	−0.11	0.05	−0.04	−0.10	−0.07

[a]Demonstrating a trend toward significance $p \leq 0.15$.

*$p < 0.05$.

**$p < 0.01$.

Note: MITT indicates Mean Initial Think Time; MSTT, Mean Subsequent Think Time; Sample size, 25.

Spatial Span (SSP)

No statistically significant differences between groups were demonstrated with respect to the SSP task ($p = 0.634$). No statistically significant relationship between spatial span length and BFRB outcomes were demonstrated within the BFRB group.

Stockings of Cambridge (SOC)

Results revealed no statistically significant differences between groups with respect to Mean Initial or Subsequent Think Time 2 Moves ($p = 0.942$ and 0.272, respectively), Mean Initial or Subsequent Think Time 3 Moves ($p = 0.994$ and 0.265, respectively), Mean Initial or Subsequent Think Time 4 Moves ($p = 0.300$ and 0.912, respectively), and Mean Initial or Subsequent Think Time 5 Moves ($p = 0.974$ and 0.828, respectively).

Pearson correlation (Table 3) revealed a trend toward a relationship between both frequency and self-reported severity of hair pulling and Mean Initial Think Time 4 Moves ($r = 0.37$, $p = 0.072$ and $r = 0.36$, $p = 0.077$, respectively) as well as a moderate to strong and strong relationship between with Mean Subsequent Think Time 2 Moves and frequency and self-reported severity of hair pulling ($r = 0.43$, $p = 0.033$ and $r = 0.57$, $p = 0.003$, respectively). Pearson correlations also revealed a moderate to strong relationship between self-reported nail biting severity and Mean Subsequent Think Time 5 Moves ($r = -0.45$, $p = 0.033$). Although not reaching statistical significance, several moderately strong relationships were also noted between frequency and self-reported severity of skin picking (as well as nail biting and hair pulling) and various SOC outcomes including Problems Solved in Minimum Moves ($r = 0.33$, $p = 0.117$), Mean Subsequent Think Time 2 Moves ($r = -0.30$, $p = 0.144$), and Mean Subsequent Think Time 4 Moves ($r = 0.31$, $p = 0.127$).

DISCUSSION

The present study is the first of its kind to focus on nail biting, hair pulling, and skin picking as an interrelated cluster of BFRBs—a transdiagnostic approach grounded in prior research supporting the purported biological overlap among these behaviors (*e.g.*, Bienvenu et al., 2009; Roberts et al., 2013)—as it pertains to cognitive functioning within this group. Current results support the existence of deficits in executive functioning (*e.g.*, reversal learning) among young adults exhibiting BFRBs and suggest important implications for the field's understanding regarding the pathogenesis of BFRBs.

Analysis of the IDED provide partial support for the study's hypotheses. This large effect (d = 0.63) supports prior research (Chamberlain et al., 2006b) among clinical samples of adults with TTM and PSP and offers a novel extension to BFRBs, broadly defined. With respect to findings in relation to the SOC and SSP, only 1 prior study has examined planning and organization (*i.e.*, SOC), finding no difference between patients with TTM and controls (*e.g.*, Keuthen et al., 1996). The results herein replicate this prior work through the use of an automated battery, suggesting that neither planning and organization nor working memory differentiates persons who exhibit BFRBs from those who do not. With that said, findings in relation to subsequent correlational analyses suggest further inquiry is warranted.

Correlational analyses generally revealed poorer performance on the SOC (*i.e.*, diminished ability to plan and organize) associated with worsened self-report of BFRBs. These results complicate the interpretation of our group-based null findings. Planning and organization may thus be important for understanding the (de)escalting frequency and severity of BFRBs (*i.e.*, from typical to impairing) but not for differentiating those who do or do not exhibit such behaviors, although several moderate, nonsignificant effects were noted (*i.e.*, Mean Initial Think Time 4 Moves and Mean Subsequent Think Time 2 and 3 Moves) and warrant further inquiry within a larger clinical sample. Further research across (*e.g.*, nail biting *vs.* sking picking) and within (*e.g.*, BFRBs *vs.* controls) these clusters of behaviors is needed to explore these hypotheses further. Yet these results highlight the importance of the present study's findings for informing and refining key areas (*i.e.*, reversal learning, planning, and organization) of cognitive functions that may be most fruitful in future larger-scale investigations.

Limitations must be considered. The symptoms assessed via self-report may not be analogous to clinically severe behaviors. Future research may seek to replicate this study's methodology employing a clinical sample of adults exhibiting BFRBs, perhaps employing more rigorous self-monitoring (*i.e.*, golf counters, daily diaries, etc.) approaches. In addition, the use of a convenience sample, university students, suggests the value of subsequent research recruiting more diverse samples. With a greater push for transdiagnostic research, the present study represents an important step in understanding BFRBs and fits well alongside the current course of science. Reversal learning, in the present study, represents at least 1 domain differentiating those with marked BFRBs yet planning and organization may play a role in understanding the frequency and severity of these behaviors. The novelty of this investigation and the questions that remain further emphasize the need for more research of the like in terms of neurocognitive explanations for BFRBs to aid the field in developing a better understanding of BFRBs and related repetitive behaviors (*e.g.*, obsessions, compulsions, etc.), their underlying pathophysiology, and improved treatments.

DISCLOSURES

The authors declare no conflict of interest.

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