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ORIGINAL ARTICLE

Inhibitory Control in Pediatric Trichotillomania (Hair Pulling Disorder): The Importance of Controlling for Age and Symptoms of Inattention and Hyperactivity

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Abstract Trichotillomania (hair pulling disorder, HPD) is characterized by significant psychological distress, childhood-onset, and, in adults, certain cognitive deficits such as inhibitory control. A total absence of such literature exists within pediatric HPD samples, including research investigating neurocognitive aspects of disparate pulling-styles. The present study aims to address these gaps in the literature. Youth with HPD and healthy controls ($N = 45$) were compared on an automated neurocognitive task—stop-signal task (SST)—assessing inhibitory control. Youth with HPD ($n = 17$), controlling for age and attention issues, were found to perform better on the stop-signal reaction time compared to controls ($n = 28$). No significant relationships between performance on the SST and HPD severity, distress/impairment, or pulling-styles were noted. Findings from the current study suggest that children with HPD may not exhibit deficits in motor inhibition as compared to controls when the effects of age and attentional problems are controlled.

Keywords Trichotillomania · Hair pulling disorder · Impulsivity · Motor inhibition · Children

Introduction

Trichotillomania, or hair pulling disorder (HPD), involves the chronic and excessive pulling out of one's hair. Individuals suffering from symptoms of HPD typically experience significant dysfunction that manifests across numerous domains such as medical (e.g., trichobezoars, scarring), psychological (e.g., emotional distress), social (e.g., embarrassment), economic (e.g., work disruption), and cognitive (e.g. impulsivity) [1, 2]. These difficulties may be particularly impactful during the sensitive developmental years of youth. Lifetime prevalence estimates range from 1 to 3 % in the United States [3], though it is likely that the prevalence of this disorder is considerably higher [4]. A strong female predominance has been found in clinical adult samples (e.g., Cohen et al. [5]; Christenson and Crow [6]) though this disparity may be less pronounced among children. While the typical age of onset is during childhood (11–13 years) [5, 7, 8], HPD may persist throughout the lifetime, often due to inadequate or lack of treatment [5, 9].

Previously categorized in the Diagnostic Statistical Manual IV as a disorder of impulse control [10], HPD has also been conceptualized as a grooming behavior or a body-focused repetitive behavior (BFRB) along with nail biting and skin picking, behaviors which can manifest from normative to pathological [11, 12]. With the recent publication of the fifth edition of the DSM [13], however, HPD has been grouped within the Obsessive Compulsive and Related Disorders (OCRDs) alongside disorders such as obsessive compulsive disorder (OCD), hoarding disorder (HD), pathological skin picking (PSP), and body dysmorphic disorder (BDD). This unstable classification of HPD helps to highlight the many questions that exist regarding the disorder's underlying pathophysiology and phenomenology—the former of which we begin to address in the current exploratory study.

Brief Neurobiology and Motor Inhibition

Within OCRDs, researchers have frequently postulated the existence of an impulsivity–compulsivity spectrum, with

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compulsivity characterized by such features as harm avoidance and low sensation seeking [14, 15] and impulsivity involving high sensation seeking with a lack of behavioral inhibition [16]. Though facets to HPD may be characterized as compulsive in nature [17], the disorder is most commonly viewed as falling on the impulsivity end of this spectrum [18–20]. Considering the link between impulsivity (and compulsivity) and disorders related to HPD, a more comprehensive developmental approach to the underlying pathophysiology of HPD may lead to a better understanding of psychomotor and neurocognitive aspects of the disorder. Ultimately, such investigations may inform better prophylactic and therapeutic interventions. To date, however, the neurobiological and neurocognitive risk factors for HPD have received only scant attention, particularly among pediatric populations. As such, the aim of the present investigation is to more thoroughly examine cognitive correlates of impulsivity within youths exhibiting HPD—an area that has received no empirical attention up to this point.

Available literature examining both adults and children with OCRDs like HPD suggests the behaviors characteristic of these disorders are largely driven by malfunction in the cortico-basal ganglia circuitry [15, 21–25]. With respect to HPD, deficits in motor inhibition, or the propensity to suppress pre-potent motor responses, have been theorized to be central to neurocognitive functioning in this phenotype [26]. Such theories draw a link between the involvement of numerous cortical regions of the brain in HPD and in the suppression of motor reactions [27–31] with evidence for deficits in motor inhibition exhibited in several studies of adults with HPD [32–35]. Despite this, an absence of such work exists more proximal to the disorder's typical onset—childhood.

Interestingly, Odlaug et al. [35] found evidence of greater HPD severity and motoric impairment in adults with late-onset HPD. More specifically, Odlaug et al. found that, compared to healthy controls, participants reporting child-onset HPD failed to demonstrate deficits in relation to motor inhibition, while those with adult-onset did, in fact, demonstrate significantly impaired motor performance. Conversely, Bohne et al. [33], utilizing a GoNoGo task, suggested the presence of diminished motor inhibition abilities in individuals with early-onset HPD. Despite incongruent findings from these two studies, both investigations suggest that some aspects of neurocognitive deficits in HPD may be dependent upon the interaction of development and the onset of symptoms. While the existing literature on HPD in adults is helpful in better understanding the disorder, the only information available regarding neurocognitive deficits during childhood has been provided via retrospective accounts. This reliance on recall of the time of onset and corresponding cognitive outcomes poses a significant gap in the literature. Most notably, no study has examined cognitive functioning among youths with HPD. Due to this, and considering the likely prevalence of HPD symptoms in youth and the common persistence of hair pulling into adulthood, it is important to focus resources on a more developmentally driven awareness of the disorder's pathogenesis. The present study seeks to address this gap in the literature via investigating cognitive functioning in pediatric HPD, a heretofore unexamined topic of investigation.

Pulling Styles

A similarly unattended to area within the field of HPD research has been the unique and/or shared pathophysiology underlying disparate pulling styles in HPD—automatic and focused pulling—evidenced in adults and youth with this disorder [36–39]. Automatic pulling is characterized by pulling outside of one's awareness (e.g., while watching television, reading a book, etc.), while focused pulling is most frequently operationalized as pulling that serves more of an emotion regulation function (i.e., reduce a negative emotional state, achieve some degree of pleasure or gratification, etc.) [17, 36–38]. It is rare, however, that any one person engages in only "automatic" or "focused" pulling [36]. Based upon this prior research and operational definitions of these pulling styles constructs, it is plausible that aspects of impulsivity may differ among patients exhibiting varying degrees of these styles of pulling. For example, increasingly focused pulling may be more strongly associated with greater impulsivity as this style of pulling is more characterized by an awareness of and an inability to restrain oneself from pulling. This would thereby imply that increasingly focused pulling may be associated with increasingly impaired performance on tasks of motor inhibition. This may, in turn, suggest differences in brain structure or functional pathways—as compared to engagement in increasingly automatic pulling. These possibilities have yet to be studied but may greatly inform the field's understanding of how these disparate pulling styles develop, as well as inform treatment development.

Hypothesis and Aims

With the influence of the National Institute of Mental Health (NIMH) Research Domain Criteria (RDoC) [40, 41] in mind, it is particularly crucial to focus on the neurological underpinnings (i.e., performance on tasks of motoric inhibition) of pediatric HPD as inquiries of this nature are likely to inform subsequent, transdiagnostic research examining the development of repetitive behaviors in children. As previous research has indicated deficits in

motor inhibition in adults with HPD [32–35], this exploratory study aims to better characterize impulsivity—and more specifically motor inhibition—in children presenting with the disorder. We hypothesize that, after controlling for potentially confounding variables, children with HPD will exhibit poorer performance on an automated neurocognitive test of motor inhibition (i.e., Stop Signal Task, SST) than healthy controls. Additionally, and as an exploratory aim, we hypothesize that increasingly focused pulling will be associated with poorer performance on this same measure.

Methods

Participants

This study was approved by the Kent State University Institutional Review Board. Participants were recruited throughout Northeast Ohio via newspaper advertisements, poster fliers, and letters to mental and medical health professionals and schools as part of a larger ongoing study examining biological and psychosocial risk factors for pediatric anxiety and related problems. For the purposes of the current study, participants were included in all subsequent analyses if the child (1) was between 9 and 17 years of age, (2) met DSM 5 diagnostic criteria for HPD or failed to meet diagnostic or subclinical criteria for any psychiatric diagnosis (controls), (3) reported English as their primary language, (4) did not meet diagnostic criteria for major depressive disorder, psychotic disorders, or an autism spectrum disorder, (5) was not currently taking stimulant medication, and (6) completed all study measures (described below). For these analyses, a total of 17 children met DSM 5 criteria for a diagnosis of HPD (15 met for primary HPD, 2 secondary HPD to a primary anxiety disorder diagnosis) while 28 were considered to be healthy controls—as assessed via structured and semi-structured interview. No biological siblings were included in these analyses. Demographic characteristics are presented in Table 1.

Measures

Kiddie-Schedule for Affective Disorders and Schizophrenia—Present and Lifetime Version (K-SADS-PL) [42] is a structured interview designed to be administered to children with or without input from their parents. Thirty-four parent–child dyads were assessed using the K-SADS-PL in the current study. The interview possesses excellent inter-rater reliability and good concurrent validity [43].

Anxiety Disorders Interview Schedule for DSM-IV: Child Version (ADIS-C) [44] is a structured interview of pediatric psychopathology administered, for purposes of this study, jointly to the child and at least one parent. Prior research has documented excellent reliability and validity for the measure [45–47]. A smaller portion of participants ($n = 16$) in this study was assessed using the ADIS-C rather than the K-SADS-PL, reflecting a minor change in study design.

Trichotillomania Diagnostic Interview (TDI) [2] is a semi-structured interview designed to assess symptoms related to HPD and has been used extensively as a diagnostic measure of HPD in research focusing on children and adults with the disorder (e.g., Diefenbach et al. [48]). At the commencement of this study, proposed changes to the diagnostic criteria for HPD had not yet taken place (i.e., removal of tension reduction and pleasure, gratification, or relief criterion for HPD). While DSM 5 diagnostic criteria were used for entrance into the study described herein, all participants included in the present analyses would have also met DSM-IV-TR diagnostic criteria.

Trichotillomania Scale for Children—Child Version (TSC-C) [49, 50] is a 12-item self-report measure of pediatric HPD. The measure consists of two components, including "severity" and "distress/impairment." Prior research has documented this scale's strong internal consistency, test–retest reliability, and concurrent validity with other measures of HPD severity [49]. Chronbach's alpha for the current study was high ($\alpha = 0.99$).

Milwaukee Inventory for Styles of Trichotillomania—Child Version (MIST-C) [38] is a 25-item self-report measure designed to assess two disparate styles of pulling: automatic and focused pulling scales. Each item is rated on a scale from 0 to 9. Higher scores indicate increasingly focused or automatic pulling. Both the focused ($\alpha = 0.90$) and automatic ($\alpha = 0.83$) scales have demonstrated strong psychometric properties in prior research. Chronbach's alpha was high ($\alpha = 0.99$) for the current study, suggesting excellent internal consistency.

Child Behavior Check List (CBCL) [51] assesses aspects of social skills, school functioning, and emotional and behavioral problems per parental report. The 112-item measure results in internalizing, externalizing, and total scores, as well as sub-scale scores. The CBCL has been demonstrated to be reliable and valid for use in children and adolescents by a strong body of research [52–54]. For the purpose of this study, the attention subscale score was utilized as a measure of ADHD-related symptoms, and the DSM 5-oriented depression and anxiety subscale scores were utilized as measures of depressive and anxiety symptoms.

Cambridge Automated Neurocognitive Assessment Battery (CANTABeclipse) [55] is a standardized neurological assessment battery designed to reduce test performance variability due to differences in administration. Several

Table 1 Demographic characteristics of the pediatric sample (N = 45)

	HPD (n = 17)	HC (n = 28)
Sex (female)	11 (64.70 %)	13 (46.40 %)
Age (years)	11.29	12.50
Race (Caucasian)	15 (88.20 %)	26 (92.90 %)
Education (grade range)	4th–10th	3rd–11th
Comorbid diagnoses	4 GAD, 2 Social Phobia, 2 ODD, 5 ADHD, 2 Specific Phobia	None
1* Relative with psychiatric illness (self-reported)	71 %	31 %

subtests on the CANTAB were administered to each participant as part of the larger study associated with the current investigation; however, findings from these additional tasks will not be reported in this paper. For the purposes of the current study, the SST was employed as a measure of motor inhibition and was the only measure of inhibitory control utilized as part of the neurocognitive assessment battery subsumed under the larger study.

Stop-Signal Task is a well-validated and sensitive task that focuses on aspects of impulsivity, specifically relating to motor inhibition. Normative data have not been released for SST outcomes in children. Research has, however, found that the CANTAB reliably assesses the same processes in individuals ranging across age and developmental groups (e.g., 4–90 years; Luciana, [56]).

For the SST, participants are asked to observe a series of left- or right-facing arrows appearing individually on a screen, and to provide hurried motor responses depending upon the direction of the arrow. The "stop-signal" (an auditory beep) sounds for a subset of trials, indicating that the subject should try to refrain from (inhibit) completing their response for that arrow. The paradigm automatically adjusts depending on the child's performance, allowing for a likely approximation of successfully inhibited responses over the entire task to be at 50 %. Primary outcome measures include a sensitive estimate of the time taken to stop a pre-potent response (Stop Signal Reaction Time, SSRT), Median Correct Reaction Time for GO Trials (median correct RT), and number of Directional Errors made on STOP and GO trials (direction errors). This task is sensitive to neural circuitry functioning, including the right frontal gyrus and bilateral anterior cingulate cortices [32].

Procedures

Upon contact with a research assistant (RA), interested families were provided with an overview of the methods, procedures, and aims of the study. A brief phone screen was conducted to determine the child's potential eligibility for the study. Prior to arriving, potentially eligible children and one biological parent completed self-report measures sent to their home address, including a demographic questionnaire (i.e., child age, presence/absence of perinatal events at birth, etc.) and several self- and parent-report measures. Following written parental consent and child consent/assent, a clinical psychology graduate student (i.e., CARe Program clinician), trained in the proper administration of the K-SADS-PL and ADIS by the last author (CAF), administered the (semi) structured interview, TDI, and additional semi-structured interviews (as needed; i.e., tic or OCD severity scales) jointly to the parent and child. Finally, all eligible children were asked to complete a neurocognitive test battery from the CANTAB including tasks designed to assess executive functioning, attention, memory, and, germane to the present investigation, a task of motor inhibition (SST).

Data Analytic Plan

Preliminary analyses revealed no significant differences between groups with regard to key demographic characteristics including age, gender, socioeconomic status, and race. Assumptions germane to the analyses conducted were examined and, if necessary, appropriate analytic modifications were performed (e.g., square root of Direction Errors, Median Correct Reaction Time; inverse of CBCL attention T-score). Based upon our own preliminary analyses and informed by prior research, child age, sex, ADHD-related symptoms (i.e., scores on the CBCL attention scale), depressive symptoms (i.e., scores on the CBCL depression scale), anxiety symptoms (i.e., scores on the CBCL anxiety scale), and perinatal events were considered as control variables in specific analyses incorporating SST outcomes. When appropriate, as determined by preliminary correlational analyses, these variable(s) were subsequently included into Step 1 one of our regression model. A priori power analyses were conducted based upon available evidence from literature examining performance of adult HPD patients on the SST. A review of these findings revealed effect sizes ranging from 0.29 to 1.58 (e.g., Chamberlain et al. [32]; Grant et al. [34]; Odlaug et al. [35]) with an average effect size of 0.72, suggesting that a sample size of

31—using hierarchical regression—is requisite for detecting a significant effect, if an effect is indeed present. Therefore, the sample size utilized for purposes of this study ($N = 45$) is sufficient to examine this study's primary aim.

In accordance with prior research [32, 34, 35], three separate hierarchical regression models were explored to examine whether a diagnosis of HPD was predictive of neurocognitive performance on the SST—as measured by the directional errors, median correct RT, and SSRT outcomes. Multivariate statistics were not explored based upon within-cell correlations between the dependent variables of interest [57]. For each regression, appropriate control variables, when applicable and based upon our preliminary analyses (see above) were included in Step 1 and our dummy coded diagnostic variable (0 = healthy control, 1 = HPD) was entered into Step 2. Due to the exploratory nature of the current study, and in accordance with prior related research (e.g., Ornstein et al. [58, 59]) as well as a prior power analyses (see above), an alpha level of 0.05 has been maintained for these analyses.

Further, three groups of correlational analyses were conducted to examine whether performance on the SST was associated with HPD severity and/or impairment/distress, as measured by the TSC-C, for children with HPD. Finally, two sets of correlations were conducted to examine our exploratory aim regarding whether a relationship exists between pulling styles—automatic and focused pulling—and performance on the SST. For each of the above described sets of correlational analyses, partial correlations were used (when appropriate) to account for and remove the influence of potential co-varying factors in a given correlational analysis. When no covariates were deemed appropriate based on preliminary analyses, zero-order Pearson correlations were utilized. Unless otherwise noted and due to the exploratory nature of this study, an alpha level of 0.05 was used to determine statistical significance for all analyses.

Results

Hierarchical Regression Analyses

Mean scores on the primary outcomes of interest, as well as those from other, adult, studies of participants with HPD are presented in Table 2.

A regression analysis was conducted specifically focusing on the Stop Signal Reaction Time on Last Half (SSRT) outcome, one of our primary outcome measures. This analysis indicated that child age ($\beta = -0.41$, $p < .01$) and attention problems ($\beta = -0.18$, $p = .22$) accounted for 24.3 % of the variance in SSRT, $F(2,42) = 6.75$, $p < .01$. Adding diagnostic status in Step 2 of our model ($\beta = -0.35$, $p = .05$) significantly improved model fit, $F(3,41) = 6.21$, $p < .01$, and explained an additional 7 % of the variance, suggesting that child diagnostic status is predictive of better SSRT performance in children with HPD.

A second linear regression analysis was conducted with directional errors as the dependent variable and diagnostic status as the independent variable. The analysis revealed that diagnostic status ($\beta = -0.13$, $p = .41$) did not contribute significantly to the model, $F(1,43) = 0.70$, $p = .41$, and explained 1.6 % of the variation in direction errors. This suggests that child diagnostic status (i.e., HPD) is not predictive of greater or fewer directional errors (see Table 3).

A final hierarchical regression was performed with median correct RT as the dependent variable and age as a covariate. Results showed that child age ($\beta = -0.42$, $p < .01$) explained 17.3 % of the variability associated with participants' median correct RT, $F(1,43) = 9.03$, $p < .01$. Adding diagnostic status ($\beta = -0.03$, $p = .81$) did not explain any additional variance, however, suggesting that child diagnostic status was not predictive of performance on this particular SST outcome, $F(2,42) = 4.44$, $p = .02$.

Correlational Analyses

Next, we examined the relationships between severity, distress/impairment ratings, and total score on the TSC-C and our three measures of decision making and impulse control (see Table 4). Mean scores were as follows for children with HPD (total score, $M = 2.09$ SD = 0.88; severity rating, $M = 1.24$ SD = 0.46; and distress/impairment rating, $M = 0.86$ SD = 0.55). None of the resulting zero-order or partial correlations was statistically significant. Finally, correlational analyses were conducted between pulling styles and our SST outcomes (see Table 4). Mean scores on each pulling scale were as follows for children with HPD (automatic, $M = 15.00$ SD = 6.62; focused, $M = 63.25$ SD = 27.85). No significant zero-order or partial correlations were seen between any SST outcome of interest and either MIST-C outcome.

Discussion

Conclusions

This paper represents the first study to directly analyze neurocognitive functioning in youth with HPD, a debilitating and understudied disorder which often begins

Table 2 Relative variability on SST outcomes for children versus adults with HPD and Healthy Controls

SST outcome	Present study	Adults			
		Chamberlain et al. [32]	Grant et al. [34]	Odlaug et al. [35]	
				Child-onset group	Adult-onset group
HPD group					
Directional errors	4.82 (7.21)	6.80 (9.20)	2.08 (2.98)	–	–
Median correct	496.56 (128.23)	397.20 (36.10)	469.90 (141.20)	464.20 (76.70)	475.20 (172.40)
SSRT	213.47 (67.92)	264.90 (72.20)	171.00 (46.40)	164.50 (36.30)	184.90 (53.90)
Control group					
Directional errors	6.14 (9.29)	2.20 (2.60)	1.33 (1.81)	–	
Median correct	480.94 (204.87)	421.20 (63.70)	492.80 (127.10)	485.50 (127.30)	
SSRT	209.14 (90.56)	167.80 (48.60)	157.50 (47.60)	152.60 (42.90)	

Table 3 Summary of Hierarchical regression analyses for neurocognitive outcome variables (SST)

SST outcome	*B*	*SE (B)*	*β*	R^2	*F*	ΔR^2
Stop signal RT						
Step 1				0.24	6.75	0.24**
Age	−14.60	5.0	−0.41**			
Attention Prob.	−6140.20	4888.65	−0.17			
Step 2				0.31	6.21	0.07*
Age	−15.41	4.84	−0.43**			
Attention Prob.	−13,975.69	6098.66	−0.40*			
Diagnostic status	−58.69	28.95	−0.35*			
Direction errors						
Step 1				0.02	0.70	0.02
Diagnostic status	−0.41	0.49	−0.13			
Median correct RT						
Step 1				0.17	9.03	0.17**
Age	−0.65	0.22	−0.42**			
Step 2				0.18	4.44	0.00
Age	−0.66	0.22	−0.43**			
Diagnostic status	−0.25	1.06	−0.03			

Diagnostic status was coded as such: 0 = healthy control, 1 = HPD diagnosis

* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed)

Table 4 Correlations between outcomes on the SST, TSC-C, MIST-C: automatic, and MIST-C: focused for Children with HPD (N = 16)

SST	TSC-C			MIST-C	
	Severity	Impairment/distress	Total score	Automatic scale	Focused scale
Stop signal RT[c]	0.41	0.34	0.43	0.21	0.20
Direction errors[a]	0.23	0.15	0.22	0.07	0.02
Median correct RT[b]	0.11	0.26	0.22	0.22	0.32

[a] Denotes the use of bivariate correlational analyses

[b] Denotes a partial correlational analysis controlling for child age

[c] Denotes a partial correlational analysis controlling for both child age and attention difficulties

* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed)

during childhood [5, 7, 8] and has been conceptualized to involve inhibitory control deficits that often manifest through excessive motor behaviors [60]. Findings from the current investigation surprisingly demonstrate that children diagnosed with HPD—as compared to healthy controls—exhibit superior performance on a task of motor inhibition (i.e., SSRT) after controlling for child age and ADHD-related symptoms. These results suggest several important implications, particularly as the outcomes reported in this paper are largely in contrast with the extant literature from prior work among adult patients with HPD (see Table 2) [32, 35], as discussed below.

Our contrariwise findings among a pediatric sample lend themselves to several plausible explanations. First, the present study's findings may suggest that during childhood, patients with HPD may simply not exhibit deficits in facets to inhibitory control measured by the SST—a measure of action cancellation (i.e., inhibition of a motor response during its execution). It may be that the cognitive deficits associated with HPD in adults, such as impaired reaction times, do not appear until later in development and are more characteristic of adult-onset HPD, as supported by Odlaug et al. [35]. Conversely, Bohne et al. [33] demonstrated poorer motor inhibition in relation to performance on a go/no go task—a measure of action restraint (i.e., inhibition of a motor response before it starts)—among patients reporting child-onset HPD compared to both adult-onset HPD and controls. It may be the case that child-onset HPD is marked by deficits in specific facets to inhibitory control (i.e., action restraint rather than action cancellation) as compared to adult-onset HPD. Second, with the exception of Chamberlain et al. [32], performance amongst the current pediatric sample is markedly slower and exhibits greater variability than performance documented in adult HPD and control samples (Table 2). The present findings may thus be, in part, due to variability in performance present amongst pediatric samples in general. Obviously, future large-scale research is necessary to adequately examine these potential hypotheses, as the current study design allowed for neither the examination of multiple measures of inhibitory control, nor for the opportunity to examine variability in SST performance among youths and adults.

With regards to the lack of a relationship between HPD severity and/or distress/impairment ratings and any of the SST outcomes, our findings suggest that a diagnosis of HPD may not deleteriously impact performance on the SST in this sample of children. While these results are in line with findings in pediatric OCD from Andres et al. [61], they are in contrast with research in adults that has linked self-rated HPD severity to inhibitory impairment [32]. The impact of HPD on neurocognitive functioning in children may indeed be separate from severity of symptoms or pulling style; however, this lack of a relationship may also be due to the children's limited understanding of their own symptoms. Future research might make use of a larger sample size, as well as a more rigorous assessment of impairment and severity, as there are limitations in the reliability of self-report, particularly in children. Another possible explanation for these findings involves the role of emotion regulation in repetitive behaviors such as hair pulling. For example, HPD has been suggested to serve the function of regulating emotional states (e.g., Diefenbach et al. [62]; Shusterman et al. [63]). Focused pulling in particular may thus actually represent a less impulsive attempt at regulating one's emotions; however, the dysregulation of emotions, which can sometimes follow pulling, has also been hypothesized to be linked with greater impulsivity (though findings are mixed for behavioral versus cognitive impulsivity; e.g., Schreiber et al. [64]). The SST may assess both motor and cognitive aspects of response inhibition that cannot be distinguished without the use of neuroimaging technology. Such lines of inquiry are certainly in need of further exploration.

Limitations and Future Directions

Despite the noteworthy findings of this study, several important limitations are worth stating. First, the present sample was relatively homogenous ($\approx$90 % Caucasian) and the recruitment of a more racially and ethnically diverse sample would enhance the external validity of this study. Second, data were collected in relation to only one measure of inhibitory control (i.e., SST), potentially confounding the extent to which these findings would replicate and/or extend to other domains of motor (i.e., go/No go tasks) or cognitive inhibition (i.e., Stroop Test). Finally, the present study used only child age as our "proxy" measure of child developmental level, rather than incorporating potentially more robust measures of intellectual functioning (i.e., IQ score) and pubertal development (i.e., Tanner Scale). Although child age has been used often in prior research (e.g., Andres et al. [61, 65]; Ornstein et al. [58]), future research may wish to consider the inclusion of a more diverse and robust array of developmental measures to consider as potential covariates in data analysis, such as cognitive reserve [66]. Additionally, the statistical constraints explored with regards to the current study highlight the need for larger scale examinations of cognitive functioning in pediatric HPD samples to more fully test neurocognitive phenomenon in such a sample.

As the development of the brain is largely fluid during the early years of life and exploratory investigations such as this inspire additional questions and hypotheses, more research is needed to better understand where differences in cognitive functioning exist between pediatric HPD and healthy

controls. Ideally, movements such as the NIMH's RDoC will bring about such change and improvements. Better understanding of such functioning may even lead to improved treatment efforts, including targeted treatments for specific deficits which may tangentially improve overlying symptomatology. Ultimately, additional transdiagnostic research and dissemination of findings regarding cognitive functioning in disorders such as HPD in pediatric populations is crucial at this time, keeping in mind that what deficits might be evidenced in youth with HPD could have an impact on other areas of psychosocial development.

Summary

Hair pulling disorder is a debilitating disorder that may present across the lifespan with characteristic origins in childhood. Though deficits in inhibitory control have been noted in adult samples, no such research has examined this domain of functioning within a pediatric HPD sample. However, the present study provides evidence to suggest that such deficits may present disparately in youth as compared to adults, particularly when assessed using a targeted test (Stop Signal Task) as part of an automated neurocognitive testing battery (CANTAB). Specifically, the importance of controlling for potentially confounding variables, such as age and issues with inattention, needs to be addressed when evaluating for such dysfunction in youth. The results of this study have implications for the field's understanding of neurological processes associated with pediatric HPD, specifically as youth with HPD were found to evidence a relative strength on the Stop Signal Task as compared to healthy controls. Additional research investigating such dysfunction in youth with HPD is yet needed to better understand the cognitive features of such symptoms in youth.

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