Cognitive Therapy and Research (2024) 48:147–155
https://doi.org/10.1007/s10608-023-10448-8

ORIGINAL ARTICLE

Self-Report Measures of Sensory Phenomena in Body-Focused Repetitive Behaviors: A Comparison to Healthy Controls

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Accepted: 14 October 2023 / Published online: 14 November 2023

Abstract

Background Early studies identified sensory phenomena as an important facet of hair pulling and skin picking. Research in this area has grown in recent years; however, extant research on sensory abnormalities in BFRBs demonstrates limitations. The current study seeks to address gaps in the literature by examining differences in the experiences of sensory phenomena among patients with BFRBs as compared to healthy controls.

Methods Participants were 106 individuals, including 72 with BFRBs (32 hair pulling disorder [HPD], 31 skin picking disorder [SPD], 9 HPD with SPD) and 34 healthy controls, aged 11–65 years. All participants were assessed for psychiatric diagnosis via clinician-rated interviews and rated global hair pulling and skin picking severity. Participants also rated sensory phenomena using the Sensory Gating Inventory and Adolescent/Adult Sensory Profile.

Results Results revealed that participants with BFRBs exhibited significantly (or trends towards significantly) higher scores across most sensory domains (i.e., Over-inclusion, Distractibility, Stress-Fatigue Vulnerability, Low Registration, Sensation Avoidance, and Sensation Sensitivity) than healthy controls. There were no significant differences between discrete BFRB groups across any sensory experience. There were positive, moderate associations between a clinician-rated measure of skin picking-related global severity and most sensory experiences.

Conclusions These findings suggest that sensory dysregulation does separate those with BFRBs from healthy controls. Implications for future research and treatment are discussed.

Keywords Stimuli · Sensation · Excoriation · Trichotillomania

Introduction

Body-focused repetitive behaviors (BFRBs) are a group of self-grooming actions that include hair pulling and skin picking (American Psychiatric Association, 2013). BFRBs are often categorized together due to overlap in clinical presentation, course of illness, and genetic vulnerabilities (Maraz et al., 2017; Snorrason et al., 2021; Snorrason, Belleau et al., 2012), particularly with respect to hair pulling and skin picking (Moritz et al., 2022). These behaviors diverge from typical grooming patterns in their frequency and intensity, resulting in disfiguration or physical injury

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to the body. The consequences of BFRBs are wide-ranging and may include, but are not limited to, permanent scarring, expenses related to treatment and concealment of wounds, interpersonal relationship deficits, occupational problems, and diminished self-worth (Brennan et al., 2017; Flessner & Woods, 2006; Gallinat et al., 2021; Soriano et al., 1996; Tucker et al., 2011). The intensity of the urges to engage in BFRBs often results in feeling out of control and powerless to cease these behaviors (Madjar & Sripada, 2016).

An array of triggers can prompt an urge to pull or pick (e.g., affective states, thoughts, environmental cues; Roberts et al., 2013), and this is particularly true with respect to sensory phenomena, which not only prompt pulling, but may also reinforce BFRBs. BFRBs are both negatively and positively reinforced through the reduction in uncomfortable sensations and the elevation of pleasant sensations, respectively (Bosseti et al., 2016; Snorrason et al., 2015). For example, some individuals with BFRBs report a sense of gratification or relief when engaging in these behaviors, which may be related to either the sensory feedback they receive from engaging in the behavior (e.g., looking at the hair bulb, smelling the excoriate, or stroking the skin/hair) or some sensory outcome that is achieved by the behavior (e.g., feeling the smooth skin following the removal of a scab or seeing the clean eyelid without any black hairs). Other individuals report specific sensory sensitivity to certain types of stimuli, such as the texture of a certain hair or the rough feeling of a hangnail which may signal the urge to engage in the behavior. According to the Stimulus Regulation Model proposed by Penzel (2003), people with hair pulling disorder pull when they are overstimulated and pull when they are under stimulated, implying that hair pulling (and likely other BFRBs) serves to regulate an internal experience of sensory imbalance. Sensory dysfunction in children and adults is likely experienced as distressing, resulting in attempts to reduce or to settle down the nervous system (Dar, Khan, & Carmeli, 2012). Several studies have documented a relationship between sensory processing difficulties in childhood and rigid, inflexible, and "ritualistic" behaviors in children (Ben-Sasson, A. & Bodily, T. (2017), as well as OCD symptoms involving the need for symmetry and exactness, repeating rituals, and rigid behaviors (Baranek, G., Foster, L., & Berkson, G. (1997). These findings could explain how problems in the sensory system lead to repetitive, compulsive, ritualistic behaviors such as hair pulling and skin picking.

The intertwining of BFRBs and sensations has led some researchers to wonder whether those with BFRBs experience sensory phenomena differently than those who do not engage in BFRBs. Thus far, increased sensory sensitivity and diminished sensory filtering have been shown in those with BFRBs. Houghton et al. (2018) assessed six domains of sensory processing (auditory, visual, taste/smell, movement, body position, and touch), and found that participants with clinical BFRBs reported more sensitivity to sensory stimuli and more sensation avoidance compared to those classified as experiencing subclinical BFRBs or healthy controls. More recently, Houghton and colleagues (2019) demonstrated that those with BFRBs (i.e., hair pulling, skin picking) exhibited deficits in sensory gating (i.e., the ability to filter out redundant or irrelevant stimuli) and increased tactile sensitivity compared to controls. Interestingly, Schienle and Wabnegger (2022) found that participants with more severe skin picking reported an urge to pick their skin after being softly touched, as compared to the general population who are more likely to perceive soft touch as soothing. In a similar vein, hair pulling disorder has been linked to the experience of significantly higher auditory and tactile sensory over-responsivity (i.e., exaggerated response to ordinary stimuli) compared to controls (Falkenstein et al., 2018). Moreover, greater sensory over-responsivity is associated with greater perfectionism, urges to pull out the hair of others, and functional impairment.

Sensory abnormalities have been found across the obsessive-compulsive spectrum (i.e., OCD, hair-pulling, skin-picking, hoarding, body dysmorphic symptoms; Ferrão et al., 2012; Moreno-Amador et al., 2023), and in other disorders characterized by repetitive behaviors (i.e., Tourette syndrome, autism spectrum disorder; Isaacs et al., 2022; Scheerer et al., 2021; Thye et al., 2018). Indeed, a recent meta-analysis suggests that sensory processing difficulties extend broadly across a wide range of mental health conditions, suggesting that it may be a non-specific transdiagnostic risk factor (van den Boogert et al., 2022). Despite this finding, the extant literature regarding sensory phenomena and BFRBs is scant and has been hindered by a variety of limitations ranging from small sample sizes (Houghton et al., 2019; Meunier et al., 2009) to a failure to confirm BFRB diagnostic status (Falkenstein et al., 2018; Houghton et al., 2018, 2019) to restricted number of measures used to assess sensory phenomena and age level of participants examined (Meunier et al.; Falkenstein et al.; Houghton et al.). Additional research is needed to elucidate the nuances of sensory phenomena among those with BFRBs in a more comprehensive and rigorous manner. To expand upon the growing body of knowledge pertaining to abnormal sensory experiences, this study seeks to evaluate sensory phenomena using multiple measures in a combined sample of children and adults with BFRBs (i.e., hair pulling disorder [HPD], skin picking disorder [SPD]) relative to healthy controls. We hypothesized that participants presenting with a BFRB would demonstrate greater sensory disturbance compared to healthy controls. In an exploratory aim, we sought to investigate whether differences exist in sensory abnormalities

across discrete diagnostic groups (i.e., HPD, SPD, HPD with SPD, and healthy controls). In a final exploratory aim, we examined the relationship between sensory abnormalities and BFRB-related symptom severity (as assessed via clinician-rated measures of severity).

Methods

Participants

The current investigation included participants recruited as part of a large, multi-site study seeking to inform understanding of the neurobiological, cognitive, and behavioral underpinnings of BFRBs (i.e., HPD and SPD). Detailed information regarding this sample and the sites involved in data collection can be found elsewhere (Grant et al., 2021). Data collection for the larger study occurred between October 2017 and March 2019. Inclusion criteria for the current study were: 1a) DSM 5 diagnosis of HPD or SPD (BFRB group only); 1b) no current or lifetime history of any DSM-5 mental disorder (healthy controls only); 2) age of 11–65 years; 3) fluency in English; 4) naïve to psychotropic medication or on a stable dosage of the medication for the past 3 months; 5) demonstrated an ability to provide informed consent; and 6) possessed complete data for all variables (i.e., potential covariates, dependent variables) examined as part of the current study. Due to the parameters of the larger study from which these data were obtained (i.e., neuroimaging), a number of exclusion criteria were also applied to the current sample: (1) Current or lifetime diagnosis of any major medical illness/condition (i.e., visual or auditory impairment) or psychiatric condition (i.e., cognitive impairment, psychotic disorder) that would make it exceedingly difficult to complete all study procedures; (2) a neurological condition that would impact the participants ability to complete neurocognitive tasks; (3) affirmative response to a neuroimaging form inquiring about the presence of body metal; and (4) positive pregnancy test for females of childbearing age. Recruitment for the aforementioned healthy control sample occurred via recruitment flyers and community outreach.

Table 1 provides an overview of key demographic characteristics for participants from the current study. In total, 106 participants met inclusion criteria for this study. For purposes of addressing the study's primary aim (i.e., examining sensory phenomena among patients with BFRBs as compared to healthy controls), 72 participants were classified as part of the BFRB (32 HPD, 32, SPD, 9 HPD + SPD) group and 34 were classified as healthy controls (see Data Analytic Plan for greater detail regarding the way groups were determined). Groups did not differ ($p \leq 0.01$) with respect to age, biological sex (as determined on birth certificate), race, or ethnicity. Groups did differ with respect to medication status; however, medication status was not related to any of the outcome variables of interest and was not examined further in subsequent analyses. The current sample predominantly reported female (n = 92) as their biological sex at birth and was majority White/Caucasian (n = 71) and of non-Hispanic (n = 78) ethnicity.

Measures

A myriad of assessment tools were utilized as part of the larger study from which the current sample was obtained. All participants completed the Mini International Neuropsychiatric Interview 7.0 (Sheehan et al., 1998), BFRB specific

Table 1 *Demographic Characteristics for BFRB Group, Healthy Control Group, and Entire Sample*

	BFRB Group		Healthy Control Group		Full Sample	
Age (years)	Mean	SD	Mean	SD	Mean	SD
	29.2 [a]	11.9	22.5 [a]	8.7	27.07	11.4
Biological Sex						
Male	8		8		16	
Female	64		26		90	
Race[1]						
White/Caucasian	53		17		70	
Black/African-American	1		1		2	
American Indian or Alaskan Native						
Asian	4		8		12	
Hawaiian or Other Pacific Islander						
Biracial	6		4		10	
Other	5		3		8	
Ethnicity[1]						
Hispanic	12		10		22	
Not Hispanic	56		21		77	

[a] Groups are significantly different from one another at a level of $p < 0.05$

[1] Due to missing data, frequency distributions for the entire sample do not equal the total sample examined for purposes of this study

diagnostic modules, a variety of BFRB specific symptom severity measures, neurocognitive test battery, and self-report measures assessing multiple domains of functioning including BFRB symptoms, general psychopathology, quality of life, and family environment. What follows is a detailed description of the specific measures germane to the current study.

Sensory Gating Inventory (SGI; Hetrick et al., 2012). The Sensory Gating Inventory (SGI) is a 36-item self-report measure assessing various sensory-related experiences. The SGI yields a total and four subscale scores. Higher scores indicate more intense experiences within that domain. Domains assessed via the SGI include perceptual modulation (e.g., "I have feelings of being flooded by visual experiences, sights, or colors.", "It seems like I hear everything all at once.", etc.), distractibility (e.g., "I find it hard to concentrate on just one thing.", "I am easily distracted.", etc.), over-inclusion (e.g., "I notice background noises more than other people.", "Maybe it's because I notice so much more about things that I find myself looking at them for longer time.", etc.), and fatigue-stress vulnerability (e.g., "When I am tired, the brightness of lights bothers me.", "It seems that sounds are more intense when I'm distress.", etc.). The SGI has demonstrated strong reliability and validity (Hetrick et al., 2012).

Adolescent/Adult Sensory Profile (AASP; Dunn & Brown, 2002). The AASP is a 60-item self-report measure assessing sensory phenomena across four quadrants or domains: Low registration (e.g., "I trip or bump into things.", "I miss the street, building, or room signs when trying to go somewhere new.", etc.), sensation seeking (e.g., "I choose to engage in physical activities.", "I like to go places that have bright lights and that are colorful.", etc.), sensory sensitivity (e.g., "I dislike the movement of riding in a car.", "I become frustrated when trying to find something in a crowded drawer or messy room.", etc.), and sensation avoiding (e.g., "I keep the shades down when I am home.", "I choose to shop in smaller stores because I am overwhelmed in larger stores.", etc.). Higher scores indicate greater or more intense experiences within these domains. The AASP has demonstrated strong reliability and validity (Dunn & Brown, 2002).

Clinical Global Impression – Severity (CGI-S; Guy, 1976*)*. The CGI-S is a clinician-rated, 7-point Likert-type scale designed to assess overall symptom severity pertaining to a specific psychiatric condition (i.e., SPD, HPD). Response anchors on the CGI-S range from 1 ("Normal. Not ill at all") to 7 ("Among the most extremely ill patients"). Ratings were obtained by trained diagnosticians possessing a bachelor's degree or higher and trained to reliability. All diagnosticians were supervised by a doctoral-level clinician with experience assessing HPD and SPD. For purposes of this study, CGI-S ratings were obtained with respect to both HPD (i.e., CGI-S-HPD) and SPD (i.e., CGI-S-SPD) for all participants.

Procedures

Similar procedures were enacted across all study sites and typically occurred over the course of two days, with no more than 14 days elapsing between assessments. All study procedures were approved by the Institutional Review Boards at each study site. Participants contacting the study site coordinator were administered a brief phone screen to determine potential eligibility for the study. Potentially eligible participants were subsequently scheduled for an in-person screening assessment. At the time of the assessment, participants met with a member of the research team to complete informed consent documentation. Pertinent to this investigation, participants completed a comprehensive battery of diagnostic interviews, and self-report questionnaires. Additional procedures included neurocognitive tasks and neuroimaging. All participants were compensated for their time.

Data Analytic Plan

Assumptions germane to independent samples t-tests and univariate analysis of variance were examined and, as appropriate, adjusted (e.g., use of statistics applicable in cases for which equivalent variances between groups cannot be assumed). Prior to conducting any analyses and based upon both theory and prior research, participant age and depressive symptoms (as assessed via the Mood and Feelings Questionnaire [MFQ; Angold et al., 1995]) were examined as a potential covariate across all SGI- and AASP-related scales. These analyses revealed no statistically significant relationship between age and any of the various dependent variables examined herein; thus, age was not employed as a covariate in any of the analyses described below. Depression was found to exhibit a significant relationship and, in turn, was used as a covariate where appropriate.

For purposes of examining the study's primary hypothesis (i.e., significant differences will be present among participants presenting with BFRBs as compared to healthy controls), an analysis of covariance (ANCOVA) was conducted. Participants meeting DSM-5 criteria for HPD, SPD, or both were placed within the BFRB group, while those failing to meet a current or lifetime diagnosis of any psychiatric condition were classified as healthy controls. Due to the number of analyses conducted ($n = 9$), an alpha level of 0.006 was used to determine statistical significance for examination of our primary aim and both exploratory aims.

As described earlier, two additional sets of exploratory analyses were conducted. First, differences in sensory

phenomena were examined across distinct presentations of BFRBs. Therefore, participants classified within the BFRB group were subsequently partitioned into one of three clinical groups: (1) HPD alone, (2) SPD alone, or (3) HPD and SPD (i.e., receipt of both diagnoses). Univariate analyses of covariance were conducted to examine differences between these three clinical groups as compared to healthy controls. When appropriate, post hoc analyses were conducted using Bonferroni (i.e., equal variances assumed) or Tamhane's T2 (i.e., equal variances not assumed) corrections. Second, Pearson correlations were conducted to examine the relationship between SGI- and AASP-related subscales and SPD and HPD symptom severity (i.e., CGI-S-SPD and CGI-S-HPD, respectively).

Results

To aid with ease of interpretation, results from the analyses conducted herein are partitioned based upon this study's stated aims. What follows are a description of these findings:

Primary Aim: Examine differences with respect to sensory phenomena among participants with BFRBs as compared to healthy controls. First, a series of univariate analyses of covariances (ANCOVAs) examined group differences across the SGI: Total and subscale scores controlling for the influence of depressive symptoms (i.e., MFQ Total Score; see Table 2). Participants in the BFRB group scored significantly higher than healthy controls on the SGI: Distractibility [$F(1, 103) = 9.28$, $p = 0.003$; *partial eta-squared* = 0.08] and SGI: Fatigue-Stress Vulnerability [$F(1, 103) = 10.90$, $p \leq 0.001$; *partial eta-squared* = 0.10] subscales. Trends towards statistical significance were noted with respect to the SGI: Total scale [$F(1, 103) = 5.60$, $p = 0.02$; *partial eta-squared* = 0.05] and SGI: Overinclusion subscale [$F(1, 103) = 3.25$, $p = 0.07$; *partial eta-squared* = 0.03]. No statistically significant differences were found with respect to SGI: Perceptual Modulation subscale (p = 0.26; *partial eta-squared = 0.01*).

Table 2 *Estimated Marginal Means and Standard Errors for Participants Categorized as Members of the BFRB or HealthyControl Groups with Respect to Scores on the Sensory Gating Inventory and Adolescent/Adult Sensory Profile*

	BFRB Group		Healthy Control Group	
	Mean	SE	Mean	SE
Sensory Gating Inventory				
Total Scale	52.1[T]	3.6	36.2[T]	5.4
Perceptual Modulation	16.1	1.7	12.6	2.5
Distractibility	15.6[a]	1.0	9.9[a]	1.5
Overinclusion	11.2[T]	0.8	8.6[T]	1.2
Fatigue	9.1[a]	0.7	5.0[a]	1.0
Adolescent/Adult Sensory Profile				
Low Registration	32.3[T]	0.8	29.1[T]	1.3
Sensation Seeking*	44.9	7.9	46.2	6.7
Sensation Sensitivity	35.8[a]	1.0	29.8[a]	1.5
Sensation Avoiding	35.7[T]	1.0	30.6[T]	1.5

[a] Groups are significantly different from one another at a level of $p < 0.006$

T Groups exhibit a trend towards being significantly different from one another

*Descriptive statistics provided for this variable represent mean and standard deviation, due this variable not requiring the use of a covariate (i.e., MFQ) in analyses

A separate series of independent samples t-tests (i.e., AASP: Sensation Seeking) and ANCOVAs examined group differences across AASP quadrants/domains. Results revealed that participants in the BFRB group scored significantly higher than healthy controls on the AASP: Sensory Sensitivity [$F(1, 103) = 11.13$, $p \leq 0.001$; *partial eta-squared* = 0.10] domain. A trend towards statistical significance was noted with respect to the AASP: Low Registration [$F(1, 103) = 4.05$, $p = 0.05$; *partial eta-squared* = 0.04] and AASP: Sensation Avoiding [$F(1, 103) = 7.45$, $p = 0.007$; *partial eta-* = 0.07] domains. No statistically significant differences were demonstrated with respect to the AASP: Sensation Seeking domain ($p = 0.43$; $d = 0.17$).

Exploratory Aim #1: Examine differences with respect to sensory phenomena among discrete groups of participants with HPD, SPD, or both as compared to healthy controls. A series of univariate analyses of covariance (ANCOVAs) examined group differences across the SGI: Total and subscale scores controlling for the influence of depressive symptoms (see Table 3). Trends towards statistical significance were noted with respect to the SGI: Total scale [$F(3, 101) = 2.39$, $p = 0.07$; *partial eta-squared* = 0.07] and SGI: Distractibility [$F(3, 101) = 3.06$, $p = 0.03$; *partial eta-squared* = 0.08) and SGI: Fatigue-Stress Vulnerability [$F(3, 101) = 3.91$, $p = 0.01$; *partial eta-squared* = 0.10] subscales. No statistically significant differences were found with respect to the SGI: Perceptual Modulation ($p = 0.287$; *partial eta-squared* = 0.04) or SGI: Overinclusion ($p = 0.17$; *partial eta-squared* = 0.05) subscales. Based upon these results, post hoc analyses were not conducted.

A separate set of ANOVAs (i.e., AASP: Sensation Seeking) and ANCOVAs examined group differences with respect to AASP quadrants/domains. A statistically significant main effect was demonstrated with respect to scores from the AASP: Sensory Sensitivity [$F(3, 101) = 4.38$, $p = 0.006$; *partial eta-squared* = 0.12]. A trend towards statistical significance was noted with respect to scores from the AASP: Sensation Avoiding [$F(3, 101) = 2.55$, $p = 0.06$; *partial eta-squared* = 0.07] domain. No statistically significant differences were found with respect to the AASP: Low Registration ($p = 0.18$; *partial eta-squared* = 0.05) or AASP:

Table 3 *Estimated Marginal Means and Standard Errors for Participants Categorized as Members of the HPD, SPD, HPD + SPD or Healthy Control Groups with Respect to Scores on the Sensory Gating Inventory and Adolescent/Adult Sensory Profile*

	HPD (n = 32)		SPD (n = 31)		HPD + SPD (n = 9)		Healthy Control (n = 34)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Participant Age (years)*	31.5	12.8	28.3	12.0	24.2	5.5	22.5	8.7
Sensory Gating Inventory								
Total Scale	47.6	5.3	54.7	5.7	61.1	10.2	35.5	5.5
Perceptual Modulation	13.7	2.4	17.4	2.6	21.7	4.7	12.3	2.5
Distractibility	15.4	1.5	16.0	1.6	15.7	2.9	9.9	1.5
Overinclusion	10.3	1.1	11.7	1.2	13.5	2.2	8.5	1.2
Fatigue	8.4	1.0	9.6	1.1	10.1	1.9	4.9	1.0
Adolescent/Adult Sensory Profile								
Low Registration	31.5	1.2	32.8	1.3	32.8	1.3	34.0	2.4
Sensation Seeking*	44.2	7.5	44.9	8.2	47.3	8.4	46.2	6.7
Sensation Sensitivity	34.7[a]	1.4	36.2[b]	1.5	39.0[c]	2.7	29.6[a,b,c]	1.5
Sensation Avoiding	35.1	1.5	36.3	1.6	36.0	2.8	30.6	1.5
CGI-S-SPD*	1.5	1.1	4.5	0.7	3.9	1.3	1.0	0.0
CGI-S-HPD*	4.2	0.8	1.0	0.2	4.8	1.1	1.0	0.0

Groups with similar lettering (i.e., a, b, c) are significantly different from one another at a level of $p < 0.05$ based upon pairwise comparisons

*Descriptive statistics provided for this variable represent mean and standard deviation, due this variable not requiring the use of a covariate (i.e., MFQ) in analyses or the variable used as a descriptive statistic only (i.e., age, CGI-S, CGI-HPD).

Table 4 *Partial Correlations between BFRB Symptom Severity Measures and Scores from the Sensory Gating Inventory and Adolescent/Adult Sensory Profiles, after Controlling for the Influence of Depressive Symptoms*

	SGI Total	SGI: Perceptual Modulation	SGI: Distractibility	SGI: Overinclusion	SGI: Fatigue	ASP: Low Registration	ASP: Sensation Seeking	ASP: Sensation Sensitivity	ASP: Sensation Avoiding
CGI-S-SPD	0.17[T]	0.12	0.16	0.15	0.21*	0.15	-0.05	0.16	0.17[T]
CGI-S-HPD	0.12	0.05	0.16	0.13	0.15	0.11	0.01	0.13	0.06

*$p < 0.05$

[T] Trend towards statistical significance (i.e., $p < 0.10$)

Sensation Seeking ($p = 0.61$; partial eta-squared = 0.02) domain.

Pairwise comparisons, conducted only for the variable (i.e., AASP: Sensory Sensitivity) demonstrating a significant main effect in our omnibus analyses, revealed that participants in the HPD, SPD, and HPD + SPD groups scores significantly higher than healthy controls on the AASP: Sensory Sensitivity ($p = 0.014$, $p = 0.004$, and $p = 0.004$, respectively) domain. No statistically significant differences were noted between those in the HPD, SPD, and HPD + SPD groups.

Exploratory Aim #2: Examine the relationship between sensory phenomena and clinician-rated measures of HPD and SPD severity. A series of Partial correlations, controlling for the influence of depressive symptoms, were conducted to examine the relationship between scores on the SGI, AASP, and clinician-rated measures of disorder-level severity (i.e., CGI-S-HPD and CGI-SPD; see Table 4). Results revealed a small to moderate correlation between skin picking severity and the SGI: Fatigue-Stress Vulnerability subscale ($r = 0.21$, $p = 0.029$) and trends towards small, statistically significant correlations with respect to the SGI: Total scale ($r = 0.17$, $p = 0.08$) and AASP: Sensation Avoiding ($r = 0.17$, $p = 0.08$) scales/domains. Conversely, results revealed no statistically significant relationships between hair pulling severity and any scales from either the AASP or SGI.

Discussion

The current study sought to address gaps in prior literature by enhancing knowledge of the relationship between sensory phenomena and BFRBs to inform understanding of their underlying function, as well as to improve best-practice treatment approaches by addressing this often-overlooked aspect of BFRB treatment. Collectively, results from this study suggest differences with respect to the experience of sensory phenomena between those with BFRBs as compared to healthy controls. What follows is a more detailed discussion of these findings and potential implications.

Results from this study are consistent with previous findings suggesting a relationship between sensory

dysregulation and BFRBs. Specifically, individuals with BFRBs demonstrated significantly higher scores on the Sensory Sensitivity scale of the ASP supporting previous findings that people with BFRBs also have increased sensory sensitivity (Houghton, 2019). This makes sense clinically as people with BFRBs tend to be attracted to hairs that feel/look different (i.e., thick, coarse, dark, light, curly, etc.), or skin that has some aberration either visually or tactilely (i.e., a bump, scab, rough spot, or other difference). Post pulling and picking behaviors often include oral, tactile, visual, and olfactory aspects which also could be explained by higher scores on the Sensory Sensitivity scale. Further, there was a trend toward significance on the Low Registration and Sensory Avoiding subscales of the ASP suggesting that people with a BFRB have reduced awareness of incoming sensory information (Low-Registration) and/or active avoidance of certain unpleasant sensory experiences (Sensory Avoidance). According to Kamath et al. (2020), high scores on Low Registration may indicate difficulty reacting to sensory stimuli, especially if the stimuli is weak or less salient. This could explain the "intense focus" many people describe with BFRBs whereby a person will ignore everything (less salient stimuli) except for the BFRB activity. This could explain why people often describe being in a "trance" while pulling or picking. The trend toward Sensory Avoidance seen on the SGI might explain the inability to tolerate perceived defects or aberrations on skin and hair. Simply removing the offensive stimuli allows individuals to avoid the unpleasant sensory experience altogether.

On the SGI, subjects in the BFRB group scored significantly higher on the Distractibility and Fatigue-Stress Vulnerability scales of the SGI when compared to healthy controls. These findings suggest that people with BFRBs may struggle to stay focused on the task at hand without getting distracted by seemingly irrelevant sensory cues (a hair out of place or a bump on the skin) and may become overwhelmed by sensory stimuli leading to stress and fatigue. These findings support the hypothesis that BFRBs may serve a self-soothing function in response to stress or fatigue, which is a common trigger for BFRB episodes.

When we partitioned those with a BFRB into discrete diagnostic groupings as part of our exploratory analyses, no significant differences were noted between those with HPD or SPD across any of the measures of sensory experiences. While this is interesting, it is not necessarily surprising and supports conceptualizing BFRBs as a group, not as separate subgroups of "pullers" and "pickers," at least regarding sensory aspects of the behavior. Interestingly, however, we found a positive, moderate relationship between skin picking severity and nearly all sensory experiences investigated herein, whereas no such relationship existed with respect to hair pulling severity. This may suggest that, while many sensory processing experiences are problematic for all BFRBs, the impact of these experiences may exert a greater influence, and potentially have stronger treatment implications, among those presenting with SPD.

Study Limitations - Despite the importance of the findings described above, several limitations are noteworthy. First, the small number (n = 9) of participants within the HPD + SPD group limits our ability to examine unique characteristics of this comorbidity. Future research would be well-advised to examine the impact of multiple BFRBs on one's experience of sensory phenomena. Further, the present study lacked an objective assessment of sensory processing, as has been employed successfully in prior work (Houghton et al., 2019). Relatedly, our measurement of sensory phenomena were self-reported in nature among children and adults with BFRBs. It is possible, though unable to be determined with the data collected as part of the larger study, that some children may have experienced poor insight regarding these private experiences. In turn, the addition of a parent-report measure may have been beneficial. In the future, it will be important for researchers to incorporate more comprehensive assessment batteries targeting self-report, parent-/other-report, and objective measurement techniques.

Implications for treatment – These findings underscore the importance of addressing the sensory experiences of all people with a BFRB. Understanding the sensory function of the BFRB (e.g., to reduce a negative stimulus, help with sensory processing, to reduce feelings of stress and fatigue, or satisfy a sensory urge) has the potential to develop more targeted solutions. For example, if the removal of a scab satisfies the need to be rid of the rough texture of the scab to leave a smooth surface, the solutions offered might include covering the scab with a smooth bandage, feeling a smooth stone in the hand, and wearing a smooth satin blouse. More generally, the findings described herein may also reinforce the importance of understanding a patient's sensory experience in general before proceeding with treatment. Determining which sensory sensations are calming and soothing to a person and then encouraging them to interact with these stimuli when needing to feel calm and soothed, even when it is not specific to the BFRB. For example, if listening to classical music, smelling lavender, and dimming the lights creates a calming environment for a person, this might be a good wind-down activity for 20 minutes after a long workday. Finding alternative methods for calming the nervous system provides choices when trying to reduce their BFRB and fits with a functional intervention approach (Mansueto et al., 1997).

Overall, these findings suggest that sensory dysregulation does separate those with BFRBs from healthy controls. These results are in line with recent research outlining how interventions to improve sensory processing also served to

reduce anxiety in children with autism spectrum disorders (Case-Smith, 2015) and adults (not on the ASD spectrum) with anxiety and depressive disorders (Papadopoulos et al., 2018). Future research should investigate further the mechanisms underlying the relationship between sensory dysregulation and BFRB activity. The purpose of such research would be to understand the function of hair pulling and skin picking as it relates to satisfying sensory triggers, cues, and urges through both positive and negative reinforcement, as well as the direct implications for improving treatment outcomes.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10608-023-10448-8.

Acknowledgements The authors would like to thank the TLC Foundation for Body-Focused Repetitive Behaviors and their many donors for funding and providing administrative support for this project. We would also like to thank the following people who helped collect data or provide valuable insights into the study: Sarah Redden, Elizabeth Cavic, and Stephanie Valle (University of Chicago); Noah Berman, Ph.D., Erin Curley, Ryan Jacoby PhD, Grant Jones, and Esther Tung (MGH); Joseph O'Neill, Caitlin Lau, and Jocelyn Perez (UCLA); Clara Marincowitz, Gaironeesa Hendricks, and Karen Mare (Stellenbosch University) and members of the TLC Foundation for Body-Focused Repetitive Behaviors Scientific Advisory Board (Fred Penzel, Ph.D., Martin Franklin, Ph.D., Joseph Garner, Ph. D., David A. F. Haaga, Ph.D., Ruth Golomb, M.Ed., LCPC, Charles S. Mansueto, Ph.D., Carol Novak, M.D., and John Walkup, M.D.)

Declarations

The research reported in this manuscript was funded by the Body-Focused Repetitive Behavior Precision Medicine Initiative granted by the TLC Foundation for Body-Focused Repetitive Behaviors to University of Chicago (Dr. Jon Grant), Massachusetts General Hospital/Harvard (Dr. Nancy Keuthen), and University of California, Los Angeles (Dr. John Piacentini). This study was completed with support from the REDCap project at the University of Chicago, which is hosted and managed by the Center for Research Informatics and funded by the Biological Sciences Division and by the Institute for Translational Medicine, CTSA grant number UL1 TR000430 from the National Institutes of Health. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the TLC Foundation for Body-Focused Repetitive Behaviors, its Scientific Advisory Board, or the National Institutes of Health.

The authors of this manuscript have no conflicts of interest to report.

The study described herein was approved by the Institutional Review Boards of all institutions noted in the preceding paragraph. Informed consent was obtained for all participants.

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