Published in final edited form as:
J Clin Psychol. 2011 April ; 67(4): 391–403. doi:10.1002/jclp.20770.

The Significance of Repetitive Hair-Pulling Behaviors in Eating Disorders

Nancy Zucker, PhD,
Duke University Medical Center, Durham, North Carolina, USA

Ann Von Holle, MS,
University of North Carolina, Chapel Hill, North Carolina, USA

Laura M. Thornton, PhD,
University of North Carolina, Chapel Hill, North Carolina, USA

Michael Strober, PhD,
University of California, Los Angeles, USA

Kathy Plotnicov, PhD,
University of Pittsburgh, Pittsburgh, Pennsylvania, USA

Kelly L. Klump, PhD,
Michigan State University, East Lansing, Michigan, USA

Harry Brandt, MD,
University of Maryland School of Medicine, Baltimore, Maryland, USA

Steve Crawford, MD,
University of Maryland School of Medicine, Baltimore, Maryland, USA

Scott Crow, MD,
University of Minnesota Medical School, Minneapolis, MN, USA

Manfred M. Fichter, MD,
University of Munich, Munich, Germany

Katherine A. Halmi, MD,
Weill Medical College of Cornell University, White Plains, New York, USA

Craig Johnson, PhD,
Eating Disorders Recovery Center, Denver, Colorado, USA

Allan S. Kaplan, MD,
Center for Addiction and Mental Health, Toronto, Canada; Department of Psychiatry, University of Toronto, Toronto, Canada; Department of Psychiatry, Toronto General Hospital, University Health Network, Toronto, Canada

Pamela Keel, PhD,
Florida State University, Tallahassee, Florida, USA

Maria LaVia, MD,
University of North Carolina, Chapel Hill, North Carolina, USA

James E. Mitchell, MD,
University of North Dakota School of Medicine and Health Sciences, Fargo, North Dakota, USA

Address Correspondence To: Cynthia M. Bulik, PhD, FAED, Department of Psychiatry, School of Medicine, University of North Carolina at Chapel Hill, CB #7160, 101 Manning Drive, Chapel Hill, NC 27599-7160.

Alessandro Rotondo, MD,
University of Pisa, Pisa, Italy

D. Blake Woodside, MD,
Toronto General Hospital, Toronto, Canada

Wade H. Berrettini, MD, PhD,
University of Pennsylvania, School of Medicine, Philadelphia, Pennsylvania, USA

Walter H. Kaye, MD, and
University of California, San Diego, California, USA

Cynthia M. Bulik, PhD
University of North Carolina, Chapel Hill, North Carolina, USA

Abstract

We studied the relation between intrusive and repetitive hair-pulling, the defining feature of trichotillomania, and compulsive and impulsive features in 1453 individuals with anorexia nervosa and bulimia nervosa. We conducted a series of regression models examining the relative influence of compulsive features associated with obsessive compulsive disorder; compulsive features associated with eating disorders; trait features related to harm avoidance, perfectionism and novelty seeking; and self harm. A final model with a reduced sample (n=928) examined the additional contribution of impulsive attributes. One out of 20 individuals endorsed hair-pulling. Evidence of a positive association with endorsement of compulsive behavior of the obsessive compulsive spectrum emerged. Hair-pulling may be more consonant with ritualistic compulsions than impulsive urges in those with eating disorders.

Keywords

eating disorders; trichotillomania; hair-pulling; anorexia nervosa; bulimia nervosa; impulsivity; compulsivity

---

Anorexia nervosa (AN) and bulimia nervosa (BN) are complex, partially overlapping, and heterogeneous diagnostic categories (Anderluh, Tchanturia, Rabe-Hesketh, Collier, & Treasure, 2009; Bulik et al., 2010; Eddy et al., 2008; Fichter, Quadflieg, & Hedlund, 2006). Defining homogenous groups based on eating disorder diagnosis may thus not provide sufficient parsimony. Rather, to tailor treatments that succinctly encapsulate eating disorder features and comorbid syndromes, there is impetus to focus on specific clinical characteristics and behavioral processes that transcend traditional diagnostic boundaries (American Psychiatric Association (APA), 1994; Gottesman & Gould, 2003; Happe, Ronald, & Plomin, 2006; Psychiatric GWAS Consortium (PGC), 2009; Ronald, Happe, Price, Baron-Cohen, & Plomin, 2006). In line with this movement, we focus on repetitive behaviors characteristic of disorders that comprise the obsessive compulsive spectrum including eating disorders. Such features in eating disorders manifest as repetitive motoric behaviors (e.g., body checking, foot tapping, excessive exercise), intrusive cognitive obsessions (e.g., doubts about the exact nutritional content of foodstuffs), and impulsive actions (e.g., self-harm). Organizing such features along uniform dimensions may lead to novel insights about the function of symptom profiles within the spectrum of eating disturbance.

For example, repetitive, intrusive hair-pulling, the core feature of trichotillomania (TTM), is a particularly interesting area of inquiry in eating disorders. Advanced study of TTM subtypes (e.g., automatic versus focused hair-pulling) can inform the delineation of diverse

subjective experiences accompanying compulsive and impulsive behaviors among those with eating disorders (Duke et al., 2010). For instance, current clinical nosology categorizes TTM with other impulse control disorders such as pathological gambling, kleptomania, pyromania, and intermittent explosive disorder. These disorders are characterized by repetitive or compulsive patterns of behavior that are performed despite adverse consequences, the experience of diminished control over these behaviors, and the presence of appetitive urges prior to engagement (Brewer & Potenza, 2008). Yet, the phenomenology, neurobiology, and features of TTM have also led it to be considered as part of the obsessive compulsive spectrum (Hollander, Kim, Braun, Simeon, Zohar, 2009; Lochner & Stein, 2006). Such considerations, combined with complex patterns of overlap with comorbid diagnoses, have propelled numerous attempts to arrive at typologies of repetitive behaviors to help delineate uniform groups within broad diagnostic spectra (Stein et al., 2010). Yet, despite similar debates about the nature of impulsive and compulsive features in those with eating disorders, repetitive, intrusive hair-pulling is infrequently studied.

Disturbances in eating behavior and frank eating disorders are reported in a significant proportion of individuals with TTM (Christenson, Pyle, & Mitchell, 1991). Among individuals with TTM, 20% endorsed an eating disorder (as cited in Christenson & Mitchell, 1991). Among those individuals with BN, rates of TTM did not evidence statistically significant differences relative to controls; however, agitated behaviors directed towards the body occurred at twice the frequency as the control sample (Christenson & Mitchell, 1991). Such findings highlight the need for larger sample sizes to determine both the clinical and statistical significance of intrusive hair-pulling (Christenson, Mackenzie, & Mitchell, 1991).

Less is known about the comorbidity of AN and TTM. One case report (Pinhas, Geist, & Katzman, 1996) described an adolescent with AN and TTM who also engaged in a pattern of rigid exercise. In contrast, Tyler et al. (2002) reported that TTM is uncommonly endorsed in AN using qualitative methodologies. In BN, Engel et al. (2005) reported that those scoring high on impulsive and compulsive features exhibited the greatest degree of personality pathology, alcohol and substance use, depressive symptoms, eating disorder symptoms, and impairment. Combined, this pattern of results may indicate one of several conclusions. First, hair pulling may be relatively uncommon in individuals with AN, specifically, or in those with eating disorders more generally. Second, those with eating disorders and TTM may represent a unique subgroup with a distinct neurobiological and genetic profile. Third, while the full diagnostic syndrome of TTM may be uncommon, the prevalence of behavioral agitation, in general, and hair pulling, specifically, may be higher in individuals with eating disorders than in the general population. Fourth, TTM in individuals with eating disorders may index a particularly severe diagnostic group.

To better characterize sources of heterogeneity in eating disorders, we examined the association of the defining feature of TTM, disfiguring and repetitive hair-pulling, with clinical aspects of eating disorders in two large samples of women enrolled in multi-national studies of the genetics of AN and of BN (Kaye et al., 2004; Reba et al., 2005). To this end, we sought to determine whether the presence of repetitive hair-pulling is associated with a unique constellation of traits and symptomatic behaviors associated with eating disorders. Given its core phenotypic elements and presumed neural underpinnings in atypical habit control circuitry (Stein & Lochner, 2006), we hypothesized there would be greater endorsement of both impulsive and compulsive behaviors, greater novelty seeking, greater bulimic pathology, and more severe eating disorder pathology in the sample with repetitive hair-pulling.

Methods

Overview

Data for this project were drawn from two multisite, international collaborative studies designed to identify genetic regions associated with AN, BN, and related eating disorders using linkage analyses, the *AN Trios* and *Bulimia Nervosa Affected Relative Pair* (BN-ARP) cohorts (see sample descriptions). As the AN Trios study ascertained participants between 2000 and 2003 the BN-ARP study ascertained between 1998 and 2000, and assessment batteries differed slightly across studies, the sample size is constrained by the absence of some measurements across both groups. Each site obtained ethical approval separately from its home institutional review board or ethics committee.

All clinical interviewers went through a training process for the administration of each clinical assessment. The Data and Administrative Core at Pittsburgh developed a training package consisting of readings and explanations of the rating instruments. Before interviewing participants, each clinical interviewer completed a 4-day training program for the administration of the SCID, SCID-II, SIAB, the Y-BOCS, and the YBC-EDS. The training program included the following: 1) viewing videotapes of trained raters performing the assessments; 2) scoring another set of videotapes at an accepted standard of accuracy; and 3) taping their own practice interviews, which were evaluated for accuracy by study project coordinators. Subsequent to this training, every 10th interview was audiotaped for review by the project coordinator of the data core for drift prevention. Additionally, the interviewers at each site blindly rated tapes at 3-month intervals to ensure rating consistency across sites. Clinical interviewers for the study were masters or doctoral level psychologists or other mental health specialists, many of whom had participated in the preceding Price Foundation study. Upon certification with all interviews, clinical interviewers were permitted to begin interviewing for the study.

Sample

AN Trios Study (Reba et al., 2005)—Individuals affected with restricting or purging-type AN and both biological parents were recruited from nine sites in North America and Europe: Pittsburgh, New York, Los Angeles, Toronto, Munich, Pisa, Fargo, Baltimore, and Tulsa. Identified cases (hereafter referred to as probands) were required to meet the following criteria: (a) modified criteria of the 4th edition of the Diagnostic and Statistical Manual of Mental Disorders (APA, 1994) lifetime diagnosis of AN, with or without amenorrhea; (b) low weight that is/was less than the 5th percentile of body mass index (BMI) for age and sex on the chart of a National Health and Nutrition Examination Survey epidemiologic sample; (c) onset before the age of 25 years; (d) weight that is/was controlled through restricting and/or purging, which includes vomiting, use of laxatives, diuretics, enemas, suppositories, or Ipecac; (e) age between 13 years and 65 years; (f) Caucasian (one grandparent from another racial group did not preclude inclusion); (g) no lifetime history of regular binge eating; and (h) study diagnostic criteria were met at least 3 years before study entry. This last inclusion criterion ensured that individuals with AN were unlikely to develop binge eating in the future, as research has shown that most binge eating develops within the first 3 years of illness in AN (Bulik, Sullivan, Fear, & Pickering, 1997; Eckert, Halmi, Marchi, Grove, & Crosby, 1995; Eddy et al., 2002; Strober, Freeman, & Morrell, 1997; Tozzi et al., 2005). Potential participants were excluded if they reported a maximum BMI since puberty >27 kg/m^2 for females and >27.8 kg/ m^2 for males. This exclusion of individuals who were overweight or obese was based on the initial inclusion criteria for the genetic studies which were designed to increase sample homogeneity. Only probands (i.e., not affected relatives) from this sample were used in the current study.

Bulimia Nervosa Affected Relative Pair Study (BN-ARP)—For the BN-ARP sample, eligible probands had a lifetime diagnosis of BN, purging type, as defined in DSM-IV (APA, 1994) with the additional criterion of self-induced vomiting at a threshold of severity of at least twice weekly for a period of six months. In addition, they had to have a biological relative (who was not the parent, monozygotic twin, or child) who was willing to participate and had a lifetime diagnosis of AN, BN or subthreshold AN or BN. Additional inclusion criteria for the proband included age between 13-65 years old and primarily of European descent. History of AN was acceptable. Exclusions included prior or current diagnosis of mental retardation, dementia, organic brain syndromes, psychotic disorders, Turner's syndrome, or any medical condition that could affect appetite, body weight, or eating (e.g., diabetes and thyroid conditions were excluded if the onset of the disease preceded the onset of the eating disorder). Bipolar I and Bipolar II were excluded only if symptoms of BN occurred exclusively during manic or hypomanic episodes.

Inclusion criteria for affected relatives were age between 13 and 65 years and at least one of the following lifetime eating disorder diagnoses: (1) DSM-IV BN, purging or nonpurging type; (2) modified DSM-IV AN (amenorrhea not required), restricting type or binge eating/purging type; or (3) EDNOS (subthreshold AN, subthreshold BN, or subthreshold mixed). For a complete description of the study see (Kaye et al., 2004).

Study Sample—A total of 730 probands from the *AN Trios* study and 723 probands and affected relatives from the *BN ARP* study were eligible for inclusion in this study. The combined sample (n=1453) excluded 28 male participants, 2 participants missing data on eating disorder diagnosis, and 20 lacking data on hair pulling status. However, 69% of the BN ARP sample did not complete the Barratt Impulsivity Scale (BIS), and the final sample available for Model 7 (which included the BIS) was n=928.

Assessments

All measures were carefully chosen based on well-established reliability and validity of constructs of interest in prior work with samples with eating disorders, established discriminant validity in discerning unaffected biological relatives from relatives of controls, and predictive validity in discerning treatment course. Validity data on each measure are included with the individual measure descriptions below. See Kaye et al. for a detailed discussion of the study battery (Kaye et al., 2004). All interviews were conducted according to a standard protocol.

Psychiatric Diagnosis—Lifetime histories of eating disorders and the presence or absence of eating disorder behaviors (e.g., dieting, binge eating, purging) in probands and affected relatives were assessed with the Structured Interview for Anorexia Nervosa and Bulimia Nervosa (SIAB; Fichter, Herpertz, Quadflieg, & Herpertz-Dahlmann, 1998) and with an expanded version of Module H of the Structured Clinical Interview for DSM-IV (SCID) Axis I Disorders (First, Gibbon, Spitzer, & Williams, 1996).

Personality Traits—Temperament and character dimensions were measured with the Temperament and Character Inventory (TCI; Cloninger, Przybeck, Svrakic, & Wetzel, 1994), a widely used measure of temperament and purported environmentally influenced character variables. The TCI has demonstrated predictive validity in eating disorder treatment research (Grave, Calugi, Brambilla, & Marchesini, 2008), discriminant validity in discerning eating disorder subtypes both in the US and cross-culturally (Fassino, Amianto, & Abbate-Daga, 2009; Nishimura et al., 2008; Rybakowski et al., 2006), and construct validity with behavioral (e.g., Grave, Calugi, & Marchesini, 2008) and biological (e.g., Frank et al., 2005) features in those with eating disorders. Perfectionism was assessed with

the Frost Multidimensional Perfectionism Scale (MPS; Frost, Marten, Lahart, & Rosenblate, 1990). Given prior research supporting the specific relevance of the Concerns Over Mistakes subscale of this measure in discriminating individuals with AN relative to other psychiatric disorders (Tozzi et al., 2004) only this scale was entered into our statistical model. Trait levels of anxiety were assessed with the Trait subscale of the State-Trait Anxiety Inventory (STAI; Spielberger, 1983). Impulsive personality features were assessed with the Barratt Impulsivity Scale (BIS; Barratt & Patton, 1983), a widely used measure of impulsive personality traits composed of three factor-derived second order subscales of impulsivity (cognitive, motor, nonplanning) and found to discriminate those with eating disorders who abuse substances from those who do not (Bulik et al., 2004). These factor scores were combined into one total score in our statistical models. Reliability and validity of the use of this instrument was summarized in a 2009 comprehensive review (Stanford et al., 2009).

Axis I and II Psychiatric Disorders—Axis I disorders including TTM were assessed with the SCID (First et al., 1996). Because of controversy regarding the relevance of precise subjective states both prior to and following repetitive hair pulling (Criterion B and C), we chose to use just criterion A (Recurrent pulling out of one's hair resulting in noticeable hair loss). Personality disorders were assessed with the SCID II Personality Disorders (Spitzer, Williams, & Gibbon, 1987).

Obsessions and Compulsive Behaviors—The severity of obsessions and compulsions associated with Obsessive-Compulsive Disorder were assessed with the Yale-Brown Obsessive Compulsive Scale (YBOCS; Woody, Steketee, & Chambless, 1995). Individuals were first assessed regarding the nature of specific obsessions and compulsions via a checklist that is part of the YBOCS. Notably, the checklist for this study did not include hair-pulling. Using the most prominent obsessions and compulsions, subsequent interview questions queried the intrusiveness, frequency, duration, and impairment related to OCD symptomatology. For our statistical model, obsessions and compulsions associated with obsessive compulsive disorder were entered as separate variables. The Yale Brown Cornell Eating Disorder Scale (YBC-EDS; Sunday, Halmi, & Einhorn, 1995) is a measure modeled after the YBOCS but with specific assessment of those compulsions and obsessions associated with eating disorder diagnoses (e.g., cutting food into a certain number of bites, counting number of chews). The YBC-EDS has established validity (Goodman et al., 1989) and has been found to discriminate between the full and partial syndrome of BN (Crow, Agras, Halmi, Mitchell, & Kraemer, 2002). Obsessions and compulsions related to eating disorder symptomatology were entered as one score in our statistical model.

Self-Harm—History of self-harm was assessed by an item from the SCID-II personality disorders interview (First, Gibbon, Spitzer, Williams, & Benjamin, 1997) assessing lifetime presence of attempts from the section assessing borderline personality disorder (Have you tried to hurt or kill yourself or threatened to do so?).

Model Building and Statistical Analyses

We used univariate Poisson regression to estimate the relative risk of hair-pulling status. Our data contain correlated observations due to the presence of family members in the same sample with varying degrees of biological relatedness. Thus, we used Generalized Estimating Equations (GEE) to estimate the covariance structure for the errors, which adjusted for the within-family correlations. To maintain the minimum number of predictor variables that still addressed our research questions, we made some concessions in our data analytic strategy. First, given the importance of both obsessions and compulsions in the delineation of facets of the OCD spectrum, we kept these as two separate variables. We combined obsessions and compulsions related to eating disorder symptoms into one total

score as we lacked research supporting the distinction of these variables in regard to the OCD spectrum. The order of variable entry was based on the following assumptions. As we were interested in the unique association between anxiety related to the obsessive compulsive spectrum and hair pulling, general anxiety was included in the first model to control for variance due to trait anxiety. The order of predictor entry of remaining variables was based on weighing the following considerations: 1) the developmental trajectory of syndrome or feature onset relative to eating disorder onset (disorders and associated features associated with emergence early in the developmental trajectory were entered prior to associated features that appear later the developmental course, i.e. perfectionism prior to self-harm; and 2) trait features prior to state features (e.g., harm avoidance prior to compulsions associated with eating). Via these decisions, we tested a series of 7 models predicting hair-pulling status (yes/no) risk by incrementally adding the following covariates: Model 1, general anxiety (STAI); Model 2, anxiety related to OCD (Y-BOCS); Model 3, perfectionism (MPS-Concerns over Mistakes Scale); Model 4, temperament (TCI- Harm Avoidance and Novelty Seeking Score); Model 5, compulsions and obsessions related to eating (YBC-Worst Period Total); and Model 6, self-harm/cutting (SCID-II item).

The BIS total score, a self-report measure of impulsivity, is first introduced in Model 7. This score was measured for 227 (31%) of the participants in the *BN ARP* study and in 96% of the participants in the *AN Trios* study. This is potentially problematic as our data indicate that individuals from the BN-ARP study were also less likely to endorse hair-pulling. Thus, we wanted to ensure that any relationship between hair-pulling and impulsivity was a general effect and not confounded by participant study status or eating disorder subtype. To assess for this potential bias, we conducted several sensitivity analyses before selecting the final set of models. First, we compared parameter estimate differences for models 1-6 between two samples. The first sample comprised all participants (n=1,453) and the second sample was restricted to those with a BIS total score (n=928). If comparisons between the two models demonstrated comparable findings, this would ensure that all findings from Models 1-6 generalize to the entire sample regardless of whether they completed the BIS. With the exception of self-harm, which had an increase of 10% (greater in the reduced sample), no parameter estimate changes more than 2% in value. In part because of this finding, we conducted a post-hoc analysis that was not a part of our original data analysis plan in which we compared hair-pulling status as a function of eating disorder diagnostic subtype. Further, there was a check of parameter estimates for models 1-7 in the total sample relative to models in which we controlled for eating disorder subtype. Again, there was a negligible parameter estimate change, no more than 1%, with the exception of self-harm, which had a 3% change. Because comparisons of our results between models run with the full sample and models run with a sample restricted to completion of the BIS demonstrated the same pattern of results, these outcomes from the sensitivity analyses justified the use of a restricted population in Model 7 containing no control for eating disorder subtype.

For model-building, a common guideline is to restrict the analysis to no fewer than 10 events per variable (the presence of hair-pulling was our event of interest, 69 events in current sample). Thus, according to these guidelines, we would have restricted our models to 7 variables. In fact, constructing our regression models with all variables of interest, including the sensitivity analyses, resulted in a minimum ratio of five events per variable (12 predictor variables and 58 events) and a maximum ratio of approximately 7 variables per event, depending on the model. Recent simulation studies have been conducted to examine the flexibility of this ratio when other parameters (e.g. sample size, prevalence of the outcome variable of interest) are manipulated. Such analyses indicated an acceptable amount of bias and type I error with a more flexible events-per-variable ratio (Vittinghoff & McCulloch, 2006). Given these findings, we considered the events per variable of 7 as adequate (Vittinghoff & McCulloch, 2006). All analyses were performed using SAS/STAT

software, Version 9.1 of the SAS System for Windows (SAS Institute Inc., 2004). Finally, violation of potential model assumptions were examined (e.g. multicollinerarity). To check for this violation, we examined the variance inflation factor and found no index greater than 3. According to O'Brien (2007), variance inflation factors greater than 5 are considered problematic and thus the proposed models did not violate this assumption.

Results

Sample characteristics

The mean age of onset of eating disorder diagnosis was 16.9 years (standard deviation = ± 3.5; range 8-38 years) with an average duration of illness of 9.0 years (± 7.5; range 0-46 years). Average age at interview was 27.1 (± 8.5; range 13-64 years). The most frequent diagnosis was AN (26.8%, n = 389 restricting subtype; 14.8%, n=215 purging subtype, 9.5%, n=138 binge-purge subtype) with another 25.2% (n = 366) meeting criteria for a lifetime diagnosis of both AN and BN. An additional 17.8% (n = 258) met criteria for the purging subtype of BN, 1.5% (n=22) met criteria for the non-purging subtype of BN, and 4.5% (n = 65) met criteria for ED-NOS. Approximately 58.7% of the sample has never married, with another 14.8% not-married (i.e., divorced, separated, widowed, or living with a significant other), 20.9% married, and 5.6% missing this information. The largest proportion of the sample completed high school (42.9%); an additional 27.0% completed college, 13.7% completed graduate work, 9.3% did not complete high school, and 7.0% were missing that information. Because of the constraints imposed by genetic research, the race of the sample was homogenous and primarily of European descent.

Prevalence of features of TTM—Approximately 5% (n = 69) of the sample engaged in repetitive hair-pulling resulting in noticeable hair loss. Table 1 presents mean values of features proposed to differentiate groups as a function of hair-pulling status (yes = endorsement of hair-pulling), including obsessions and compulsions related to eating disorder and anxiety symptomatology, temperament variables, impulsivity, and self-harm behaviors.

Association between Hair-Pulling and Clinical Features—Without any adjusting factors, a one unit increase in the trait anxiety scale was associated with 2% higher risk of hair-pulling (Z-statistics (Z) = 2.29, $\underline{p}$ <.03) (see Table 2). As described in the methods, subsequent models in Table 2 are cumulative, keeping covariates from previous models and adding new ones. In Model 2, obsessions and compulsions assessed via the YBOCS were entered as the second and third covariates. In this model, compulsions reduced the strength of association between trait anxiety and hair pulling intensity by one percentage point, resulting in a coefficient no longer significant at an alpha level of 0.05. A one unit increase in compulsion score was associated with an 8% increase in risk of hair pulling (Z = 2.33, p < .02). The association between the obsession score and hair-pulling was less than 1%. Model 3 introduced Concern over Mistakes, a facet of perfectionism. There was a positive association between this aspect of perfectionism and hair pulling, which was neither statistically significant (Z = 0.99, p > .3), nor did it significantly alter the contribution of compulsions to hair-pulling. A similar pattern was seen for Models 4 and 5, in which a positive association with risk of hair pulling emerged for novelty seeking and harm avoidance, but did not alter the significant findings from prior models. Model 6 introduced self-harm behaviors. With their addition, compulsive behaviors were no longer significant, and the relative risk declined by one percentage point. Self-harm had the second largest effect size, after the compulsion score, resulting in a 6% increase in likelihood of hair-pulling. However, the variable of self-harm was not statistically significant. Finally, Model 7 introduced impulsivity as indexed by the total score of the BIS. This variable was inversely

associated with hair-pulling but was not statistically significant. Thus, in summary, compulsions were the only significant predictor of hair pulling, remaining significant after controlling for all variables except for self-harm. Both self-harm and the compulsion score had the largest effects of the nine predictors.

Discussion

We explored the utility of hair-pulling as a means of identifying uniform subgroups within the eating disorder spectrum. Among multiple putative associated features, compulsive features and trait anxiety were the only statistically significant predictors of hair-pulling at model entry. Specifically, in regression models that examined the association of hair-pulling with trait characteristics (perfectionism, harm avoidance, trait anxiety, novelty seeking), obsessive compulsive spectrum phenomena, eating disorder specific obsessions and compulsions, impulsive behaviors, and self-harm, only compulsive behavior associated with the obsessive compulsive spectrum was a statistically significant predictor, increasing the risk of hair pulling by 8% for every unit increase in score. With a 2-unit increase in compulsive symptomatology according to the Y-BOCS, individuals would have a 17% greater likelihood of hair-pulling. Trait anxiety in model 1 was the only other significant factor associated with hair-pulling with a relative risk of 1.02. Thus, in this sample, individuals with eating disorders who also endorse hair-pulling are more likely to endorse ritualistic compulsions associated with the obsessive compulsive spectrum, rather than impulsive features.

While TTM is currently regarded as an impulse control disorder, the presence of the defining clinical feature of TTM in this eating disorders sample had no association with scores on continuous measures of impulsivity. By contrast, compulsive behavior was predictive of hair-pulling, in accord with the notion that hair-pulling may share underlying features in common with the ritualistic compulsions in those with eating disorders. Rigid behavioral routines are typically seen in the premorbid histories of individuals with eating disorders, and they are reflected in the acute psychopathology of the syndrome as well, e.g., ritualistic eating patterns and rigid exercise regimens. Likewise, specific eating disorder symptoms such as binge eating have been simultaneously viewed as impulsive and compulsive in character. This pattern of results highlights the importance of investigating not only the presence of comorbid features, but also the phenomological experience of these features. The same behavioral feature (i.e., hair pulling) may be experienced by some as impulsive and others as compulsive, differences in experience that may lead to novel hypotheses about putative etiological pathways or nosological subtypes. In fact, such phenomological distinctions have prompted broader conceptualizations of the cues that may precede hair-pulling episodes or the experience of the episode itself (e.g., focused vs. automatic) leading to advanced conceptualizations of TTM (Duke, Keeley, Geffken, & Storch, 2010; Mackenzie, Ristvedt, Christenson, Lebow, & Mitchell, 1995). Unfortunately, data from the current study cannot speak to such subjective distinctions among specific hair-pulling episodes. This work may serve as a foundation for focused study of the shared phenomenology of specific clinical features, i.e. help define response classes within individuals.

Prior research examining impulse control disorders in those with eating disorders highlights the potential utility of a focused symptom approach. In a study examining the prevalence of impulse control syndromes and associated features in those with BN, obsessive-compulsive symptoms were higher relative to those without an impulse control disorder (Fernandez-Aranda et al., 2006). In fact, the group with BN and a comorbid impulse control disorder had elevated scores on all clinical subscales except paranoia (Fernandez-Aranda, et al., 2006). Thus while findings from this study are important in identifying those with comorbid

impulse control disorders as a severe clinical group, inferences about underlying biology using this approach may not be sufficiently constrained. A second study comparing impulse control disorders in a mixed clinical sample of those with eating disorders found that the presence of impulse control disorders were more likely in those who exhibited the symptom of binge eating, whether against a background of AN, BN, or ED-NOS (Fernandez-Aranda et al., 2008). Thus, these studies highlight the utility of the approach employed in the current study raising the possibility that focusing on comorbid symptoms rather than syndromes may help to define more homogenous groups. Such an approach would be consonant with similar strategies being employed in other neurodevelopmental disorders such as autism spectrum disorders (Happe, et al., 2006).

Further, our findings indicate that one out of every 20 individuals with eating disorders in this sample endorsed hair-pulling that resulted in noticeable hair loss. In a 2010 review of trichotillomania, Duke, Keeley, Geffken, and Storch (2010) describe how the true incidence and prevalence estimates of the full diagnostic criteria of trichotillomania are unknown. For example, the prevalence of hair-pulling varies widely in studies of college students (ranging from 1-13.3%) due to issues such as measurement strategy and sampling design. Given these constraints, we are unable to discern whether the prevalence of hair-pulling (or full diagnostic criteria for trichotillomania) is elevated in individuals with eating disorders. Our 5% prevalence estimates can serve as a starting point for future focused research on this question.

An additional consideration for future investigations is whether the phenomenology of clinical features (such as hair-pulling) or other forms of impulse dyscontrol are markers of disease progression, from appetitive learning to uncontrolled habit behavior instantiated by alterations in cortico-striatal functional circuitry. Such delineation might have future relevance for understanding the neurobiology of eating disorders in that current debates regarding symptom neurobiology and phenomenology may be more refined as longitudinal studies of brain function increasingly inform disease progression.

The results of this study must be considered in light of several limitations. To be statistically conservative, we maintained a selection of nine predictor variables in our regression models, a choice which forced us to use the total scales from several multi-factorial assessment measures. Thus, while compulsions were a significant predictor, obsessions were not. Further, we used one item administered via clinical interview to assess disfiguring hair-pulling and did not rely on objective substantiation of the degree of hair loss. Although this choice was necessitated by study design, nonetheless, there remains the possibility that hair-pulling was over-diagnosed. The relatively low prevalence suggests that this is unlikely. Further, via this limited assessment strategy, we were not able to differentiate subtypes of hair-pulling, a delineation that may add further refinement to future models of symptom comorbidity. Finally, generalization of study findings is constrained by the specificity of the sample. Although necessary for genetic research, such strict definitions for eligibility limit the degree to which study findings are emblematic of the general eating disorder population. Large scale epidemiological samples are essential to address this question.

In summary, we describe a unique group of individuals with eating disorders, those who engage in repetitive hair-pulling. The presence of such index clinical features may help to delineate more homogenous subgroups for more refined biological, genetic, and therapeutic study.

Acknowledgments

Dr. Zucker was supported by National Institute of Health grant (K23-MH-070418). Dr. Strober was supported in part by the Franklin Mint Endowed Chair in Eating Disorders. The authors wish to thank the Price Foundation for

the support of the clinical collection of participants and support of data analysis. The authors acknowledge the staff of the Price Foundation Collaborative Group for their efforts in participant screening and clinical assessments. The authors are indebted to the participating families for their contribution of time and effort in support of this study. This study was also supported by grant MH-66117 from the National Institutes of Health, Bethesda, MD.

References

American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 4. Washington, DC: 1994.

Anderluh M, Tchanturia K, Rabe-Hesketh S, Collier D, Treasure J. Lifetime course of eating disorders: design and validity testing of a new strategy to define the eating disorders phenotype. Psychological Medicine. 2009; 39:1–10.

Barratt, ES.; Patton, JH. Impulsivity: Cognitive, behavioral and psychophysiological correlates. In: Zuckerman, M., editor. Biological bases of sensation seeking, impulsivity and anxiety. Hillsdale, NY: Lawrence Erlbaum; 1983.

Brewer JA, Potenza MN. The neurobiology and genetics of impulse control disorders: Relationships to drug addictions. Biochemical Pharmacology. 2008; 75(1):63–75. [PubMed: 17719013]

Bulik CM, Klump KL, Thornton L, Kaplan AS, Devlin B, Fichter MM, Kaye WH, et al. Alcohol use disorder comorbidity in eating disorders: A multicenter study. Journal of Clinical Psychiatry. 2004; 65(7):1000–1006. [PubMed: 15291691]

Bulik CM, Sullivan PF, Fear J, Pickering A. Predictors of the development of bulimia nervosa in women with anorexia nervosa. Journal of Nervous and Mental Disease. 1997; 185:704–707. [PubMed: 9368548]

Bulik CM, Thornton LM, Root TL, Pisetsky EM, Lichtenstein P, Pedersen NL. Understanding the relation between anorexia nervosa and bulimia nervosa in a Swedish national twin sample. Biological Psychiatry. 2010; 67(1):71–77. [PubMed: 19828139]

Christenson GA, Mackenzie TB, Mitchell JE. Characteristics of 60 adult chronic hair pullers. American Journal of Psychiatry. 1991; 148(3):365–370. [PubMed: 1992841]

Christenson GA, Mitchell JE. Trichotillomania and repetitive bBehavior in bulimia nervosa. International Journal of Eating Disorders. 1991; 10(5):593–598.

Christenson GA, Pyle RL, Mitchell JE. Estimated lifetime prevalence of trichotillomania in college-students. Journal of Clinical Psychiatry. 1991; 52(10):415–417. [PubMed: 1938977]

Cloninger, CR.; Przybeck, TR.; Svrakic, DM.; Wetzel, RD. The Temperament and Character Inventory: A Guide to Its Development and Use. St Louis, MO: Washington University Center for Psychobiology of Personality; 1994.

Crow SJ, Agras WS, Halmi K, Mitchell JE, Kraemer HC. Full syndromal versus subthreshold anorexia nervosa, bulimia nervosa, and binge eating disorder: A multicenter study. International Journal of Eating Disorders. 2002; 32(3):309–318. [PubMed: 12210645]

Duke DC, Keeley ML, Geffken GR, Storch EA. Trichotillomania: A current review. Clinical Psychology Review. 2010; 30(2):181–193. [PubMed: 19926375]

Eckert ED, Halmi KA, Marchi P, Grove E, Crosby R. Ten-year follow-up of anorexia nervosa: clinical course, and outcome. Psychological Medicine. 1995; 25:143–156. [PubMed: 7792349]

Eddy K, Keel P, Dorer D, Delinsky S, Franko D, Herzog D. Longitudinal comparison of anorexia nervosa subtypes. International Journal of Eating Disorders. 2002; 31:191–201. [PubMed: 11920980]

Eddy KT, Dorer DJ, Franko DL, Tahilani K, Thompson-Brenner H, Herzog DB. Diagnostic crossover in anorexia nervosa and bulimia nervosa: implications for DSM-V. American Journal of Psychiatry. 2008; 165(2):245–250. [PubMed: 18198267]

Engel SG, Corneliussen SJ, Wonderlich SA, Crosby RD, le Grange D, Crow S, Steiger H, et al. Impulsivity and compulsivity in bulimia nervosa. International Journal of Eating Disorders. 2005; 38(3):244–251. [PubMed: 16211626]

Fassino S, Amianto F, Abbate-Daga G. The dynamic relationship of parental personality traits with the personality and psychopathology traits of anorectic and bulimic daughters. Comprehensive Psychiatry. 2009; 50(3):232–239. [PubMed: 19374967]

Fernandez-Aranda F, Jimenez-Murcia S, Alvarez-Moya EM, Granero R, Vallejo J, Bulik CM. Impulse control disorders in eating disorders: clinical and therapeutic implications. Comprehensive Psychiatry. 2006; 47(6):482–488. [PubMed: 17067872]

Fernandez-Aranda F, Pinheiro AP, Thornton LM, Berrettini WH, Crow S, Fichter MM, Bulik CM, et al. Impulse control disorders in women with eating disorders. Psychiatry Research. 2008; 157(1-3):147–157. [PubMed: 17961717]

Fichter MM, Herpertz S, Quadflieg N, Herpertz-Dahlmann B. Structured interview for anorexic and bulimic disorders for DSM-IV and ICD-10: Updated (third) revision. International Journal of Eating Disorders. 1998; 24(3):227–249. [PubMed: 9741034]

Fichter MM, Quadflieg N, Hedlund S. Twelve-year course and outcome predictors of anorexia nervosa. International Journal of Eating Disorders. 2006; 39(2):87–100. [PubMed: 16231345]

First, M.; Gibbon, M.; Spitzer, R.; Williams, J.; Benjamin, L. User's guide for the structured clinical interview for DSM-IV Axis II personal disorders (SCID-II). Washington, D.C.: American Psychiatric Press; 1997.

First, MB.; Gibbon, M.; Spitzer, RL.; Williams, JBW. Users guide for the structured clinical interview for DSM-IV Axis I disorders—research version (SCID-I, version 2.0, February 1996 final version). New York: New York State Psychiatric Institute; 1996.

Frank GK, Bailer UF, Henry SE, Drevets W, Meltzer CC, Price JC, Kaye WH, et al. Increased dopamine D2/D3 receptor binding after recovery from anorexia nervosa measured by positron emission tomography and [C-11]raclopride. Biological Psychiatry. 2005; 58(11):908–912. [PubMed: 15992780]

Frost RO, Marten PA, Lahart C, Rosenblate R. The dimensions of perfectionism. Cognitive Therapy and Research. 1990; 14:449–468.

Goodman W, Price L, Rasmussen S, Mazure C, Fleischmann R, Hill C, Charney DS, et al. The Yale-Brown Obsessive-Compulsive Scale (Y-BOCS): I. development, use, and reliability. Archives of General Psychiatry. 1989; 46:1006–1011. [PubMed: 2684084]

Gottesman II, Gould TD, et al. The endophenotype concept in psychiatry: Etymology and strategic intentions. American Journal of Psychiatry. 2003; 160(4):636–645. [PubMed: 12668349]

Grave RD, Calugi S, Brambilla F, Marchesini G. Personality dimensions and treatment drop-outs among eating disorder patients treated with cognitive behavior therapy. Psychiatry Research. 2008; 158(3):381–388. [PubMed: 18295903]

Grave RD, Calugi S, Marchesini G. Compulsive exercise to control shape or weight in eating disorders: prevalence, associated features, and treatment outcome. Comprehensive Psychiatry. 2008; 49(4):346–352. [PubMed: 18555054]

Happe F, Ronald A, Plomin R. Time to give up on a single explanation for autism. Nature Neuroscience. 2006; 9(10):1218–1220.

Kaye WH, Devlin B, Barbarich N, Bulik CM, Thornton L, Bacanu S-A, Berrettini WH, et al. Genetic analysis of bulimia nervosa: methodos and sample description. International Journal of Eating Disorders. 2004; 35:557–570.

Hollander E, Kim S, Braun A, Simeon D, Zohar J. Cross-cutting issues and future directions for the OCD spectrum. Psychiatry Research. 2009; 170:3–6. [PubMed: 19811839]

Lochner C, Stein DJ. Does work on obsessive-compulsive spectrum disorders contribute to understanding the heterogeneity of obsessive-compulsive disorder? Progress in Neuro-Psychopharmacology & Biological Psychiatry. 2006; 30(3):353–361. [PubMed: 16458405]

Mackenzie T, Ristvedt S, Christenson G, Lebow A, Mitchell J. Identification of cues associated with compulsive, bulimic, and hair-pulling symptoms. Journal of Behavior Therapy and Experiemental Psychiatry. 1995; 26:9–16.

Nishimura H, Komaki G, Ando T, Nakahara T, Oka T, Kawai K, Ishikawa T, et al. Psychological and weight-related characteristics of patients with anorexia nervosa-restricting type who later develop bulimia nervosa. Biopsychosocial Medicine. 2008; 2:5. [PubMed: 18267038]

O'Brien RM. A caution regarding rules of thumb for variance inflation factors. Quality and Quantity. 2007; 41(5):673–690.

Pinhas L, Geist R, Katzman DK. Trichotillomania and anorexia nervosa in an adolescent female: A case study of comorbidity. Journal of Adolescent Health. 1996; 19(2):141–144. [PubMed: 8863086]

Psychiatric GWAS Consortium (PGC). A framework for interpreting genomewide association studies of psychiatric disorders. Molecular Psychiatry. 2009; 14:10–17. [PubMed: 19002139]

Reba L, Thornton L, Tozzi F, Klump KL, Brandt H, Crawford S, Bulik CM, et al. Relationships between features associated with vomiting in purging-type eating disorders. International Journal of Eating Disorders. 2005; 38(4):287–294. [PubMed: 16261604]

Ronald A, Happe F, Price TS, Baron-Cohen S, Plomin R. Phenotypic and genetic overlap between autistic traits at the extremes of the general population. Journal of the American Academy of Child and Adolescent Psychiatry. 2006; 45(10):1206–1214. [PubMed: 17003666]

Rybakowski F, Slopien A, Dmitrzak-Weglarz M, Czerski P, Rajewski A, Hauser J. The 5-HT2A -1438 A/G and 5-HTTLPR polymorphisms and personality dimensions in adolescent anorexia nervosa: association study. Neuropsychobiology. 2006; 53(1):33–39. [PubMed: 16397402]

SAS Institute Inc. SAS/STAT® Software: Version 9. Cary, NC: SAS Institute, Inc; 2004.

Spielberger, CD. Manual for State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press; 1983.

Spitzer, R.; Williams, J.; Gibbon, M. Structured clinical interview for DSM-III-R: personality disorders (SCID-II, 3/1/87). Biometrics Research Department, New York State Psychiatric Institute; 1987.

Stanford MS, Mathias CW, Dougherty DM, Lake SL, Anderson NE, Patton JH, et al. Fifty years of the Barratt Impulsiveness Scale: An update and review. Personality and Individual Differences. 2009; 47(5):385–395.

Stein DJ, Grant JE, Franklin ME, Keuthen N, Lochner C, Singer HS, Woods DW. Trichotillomania (hair pulling disorder), skin picking disorder, and stereotypic movement disorder: Toward DSM-V. Depression and Anxiety. 2010; 27(6):611–626. [PubMed: 20533371]

Strober M, Freeman R, Morrell W. The Long Term Course of Severe Anorexia Nervosa in Adolescents: Survival Analysis of Recovery, Relaspe, and Outcome Predictors over 10-15 Years in a Prospective Study. International Journal of Eating Disorders. 1997; 22:339–360. [PubMed: 9356884]

Sunday SR, Halmi KA, Einhorn A. The Yale-Brown-Cornell Eating Disorder Scale - a New Scale to Assess Eating Disorder Symptomatology. International Journal of Eating Disorders. 1995; 18(3): 237–245. [PubMed: 8556019]

Tozzi F, Aggen SH, Neale BM, Anderson CB, Mazzeo SE, Neale MC, Bulik CM. The structure of perfectionism: A twin study. Behavior Genetics. 2004; 34(5):483–494. [PubMed: 15319571]

Tozzi F, Thornton L, Klump K, Bulik C, Fichter M, Halmi K, Kaye WH, et al. Symptom fluctuation in eating disorders: correlates of diagnostic crossover. American Jounal of Psychiatry. 2005; 162:732–740.

Tyler I, Wiseman MC, Crawford RI, Birmingham CL. Cutaneous manifestations of eating disorders. Journal of Cutaneous Medicine and Surgery. 2002; 6(4):345–353. [PubMed: 11951131]

Vittinghoff E, McCulloch CE. Relaxing the rule of ten events per variable in logistic and cox regression. American Journal of Epidemiology. 2006; 165(6):710–718. [PubMed: 17182981]

Woody SR, Steketee G, Chambless DL. Reliability and validity of the Yale-Brown Obsessive-Compulsive Scale. Behaviour Research and Therapy. 1995; 33(5):597–605. [PubMed: 7598684]

Table 1

Characteristics of Predictor Variables by Presence of Hair-pulling.

	Hair Pulling Status	
Scale	**Yes (n=69)**	**No (n=1384)**
State-Trait Anxiety Inventory: Trait	54.67 (±13.91)	50.69 (±13.69)
Yale-Brown Obsessive Compulsive Scale: Compulsion	10.82 (±6.17)	6.87 (±6.58)
Yale-Brown Obsessive Compulsive Scale: Obsession	9.46 (±6.04)	6.22 (±6.28)
MPS: Concern over mistakes scale score	35.52 (±8.30)	31.91 (±9.64)
Temperament and Character Inventory: Harm avoidance	22.27 (±7.41)	20.26 (±7.70)
Temperament and Character Inventory: Novelty seeking scale	18.08 (±7.78)	18.39 (±7.11)
Yale-Brown-Cornell Eating Disorder Scale: Worst period total	25.96 (±5.56)	24.23 (±5.98)
SCID II: Self-harm[a]	0.23	0.16
Barratt Impulsivity total score: cognitive + motor + nonplanning[b]	61.84 (±11.63)	61.52 (±11.25)

Note. N's vary somewhat across measures.

[a]Indicates proportion, i.e. 23% of the sample who engaged in hair-pulling also engaged in self-harm.

[b]Barratt total score has sample size of n=58 for those reporting hair pulling and n=870 for those who do not.

Table 2

Relative Risk[a] (95% confidence interval) of Hair-pulling by Clinical Characteristics

	Regression Model						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1) Trait anxiety[b]	1.02 * (1.00, 1.04)	1.01 (0.99, 1.03)	1.01 (0.99, 1.03)	1.01 (0.98, 1.03)	1.01 (0.98, 1.03)	1.00 (0.98, 1.03)	1.01 (0.98, 1.04)
2) Compulsions[c]		1.08 * (1.01, 1.15)	1.08 * (1.01, 1.15)	1.08 * (1.01, 1.15)	1.08 * (1.01, 1.15)	1.07 (1.00, 1.14)	1.08 (1.00, 1.17)
3) Obsessions[c]		1.01 (0.94, 1.07)	1.00 (0.94, 1.07)	1.00 (0.94, 1.07)	1.00 (0.94, 1.07)	1.01 (0.94, 1.08)	1.01 (0.93, 1.09)
4) Concern over mistakes [d]			1.02 (0.98, 1.05)	1.02 (0.98, 1.05)	1.02 (0.98, 1.05)	1.02 (0.98, 1.06)	1.00 (0.96, 1.04)
5) Harm avoidance[e]				1.01 (0.96, 1.05)	1.01 (0.96, 1.06)	1.01 (0.97, 1.06)	1.04 (0.98, 1.09)
6) Novelty seeking[e]				1.02 (0.98, 1.06)	1.02 (0.98, 1.06)	1.02 (0.99, 1.06)	1.05 (0.99, 1.11)
7) Eating compulsions and obsessions[f]					1.00 (0.95, 1.06)	1.01 (0.95, 1.07)	0.99 (0.92, 1.06)
8) Self-harm behavior (yes/no)[g]						1.06 (0.57, 1.98)	1.19 (0.60, 2.36)
9) Impulsivity[h]							0.98 (0.94, 1.01)

[a]Relative risk refers to the risk of an event occurring relative to exposure to some event (in this case our predictor variables). For example, in Model 1, with each unit increase on the STAI, individuals are twice as likely to engage in hair-pulling.

[b]State-Trait Anxiety Inventory,

[c]Yale-Brown Obsessive Compulsion Scale;

[d]Multi-dimensional Perfectionism Scale,

[e]Temperament and Character Inventory,

[f]Yale-Brown-Cornell Eating Disorder Scale,

[g]Self-harm as measured by the SCID-II,

[h]Barrett Impulsivity Scales.

*p <.05