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Is the Relationship Between Binge Eating Episodes and Personality Attributable to Genetic Factors?

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Aspects of disordered eating and personality traits, such as neuroticism, are correlated and individually heritable. We examined the phenotypic correlation between binge eating episodes and indices of personality (neuroticism, extraversion, openness to experience, agreeableness, conscientiousness, and control/impulsivity). For correlations ≥|0.20|, we estimated the extent to which genetic and environmental factors contributed to this correlation. Participants included 3,446 European American same-sex female twins from the Missouri Adolescent Female Twin Study (median age = 22 years). Binge eating episode was assessed via interview questions. Personality traits were assessed by self-report questionnaires. There was a significant moderate phenotypic correlation between binge eating episode and neuroticism ($r = 0.33$) as well as conscientiousness ($r = -0.21$), while other correlations were significant but smaller (r ranging from -0.14 to 0.14). Individual differences in binge eating episodes, neuroticism, and conscientiousness were attributed to additive genetic influences (38% [95% CI: 21–53%], 45% [95% CI: 38–52%], and 44% [95% CI: 0.33–0.55%] respectively), with the remaining variance attributed to individual-specific environmental influences. Covariance was attributable to genetic (neuroticism $r_g = 0.37$; conscientiousness $r_g = -0.22$) and individual-specific environmental (neuroticism $r_e = 0.28$; conscientiousness $r_e = -0.19$) influences. Personality traits may be an early indicator of genetic vulnerability to a variety of pathological behaviors, including binge eating episode. Furthermore, prior research documenting phenotypic correlations between eating disorder diagnoses and personality may have stemmed from etiological overlap between these personality traits and aspects of disordered eating, such as binge eating episode.

■ **Keywords:** eating disorders, binge eating, personality, neuroticism, twins, bivariate analysis

Anorexia nervosa and bulimia nervosa affect approximately 0.9% and 1.5% of women, respectively (Hudson et al., 2007). Despite these seemingly modest rates, disordered eating is a serious mental health problem, especially for women in their teens and early twenties, contributing to significant morbidity and mortality (Whiteford et al., 2013). While clinical diagnoses are relatively rare, the frequency of specific disordered eating symptoms, such as episodes of binge eating (eating a large amount of food in a discrete period of time, accompanied by a sense of loss of control) are reported to be more prevalent. For example, a population-based study conducted by Hudson and colleagues (2007) found the lifetime prevalence of bulimia nervosa to be around 1.5% in women, but the prevalence of binge eating behavior (i.e., recurrent episodes of binge eating accompanied by lack of control during episodes, occurring two times a week for 3 months or longer) alone to be 4.5%.

Prior research has suggested that personality traits may play a distinct role in the development of eating pathology (see Cassin & von Ranson, 2005, for a review). High neuroticism scores have been consistently correlated with eating disorder diagnoses. Results for other indices of personality have been equivocal. For instance, mixed evidence suggests

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that lower conscientiousness and agreeableness and greater openness to experience are associated with eating disorders, although the association with openness may be mediated by low neuroticism and agreeableness scores. Extraversion, on the other hand, appears to have weak to non-existent associations with disordered eating. Increased impulsivity and novelty seeking have also been noted among individuals with bulimia nervosa, the binge/purge subtype of anorexia nervosa, and those who binge eat compared with control individuals. Other aspects of temperament, such as harm avoidance, are also elevated across all subtypes of eating disorders. Taken together, these studies suggest that personality traits may be contributors to the etiology of disordered eating.

Aspects of disordered eating (e.g., binge eating episodes) and personality traits are moderately heritable. Previous research has indicated that disordered eating characteristics are influenced by additive genetic effects and individual-specific environmental effects, with shared environment playing a negligible role overall. Specifically, for binge eating, heritability estimates range from 17–82% (Bulik et al., 1998, 2003; Munn et al., 2010; Munn-Chernoff et al., 2013; Reichborn-Kjennerud et al., 2003, 2004; Wade et al., 2008). Likewise, additive genetic and individual-specific environmental factors account for the majority of the variance in personality traits (Jang et al., 1996; Viken et al., 1994) with heritabilities ranging from 40–55% (Bezdjian et al., 2011; Finkel & McGue, 1997; Jang et al., 1996; Luciano et al., 2006). Similar to binge eating, there is little evidence for shared environmental factors; however, some studies have supported the role of non-additive genetic influences on personality, particularly neuroticism, as assessed via the Eysenck Personality Questionnaire (Eaves et al., 1998; Keller et al., 2005; Lake et al., 2000) but not when measured using other scales, such as the NEO Inventories (Jang et al., 1996, 1998).

Despite this evidence for phenotypic correlations between aspects of disordered eating, particularly binge eating, and personality traits and their individual, heritable underpinnings, only three studies have investigated the overlap of genetic and environmental factors on disordered eating and personality. Wade and colleagues (2000) examined the overlapping origins of eating pathology (score across 16 items related to disordered eating), personality traits such as neuroticism and self-esteem, and factors pertaining to perceptions of parental bonding in middle-aged women. From a single independent pathway model, they noted that individual-specific environmental factors accounted for a large proportion of the variance in and covariance between a majority of the variables, with little evidence for shared genetic influences. A second study (Klump et al., 2002) of adolescent girls reported significant correlations between negative emotionality (tendency to experience negative mood states, such as anxiety; Tellegen, 1982), positive emotionality (tendency to be social and engage in positive mood states) and constraints, and aspects of disordered eating such as body dissatisfaction, weight preoccupation, compensatory behaviors, and binge eating. Unlike the prior study (Wade et al., 2000), Klump and colleagues (2002) concluded that additive genetic and individual-specific environmental factors best explained the overlap between personality traits and aspects of disordered eating. Finally, a recent study (Racine et al., 2013) examined associations among negative urgency (or the tendency to act rashly or impulsively in response to negative affect), negative affect, binge eating, and emotional eating in late adolescent girls and young adult women. Similar to Klump and colleagues (2002), genetic and individual-specific environmental factors contributed most to the overlap of these phenotypes, with the largest proportion of the correlation explained by genetic factors. Thus, the evidence surrounding the role of genetic contributions to the correlation between aspects of disordered eating and personality remain mixed and largely restricted to personality indices of negative mood states.

In an effort to extend this literature, the aim of the current study was to examine the association between personality traits (neuroticism, extraversion, conscientiousness, agreeableness, openness to experience, and control/impulsivity) and binge eating episode, the most widely studied aspect of disordered eating and now the basis for the new DSM-5 binge eating disorder (American Psychiatric Association, 2013). As noted above, prior studies have largely focused on neuroticism alone or broader domains of negative mood states, and we are not aware of any study that has explored the role of genetic factors in the relationship between additional personality measures (e.g., conscientiousness) and binge eating episodes. For those personality traits that were significantly associated with binge eating, we then examined the extent to which genetic and environmental factors contributed to this correlation.

Methods

Sample

Data for this study are drawn from the Missouri Adolescent Female Twin Study (MOAFTS), a cohort of same-sex female twin pairs identified from birth records who were born between July 1, 1975 and June 30, 1985 (Heath et al., 2002). Using a cohort-sequential sampling design, twins and their parents were invited to take part in the baseline interviews, with at least one biological parent interviewed (generally the mother) during 1994–1999, when the twins were 13, 15, 17, or 19 years old. Further details regarding sample recruitment and characteristics of this first wave of interview data are given elsewhere (Knopik et al., 2005). As the baseline assessment was targeted at behaviors specific to childhood and adolescence, not all measures of psychopathology were administered. During 2002–2005, all eligible twins, regardless of whether they had participated in the baseline assessments or not (and as long as they had not declined

to participate in future interviews) were invited to participate in the first full-length adult follow-up interview. Of the 3,446 twins interviewed at baseline, 2,356 (82.9%) participated in the adult follow-up, along with an additional 1,431 eligible twins, aged 18–29 years. The final sample (N = 3,787, 14.6% African American, with the remainder of European American ancestry) represented 80% of live born female twins identified via state birth records. The individual twins could be classified as 964 monozygotic (MZ) and 809 dizygotic (DZ) pairs with an additional 97 MZ and 145 DZ twins whose co-twin did not participate. Contemporaneously, 3,661 of these twins responded to a mailed questionnaire that included personality measures. The protocol was approved by the Washington University School of Medicine Institutional Review Board, and all twins gave informed consent before study participation.

For the present analyses, data on 3,233 twins of self-reported European American descent were utilized. As the etiological underpinnings of binge eating episodes and personality may vary across ethnic groups and the proportion of African American twins available was modest, we restricted these analyses to the European American subjects only. The 3,233 twins constituted 854 MZ and 663 DZ pairs as well as 84 MZ and 115 DZ twins whose co-twins did not participate.

Measures

Binge eating episode. The Semi-Structured Assessment of the Genetics of Alcoholism (SSAGA) was administered via a telephone interview to the twins (Bucholz et al., 1994). The eating disorders section was adapted from the Diagnostic Interview Schedule (version 4; Robins et al., 1996). Although primarily aimed at obtaining DSM-IV diagnoses, some changes were made to the section — a detailed explanation of these modifications may be found elsewhere (Duncan et al., 2007). All items represent lifetime assessments, were dichotomously coded, and based on single items that were presented to all participants without any study-related skips. Binge eating was assessed as *ever eating a large amount of food in a short period of time, usually less than two hours.* Those who reported binge eating were asked if they had experienced loss of control (i.e., they were afraid that they could not stop eating) during those times. A three-level ordinal measure (no binge eating, binge eating without loss of control, and binge eating with loss of control) was used to define an episode of binge eating and for analyses.

Personality. Neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness were coded using 12 items, each drawn from the NEO Five Factor Inventory (Costa & McCrae, 1985), whereas control/impulsivity was scored by reverse-coding 12 items that assessed control from the Multidimensional Personality Questionnaire (MPQ; Tellegen, 1982) — hence increasing scores on our measure of impulsivity reflect lower levels of control (i.e., being cautious, reflective, rational, liking to plan). We refer to this measure throughout the article as control/impulsivity to distinguish it from numerous other measures of impulsivity (e.g., sensation seeking, disinhibition). Average scores for each individual were calculated and then scores in the sample were used to create categorical personality variables representing data quartiles. This was done for two reasons — first, the personality measures were not normally distributed; second, the statistical software package used for twin analyses did not accommodate the modeling of covariation between an ordinal (e.g., binge eating) and a continuous (e.g., continuously distributed neuroticism) measure.

Analysis

First, we examined phenotypic correlations for each categorically defined personality measure with binge eating, using polychoric correlation estimates from SAS (SAS Institute, 1999). Only those correlations that were equal to or exceeded an absolute value of 0.20 were further explored using the twin design.

Bivariate twin models using Cholesky decomposition were used to parse the variance in and the covariance between individual personality traits and binge eating episodes into their additive genetic (A), shared environmental (C), and individual-specific environmental (E) sources. All models were fit to raw data in the statistical software package Mx (Neale et al., 2006) using full information maximum likelihood. Thresholds were adjusted for age. The chi-square difference test ($\Delta\chi^2$; Neale & Cardon, 1992) was used to examine whether constraining parameters to zero resulted in a significant deterioration in the model fit.

Results

Binge eating episode was endorsed by 7.4% of the sample, with 4.8% and 2.6% reporting it without and with loss of control respectively. Table 1 shows polychoric phenotypic correlations between binge eating and personality traits. Correlations ranged from -0.21 to 0.32 and were relatively modest. Correlations between binge eating episode and all personality traits were significant, with higher neuroticism, openness to experience, and impulsivity, and lower extraversion, agreeableness, and conscientiousness scores correlating with binge eating episode. Based on these phenotypic correlations, we elected to focus on the genetic relationship between binge eating episode and neuroticism as well as conscientiousness as those correlations exceeded an absolute value of 0.20.

The test for multivariate normality was satisfied for all three ordinal measures ($p > .05$). MZ and DZ twin correlations (r_{MZ} and r_{DZ}, respectively; Table 1) suggested that genetic and individual-specific environmental effects contributed to the variance in all three measures.

TABLE 1

Polychoric Correlations [95% Confidence Interval (CI)] of Binge Eating Episode With Personality Traits and Correlations Between Monozygotic (R_{MZ}) and Dizygotic (R_{DZ}) Twins for Those Measures Used in Twin Analyses

	Binge eating episode	r_{MZ} [95% CI]	r_{DZ} [95% CI]
Binge eating episode	—	0.39 [0.26–0.52]	0.17 [0.01–0.34]
Neuroticism	**0.33 [0.26–0.40]**	0.45 [0.39–0.50]	0.27 [0.21–0.34]
Extraversion	-0.12 [-0.19 to -0.05]	—	—
Agreeableness	-0.14 [-0.21 to -0.07]	—	—
Openness to experience	0.14 [0.05–0.22]	—	—
Conscientiousness	**-0.21 [-0.27** to **-0.13]**	0.46 [0.41–0.51]	0.19 [0.10–0.24]
Control/impulsivity	0.09 [0.02–0.16]	—	—

Note: All correlations significant at $p < .05$; correlations in bold ≥ |0.2| and hence, pursued in twin models.

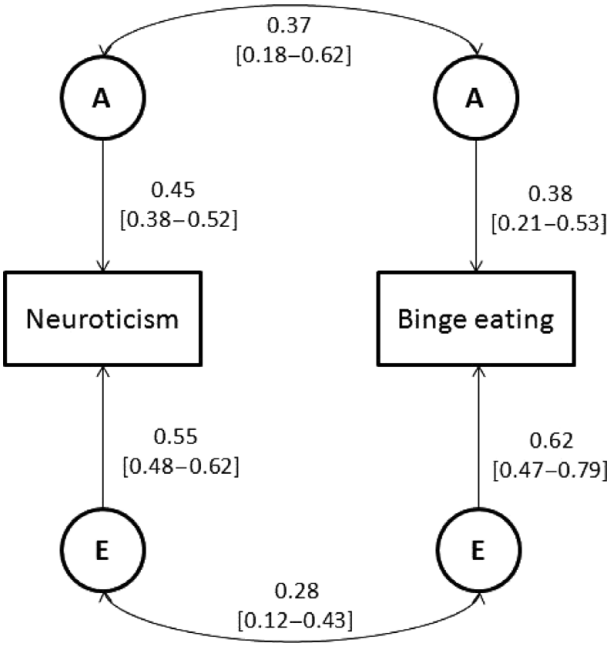

FIGURE 1

Best-fitting bivariate model of binge eating episode and neuroticism.
Note: A = additive genetic effects; E = individual-specific environmental effects. 95% confidence intervals are shown in parenthesis.

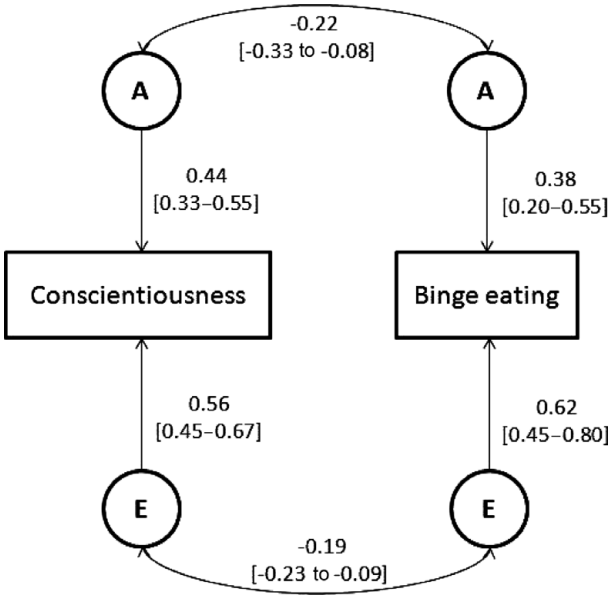

FIGURE 2

Best-fitting bivariate model of binge eating episode and conscientiousness.
Note: A = additive genetic effects; E = individual-specific environmental effects. 95% confidence intervals are shown in parenthesis.

The best-fitting bivariate twin model for the relationship between binge eating episode and neuroticism and conscientiousness is depicted in Figures 1 and 2. As indicated by the fit statistics (Table 2), shared environmental (but not genetic) influences could be constrained to zero without a significant deterioration in the model fit. Additive genetic influences explained 38–45% of the variance in the measures, with the remainder attributable to individual-specific

TABLE 2

Model-Fit Statistics for Bivariate Twin Models Examining the Relationship Between Binge Eating Episode, Neuroticism, and Conscientiousness

		Neuroticism		Conscientiousness	
	Δ (degrees of freedom)	$\Delta\chi^2$	*p* value	$\Delta\chi^2$	*p* value
Drop C	3	2.02	>.05	1.91	>.05
Drop A					
Personality	1	130.01	<.0001	132.95	<.0001
Overlap	1	13.12	2.9E-4	3.91	.047
Specific to binge eating episode	1	16.80	4.2E-5	14.99	1.1E-4
Drop E					
Overlap	1	11.64	6.5E-4	5.55	.02

environment. For both personality traits, estimates of heritability closely approximated those that would have been obtained if using continuously distributed scores (h^2_N = 0.45 [95% CI: 0.39–0.52]; h^2_C = 0.42 [95% CI: 0.35–0.48]), supporting our use of categorical personality measures.

The covariance between binge eating episode and the personality traits of neuroticism and conscientiousness was also attributable, about equally, to additive genetic and individual-specific environmental factors. For neuroticism, additive genetic and individual-specific environment explained 49% and 51% of the covariance with binge eating episode, respectively. Likewise, for conscientiousness, 45% and 55% of the covariance with binge eating episode was due to additive genetic and individual-specific environmental factors respectively. With respect to the genetic influences on binge eating episode, only 13.7% and 4.8% were attributable to those genes that also influenced neuroticism and conscientiousness respectively, suggesting that despite the significant genetic correlations, a vast majority of the genetic influences on binge eating episodes were distinct from those influencing personality. Likewise, only 8% and 3.6% of the individual-specific environmental influences on binge eating episode were attributable to those influencing neuroticism and conscientiousness respectively.

Discussion

In this study, we sought to examine the correlations between binge eating episodes and personality traits drawn from the NEO (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) as well as control/impulsivity, and to further explore the genetic and environmental underpinnings of the more robust of these correlations. Consistent with the extant literature (Cassin & von Ranson, 2005; Claes et al., 2006; Diaz-Marsa et al., 2000; Miller et al., 2006), we found positive correlations for neuroticism, openness to experience, and control/impulsivity, and negative correlations for extraversion, agreeableness, and conscientiousness. We pursued the strongest of these — the correlations between binge eating episodes and neuroticism as well as conscientiousness.

The heritability estimate of binge eating episodes from our study was fairly comparable to those reported previously (Bulik et al., 1998; Munn et al., 2010; Munn-Chernoff et al., 2013; Reichborn-Kjennerud et al., 2003), as were those for neuroticism and conscientiousness (Jang et al., 1996; Wray et al., 2007). Consistent with two prior studies (Klump et al., 2002; Racine et al., 2013) that studied varying definitions of negative mood states, we found that genetic and environmental factors contributed to the relationship between a binge eating episode and neuroticism. However, our results differ from another study (Wade et al., 2000) that indicated little genetic overlap between disordered eating and neuroticism. This might be due to the heterogeneous measure of disordered eating used in that study, which included obesity, binge eating, and clinical diagnoses for anorexia and bulimia nervosa. Additionally, the age of the twins in the study performed by Wade et al. (2000) ranged from 30 to 45 years, which is more than that of the twins examined in the present study, and it is possible that genetic effects decrease with time as individuals age beyond the point of risk for eating pathologies.

What does this shared etiology reflect? It is possible that neuroticism, which reflects a tendency towards increased negative mood states, represents a common diathesis from which binge eating episodes and a host of other related pathologies (e.g., major depression) emerge (Levinson, 2006). We did note that sisters of individuals endorsing any form of binge eating episode, on average, reported somewhat higher neuroticism scores (mean = 1.92, SE = 0.68) than sisters of those who did not have a history of any binge eating episode (mean = 1.68, SE = 0.63). Alternatively, individuals with an increased vulnerability to neuroticism, which approaches pathological levels, may cope by binge eating (Lilenfeld, 2011).

In contrast to the few studies that have previously examined negative emotionality/neuroticism, ours is the only study to have parsed the covariance between binge eating episode and conscientiousness, in equal measure, to its additive genetic and individual-specific environmental sources. While studies have documented lower scores of conscientiousness in individuals with eating disorders (Ghaderi & Scott, 2001), we are not aware of any twin studies of this relationship. As measured by the NEO-FFI, conscientiousness reflects organization and control, and therefore, may share etiological underpinnings with lack of control during binge eating episodes. Nevertheless, the phenotypic correlation was modest and the relative contribution of genetic and environmental factors should be replicated.

Some limitations of the present study are noteworthy. First, binge eating episodes were assessed with two questions and did not include frequency of these episodes. Second, as binge eating episodes and personality traits were assessed concurrently, the results from this study cannot speak of causal relations or the direction of the relation between these episodes and personality. However, as the cross-trait, individual-specific environmental correlation was significant, it is possible that causal influences contribute to the relationship between binge eating episodes and these personality traits. Fourth, it is possible that with larger sample sizes, even the modest correlations between the other personality traits and binge eating episodes could be disaggregated into their genetic and environmental sources. Finally, the results of this study may not generalize to other populations. For instance, due to the relatively modest proportion of African American twins in this cohort, we confined our analyses to the Caucasian subset of twins. Results in the African American cohort may differ from those reported here. Likewise, associations in male twins may be quite different.

Features of disordered eating, such as binge eating, are noted in the general population, including in those not meeting diagnostic criteria for eating disorders. That they share etiological underpinnings with neuroticism and conscientiousness indicates the dimensional and integrative nature of behaviors that reflect putatively disordered components (e.g., binge eating) and those that are relatively normative (e.g., personality). Furthermore, unpacking the genetic pathways that underlie these traits could shed light on how they potentially influence each other and ultimately, refine our understanding of the many facets of disordered eating.

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