

Shared Temperament Risk Factors for Anorexia Nervosa: A Twin Study

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Objective: To answer two questions about the nature of the relationship between anorexia nervosa (AN) and dimensional temperament traits: Which traits are comorbid with AN? Which traits share transmitted liabilities with AN? **Methods:** A community sample of 1002 same-gender female twins was selected with respect to participation in two earlier waves of data collection. Measures of eating disorder diagnoses and features were ascertained through interview and continuous measures of temperament were ascertained from self-report measures. **Results:** Four temperaments were comorbid with AN, namely, higher levels of perfectionism (concern over mistakes, personal standards, doubt about actions), and higher need for organization. Comparison between the female co-twins of AN probands and controls (who had never had an eating disorder) showed that the former group reported higher levels of personal standards, organization, and reward dependence. The association between personal standards and reward dependence remained when controlling for the temperament of the proband or control in monozygotic twins. **Conclusions:** The evidence overall supports the suggestion that AN may represent the expression of a common underlying familial liability to a temperament style that reflects a striving for perfectionism, a need for order, and a sensitivity to praise and reward. The nature of the shared risk factors is likely to be, in part, genetic. **Key words:** anorexia nervosa, temperament, twins, shared risk, personal standards.

AN = anorexia nervosa; MZ = monozygotic; ATR = Australian Twin Registry; DZ = dizygotic; EDE = Eating Disorder Examination; CI = confidence interval; OR = odds ratio.

INTRODUCTION

From early theorists (1) to current models of anorexia nervosa (AN) (2,3), a central and consistent theme is that the overvalued importance of control over eating and weight that typifies AN is generated by an underlying personality or temperament. The eating disorder itself, as well as comorbidity with other psychiatric disorders, is seen to reflect this temperament. Accordingly, there exists a proliferation of research examining the association between AN and temperament (4), suggesting that AN is characterized by perfectionism, obsessionality, rigidity, low impulsivity, fear of uncertainty, and avoidance of novel situations. This inhibited personality type is postulated to respond to certain environmental stressors by exerting strict control over eating, thus introducing a sense of predictability and achievement.

A major problem inherent in much of the literature examining the link between temperament and AN is the inability to determine direction of influence. Whether such characteristics emerge as a consequence of having had AN, or predispose a person to developing AN, remain unknown. Apart from case control studies focusing on temporal precedence, longitudinal and recovered studies, family studies provide a powerful de-

sign to examine this question as they can determine whether the temperament is also elevated in unaffected relatives of AN probands compared with unaffected relatives of controls (5). The existence of such an elevation in the absence of AN would suggest that this temperament has not been influenced by AN and that it shares a transmitted liability with AN. The incorporation of a twin design and examination of different patterns between monozygotic (MZ) twins (who are genetically identical) and dizygotic (DZ) twins (who share on average 50% of their genetic material) can be used to tease out information relating to whether this shared liability is due to genetic or environmental causes.

Despite a call for family studies in eating disorders to focus on temperament as providing the greatest utility in informing etiological processes (6), to date, most family studies of AN have focused attention on shared risk factors with other psychiatric disorders rather than with dimensional temperament styles (7–11). A recent review (5) identified only one study that examined dimensional temperaments and AN using a family design, which showed women with lifetime AN to be less impulsive and more restrained than their unaffected sisters (12).

Given the paucity of family studies that examine potential shared risk factors between AN and dimensional temperament traits, the purpose of the current study was to examine these relationships. To do so, we investigated the presence of such risk factors in female-female twins, where each twin was interviewed regarding her own eating disorder status, using reliable diagnostic procedures. This represents a powerful design as our twins are definitionally matched for age cohort and aspects of environmental exposure unlike other types of family studies. Thus, the current study addresses two questions: (1) Which traits are comorbid with AN? (2) Which traits share transmitted liabilities with AN?

METHODS

Participants

The sample of twins approached to participate in this study was originally derived from a cohort registered as children with the Australian Twin Registry (ATR) during 1980 to 1982, in response to media appeals and systematic appeals through schools. Female-female twins ($n = 2320$ twins or 1140 complete twin pairs) who had participated in at least one of two waves of data

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collection (13), Wave 1 during 1989 to 1992 when the twins were aged 18 to 25 years, and Wave 2 during 1996 to 2000 when the median age of the sample was 30 years, were approached during 2001 to 2003 to participate in a third wave of data collection, of whom 1083 (47%) individual twins actively consented to participate. Participation at Wave 3 was not predicted by the number of eating problems at Wave 1 (14). The mean \pm standard deviation (SD) age of the women at the time of the data collection was 35 ± 2.11 years (range = 28–40 years). The total protocol at Wave 3 consisted of two parts, a telephone interview and a self-report questionnaire. Here we report results from the interview completed by 1002 women.

The sample included 348 complete sister-sister pairs who completed Wave 3 data collection, 226 MZ pairs and 122 DZ pairs, and 360 incomplete pairs (170 MZ and 190 DZ), where only one twin participated. Zygosity was determined on the basis of responses to standard questions about physical similarity and confusion of twins by parents, teachers, and strangers, methods that give better than 95% agreement with genotyping (15).

The Flinders University Clinical Research Ethics Committee approved the data collection process. The participants provided their written informed consent after the procedures had been explained.

Measures

Self-Report Measures

Self-report measures relating to temperament were completed by the twins (Table 1). Given that a variety of factor structures have been found for the Frost perfectionism measure (22–27), the four scales measuring temperament were used as originally proposed (22), as this is the format most commonly used in the examining the relationship between perfection and eating disorders and thus makes our results comparable with other studies. The two scales that report retrospectively on parental criticism and expectations were not used. In the original formulation of this scale, the Organization scale did not load on the perfectionism construct at all (22).

Eating Disorder Status

A telephone interview was conducted consisting of the Eating Disorder Examination (EDE) 14th edition (28), revised with the insertion of lifetime questions, so that lifetime eating disorder diagnoses could be ascertained. All diagnostic questions addressed a 3-month and a lifetime time frame. Thus, the interview included questions relating to behavioral features of Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) eating disorders as well as dietary restraint, eating concern, shape concern, and weight

concern over the last 28 days. The prevalence of eating disorders in the whole group has been reported elsewhere (14), as has the eating disorder assessment procedure.

All interviewers were postgraduate clinical psychology trainees ($n = 10$) who had been trained in use of the EDE. Each interview was taped and corrective feedback was provided until the interviewer had acquired the skills required to complete the interview independently. Steps to ensure interview fidelity included monthly group meetings to discuss the interview process and independent ratings (by the first author, TDW) of a subsample of taped interviews ($n = 36$) of women who had lifetime AN. The interrater reliability (Pearson's correlation) of the four subscales of the EDE (last 4 weeks) was high: 0.96 (weight concern), 0.98 (shape concern), 0.93 (eating concern), and 0.93 (dietary restraint). Another rater assessed the presence of lifetime objective binge episodes, using a random selection of 22 taped interviews (9 featuring lifetime bulimia nervosa (BN), 5 with binge eating disorder, and 8 where purging had occurred in the absence of objective binge episodes). There was agreement about the absence or presence of objective binge episodes on all occasions except one (a woman with BN, due to some ambiguity about the exact amount of food consumed when the person was feeling out of control with her eating).

Statistical Analyses

To answer our first question, namely, which temperament traits were comorbid with AN, we used the complete twin data as singleton observations. As the twin data contained correlated observations and the assumption of independent sampling was violated, we used linear mixed-effects modeling in SPSS (fixed-effects models with nonresidual errors) to compare the temperament variables across the two groups (those with lifetime AN and those without lifetime AN)—an analytic approach that not only adjusts for correlated observations but is asymptotically efficient with unbalanced data.

To examine our second question, namely, which traits shared transmitted liabilities with AN, the data were structured such that each case represented a twin pair and that if a twin had lifetime AN, she appeared as Twin 1. In aid of greater conceptual clarity, the two MZ twin pairs concordant for lifetime AN were removed from the data set. The sample therefore consisted of 346 complete sister-sister pairs: MZ twins where Twin 1 had AN ($n = 14$ pairs), DZ twins where Twin 1 had AN ($n = 18$ pairs), MZ twins where Twin 1 had no AN ($n = 210$ pairs), and DZ twins where Twin 1 had no AN ($n = 104$ pairs). Logistic regressions were used to investigate the cross-twin relationship, where the AN status (present or absent) of Twin 1 was the outcome variable, and the temperament trait of Twin 2 was the independent variable. Final results are presented as odds ratios (OR) with 95% confidence intervals. As we had standardized the continuous data, the resulting OR indicates the change in risk for the dependent measure for every SD change in the independent variable. Simulation studies indicated that logistic regression performs well in conditions where the groups are very unequal (29).

As some of the co-twins of the affected AN twin had disordered eating in the absence of AN, the data were also structured such that any twin pairs where a co-twin did not have AN but did meet the criteria for lifetime threshold (i.e., at least twice a week over a 3-month period without a break of >2 weeks), objective binge episodes and/or purging was removed to provide a cleaner comparison group. The resulting sample consisted of 279 complete sister-sister pairs: MZ twins where Twin 1 had AN ($n = 11$ pairs), DZ twins where Twin 1 had AN ($n = 14$ pairs), MZ twins where Twin 1 had no AN ($n = 168$ pairs), and DZ twins where Twin 1 had no AN ($n = 84$ pairs). Logistic regressions were used in the same way as reported above. This latter analysis therefore represents a design that can be likened to that of previous family studies (7,30), where the probands' relatives who have no eating disorder history are compared with control women's relatives who have no eating disorder history.

Where there was an association of co-twin temperament with AN status in the twin, the temperament of Twin 1 was then included as a covariate in the analyses, to determine if proband comorbidity accounted for this association. These analyses were carried out in the larger sample separately for MZ and DZ twins. In this way, if the source of shared risk is genetic, one would expect this association to be stronger in MZ than DZ twins. It should be recognized

TABLE 1. Summary and Description of the Self-Report Measures Used in the Analyses

| Variable | Description and Cronbach's α |
|---|---|
| Wave 1 | |
| Neuroticism | Eysenck Personality Questionnaire (16,17), 12 items ($\alpha = 0.80$) |
| Harm avoidance, novelty seeking, reward dependence | Tridimensional Personality Questionnaire (17,18), 18 items each scale (respective $\alpha = 0.84, 0.74, 0.62$) |
| Interpersonal dependency | Interpersonal Sensitivity Measure (19,20), 12 items ($\alpha = 0.51$) |
| Wave 3 | |
| Impulsivity | Barratt Impulsiveness Scale (BIS-10-R) (21), 30 items ($\alpha = 0.81$) |
| Perfectionism: concern about mistakes, personal standards, doubts about actions, organization | Frost Multidimensional Perfectionism Scale (22), respectively, 9 items ($\alpha = 0.90$), 7 items ($\alpha = 0.85$), 4 items ($\alpha = 0.82$), and 6 items ($\alpha = 0.90$) |

SHARED TEMPERAMENT RISK FACTORS FOR ANOREXIA

that these analyses have less power and therefore null results should be interpreted with caution.

RESULTS

Prevalence of AN

A total of 19 women met the full criteria for lifetime AN. Sixteen additional women met the criteria for AN with the exception of amenorrhea (“partial AN”). An additional eight women also met AN criteria but their amenorrhea status was less clear, as five were using oral contraceptives at the time of their low weight, two women recalled missing less than three consecutive menstrual cycles, and one woman could not remember the number of cycles missed. Lifetime threshold AN was diagnosed in 1.9% of our total sample compared with 1.5% (31), 2% (32), and 1.9% (33) in other community samples where comprehensive eating disorder assessments were completed. The prevalence of “partial” AN (amenorrhea not required) was 1.6% compared with 1.3% in an Italian study (32). A further 0.8% of women with AN had an amenorrhea status that could not be ascertained. Given that previous research indicated that amenorrhea does not meaningfully distinguish between AN cases (34), 4.3% of the sample could be said to meet substantive criteria for AN. This level is commensurate with the partial AN prevalence of 3.3% found in an Italian community sample (32) and 3.8% in young American adults (35). The mean ± SD age of developing AN was 17 ± 2.69 years (range = 13–24 years). None of the women met the body mass index criterion for AN at Wave 3 assessment, but two had current eating disorder behaviors: one with objective binge episodes and purging, and one with purging only.

Within-Twin Associations With AN

The first question, namely, which traits are comorbid with AN, was answered by examining within-person associations between AN status and temperament. As reported in Table 2, significant within-person associations existed for four of the ten temperament measures. Higher perfectionism, as indicated by concern over mistakes and personal standards, and higher organization and doubts about actions were all significantly associated with AN. Doubt about actions is a partial index of

obsessionality given that three of the four items are adapted from the Maudsley Obsessional Compulsive Inventory (36). Neuroticism and novelty seeking approached significance.

Cross-Twin Associations With AN

The second question required examination of cross-twin associations. Results from the paired data are reported in the first column of Table 3 and the results from the data where twins with binge or purge threshold behavior have been removed are reported in the second column of Table 3. The results across both analyses suggest that personal standards, organization, and reward dependence for the unaffected relatives of AN probands are elevated compared with the unaffected relatives of controls.

Cross-Twin Associations Within Zygosity Groups Including Twin 1 Temperament as a Covariate

The three temperaments identified as sharing risk factors with AN were examined within each zygosity group (Table 4). The temperament of Twin 2 was significantly associated with Twin 1 AN status when Twin 1 temperament was included as a covariate for MZ twins only, for personal standards and reward dependence.

DISCUSSION

The results of the current study contribute to and extend research examining the temperament type associated with lifetime AN. Family studies examining shared risk factors between temperament and AN are rare, and our study is the first to have used a twin design. First, with respect to within-person associations, our results replicate many previous studies (4) that showed AN to be associated with high perfectionism and high obsessionality. Here both concern over mistakes and personal standards, which load highly on “problematic” and “benign” perfectionism respectively (37), were associated with AN. AN was also associated with the Organization scale from the same perfectionism measure, a scale that does not load on the perfectionism construct (22) but rather pertains to a desire for neatness and organization.

Although these variables were associated with AN, such associations tell us nothing about the direction of the relation-

TABLE 2. Within Twin Associations Between Personality and Anorexia Nervosa (AN) Status

| Dependent Variable | No AN, Mean ± SEM | AN, Mean ± SEM | F (p) |
|---------------------------|----------------------|-------------------|---------------|
| Concern over mistakes | 1.88 ± 0.02 | 2.27 ± 0.08 | 26.37 (<.001) |
| Personal standards | 2.46 ± 0.02 | 2.72 ± 0.08 | 11.61 (.001) |
| Organization | 3.18 ± 0.02 | 3.36 ± 0.08 | 4.84 (.03) |
| Doubts about actions | 2.00 ± 0.02 | 2.32 ± 0.09 | 14.01 (<.001) |
| Impulsivity | 2.04 ± 0.01 | 2.07 ± 0.05 | 0.66 (.42) |
| Neuroticism | 0.45 ± 0.01 | 0.53 ± 0.05 | 2.96 (.09) |
| Interpersonal sensitivity | 0.43 ± 0.01 | 0.47 ± 0.03 | 1.90 (.17) |
| Harm avoidance | 0.43 ± 0.01 | 0.45 ± 0.04 | 0.25 (.62) |
| Novelty seeking | 0.48 ± 0.01 | 0.54 ± 0.03 | 2.91 (.09) |
| Reward dependence | 0.65 ± 0.01 | 0.67 ± 0.03 | 0.21 (.65) |

SEM = standard error of the mean.

TABLE 3. Cross-Twin Associations: Anorexia Nervosa (AN) Status in Twin 1 (Present/Absent) With Personality of Twin 2

| Variable (Standardized) | Cross-Twin Association | |
|---------------------------|--|--|
| | (<i>n</i> = 346 pairs) OR (95% CI) <i>p</i> | Twins Without Threshold Binge-Purge Behavior (<i>n</i> = 279 pairs) OR (95% CI) <i>p</i> |
| Concern over mistakes | 1.19 (0.83–1.70) .346 | 1.28 (0.84–1.93) .25 |
| Personal standards | 1.75 (1.21–2.54) .003 | 1.65 (1.08–2.53) .02 |
| Organization | 1.62 (1.09–2.42) .017 | 1.81 (1.16–2.83) .009 |
| Doubts about actions | 0.98 (0.68–1.42) .929 | 1.02 (0.66–1.59) .92 |
| Impulsivity | 0.74 (0.50–1.10) .134 | 0.68 (0.44–1.06) .09 |
| Neuroticism | 0.93 (0.63–1.36) .690 | 0.98 (0.65–1.48) .94 |
| Interpersonal sensitivity | 1.13 (0.77–1.66) .542 | 1.16 (0.78–1.74) .49 |
| Harm avoidance | 1.01 (0.69–1.47) .974 | 1.02 (0.68–1.52) .93 |
| Novelty seeking | 0.79 (0.53–1.18) .249 | 0.79 (0.52–1.21) .28 |
| Reward dependence | 1.75 (1.13–2.70) .012 | 1.88 (1.16–3.04) .01 |

OR = odds ratio; CI = confidence interval.

TABLE 4. Cross-Twin Associations: Anorexia Nervosa (AN) Status in Twin 1 (Present/Absent) With Temperament of Twin 2 Controlling for the Temperament of Twin 1

| Variable (Standardized) | Monozygotic Twins | Dizygotic Twins |
|----------------------------|--|--|
| | <i>n</i> = 224 Pairs OR (95% CI) <i>p</i> | <i>n</i> = 122 Pairs OR (95% CI) <i>p</i> |
| Personal standards: Twin 1 | 1.65 (0.87–3.10) .12 | 1.83 (1.05–3.19) .03 |
| Personal standards: Twin 2 | 2.01 (1.06–3.83) .03 ^a | 1.18 (0.69–2.04) .55 |
| Organization: Twin 1 | 1.63 (0.87–3.06) .13 | 1.21 (0.67–2.15) .53 |
| Organization: Twin 2 | 1.56 (0.82–2.96) .18 | 1.36 (0.78–2.38) .28 |
| Reward dependence: Twin 1 | 1.01 (0.50–2.06) .97 | 1.77 (0.88–3.58) .11 |
| Reward dependence: Twin 2 | 2.25 (1.00–5.05) .05 ^a | 1.38 (0.71–2.69) .35 |

OR = odds ratio; CI = confidence interval.

^a Significant association between Twin 2 temperament and AN status in Twin 1.

ship. It is the cross-twin associations that can indicate which variables share familial risk with AN, rather than being simply a consequence of the eating disorder. Although the results were essentially the same across our two cross-twin comparisons, the cleanest comparison comes from the second cross-twin analysis, where co-twins with disordered eating apart from AN were removed from the sample. Results of these analyses showed that personal standards, organization, and reward dependence for the unaffected relatives of AN probands are elevated compared with the unaffected relatives of controls. These relationships remained significant for personal standards and reward dependence when controlling for the commensurate temperament of Twin 1, but only in MZ twins. This indicates that the nature of the shared risk is, in part, genetic.

There currently exists a spirited debate as to the definition of perfectionism, especially in relationship to eating disorders. Perfectionism has been defined as self-evaluation that relies on the continual pursuit of personally demanding standards (38). It has been suggested that, when an eating disorder is

present, these standards are singularly focused on control over eating, shape, and weight. Such perfectionism is represented by the personal standards measure, which has previously been labeled a “benign” construct (37). However, findings of a recent study demonstrated that experimental manipulations of personal standards resulted in changes in eating behaviors in nonclinical individuals, with higher personal standards being associated with increased restraint and regret after eating (39). In contrast, other authors have suggested that self-criticism is the critical maintaining pathology of clinical perfectionism (40), based on evidence that shows concern over mistakes and doubts about action to be elevated in people with lifetime AN, but not personal standards (41). Results of the current study would suggest that it is the setting of high standards and goals, rather than self-criticism when the goals are not obtained, that predisposes people to the development of AN. This finding can most helpfully be interpreted in the context of previous findings that showed perfectionism only acts as a risk factor for disordered eating in interaction with other risk factors, including low self-esteem and body dissatisfaction (42). In summary, it would appear that so-called “benign” perfectionism may be a potent risk factor for AN.

The cross-twin associations between AN and higher Organization scores, reflecting the importance of neatness and organization, are consistent with previous findings showing women with AN to score highly on rigidity and obsessiveness (4). This trait is also consistent with low impulsivity, which approached significance in the cross-twin associations, a measure that reflects a cautious and inhibited approach to life (43). It has been said that AN persists because it serves an organizing function for individuals who value simplicity and predictability (44), and thus a high drive for organization may become focused on predictability with respect to weight and food intake, representing a sense of competence and self-control (1).

Reward dependence is a subscale from Cloninger’s personality measure (17), where temperament is viewed as emotional responses that are moderately heritable, and stable throughout life. It is hypothesized that reward dependence is related to

SHARED TEMPERAMENT RISK FACTORS FOR ANOREXIA

decreased noradrenergic activity, and higher scores indicate an attached and dependent nature. Most previous studies have failed to find a significant association between this construct and AN (4) even though reward dependence has previously been theorized to be a core characteristic of AN, where these individuals are noted to be sensitive to praise and reward and persist with previously rewarded activity (e.g., weight loss) to exhaustion (45). It is of interest to note that within-twin associations for reward dependence measure were not significant whereas the cross-twin associations were. One might expect both significant within and between twin associations for a trait that shares liability with AN. One possible explanation for the deviation observed here is that AN itself may influence patterns of reward dependence; e.g., individuals who desire praise and reward but who are unable to adequately engage interpersonally to obtain this are at greater risk of developing AN. The experience of AN commonly leads to social isolation and thus this need is necessarily reduced over time (46).

The findings of the current research should be interpreted within the context of five limitations. First, our AN group was mixed with respect to restricting only and binge/purge subtypes, and presence or absence of amenorrhea. Studies with larger groups of women with AN are required to examine the distinct temperament profile related to different types of AN. However, to date, evidence suggests that personality clusters do not correspond well to symptom-based subgroups in AN (47). Second, two factors impinge on the reliability of measurement of AN. Although we used a highly reliable and valid eating disorder interview, the accuracy of the EDE for reporting retrospective eating disorder features is unknown, and we had only one occasion of measurement of AN available for these twin pairs. Third, the influence of personality on recall of lifetime AN and the symptoms associated with it are unknown, and it is conceivable that personality characteristics such as neuroticism or perfectionism may diminish or enhance recall. Fourth, two of ten of our self-report measures had a marginal internal reliability, including reward dependence, and results pertaining to this variable require replication. Finally, given the potential importance of perfectionism as a premorbid temperament of relevance to AN, better measures of the construct of perfectionism are required to increase our understanding of the types of perfectionism that are relevant to the development of AN.

Nevertheless, the results from this study suggest that temperament is an important domain of shared risk factors for AN, consistent with theory in this area. Overall, the current findings supported the suggestion that susceptibility to AN is increased when individual characteristics relating to striving for perfectionism, a need for order, and a sensitivity to praise and reward are present.

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