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Temperament and Character in Women with Anorexia Nervosa

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The present study examined temperament differences among anorexia nervosa (AN) subtypes and community controls, as well as the effect of body weight on personality traits in women with AN. Temperament and Character Inventory (TCI) scores were compared between 146 women with restrictor-type AN (RAN), 117 women with purging-type AN (PAN), 60 women with binge/purge-type AN (BAN), and 827 community control women (CW) obtained from an archival normative database. Women with AN scored significantly higher on harm avoidance and significantly lower on cooperativeness than CW. Subtype analyses revealed that women with RAN and PAN reported the lowest novelty seeking, RAN women the highest persistence and self-directedness, and PAN women the highest harm avoidance. Body mass index had a nominal effect on subgroup differences, suggesting that personality disturbances are independent of body weight. Findings suggest that certain facets of temperament differ markedly between women with AN, regardless of diagnostic subtype, and controls. More subtle temperament and character differences that were independent of body weight emerged that distinguish among subtypes of AN.

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Approximately 30 to 63% of women with anorexia nervosa (AN) develop symptoms of bulimia nervosa (BN; Bulik et al., 1997; Eckert et al., 1995; Garfinkel et al., 1980; Strober et al., 1997). The determining characteristics that distinguish between those who remain restrictors and those who develop bingeing and purging are unclear. Temperament has been hypothesized to be one potential predictor. Clinical descriptions of individuals with AN have characterized them as rigid, emotionally and behaviorally overcontrolled, and obsessive in nature (Dally, 1969; Kay and Leigh, 1954; Sohlberg and Strober, 1994). Empirical studies have

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generally corroborated these impressions (Casper et al., 1992; Pillay and Crisp, 1977; Sohlberg and Strober, 1994), although the use of diverse assessment instruments reflecting different personality theories has complicated comparisons of study results. For example, studies have examined personality characteristics in women with AN from the perspective of the Big Five-Factor Model (Tylka and Subich, 1999), the Big Three-Factor Model (Rastam and Gillberg, 1991; Walters and Kendler, 1995), Tellegen's personality model (Casper, 1990; Casper et al., 1992; Pryor and Wiederman, 1996), and Object Relations Theory (Sordelli et al., 1996). Although findings from each of these studies have contributed significantly to our understanding of personality correlates in AN, comparing results across studies can be rather problematic.

Many recent studies have converged in utilizing Cloninger's (1986, 1987a, 1987b, 1993) theory of personality for examining personality characteristics in women with AN. Briefly, Cloninger proposes that specific dimensions of temperament and character interact with one another to influence susceptibility to emotional and behavioral disorders (Cloninger et al., 1993). Cloninger refers to temperament as emotional responses that are moderately heritable, stable throughout life, and mediated by neurotransmitter functioning in the central nervous system. Cloninger's four proposed temperament dimensions include: novelty seeking (NS), which reflects behavioral activation to pursue rewards and is posited to be related to decreased dopaminergic activity; harm avoidance (HA), which is the tendency to inhibit behavior to avoid punishment and is purported to be related to increased serotonergic activity; reward dependence (RD), which reflects the maintenance of rewarded behavior and is hypothesized to be mediated by decreased noradrenergic activity; and persistence (P), which is perseverance without intermittent reinforcement that is also purported to be related to decreased noradrenergic activity.

According to Cloninger, character, in contrast, refers to self-concepts and individual differences in goals and values that develop through experience. The character dimensions are: cooperativeness (C), which reflects the degree to which the self is viewed as a part of society; self-directedness (SD), which is the degree to which the self is viewed as autonomous and integrated; and self-transcendence (ST), which reflects the degree to which the self is viewed as an integral part of the universe. Cloninger's group has shown that that both the temperament and character scales are related to the presence of a number of personality disorders. In particular, it appears that low cooperativeness and self-directedness scores are particularly indicative of a DSM Axis II disorder (Cloninger et al., 1994; Svrakic et al., 1993). The Tridimensional Personality Questionnaire (TPQ; Cloninger, 1987b), originally developed to assess the first three dimensions of temperament (*i.e.*, NS, HA, RD), was followed by the Temperament and Character Inventory (TCI; Cloninger et al., 1993) which measures all seven dimensions of temperament and character.

Recent findings from studies examining TCI/TPQ scores in women with AN have been relatively consistent in showing elevated HA (Brewerton et al., 1993; Bulik et al., in press; Casper, 1990; Kleifield et al., 1994a; Kleifield et al., 1994b; O'Dwyer et al., 1996) and P (Brewerton et al., 1993; Kleifield et al., 1994a; Kleifield et al., 1994b) scores, and decreased NS (Casper, 1990; Casper et al., 1992; Kleifield et al., 1994a; Kleifield et al., 1994b; Ward et al., 1998), SD (Bulik et al., in press), and C (Bulik et al., in press) scores, in AN women relative to controls. In addition, some of these studies have been useful for highlighting temperament differences between subtypes of AN, including decreased NS (Casper et al., 1992; Kleifield et al., 1994a) and HA (Bulik et al., 1995b; Kleifield et al., 1994a) scores in women with restrictor-type AN (RAN) relative to women with the bingeing/purging subtype of AN (BAN) and women with a history of both AN and bulimia nervosa (AN-BN). Although less consistently found, some studies have also suggested increased P (Kleifield et al., 1994a, 1994b) and RD (Bulik et al., 1995b) scores in RAN women relative to women with BAN and AN-BN. Significant TPQ scale differences between BAN and AN-BN women have generally not been found, suggesting that these two subtypes have similar personality structures that differ significantly from that of RAN women.

Despite consistent findings, previous studies have suffered from a number of methodological limitations. First, the sample sizes of AN groups studied thus far have been relatively small (range = 9 to 70 women), potentially resulting in decreased power to detect differences in temperament across diagnostic subgroups. Second, no studies to date have investigated personality characteristics of the purging-only AN (PAN) subtype characterized by regular purging but no bingeing during the period of low weight. Although some data suggest that this subtype is more similar to BAN than RAN women in terms of depression, anxiety, and eating disorder symptoms (Garner et al., 1993; Nagata et al., 1997), it is unclear whether PAN women resemble RAN or BAN women in terms of temperament characteristics. Finally, studies have primarily included AN women who were acutely ill, leading to ambiguity about whether observed personality differences are trait- or state-related disturbances. Although a number of studies examining TPQ/TCI scores in recovered AN women have suggested that disturbances (particularly elevated HA and decreased NS scores) persist after recovery and are thus trait-related (Casper, 1990; O'Dwyer et al., 1996; Ward et al., 1998), more research is needed to tease apart cause and effect relationships between AN and personality characteristics.

The possibility that AN women's abnormalities on the moderately heritable (Heath et al., 1994) TCI/TPQ dimensions may be trait disturbances suggested that these characteristics should be investigated in genetic studies of this illness. Consequently, the TCI was administered to a large sample of AN women recruited from a multisite, international genetic study of AN (Price Foundation Genetic Study of AN; Kaye et al., in press). The current paper reports on findings related to several aims of that study. First, we characterize the temperament and character structure of AN women through comparing their TCI scores to those of a large, community sample of women. Second, we examine potential AN subtype differences in TCI scores, including differences between women with RAN, PAN, and BAN. Finally, we further investigate the relative influence of body weight on TCI scores in women with AN.

Methods

Participants

Women with AN. All women with AN were participants from the multisite, international Price Foundation Genetic Study of AN (Kaye et al., in press). This genetic study includes 196 relative pairs affected with AN, BN, or eating disorder not otherwise specified (ED-NOS) recruited from seven sites in North America and Europe including Pittsburgh, New York, Los Angeles, Toronto, London, Munich, and Philadelphia. Sample ascertainment and recruitment strategies are discussed in detail elsewhere (see Kaye et al., in press) and thus are only briefly described here. Male or female probands meeting modified (*i.e.*, criterion D, amenorrhea, not required) DSM-IV criteria for AN were identified through treatment facilities and advertisements. Upon initial screening, probands were questioned about eating disorders (*i.e.*, AN, BN, or ED-NOS) in their male and female relatives. Permission to contact all relatives (*i.e.*, first- through third-degree relatives) with suspicion of an eating disorder was then sought, and the relative(s) were subsequently contacted. If upon initial screening, the proband met modified DSM-IV criteria for AN and the identified relative(s) met DSM-IV criteria for AN, BN, or EDNOS, then the proband and relative(s) were included in the Price genetic study and administered an assessment battery including the instruments described below. However, if only the proband or relative appeared to meet criteria, then neither individual was included in the Price study.

All female probands (N = 185) and female affected relatives (N = 219) who met modified DSM-IV criteria for AN were included in the current study. Women with BN (N = 45) and ED-NOS (N = 35) were excluded from the current analyses due to their relatively low frequency in the Price sample and because the focus of this investigation is on temperament in AN subtypes. The AN women included in the present study were divided into three subtypes based on the presence or absence of bingeing and purging behavior: a) a restrictor AN (RAN; N = 147) subtype included individuals who had never engaged in regular bingeing or purging; b) a purging AN (PAN; N = 117) subtype included women who had engaged in regular purging (*i.e.*, self-induced vomiting, or the abuse of laxatives, diuretics, or diet pills) behavior during the period of AN but have never engaged in regular bingeing; and c) a binge/purge subtype (BAN; N = 60) included women who had engaged in regular binge eating and may have also engaged in purging behaviors during the period of AN. Of the AN women, 98.3% were of Caucasian ancestry, whereas the remaining 1.7% were of mixed Caucasian and Asian, or mixed Caucasian and Native American, ancestry.

Control Women (CW). The primary goals of the Price Foundation genetic study of AN were to use family-based association and linkage studies to identify susceptibility genes for the development of AN. For these types of analyses, community control data are not required, and thus the focus of the Price Foundation study was to ascertain and assess biological relatives affected with an eating disorder. As a result of this ascertainment strategy, we did not have access to community control women directly matched to the Price women. Consequently, for the current study, we obtained an archival sample of 827 female control women from Cloninger et al.'s (1994) normative TCI database. These women were matched to the Price AN women by sample mean age and Caucasian ethnicity. Approximately 65% of the CW were college students recruited from introductory psychology courses at Washington University (Cloninger et al., 1994). The remaining 35% of CW were recruited directly from the St. Louis, Missouri community (Cloninger et al., 1994).

Measures

Structured Interview of Anorexia Nervosa and Bulimia Syndromes (SIAB). Lifetime histories of modified DSM-IV AN in probands and affected relatives were assessed with the SIAB (Fichter et al., 1998). The SIAB is a semi-structured clinical interview designed to gather detailed information on weight and eating history to establish DSM-IV and ICD-10 eating disorder diagnoses. The training procedures used for the SIAB in the current study are described in detail elsewhere (Kaye et al., in press) and thus are only briefly summarized here. Clinical interviewers undertook an extensive training program on the administration of this instrument, including a) viewing videotapes of trained raters administering the SIAB; b) scoring separate sets of videotapes at accepted standards of accuracy; and c) taping their own practice interviews, which were evaluated for accuracy. Subsequent to this training, every 10th interview from each rater was audiotaped for review by the project coordinator of the Data and Administrative Core at the Pittsburgh site. In addition, interviewers at each site blindly rated videotaped interviews at 3-month intervals to ensure rating consistency across sites. These interviews were then scored independently by the project coordinator of the data core.

Several independent confirmations of the diagnoses obtained from the SIAB were made to further ensure their accuracy. First, all eating disorder diagnoses were confirmed by the PI at each satellite site after reviewing the SIAB. Second, the project coordinator of the data core independently reviewed every participant's SIAB to confirm diagnoses and scoring accuracy.

TCI. The 240-item Temperament and Character Inventory Version 9 (Cloninger et al., 1993) was used in the present study. The TCI has been normed in a large U.S. national probability sample (Cloninger et al., 1994) and shows acceptable internal consistency (range = .76 to .89; Cloninger et al., 1993).

Body Mass Index (BMI). Current body mass index (BMI = kg/m^2), lifetime minimum BMI, and lifetime maximum BMI were calculated from self-reports of body weight and height.

Statistical Analyses

Mean differences on dependent measures among women with AN and CW were examined using Generalized Estimating Equations (GEE: Diggle et al., 1994; Liang and Zeger, 1986; Zeger and Liang, 1986). GEE is a statistical approach based on regression techniques that is used to investigate correlated data, such as panel studies and the affected relative-pair data used in the current study. In such data sets, the assumption of independent observations is violated because paired, or clustered, data are collected. Neglecting to account for the dependency of the data in these situations can lead to false conclusions. In the GEE method, the correlated data are modeled using the same link function, the same linear predictor setup, and the same variance function as is used with a generalized linear model in the independent case. However, in the GEE approach, the covariance structure of the correlated measures is also modeled. Specifically, using the GEE method, the existence of a relationship between observations in a particular cluster is assumed, while no relationship is assumed between observations of separate clusters. The relationships among observations within a cluster are then estimated by the GEE method and treated as a nuisance variable in analyses. There are several choices for the form of this working correlation matrix, including a fixed correlation matrix, the identity matrix, an exchangeable correlation matrix, and an unstructured correlation matrix.

In the current study, biologically related family members comprised each cluster in the GEE analyses. However, because the current study included family members of varying relatedness (*i.e.*, first, second, and third-degree relatives as well as unrelated controls), the GEE analyses were done in two steps. First, models were fit to the TCI data via the GEE method for probands and their siblings only using the exchangeable working correlation matrix to obtain an estimate of the familial correlation among these first-degree relatives. Second, models were re-fit to the entire data set of relatives and unrelated controls using familial correlations estimated from the probands and siblings as the user-defined working correlation matrix. The model parameters and statistics from these models were then used as the final solution. This approach to the analyses can be considered conservative, as the proband/sibling correlations used are likely overestimates of the expected correlations among clusters of unrelated individuals and second- and third-degree relatives. Such overestimation is likely to result in fewer rather than more significant findings.

Several useful statistics were generated by the GEE method and used in the current study. Type 3 tests, Score statistics (χ^2), were used for testing the significance of each independent variable in the model. Means adjusted for cluster relationships as well as model covariates were also generated by the GEE analyses; contrasts were then conducted on these adjusted means to examine group differences

TABLE 1
Mean Differences in Clinical/Demographic Characteristics and TCI Scores Among AN and Control Women[a]

Scales	RAN A (N = 147)	PAN B (N = 117)	BAN C (N = 60)	CW D (N = 827)	χ^2	df	p	Contrast Results[b]
Demographic characteristics								
Age	27.01 (0.40)	27.20 (1.20)	28.20 (1.29)	27.63 (1.00)	1.06	3	.79	—
Age of AN onset	15.94 (0.27)	15.84 (0.34)	15.76 (0.37)	—	0.20	2	.91	—
Current BMI	18.44 (0.20)	18.63 (0.23)	18.41 (0.33)	—	0.77	2	.53	—
Past minimum BMI	14.35 (0.19)	14.45 (0.19)	14.79 (0.29)	—	1.50	2	.47	—
Past maximum BMI	20.92 (0.21)	21.61 (0.31)	21.90 (0.33)	—	6.83	2	.03	NS
TCI Scales								
Novelty Seeking	16.30 (0.69)	17.29 (0.61)	20.63 (0.93)	19.59 (0.22)	30.30	3	<.001	A,B<D; A,B<C
Harm Avoidance	21.21 (0.67)	23.58 (0.73)	21.82 (0.97)	15.34 (0.26)	105.10	3	<.001	A,B,C>D
Reward Dependence	16.27 (0.35)	16.78 (0.34)	17.18 (0.50)	18.41 (0.17)	32.74	3	<.001	A,B<D
Persistence	6.09 (0.19)	5.92 (0.20)	5.86 (0.26)	5.48 (0.07)	12.01	3	.007	A>D
Cooperativeness	33.09 (0.54)	32.95 (0.64)	32.00 (0.79)	36.07 (0.17)	46.00	3	<.001	A,B,C<D
Self-Directedness[c]								
Model 1	26.22 (0.78)	23.65 (0.84)	22.57 (1.14)	31.34 (0.41)	78.17	3	<.001	A,B,C<D
Model 2	26.55 (0.94)	23.13 (0.92)	22.69 (1.28)	—	13.18	2	.001	A>B,C
Self-Transcendence	13.95 (0.59)	15.07 (0.63)	15.86 (0.78)	16.79 (0.22)	22.19	3	<.001	A<D

[a]AN = anorexia nervosa; RAN = restrictor-type AN; PAN = purging-type AN; BAN = binge/purge type AN; CW = control women. Values are adjusted means and (standard errors). Model 1 was conducted using AN women and CW and included age and age × diagnosis interactions as covariates. Model 2 was conducted using AN women only and included age, BMI, center, and their interactions as covariates. For the TCI scales, the adjusted means and (standard errors) are from model 1 unless otherwise noted.
[b]See Table 2 for contrast chi-square statistics and significance levels.
[c]AN subtype contrast results differed slightly between GEE models 1 and 2, and thus results from both models are reported.

on dependent measures, with Score statistics (χ^2) again used to determine the statistical significance of these contrasts.

Previous research has indicated that some (most notably NS; Cloninger et al., 1994) of the TPQ/TCI scales are significantly correlated with age and that TPQ/TCI scores may be affected by current state of psychiatric illness (Kleifield et al., 1994; Svrakic et al., 1992). Consequently, we wished to examine the effects of these variables, as well as other covariates such as the site at which the data were collected (*i.e.*, Pittsburgh, New York, Los Angeles, Toronto, London, Munich, Philadelphia), in the TCI group analyses. However, because the control sample was not ascertained from the same sites as the AN women, and BMI data were not collected on the CW, we could not examine all of the covariates in analyses of AN women and CW combined. Consequently, we conducted two separate sets of GEE analyses. First, we examined mean TCI scale score differences between AN women and CW using age (which was available for both the AN women and CW) and age × diagnosis (*i.e.*, RAN, PAN, BAN, or CW) interactions as covariates in the GEE analyses described above (referred to as model 1).

In the second model, we examined mean TCI scale score differences between the three AN subtypes excluding the CW using age, site at which data were collected (center), BMI, and interactions between these variables, as covariates in analyses (referred to as model 2). In addition, center was added as an additional clustering variable in model 2, as it was believed that women from similar regions of the world might be more correlated for TCI scores than those from different regions. Results from these two models were then compared to determine whether the inclusion of additional covariates influences the results of the contrasts comparing AN subtypes. If they did not, then contrast results from model 1 were reported in the tables and text for all groups. If findings did differ, then contrast results from both models were reported for comparison purposes.

An alpha level of $p < .05$ was used for analyses of overall effects, whereas an alpha level of $p < .01$ was used for contrasts between groups to control for the relatively large number of contrasts conducted. All statistical analyses were conducted using the GENMOD procedure of SAS version 7.0 (SAS Institute, 1996).

Results

Presented in Table 1 are group means and standard errors adjusted for cluster relationships and covariates, Score (χ^2) statistics and corresponding significance levels indicating overall effects of diagnosis, and summaries of contrast results indicating specific group differences. Detailed in Table 2 are the corresponding chi-square and p-values from the contrast results summarized in the last column of Table 1. It should be noted that interactions among

TABLE 2
Chi-Square Statistics (df = 1) and Corresponding Significance levels for Contrasts Across AN Subtype and Controls for Clinical/Demographic Characteristics and TCI Scores[a]

Variables	RAN *vs.* CW	RAN *vs.* PAN	PAN *vs.* BAN	PAN *vs.* CW	PAN *vs.* BAN	BAN *vs.* CW
Demographic characteristics						
Age	0.02	0.22	0.08	0.78	0.13	0.33
	(.88)	(.64)	(.77)	(.38)	(.72)	(.57)
Age of onset	—	(0.05)	0.20	—	0.30	—
		(.82)	(.66)		(.86)	
Current BMI	—	0.41	0.01	—	0.34	—
		(.52)	(.93)		(.56)	
Past minimum BMI	—	0.14	1.47	—	0.99	—
		(.71)	(.22)		(.32)	
Past maximum BMI	—	3.69	5.64	—	0.50	—
		(.05)	(.02)		(.48)	
TCI Scales						
Novelty Seeking	18.32	1.17	12.47	11.38	8.79	1.17
	(<.001)	(.29)	(<.001)	(<.001)	(.003)	(.28)
Harm Avoidance	48.13	6.05	0.30	58.22	2.18	25.35
	(<.001)	(.01)	(.58)	(<.001)	(.14)	(<.001)
Reward Dependence	22.83	1.12	2.22	11.75	0.41	3.35
	(<.001)	(.29)	(.14)	(<.001)	(.52)	(.06)
Persistence	8.40	0.39	0.58	4.26	0.04	1.92
	(.004)	(.53)	(0.45)	(.04)	(.83)	(.17)
Cooperativeness	23.68	0.03	1.62	18.49	1.01	18.73
	(<.001)	(.87)	(.20)	(<.001)	(.31)	(<.001)
Self-Directedness[b]						
Model 1	25.03	5.28	6.88	41.25	0.56	27.54
	(<.001)	(.02)	(.009)	(<.001)	(.46)	(<.001)
Model 2	—	8.71	7.96	—	0.10	—
		(.003)	(.005)		(.75)	
Self-Transcendence	18.18	1.70	4.00	6.35	0.69	1.30
	(<.001)	(.19)	(.05)	(.01)	(.41)	(.25)

[a]AN = anorexia nervosa; RAN = restrictor-type AN; PAN = purging-type AN; BAN = binge/purge type AN; CW = Control Women. Values are adjusted means and (standard errors). Model 1 was conducted using AN women and CW and included age and age × diagnosis interactions as covariates. Model 2 was conducted using AN women only and included age, BMI, center, and their interactions as covariates. For the TCI scales, the adjusted means and (standard errors) are from model 1 unless otherwise noted. Statistically significant or trend-level differences are noted in bold.
[b]AN subtype contrast results differed slightly between GEE models 1 and 2, and thus results from both models are reported.

the covariates were nonsignificant for all of the TCI scales examined except SD, which showed a significant age × BMI interaction (see discussion of SD below).

As shown in Table 1, there were no significant age differences between RAN, PAN, BAN, or CW women. In addition, there were no significant differences between the three AN subtypes in age of AN onset, current BMI, or lifetime minimum BMI. However, significant differences in past maximum BMI were present across the three subtypes, with the contrasts across the three subtypes reaching trend-level significance for RAN women versus both PAN and BAN women.

Results from Models 1 and 2 were identical for six (NS, HA, RD, P, C, ST) of the seven TCI scales, and highly similar for the remaining scale (SD), indicating that AN subtype findings from model 1 were relatively robust with respect to potential differences in BMI or location of data collection. Contrasts comparing AN women to controls for the six scales showing identical results across models differed significantly depending upon the scale examined. For example, after adjusting for age ($\chi^2_{(1)} = 20.02$, $p < .0001$), RAN and PAN women were found to have significantly lower NS scores relative to CW and BAN women. Similarly, these two AN groups were also found to have significantly lower RD and ST, and higher P, scores relative to CW, with an additional trend-level difference between RAN and BAN women on ST. Finally, after adjusting for age (HA: ($\chi^2_{(1)} = 4.74$, $p < .03$; C: ($\chi^2_{(1)} = 45.75$, $p < .0001$), all three groups of AN women scored significantly different from CW on HA and C, with all AN women scoring significantly higher on HA, and significantly lower on C, than CW. In addition, there was a trend for PAN women to score higher than RAN women on HA. Although contrasts between BAN and PAN women on this scale were nonsignificant, it is notable that the BAN adjusted mean was similar to the

RAN one, suggesting that PAN women may exhibit the highest level of HA of all three AN subtypes.

As mentioned above, results from the two models were highly similar, but not identical, for SD. For this scale, trend level contrast results from model 1 became statistically significant when additional covariates were added to model 2. Specifically, after adjusting for age ($\chi^2_{(1)} = 45.75$, $p < .0001$), results from model 1 indicated that all three AN subtypes scored significantly lower than CW and that RAN women scored significantly higher than BAN women on this scale. In addition, there was a trend level difference between RAN and PAN women, with RAN women scoring higher than PAN women on SD. In model 2, the difference between RAN and BAN women remained statistically significant, and the trend level difference between RAN and PAN women from model 1 became statistically significant, after adjusting for age ($\chi^2_{(1)} = 2.48$, $p = .12$), BMI ($\chi^2_{(1)} = 1.03$, $p = .31$), center ($\chi^2_{(6)} = 18.18$, $p < .0006$), and an age × BMI interaction ($\chi^2_{(1)} = 3.91$, $p = .048$). It should be noted that the significant age × BMI interaction is due to a significant, positive association between BMI and SD scores in older (*i.e.*, age ≥ 35 years) but not younger (*i.e.*, age < 35 years) AN women. Nonetheless, the relative similarity in findings across the two models for this scale suggests that the addition of significant covariates to the second model just acted to further elucidate already existing AN subtype differences.

Discussion

The current investigation is by far the largest study of temperament and character in women with AN ever reported. We replicate previously observed differences in personality between women with AN and controls. In addition, we extend past work by highlighting a number of personality differences between AN subtypes that have been previously unexamined. Finally, we corroborate previous findings from studies of recovered AN women showing that personality disturbances are independent of body weight (Casper, 1990; O'Dwyer et al., 1996; Ward et al., 1998) and may therefore be traits contributing to the disorder's pathogenesis.

TCI score differences emerged between women with AN and CW as well as across AN subtypes. In general, RAN women showed the greatest number of significant TCI score differences from CW. Specifically, results from the temperament scales characterize the personality profile of these women as anxious, conventional, and highly persevering and perfectionistic. Findings also suggest that their character profile is marked by intolerance, feelings of ineffectiveness and unfullfillment, a critical disposition, and a desire to maintain control over one's self, life, and world. This profile is consistent with previous impressions from clinical and empirical observations which have characterized RAN patients as suffering from extreme self-criticism (Swift et al., 1986), feelings of ineffectiveness (Garner and Olmsted, 1984), and a need to maintain control at all costs (Swift et al., 1986).

In addition to differences from CW, women with RAN also showed a number of notable differences from the other AN subtypes, including having the lowest NS, and the highest SD, score of the three groups. These findings suggest that RAN women may be the most avoidant of risk and change of the three subtypes. Indeed, aspects of persistence and self-directedness may provide the necessary determination and perseverance to perpetuate restricting behavior and be protective against the development of bingeing and purging in these women.

In general, the temperament and character profile of BAN women is more similar to previous reports of women with BN than to women with RAN. BAN women's scores on NS, RD, and P were similar to those previously reported for BN (Bulik et al., 1995a) and were not significantly different from CW, suggesting that neither BAN nor BN women exhibit the extreme avoidance of risk and novel situations, and excessive perseverance, observed in women with RAN. In addition, BAN women's scores on SD were the lowest of the three AN subtypes, suggesting that BAN women may be at greatest risk for the development of personality disorders characterized by identity disturbances, extreme feelings of ineffectiveness, and destructive tendencies (Bulik et al., 1995a). Finally, like BN women (Brewerton et al., 1993; Bulik et al., 1995a, 1995b; Kleifield et al., 1994a), BAN individuals share with RAN women elevated HA scores, reflecting an anxious disposition, as well as elevated C scores which reflect a critical, intolerant nature.

The temperament and character profile of PAN women exhibited similarities to that of both the RAN and BAN individuals. PAN women share with RAN women significantly lower NS and RD, and trend-level higher P, scores relative to CW, suggesting that they too are avoidant of novel situations and change, and tend to be extremely perseverant and perfectionistic. By contrast, both PAN and BAN women scored significantly lower on SD than women with RAN, indicating that they may experience more self-destructive tendencies and feelings of ineffectiveness than individuals with RAN. Finally, PAN women exhibited the highest HA score of the three AN subtypes. This finding may reflect higher levels of depression in women with PAN relative to RAN and BAN, as HA scores have been shown to be positively related to depression levels in the acutely ill state (Kleifield et al., 1994b; see discussion below). Alternatively, they may reflect an extreme aversion to, and avoidance of, negative consequences in PAN women that can explain why these women purge as well as severely restrict their food intake. In essence, extreme HA traits may drive these individuals to develop these additional pathological behaviors to ensure that dreaded events (e.g., weight gain) do not occur.

Our findings suggest two broad conclusions. First, certain facets of temperament differ markedly between all women with AN, regardless of diagnostic subtype, and controls. Second, within the sample of AN women, more subtle temperament and character differences emerged that distinguish among diagnostic subtypes of AN.

Relative to the first point, all AN women, regardless of subtype, shared elevated HA scores relative to CW. This finding corroborates previous research showing elevated HA scores among individuals with both AN and BN (Brewerton et al., 1993; Bulik et al., 1995b; Kleifield et al., 1994a), suggesting that a fearful, anxious disposition may be a risk factor for the development of a range of eating pathology. Neurobiological research showing significant serotonergic dysfunction in ill and recovered AN (Kaye et al., 1991) and BN (Kaye et al., 1998a, 1998b) patients would seem to corroborate these impressions, as HA has been hypothesized to be related to this neurotransmitter system. However, studies of acutely ill AN and BN patients have indicated decreased HA scores after depression levels are statistically accounted for (Kleifield et al., 1994b). These findings highlight the possibility that observed HA elevations may be state dependent consequences of depressive symptoms in eating disorder patients rather than traits contributing to the disorders' development.

Although depressive symptoms were not assessed in the present study, previous studies suggest that HA may be less influenced by depressive symptoms than initially believed. Specifically, elevated HA scores have been found in both AN and BN patients following remission of eating disorder (Casper, 1990; Kaye et al.;[12] Kleifield et al., 1994b; O'Dwyer et al., 1996; Ward et al., 1998) and depressive (Kleifield et al., 1994b) symptomatology. These findings suggest that elevated HA scores may be trait disturbances in AN and BN, and that continued investigation of their etiological significance is warranted. One goal of the Price Genetic Study of AN is to further elucidate this significance by examining whether the moderately heritable HA traits are part of the genetic diathesis for the development of AN. This will be accomplished through association studies examining serotonergic as well as other candidate genes, and linkage analyses that will use HA and other quantitative traits to identify susceptibility genes for AN.

Despite the many strengths of this study, a number of limitations should be noted. First, the control group was archival in nature. Although the ethnicity and mean ages of the two samples did not differ, undetected differences in other demographic characteristics (e.g., socioeconomic status) may have affected results. Second, the different ascertainment of the two samples made it impossible to examine covariates such as BMI and data collection site in group analyses, making it necessary to run two separate analytic models. Although this complicated analyses, results across models were highly similar, indicating that neither BMI nor location of data collection significantly influenced results.

Finally, our inability to examine the influence of depression on TCI scores limited the conclusions that could be drawn, particularly with regard to the HA findings. However, as mentioned above, considerable evidence suggests that HA scores remain elevated after recovery from AN, indicating that they may be trait- rather than state-related disturbances. Future research should continue to elucidate the biological and psychological nature of these and other personality disturbances as well as their meaning for the pathogenesis of eating disordered behavior.

12 Kaye WH, Frank GK, Meltzer CC, Price JC, Crossan P, Klump KL (submitted) Alterations of serotonin functional activity in the medial orbital-frontal cortex after recovery from bulimia nervosa: Implications for the modulation of impulsive and compulsive behaviors.

References

Brewerton TD, Hand LD, Bishop ER (1993) The Tridimensional Personality Questionnaire in eating disorder patients. *Int J Eating Disord* 14:213–218.

Bulik CM, Sullivan PF, Fear JL, Pickering A (1997) Predictors of the development of bulimia nervosa in women with anorexia nervosa. *J Nerv Ment Dis* 185:704–707.

Bulik CM, Sullivan PF, Fear JL, Pickering A (in press) The outcome of anorexia nervosa: Eating attitudes, personality, and parental bonding. *Int J Eating Disord.*

Bulik CM, Sullivan PF, Joyce PR, Carter FA (1995a) Temperament, character, and personality disorder in bulimia nervosa. *J Nerv Ment Dis* 183:593–598.

Bulik CM, Sullivan PF, Weltzin TE, Kaye WH (1995b) Temperament in eating disorders. *Int J Eating Disord* 17:251–261.

Casper RC (1990) Personality features of women with good outcome from restricting anorexia nervosa. *Psychosom Med* 52:156–170.

Casper RC, Hedeker D, McClough JF (1992) Personality dimensions in eating disorders and their relevance for subtyping. *J Am Acad Child Adolesc Psychiatry* 31:830–839.

Cloninger CR (1986) A unified biosocial theory of personality and its role in the development of anxiety states. *Psychiatr Dev* 3:167–226.

Cloninger CR (1987a) Neurogenetic adaptive mechanisms in alcoholism. *Science* 236:410–416.

Cloninger CR (1987b) A systematic model for clinical description and classification of personality variants. *Arch Gen Psychiatry* 44:573–588.

Cloninger CR, Przybeck TR, Svrakic DM, Wetzel RD (1994) *The Temperament and Character Inventory (TCI): A guide to its development and use.* Center for Psychobiology of Personality, Washington University, St. Louis, Missouri.

Cloninger CR, Svrakic DM, Przybeck TR (1993) A psychobiological model of temperament and character. *Arch Gen Psychiatry* 44:975–990.

Dally P (1969) *Anorexia nervosa.* New York: Grune and Straton.

Diggle PJ, Liang KY, Zeger SL (1994) *Analysis of longitudinal data.* Oxford: Oxford Science.

Eckert ED, Halmi KA, Marchi P, Grove W, Crosby R (1995) Ten-year follow-up of anorexia nervosa: Clinical course and outcome. *Psychol Med* 25:143–156.

Fichter MM, Herpetz S, Quadflieg N, Herpetz-Dahlmann B (1998) Structured Interview for Anorexic and Bulimic disorders for DSM-IV and ICD-10: Updated (third revision). *Int J Eating Disord* 24:227–257.

Garfinkel PE, Moldofsky H, Garner DM (1980) The heterogeneity of anorexia nervosa. *Arch Gen Psychiatry* 37:1036–1040.

Garner DM, Garner MN, Rosen LW (1993) Anorexia nervosa "restrictors" who purge: Implications for subtyping anorexia nervosa *Int J Eating Disord* 13:171–185.

Heath AC, Cloninger CR, Martin NG (1994) Testing a model for the genetic structure of personality: A comparison of the personality systems of Cloninger and Eysenck. *J Pers Soc Psychol* 66:762–775.

Garner DM, Olmsted MP (1984) *Manual for Eating Disorder Inventory (EDI).* Odessa Psychological Assessment Resources, Inc.

Kay DWK, Leigh D (1954) The natural history, treatment, and prognosis of anorexia nervosa based on a study of 38 patients. *J Ment Sci* 100:411–439.

Kaye WH, Gendall K, Strober M (1998a) Serotonin neuronal function and SSRI treatment in anorexia and bulimia nervosa. *Biol Psychiatry* 44:825–838.

Kaye WH, Greeno CG, Moss H, Fernstrom J, Fernstrom M, Lilenfeld LR, Weltzin TE, Mann J (1998b) Alterations in serotonin activity and psychiatric symptomatology after recovery from bulimia nervosa. *Arch Gen Psychiatry* 55:927–935.

Kaye WH, Gwirtsman HE, George DT, Ebert MH (1991) Altered serotonin activity in anorexia nervosa in long-term weight restoration: Does elevated cerebrospinal fluid 5–hydroxyindoleacetic acid level correlate with rigid and obsessive behavior? *Arch Gen Psychiatry* 48:556–562.

Kaye WH, Lilenfeld LR, Berrettini WH, Strober M, Devlin B, Klump KL, Goldman D, Bulik CM, Halmi KA, Fichter MM, Kaplan A, Woodside DB, Treasure J, Plotnicov KH, Pollice C, Rao R, McConaha CW (in press) A search for susceptibility loci in anorexia nervosa: Methods and sample description. *Biol Psychiatry.*

Kleifield EI, Sunday S, Hurt S, Halmi KA (1994a) The Tridimensional Personality Questionnaire: An exploration of personality traits in eating disorders. *J Psychiatr Res* 28: 413–423.

Kleifield EI, Sunday S, Hurt S, Halmi KA (1994b) The effects of depression and treatment on the Tridimensional Personality Questionnaire. *Biol Psychiatry* 36:68–70.

Liang KY, Zeger SL (1986) Longitudinal data analysis using generalized linear models. *Biometrika* 73:13–22.

Nagata T, McConaha C, Rao R, Sokol MS, Kaye WH (1997) A comparison of inpatients with anorexia nervosa. *Int J Eating Disord* 22:309–314.

O'Dwyer AM, Lucey JV, Russell GFM (1996) Serotonin activity in anorexia nervosa after long-term weight restoration: Response to d-fenfluramine challenge. *Psychol Med* 26:353–360.

Pillay M, Crisp AH (1977) Some psychological characteristics of patients with anorexia nervosa whose weight has been restored. *Br J Med Psychol* 50:375–380.

Pryor T, Wiederman MW (1996) Measurement of nonclinical personality characteristics of women with anorexia nervosa or bulimia nervosa. *J Pers Assess* 67:414–421.

Rastam M, Gillberg C (1991) The family background in anorexia nervosa: A population-based study. *J Am Acad Child Adolesc Psychiatry* 30:283–289.

SAS Institute (1996) *SAS/STAT Software: Changes and Enhancements for Release 6:12.* Cary, NC: SAS Institute, Inc.

Sohlberg S, Strober M (1994) Personality in anorexia nervosa: An update and a theoretical integration. *Acta Psychiatr Scand* 89(Suppl 378):1–15.

Sordelli A, Fossati A, Devoti RM, La Viola S (1996) Perceived parental bonding in anorectic and bulimic patients. *Psychopathology* 29:64–70.

Strober M, Freeman R, Morrell W (1997) The long-term course of severe anorexia nervosa in adolescents: Survival analysis of recovery, relapse, and outcome predictors over 10–15 years in a prospective study. *Int J Eating Disord* 22:339–360.

Svrakic DM, Przybeck TR, Cloninger CR (1992) Mood states and personality traits. *J Affect Disord* 24:217–226.

Svrakic DM, Whitehead C, Przybeck TR, Cloninger CR (1993) Differential diagnosis of personality disorders by the seven factor model of temperament and character. *Arch Gen Psychiatry* 50:991–999.

Swift WJ, Bushnell NJ, Hanson P, Logemann T (1986) Self concept in anorexia nervosa. *J Am Acad Child Psychiatry* 25: 826–835.

Tylka TL, Subich LM (1999) Exploring the construct validity of the eating disorder continuum. *J Couns Psychol* 46:268–276.

Walters EE, Kendler KS (1995) Anorexia nervosa and anorexic-like syndromes in a population-based female twin sample. *Am J Psychiatry* 152:64–71.

Ward A, Brown N, Lightman S, Campbell IC, Treasure J (1998) Neuroendocrine, appetitive, and behavioural responses to d-fenfluramine in women recovered from anorexia nervosa. *Br J Psychiatry* 172:351–358.

Zeger SL, Liang KY (1986) Longitudinal data analysis for discrete and continuous outcomes. *Biometrics* 42:121–130.