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Categories or Continua?

Taxometric Analysis of Personality Disorders

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Running Head: TAXOMETRICS OF PERSONALITY DISORDERS

Abstract

Recent calls to replace the categorical classification of personality pathology with a dimensional system implicitly assume that none of the current personality disorders (PDs) are natural categories. Taxometrics is a statistical method designed to test this assumption. However, it has been rarely applied to PDs. We evaluated the categorical nature of the 10 specific PDs using three taxometric procedures: MAXCOV, MAMBAC, and L-Mode. Each disorder was operationalized with dichotomous diagnostic criteria and with continuous maladaptive personality traits. Both were assessed with the Schedule for Nonadaptive and Adaptive Personality (SNAP). In trait analyses, PDs were defined by clusters of personality dimensions, which were derived from empirical and conceptual matches between traits and diagnoses. Analyses were performed in a combined sample of patients, community dwellers, and undergraduates (N = 3309). None of the syndromes produced compelling evidence of taxonicity in either operationalization. It appears that existing PDs are dimensional constructs.

Key words: Taxon, taxometrics, personality disorders, classification, diagnosis

Categories or Continua? Taxometric Analysis of Personality Disorders

The current diagnostic system codified in the *Diagnostic and Statistical Manual for Mental Disorders-Fourth Edition* (DSM-IV; American Psychiatric Association [APA], 2000) describes personality pathology in terms of discrete disorders. This approach has been heavily criticized, and many have called for replacement of the categorical model with a dimensional classification (Clark, 2007; Livesley, 2005; Widiger, Simonsen, Krueger, Livesley, & Verheul, 2005). The critics observed that the extant nosology of personality pathology suffers from high levels of comorbidity, within-diagnosis heterogeneity, and unreliability, whereas dimensional constructs are more internally consistent, stable, and differentiable at least in the domain of personality disorder (e.g., Clark, Livesley, & Morey 1997; Clark & Watson, 1999; Trull & Durrett, 2005). Validity of these arguments have been subject to debate (First, 2005; Watson & Clark, 2006), but it is almost certain that wholesale abolition of categorical diagnoses would be a mistake, if some personality disorders are actual types. Conversely, upholding of the existing categorical nomenclature would be problematic, if personality pathology is truly continuous.

Unfortunately, there is little empirical evidence that pertains directly to this basic issue. Researchers have tried to evaluate the categorical nature of personality pathology with such strategies as (1) examining distributions of symptom scores for bimodality, (2) evaluating an association between the level of symptomatology and a relevant outcome (e.g., functional impairment) for nonlinearity, and (3) testing invariance of the factor structure of symptoms between disordered and nondisordered populations. A recent review (Haslam, 2003) argued that these procedures cannot provide definitive evidence for or against the existence of a latent category. For example, bimodality of symptom scores is neither necessary nor sufficient for the existence of a true category (Waller & Meehl, 1998). New statistical methods are sorely needed, and taxometrics is one of the most promising approaches. It was developed to identify natural categories, or taxa, and was specifically designed to avoid limitations of existing methods, such as cluster analysis and latent class analysis (Ruscio, Haslam, & Ruscio, 2006; Schmidt, Kotov, &

Joiner, 2004; Waller & Meehl, 1998). Hence, taxometrics has a unique potential to address questions about the categorical nature of personality pathology.

Taxometric analyses are most informative when they examine clearly defined constructs (Lenzenweger, 2004). A variety of categorical constructs have been proposed in the area of personality pathology, but DSM-IV is the only widely-used systematic categorical classification of this domain. A notable limitation of DSM-IV is that it is atheoretical and does not necessarily capture all forms of personality pathology. Nevertheless, the majority of primary taxometric studies and all reviews of this work have been based on the DSM personality disorders (PDs) framework. More than 30 taxometric investigations of this domain have been published to date. This literature was reviewed exhaustively by Haslam (2003, 2007), and we only update these reviews with new findings.

Four PDs have been examined in multiple taxometric studies. Research relevant to Schizotypal PD focused on its subcomponents—either positive or negative schizotypy—and overwhelmingly found them to be taxonic (most recently Linscott, 2007; but for a non-replication see Rawlings, Williams, Haslam, & Claridge 2008). In fact, only one study evaluated the two components jointly and reported the overarching construct to be nontaxonic (Horan, Blanchard, Gangestad, & Kwapil, 2004). This suggests a possibility that Schizotypal PD may be a collection of taxonic entities but not a taxon itself. However, taxonicity of this disorder has not been tested directly. The majority of taxometric investigations relevant to Antisocial PD evaluated a related construct of psychopathy. Five studies produced evidence of taxonicity (most recently Harris, Rice, Hilton, Lalumiere, & Quinsey, 2007). However, nine other studies did not find the taxon (including Edens, Marcus, Lilienfeld, & Poythress, 2006; Marcus, Ruscio, Lilienfeld, & Hughes, 2008; Walters, Diamond, Magaletta, Geyer, & Duncan, 2007; Walters, Gray et al., 2007). Of these 14 reports only Edens et al. (2006) directly tested criteria for Antisocial PD. Moreover, these studies were largely limited to prison or youth populations, as only Marcus et al. (2008) evaluated taxonicity of antisocial personality in nonincarcerated adults. Two initial investigations of Borderline PD produced ambiguous results that have been

interpreted to indicate taxonicity by some and dimensionality by others (see Widiger & Samuel, 2005). Two recent studies reported more definite non-taxonic findings (Arntz et al., in press; Edens, Marcus, & Ruiz, 2008). Narcissistic PD was examined by Fossati et al. (2005) who found it to be taxonic. However, Foster and Campbell (2007) reported non-taxonic results for a related construct of narcissism.

Four other disorders were evaluated in one taxometric investigation. Arntz et al. (in press) found that Paranoid, Avoidant, Dependent, and Obsessive-Compulsive PDs are not taxonic. Unfortunately, no replications of this study have been attempted yet. In sum, emerging evidence suggests that Borderline PD is probably dimensional. Antisocial PD may be dimensional as well, but taxonic status of the remaining disorders is uncertain due to lack of replications or inconsistent results. In fact, Schizoid and Histrionic PDs have not been examined at all.

Current Study

Our aim was to clarify the nature of DSM PDs by testing taxonicity of the 10 specific disorders. Two approaches to this question are possible. One option is to analyze sets of PD criteria specified in the DSM. This approach evaluates disorders exactly as they defined in the manual, but application of taxometric procedures to dichotomous markers (i.e., diagnostic criteria) may lead to erroneous results (Maraun et al., 2003; Schmidt et al., 2004). Another option is to define PDs with continuous and reliable measures. It would be impossible to develop such measures for all PD criteria, as there are nearly 80 of them. However, DSM-IV also defines PDs as constellations of maladaptive traits (APA, 2000, p. 686). The number of these traits is more manageable, and reliable scales are available to measure them. This approach also has been advocated by Clark, Livesley, and Morey (1997), who suggested that categories and dimensions can be viewed as two levels of a hierarchical structure, so that dimensions are “the blocks from which categories may be built” (p. 206). We used both approaches in this investigation. First, we directly operationalized PDs with DSM criteria. Second, we examined sets of maladaptive trait

measures to ensure that the results were not affected by the dichotomous nature of diagnostic criteria.

Method

Samples

Three populations were sampled for the study: general adult population, college students, and psychiatric patients. Detailed descriptions of the samples are provided elsewhere (Clark, Simms, Wu, & Casillas, in press), and we give only a brief summary of sample characteristics.

The general population sample (N = 561) was recruited to provide normative data for the Schedule for Nonadaptive and Adaptive Personality (SNAP). Research participants were solicited by random-selection calling of households in Dallas (Texas), Iowa City (Iowa), and Minneapolis (Minnesota) metropolitan areas. The average age of participants was 39 years (range: 18 to 85), 58% of them were females and 83% were Caucasians. All levels of income were represented in the sample (range: from less than $10,000 to more than $90,000 a year).

The student sample (N = 1865) was a composite of six smaller samples of introductory psychology students at the University of Iowa (N = 1311) and Southern Methodist University (N = 554). The participants were recruited for various studies. These studies did not have specific selection requirements, thus the composite sample is likely to be representative of the target population. Ninety-seven percent of participants were between 17 and 24 years of age, 63% were females and 93% were Caucasians.

The patient sample (N = 883) included data from three smaller samples: (1) patients with recurrent depression (N = 147), (2) back pain patients (N = 125), and (3) a general psychiatric sample (N = 661). The participants were recruited from various clinics in Iowa City and Dallas; 143 of them were inpatients and the rest were outpatients. The average age of participants was 36 years, 63% of them were females and 88% were Caucasians. All levels of education were represented.

With three samples we had a choice of conducting taxometric analyses in each population independently or combining them. Use of composite samples is somewhat hazardous because of

the potential for pseudo-taxonicity, as an identified taxon may simply reflect the added sample (Lenzenweger, 2004; Schmidt et al., 2004). On the other hand, even the most sensitive taxometric procedure will fail to detect taxonicity when the sample includes too few taxon members (Ruscio & Ruscio, 2004). Schmidt et al. (2004) proposed that at least 30 taxon members need to be present for detection of the group. Accordingly, the size of the subsamples may be insufficient to find taxa associated with less prevalent PDs, although they should be detectable in the total sample (based on prevalence estimates of Grant et al., 2004; Lenzenweger, Lane, Loranger, & Kessler, 2007). To avoid false nontaxonic findings, primary analyses were performed in the combined sample. However, we also repeated these analyses in the subsamples to safeguard against statistical artifacts that may be associated with the composite sample.

Measures

Schedule for Nonadaptive and Adaptive Personality (SNAP). Personality traits were assessed with the SNAP (Clark, 1993), a 375-item, factor analytically derived omnibus self-report inventory that uses a true-false format to assess 15 dimensions of personality pathology (e.g., mistrust, impulsivity). These traits were derived from iterative analyses of DSM-III (APA, 1980) and DSM-III-R (APA, 1987) PD criteria. SNAP trait scales have demonstrated good internal consistency (*Mdn* alphas =.80 to .85 in student, adult, and patient samples), test-retest reliability (e.g., in normal adults, 1 week to 4 months mean r = .87), and discriminant validity (mean interscale r = approximately |.20|) (Clark at al., in press). The three higher order temperament dimensions (positive temperament, negative temperament, and disinhibition) reflect the factor structure of the instrument, and validity of the scales has been supported in several studies reviewed in the manual. The SNAP also assesses categorical PDs. These ratings are superior to many other self-report diagnostic instruments and agree with interview-based diagnoses no worse than different interview measures agree with each other (Clark et al., 1997). Psychometric properties of the instrument in the present samples are reported in Clark et al. (in press). We chose to use the SNAP in this study for three reasons. First, it is one of the best

established dimensional taxonomies of personality pathology. Second, the SNAP was derived from DSM criteria and is likely to contain all traits necessary to operationalize each PD. Third, it specifically targets pathological rather than normative ranges of these traits. Indeed, information curves for nearly all SNAP scales peak well above the mean (Simms, 2003).

Indicator Selection

PDs were operationalized with numbered DSM criteria (i.e., specific symptoms listed under criterion A). These dichotomous markers were scored from the SNAP in accordance with the manual. Schizotypal PD was missing criterion A.7, which is not assessed by the SNAP as it requires a behavioral observation. All other PDs were defined with complete sets of criteria.

In follow-up analyses, PDs were represented by ten sets of trait indicators selected based on conceptual and empirical considerations. Clark (1993) reviewed DSM-III-R general conceptualizations of PDs (i.e., essential features described in criterion A) and selected SNAP scales relevant to each PD. In addition, we examined numbered diagnostic criteria in DSM-IV to identify traits implied in these more detailed definitions. Thus, nine new conceptual matches were added to the original list of 26. An independent expert reviewer (L. A. Clark) verified appropriateness of the new matches. Empirical evidence was derived from three patient samples, in which scores on diagnostic interviews for PDs could be correlated with SNAP scales (samples are described in Clark et al., in press). Altogether, SNAP scores and diagnostic information was available on 308 patients, and a total of 304 PD diagnoses were assigned to them. Correlations between SNAP scales and the number of criteria met for a particular diagnosis were evaluated in each sample. Strong and statistically significant correlations were considered evidence of a match. Conceptual and empirical considerations were integrated according to three rules. First, each indicator set needed to include at least three SNAP scales, as the primary taxometric procedure requires three indicators. Second, a scale was included if it had an empirical match and a conceptual match, or if it had two empirical matches (i.e., was associated with the disorder at least in two of the three samples). Third, a scale was excluded if it was based purely on empirical evidence and resulted in an overlap between two sets of more than 50%. This was done

to avoid interpretive problems. For instance, if two taxa share three indicators and each has only one unique marker, it is unclear whether these categories can be considered separate entities. Also, self-harm could not be included on purely empirical grounds, as this trait is associated with psychiatric problems in general and liberal inclusion of this variable would likely reduce discriminant validity of the indicator sets. The resulting sets of variables are listed in Table 1.

Data Analyses

Three taxometric methods were used to test the taxonic conjecture: Maximum Covariance (MAXCOV), Mean Above Minus Below a Cut (MAMBAC), and Latent Mode (L-Mode), as they are the most widely used procedures and offer independent tests of taxonicity. The general logic of the methods is described below (for detail see Ruscio et al., 2006; Schmidt et al., 2004; Waller & Meehl, 1998). Analyses were conducted using software programs developed by Niels Waller (2007) and by John Ruscio (2007).

MAXCOV. This procedure examines triplets of indicators. MAXCOV divides one indicator into several intervals and computes the average covariance of the other two indicators within each interval. In this study, the interval size was individually determined for each indicator set. It was selected so that a scale with the smallest standard deviation (SD) in the set had one raw score in each interval. To reduce noise in the analyses, covariance was estimated only in intervals that included at least 15 cases. A peaked covariance curve indicates presence of a taxon, and position of the peak provides the basis for estimating taxon base rate. The analysis is repeated with different configurations of indicators, thus generating multiple plots and base rate estimates. Consistency of the analyses can be evaluated by the "nose count" of taxonic curves. Simulation studies suggest that when at least 50% of plots are peaking, the data should be considered taxonic (Schmidt et al., 2004). Variability of the taxon base rate estimates is another consistency test, albeit a weaker one, and large variability (typically > .10; Schmidt et al., 2004) is considered evidence against taxonicity. Analyses of dichotomous indicators required a standard modification to the procedure. Covariance was computed between pairs of indicators, as all other markers were summed and the composite was divided into intervals.

MAMBAC. This technique analyses pairs of indicators. A cut is made on one indicator to divide the sample into two groups. A mean score on another indicator is calculated for each of the two groups, and the mean difference is computed. The cut is moved progressively along the input indicator resulting in a plot of group mean differences. A convex curve is indicative of taxonicity. MAMBAC also provides an estimate of taxon base rate. The analysis is repeated with different configurations of indicators, producing multiple plots, and thus allows for both nose count and base rate variability tests. In analyses of dichotomous variables, one indicator was used to compute the mean difference, all others were summed, and progressive cuts were made on the composite.

L-Mode. This method examines the shape on the distribution of scores on the first unrotated common factor. Bimodality suggests taxoncity, whereas a unimodal distribution is interpreted as evidence of continuity. The procedure yields only one graph, but taxon base rate can be calculated independently twice from positions of each mode. These estimates should agree to encourage taxonic inference.

Three judges extensively trained on simulated data scored all plots not knowing their source. To ensure blinding study graphs were intermixed with plots from other taxonic and continuous data. MAXCOV and MAMBAC curves were rated using a three-point scale: nontaxonic (zero), ambiguous (half), and taxonic (one). The median of the three ratings was used as the final score. These scores were averaged across plots to produce the overall rating of taxonicity. This index was considered indicative of taxonicity if it was greater than the .50 cutoff. Plot ratings had acceptable reliability with average intraclass correlations between raters of .80 and .77 for MAXCOV and MAMBAC, respectively. L-mode curves were scored dichotomously (taxonic or not). The raters showed perfect agreement on these plots.

Within-group (nuisance) correlations among indicators can diminish the capacity of the method to detect taxonicity. However, Monte Carlo simulations suggest that nuisance correlations of up to .30 do not significantly degrade performance of taxometric procedures, and larger values are tolerable if nuisance correlations are approximately equal in taxon and

nontaxon groups (Meehl, 1995, 1999). Indicator validity—a separation between the means of taxon and nontaxon groups—also influences performance of the method. An average indicator validity of Cohen's *d* = 1.25 or above is recommended for reliable detection of a taxon (Beauchaine & Beauchaine, 2002; Meehl, 1995). To ensure that selected trait indicators confirm to these assumptions, suitability analyses were performed as described later in the text.

A number of recent studies have used sample-specific simulated data to aid interpretation of the results (e.g., Edens et al., 2006; Walters, Diamond et al., 2007). We decided against this method for two reasons. First, sample-specific simulations seem to be most useful when a construct is considered in isolation, without other real data to serve as a comparison. In this study, however, nine other sets of indicators with very similar psychometric properties were available to provide interpretive benchmarks for each analysis. Second, there is an ongoing controversy as to when sample-specific simulations are appropriate and whether they can lead to erroneous inference (e.g., Beauchaine, Lenzenweger, & Waller, 2008). We judged that in this study the added value of simulated comparison data was not sufficient weighed against the contentions surrounding this technique.

Results

Analyses of PD criteria

First, we evaluated taxonicity of PD criteria sets. Results for the total sample are reported in Table 2. MAXCOV analyses produced evidence of taxonicity only for antisocial and borderline syndromes (plots 67% and 57% taxonic, respectively). However, the base rate estimates were three times higher than expected and quite variable (SD = .12 and .18). Moreover, the corresponding MAMBAC graphs were only 25% and 13% taxonic. In general, MAMBAC did not suggest taxonicity for any of the 10 syndromes. Indeed, none of the plot ratings crossed the threshold, although those for histrionic and avoidant approached it. These two analyses were judged to be non-taxonic as they did not clear the cutoff and produced highly variable base rate estimates (SD = .16 and .27, respectively). L-mode curves also were clearly nontaxonic, except for the obsessive-compulsive analysis. Base rate estimates were very high and inconsistent for L-

mode analyses across the board (nearly all were between P = .31 and 1.00). Base rate estimates for the antisocial syndrome differed substantially across methods (range of P was .09 to 1.00). Borderline taxon base rates were similar in MAXCOV and MAMBAC analyses (mean P = .18 and .20), but MAMBAC estimates were based on clearly nontaxonic curves, and L-mode estimates were much higher (P = .44 and .79). In sum, no taxa received consistent support in analyses of PD criteria. Next, we tested this conclusion with trait indicators. To ensure that our trait operationalizations are sound, we examined their suitability for taxometric analyses.

Suitability of trait indicators

To assess suitability of the indicator sets, likely members of each taxon had to be identified. These groups were defined according to SNAP PD diagnoses: individuals with the diagnosis were considered likely taxon members, all others nontaxon members. Average separation between putative taxon and nontaxon members on relevant indicators provided an estimate of validity, and average indicator intercorrelation in these groups served to assess nuisance correlations (Table 1). Due to the mixed nature of the sample, overall prevalence of SNAP PDs is not comparable to the general population. Hence, we compared rates of SNAP diagnoses in each subsample to published estimates for the corresponding population and found our rates to be broadly consistent with expectations, except for Histrionic PD (data available from the authors). In the community sample, Histrionic PD had prevalence of 9.8%, which is five times greater than the expected rate (Grant et al., 2004). Consequently, grouping based on this variable may be a poor guide for the suitability test. In fact, the corresponding validity estimate was unusually low (d = .96). The only other indicator set to produce a low validity estimate was Obsessive-Compulsive (d = 1.10). Of note, this value was just below the 1.25 threshold, and the corresponding nuisance correlations were very low, suggesting that Obsessive-Compulsive indicators may be appropriate for taxometric analyses nevertheless. Nuisance correlations were slightly above the recommended level for schizoid and antisocial PDs (Table 1). However, nuisance correlations were about equal in taxon and nontaxon groups. Moreover, both indicator sets had high validity. We decided to proceed with analyses of these data with the

above caveats in mind. Importantly, the cited cutoffs are rules of thumb, and taxometric analysis can assess potential problems more precisely post hoc.

We also screened indicators for high skew, as variables with skew greater than 2.0 may degrade performance of taxometric procedures (Beauchaine, 2007). All of our markers showed only moderate skew, which ranged from -0.55 to 1.30, and thus were deemed appropriate.

To ensure that the selected indicator sets represent target PDs well, we performed a series of multiple regression analyses. Number of symptoms for a given PD endorsed on the SNAP served as a dependent variable, and the selected scales were predictors. Proportion of reliable variance accounted by the predictors is reported in Table 1 (Coverage). Reliable variance was defined as Cronbach's α of the symptom count. The selected indicators accounted for at least 99% of reliable variance in all disorders except for the Dependent PD (90% accounted). Moreover, all chosen traits made substantial and highly significant independent contributions to respective PDs, which indicates that all of them should be retained. To determine if coverage of Dependent PD can be improved further, we tried adding the remaining scales to the predictor set one at a time. However, all of these scales contributed negligibly ($\Delta R^2 < .004$); hence no changes were made to the Dependent PD indicator set.

Analyses of trait indicators

MAXCOV analyses of the 10 trait indicators produced a total of 84 plots. The first three graphs for each set are presented in Figure 1. Plot smoothing is commonly used in taxometric research, but because of the large sample size MAXCOV curves were clear without it. MAXCOV results are reported in Table 3. Analyses of paranoid and histrionic sets did not yield parameters estimates because shapes of the corresponding graphs were severely nontaxonic. Evaluation of MAXCOV plots supported the taxonic conjecture only for the antisocial set (58% taxonic). However, corresponding taxon base rate estimates were unexpectedly high (mean P = .21) and variable (SD = .14). Graphs for other sets were clearly nontaxonic (highest plot rating of .31). Some analyses produced consistent base rate estimates, but such results can be observed in continuous data and do not constitute evidence of taxonicity in and of themselves.

MAMBAC was applied to the same indicator sets. Sample plots (first three curves) are presented in Figure 2, and all results are reported in Table 3. MAMBAC graphs supported taxonicity of the antisocial set (58% taxonic). However, its base rate estimates were even higher than those of MAXCOV (mean P = .38) and were quite variable (SD = .14). Schizoid syndrome approached the threshold (50% taxonic), but the base rate estimate was very high (mean P = .37). In fact, all MAMBAC base rates were implausibly high, ranging from .37 to .56.

L-mode did not produce results in three analyses, because factor extractions failed to converge. Full results are available on the other seven indicator sets (Table 3; Figure 3). All plots were clearly nontaxonic. Base rate estimates for the two modes were very inconsistent and high, with most falling between .34 and .99. Moreover, there was no agreement in base rate estimates across the three methods, with the exception of the obsessive-compulsive syndrome, for which MAXCOV and MAMBAC produced identical estimates of 45% prevalence.

Analyses in subsamples

To ensure that our findings are not distorted by the composition of the sample, we repeated analyses of trait indicators in the three subsamples. Table 3 reports results from the primary procedure (MAXCOV) for each subsample. Only one of the 30 analyses produced some evidence of taxonicity. Specifically, analysis of the antisocial syndrome favored taxonicity in the community sample (MAXCOV plots 71% taxonic). The corresponding base rate estimates were implausibly high (mean P = .21) but consistent (SD = .05). MAMBAC of these data also suggested taxonicity (plots 54% taxonic), but estimated the base rate to be even higher (mean P = .26; SD = .11). L-mode graph was nontaxonic with very high base rate estimates (P1 = .38, P2 = .60). In sum, consistent evidence of taxonicity was not obtained in any of the subsample analyses.

Discussion

We tested taxonicity of 10 specific PDs with three taxometric methods, applying them both to dichotomous (DSM criteria) and continuous (trait) indicators of these syndromes. The analyses did not produce convincing evidence of taxonicity for any of the disorders considered.

Our results suggest that PD diagnoses, as they are currently defined in the DSM, do no reflect natural categories. This finding reinforces conclusions of recent reviews that no PD has been consistently identified as a taxon (Haslam, 2007; Widiger & Samuel, 2005).

The only possible exception from the negative findings is Antisocial PD. In this study, the syndrome met some criteria for taxonicity, but many analyses yielded nontaxonic plots, base rate estimates differed considerably within procedures and between procedures, and were implausibly high. We interpreted this pattern as evidence of dimensionality, because taxometric procedures occasionally produce taxonic curves even if the data are continuous, but then the results are likely to be inconsistent (Meehl, 1995, 1996), as was the case here. On the other hand, a genuine antisocial taxon may have been present but was not clearly detectable in these data because of its low prevalence or inadequate operationalization. Importantly, the present findings mirror the extant literature on antisociality, for which every taxonic report is countered by a nontaxonic finding. In sum, existing support for the categorical conceptualization of antisocial PD is not compelling, and it may be fruitful to adopt the dimensional approach while the controversy is investigated. Importantly, the dimensional model retains more information and can be converted to a categorical classification, but not vice versa (Clark, 2007).

The borderline syndrome produced taxonic plots in one analysis, but the nontaxonic evidence was overwhelming, which is consistent with the predominant interpretation of previous studies as supporting dimensionality (Haslam, 2007; Trull & Durrett, 2005). With regard to Narcissistic PD our results agree more with Foster and Campbell (2007) than Fossati et al. (2005) and suggest that the disorder is not taxonic. However, this inconsistency may be due to measurement modalities, as the two negative studies used self-report assessments, whereas Fossati et al. analyzed both self-report and interview data. Taxonicity of narcissistic PD certainly requires further investigation.

The nontaxonic result for the Schizotypal PD is consistent with the only previous joint analysis of positive and negative schizotypy, as it also produced evidence of dimensionality (Horan et al., 2004). These findings should not be interpreted as evidence against positive and

negative schizotypy taxa. A structural disconnect between the disorder and its two components is quite plausible. Many natural categories are defined by constellations of continuous variables (Meehl, 1999), and the reverse is equally possible. Taxometric evidence appears to be strong enough to consider positive and negative schizotypy taxa for inclusion in the diagnostic system. However, identification of a taxon is only the first step. Validity and clinical utility of a category has to be demonstrated as well (Watson, 2003; Widiger & Samuel, 2005). Indeed, a taxon may be psychometrically sound but lack any theoretical or clinical significance. Unfortunately, construct validity of the schizotypy taxa has not yet been examined.

Methodological Considerations

We conducted analyses in a mixed sample. This approach is potentially hazardous, because it can result in pseudotaxonicity. However, no taxa were detected in the present investigation, and there are no data to suggest that mixed samples can obscure taxonicity. Moreover, we repeated analyses in the subsamples and reached the same conclusions. The community subsample was drawn from the general population, and our findings are likely to be broadly applicable. Furthermore, owing to the cross-cutting design of the study, our results are relevant not only to community dwellers, but also students and patients.

We elected not to use simulated comparison data. Nevertheless, clear interpretive benchmarks were available in this investigation, as analyses of some syndromes (e.g., schizotypal) yielded clearly dimensional outputs, whereas analyses of others (e.g., antisocial) produced clearly taxonic curves, and thus provided reasonable reference points. Also, the simulated data are primarily utilized as a safeguard against pseudotaxonic results, which was not a major concern given our findings.

Limitations

In addition to evaluation of maladaptive traits, we tested DSM diagnoses directly by examining PD criteria. However, these criteria were derived from a self-report instrument, and our findings need to be confirmed with a clinical interview measure of PDs. Nevertheless, the present study provided initial taxometric data on two disorders (Schizoid and Histrionic), offered

first replication of findings for five other syndromes, and strengthened emerging consensus on Borderline and Antisocial PDs. The status of Narcissistic PD remains uncertain, however.

Another concern is that some of our operationalizations were not ideally suited for taxometric analyses. Two indicator sets produced relatively low differentiation between putative taxon members and nonmembers, and two others had high nuisance correlations. Thus, there is some question about trustworthiness of those findings. In particular, high nuisance correlations may have precluded unambiguous detection of the antisocial taxon. Also, markers of the histrionic syndrome may have been too weak to distinguish it. Suitability of our operationalizations could have been improved by modifying the indicator sets, but such revised operationalizations would not map as clearly on DSM-IV diagnoses and this would weaken the test. Moreover, weaker suitability results may reflect problems in estimation of group membership for the corresponding PDs (i.e., overinclusiveness of the SNAP histrionic diagnosis) rather than limited validity of the indicators. We decided to proceed with the selected markers because they showed excellent psychometric properties otherwise. Nevertheless, our findings for these syndromes need to be treated with caution, as they may have been affected by weaknesses of selected indicators.

Finally, we only examined a small subset of all possible configurations of maladaptive traits. Hence, any natural category not captured by the DSM would have been overlooked, as apparent with regard to positive and negative schizotypy taxa. The present findings are best conceptualized as a test of established PDs and are limited by the scope of DSM-IV.

Conclusions

In conjunction with the existing taxometric literature, the present study suggests that DSM-IV PDs are likely to be continuously distributed. These data support the key premise of dimensional classification systems and strengthen the case for adoption of such a model (e.g., Clark, 2007; Krueger, Skodol, Livesley, Shrout, & Huang, 2007). However, we cannot conclude from this fairly limited evidence that the domain of personality pathology is devoid of natural categories. Indeed, the schizotypy literature seems to provide a counter example. We can say that

taxometric studies by and large have failed to support discreteness of DSM-IV PDs. Hence, if existing PDs are retained in DSM-V, it may be more appropriate to treat them as continua than categories (e.g., Oldham & Skodol, 2000).

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Table 1. *Suitability of Indicator Sets*.

Disorder	Prevalence (%)	Validity (*d*)	Nuisance *r*	Coverage (%)	Indicators				
					1	2	3	4	5
Paranoid	4.2	1.76	0.29	99	Mistrust	Aggression	NT		
Schizoid	3.4	1.60	0.40	100	Detachment	Exhibitionism (low)	PT (low)		
Schizotypal	4.1	1.73	0.10	100	EP	Detachment	Mistrust		
Antisocial	2.6	1.83	0.36	100	Disinhibition	Manipulativeness	Aggression	Impulsivity	
Borderline	6.1	1.47	0.21	100	Mistrust	Aggression	Self Harm	NT	Impulsivity
Histrionic	18.2	0.96	-0.07	100	Exhibitionism	NT	PT		
Narcissistic	4.4	1.40	0.14	99	Entitlement	Manipulativeness	Exhibitionism	Aggression	
Avoidant	16.2	1.29	0.15	100	Detachment	Exhibitionism (low)	Mistrust	NT	
Dependent	8.3	1.52	0.25	90	Dependency	Mistrust	NT		
Obsessive-Compulsive	5.5	1.10	0.13	100	Propriety	Workaholism	NT		

Note. N = 3309. Prevalence refers to SNAP diagnoses. Coverage indicates amount of reliable variance in a diagnosis explained by the indicator set. NT = Negative Temperament, PT = Positive Temperament, EP = Eccentric Perceptions. Indicators are ordered according to the strength of evidence for their inclusion.

Table 2. *Taxometric analyses of PD criteria.*

Disorder	MAXCOV		MAMBAC		L-Mode		
	Plots	P (SD)	Plots	P (SD)	Plot	P1	P2
Paranoid	.48	.08 (.06)	.00	.13 (.08)	No	.31	1.00
Schizoid	.33	.16 (.14)	.29	.20 (.22)	No	.23	.73
Schizotypal	.39	.13 (.15)	.19	.16 (.26)	No	.43	.73
Antisocial	**.67**	.09 (.12)	.25	.17 (.13)	No	.38	1.00
Borderline	**.57**	.18 (.18)	.13	.20 (.10)	No	.44	.79
Histrionic	.14	.31 (.19)	.50	.22 (.16)	No	.56	.97
Narcissistic	.28	.14 (.18)	.22	.27 (.15)	No	.51	.79
Avoidant	.21	.35 (.22)	.50	.40 (.27)	No	.53	.99
Dependent	.32	.13 (.14)	.06	.20 (.06)	No	.44	.95
Obsessive-Compulsive	.15	.11 (.20)	.22	.25 (.18)	Yes	.34	.83

Note. N = 3309. P = taxon base rate. Plot ratings are presented as the proportion of the highest possible score, which corresponds to all plots being scored as taxonic. Bold indicates plot scores that are above the threshold for taxonicity.

Table 3. *Taxometric analyses of trait indicators.*

Disorder	MAXCOV		MAMBAC		L-Mode			MAXCOV in Subsamples					
								Student		Patient		Community	
	Plots	P (SD)	Plots	P (SD)	Plot	P1	P2	Plots	P (SD)	Plots	P (SD)	Plots	P (SD)
Paranoid	.17	--	.33	.39 (.07)	No	.55	.84	.50	.37 (.12)	.00	--	.33	--
Schizoid	.00	.29 (.04)	.50	.37 (.06)	No	.07	.99	.33	.24 (.01)	.17	.56 (.15)	.33	.51 (.12)
Schizotypal	.17	.21 (.11)	.17	.56 (.24)	No	.45	.99	.33	.18 (.08)	.33	.50 (.29)	.33	.26 (.14)
Antisocial	**.58**	.21 (.14)	**.58**	.38 (.14)	No	.61	.99	.21	.27 (.09)	.46	.21 (.10)	**.71**	.21 (.05)
Borderline	.31	.21 (.15)	.35	.47 (.22)	No	.39	.61	.20	.30 (.12)	.27	.44 (.21)	.47	.21 (.10)
Histrionic	.17	--	.25	.64 (.27)	--	--	--	.33	--	.33	.40 (.16)	.00	--
Narcissistic	.08	.24 (.25)	.46	.39 (.15)	No	.29	.99	.08	.43 (.32)	.21	.36 (.24)	.42	.29 (.22)
Avoidant	.25	.21 (.04)	.38	.41 (.17)	No	.34	.99	.21	.28 (.17)	.25	.51 (.17)	.38	.30 (.08)
Dependent	.00	.27 (.05)	.42	.42 (.07)	No	.02	.99	.00	.36 (.18)	.50	.64 (.05)	.33	.37 (.18)
Obsessive-Compulsive	.00	.45 (.36)	.33	.45 (.07)	--	--	--	.00	.38 (.34)	.17	.64 (.32)	.33	.41 (.29)

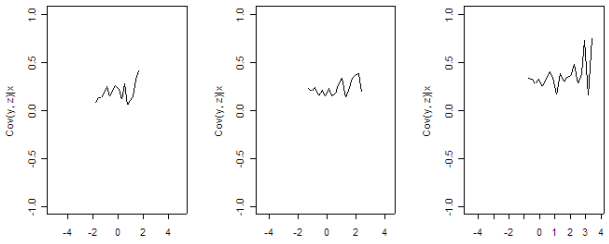
Note. N = 3309. P = taxon base rate. Dashes indicate that a parameter could not be estimated. Plot ratings are presented as the proportion of the highest possible score, which corresponds to all plots being scored as taxonic. Bold indicates plot scores that are above the threshold for taxonicity.

Figure Captions

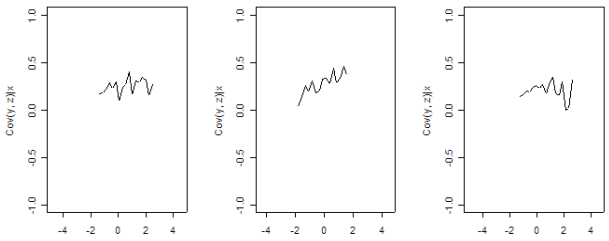
Figure 1. Sample MAXCOV plots. Three curves are presented for each syndrome.

Figure 2. Sample MAMBAC plots. Three curves are presented for each syndrome.

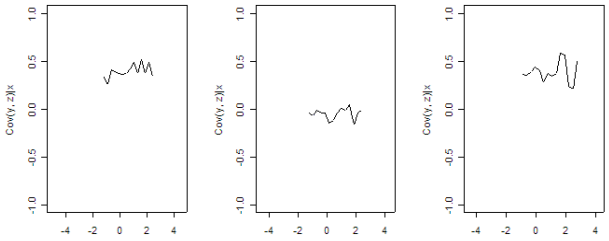
Figure 3. L-Mode plots. Vertical lines indicate positions of modes used in calculations.



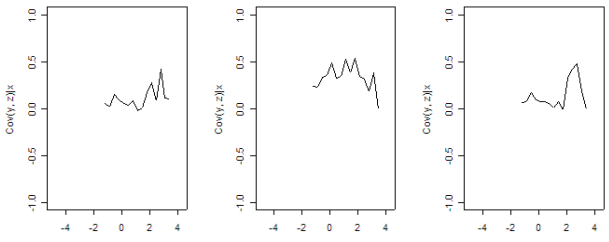
Paranoid



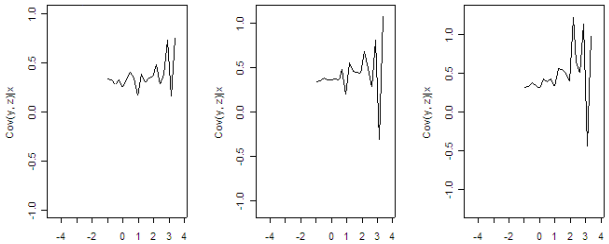
Schizoid



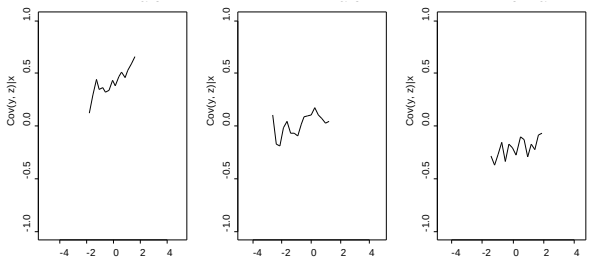
Schizotypal



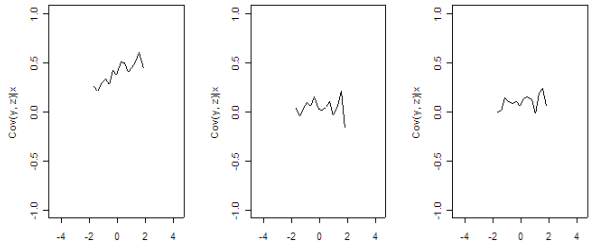
Antisocial



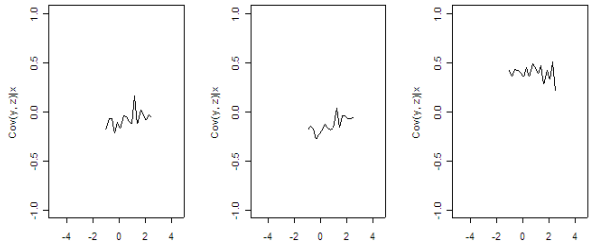
Borderline



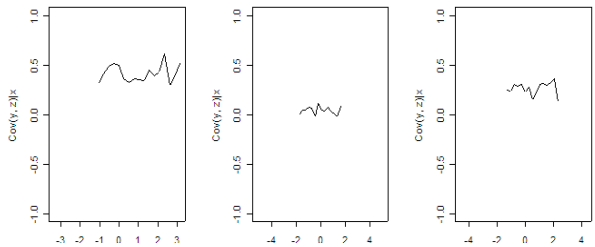
Histrionic



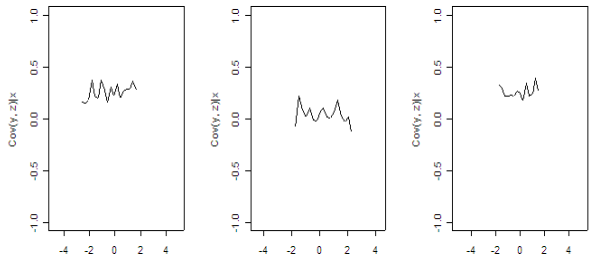
Narcissistic



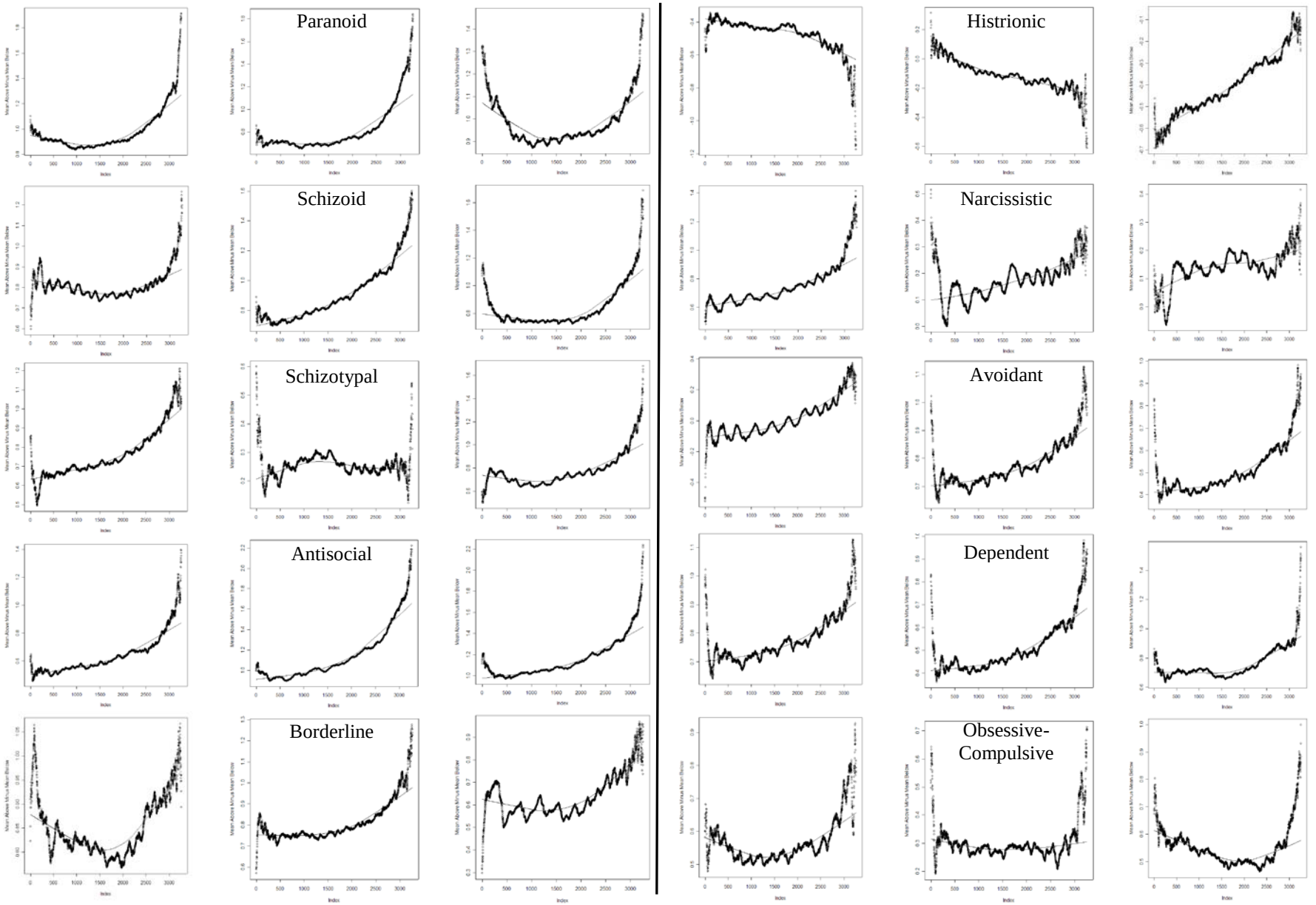
Avoidant

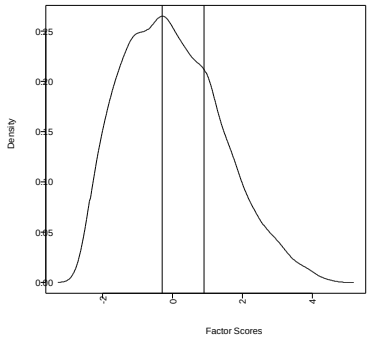


Dependent

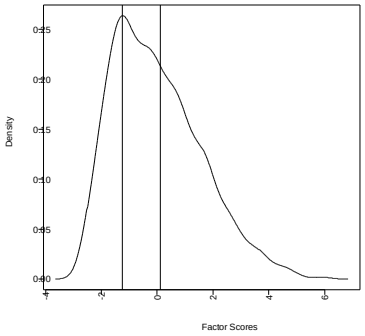


Obsessive-Compulsive


Paranoid
Histrionic
Schizoid
Narcissistic
Schizotypal
Avoidant
Antisocial
Dependent
Borderline
Obsessive-
Compulsive



Paranoid



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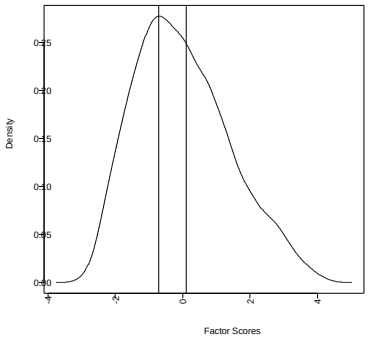
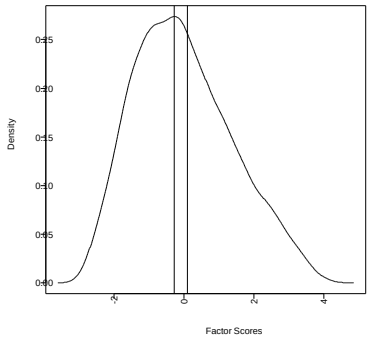
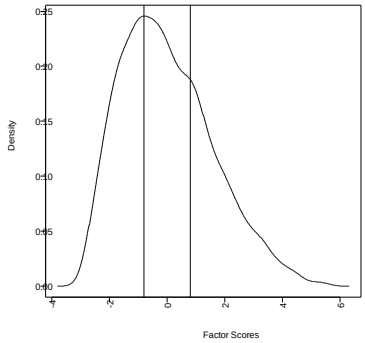


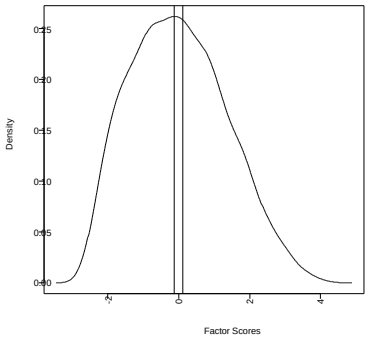
Avoidant



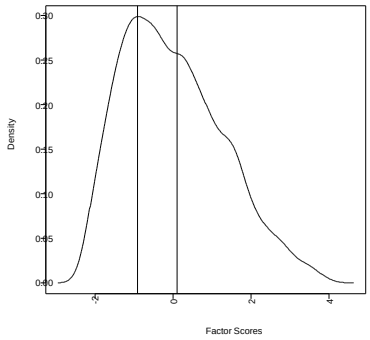
Schizoid



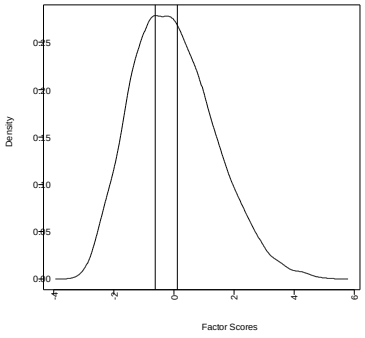
Borderline



Dependent



Schizotypal



Narcissistic