

TAXOMETRIC ANALYSIS OF BORDERLINE  
PERSONALITY DISORDER

by

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(Under the direction of Nader Amir, Ph.D.)

ABSTRACT

Controversy persists regarding the dimensional or categorical nature of personality disorders. The distinctness of Borderline Personality Disorder (BPD) as a discrete mental disorder has been questioned. In this study I investigated the latent structure of the DSM-IV BPD criteria using the MAXCOV-HITMAX (Meehl, 1973; Meehl & Golden, 1982) taxometric procedure. I performed MAXCOV on questionnaires measuring BPD as represented in the SCID II Screening Questionnaire (First et al., 1997) and Personality Assessment Inventory (PAI) – Borderline Subscale (Morey, 1991). I examined the concepts of handedness and worry to assess the validity of MAXCOV in detecting known categorical (handedness) and dimensional (worry) constructs. The graph of Handedness Questionnaire (Oldfield, 1971) items clearly revealed latent taxon. A graph of the Worry Domains Questionnaire (Tallis, Eysenck, & Mathews, 1992) items revealed a latent dimension. The results of the BPD graphs were equivocal, but generally supported the existence of a low base rate taxon.

INDEX WORDS: Taxometrics, Borderline Personality Disorder, MAXCOV-HITMAX

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## CHAPTER 1

### INTRODUCTION

There is controversy in the field of clinical psychology regarding whether mental illness is best conceptualized as categorical or dimensional (Clark, Watson & Reynolds, 1995; Widiger & Clark, 2000). The dimensional models suggest that the latent constructs underlying mental illnesses exist along a continuum. Thus normality and abnormality are theorized to fall along this continuum and therefore are not distinct entities (Widiger, 1992). Categorical models are based on the premise that the latent construct underlying a mental illness is a discrete class that is internally coherent, but distinct from other constructs (Spitzer, 1997).

Each perspective has advantages and disadvantages. For example, one of the advantages of the categorical models of classification is that they take complex characteristics and arrange them into syndromes that are easy to communicate among mental health professionals and are thus parsimonious (Widiger & Trull, 1991). Gunderson, Links, and Reich (1991) argued for four additional advantages of categorical systems. First, they stimulate research on that category. This research will clarify the distinctions between the disorders, and may culminate in more discrete concepts and, if valid, would be more reliable. Second, categories can help identify etiologic pathways and may have therapeutic implications. Third, categorical models are more familiar to clinicians and aid the acceptance of a typology. Finally, if the categories are valid, this

approach may lessen the probability of inappropriately categorizing individuals as disordered.

However, there are some disadvantages of the categorical system. For example, Widiger and Sanderson (1994) propose that the thresholds for consideration of “caseness” (i.e., whether or not an individual belongs to a category) are not empirically validated and are essentially arbitrary. Cantor, Smith, French, and Mezzich (1980) point out another disadvantage of the categorical system: the failure to find necessary and sufficient features for most mental disorders. These authors also posit that the heterogeneity of individuals within a diagnostic category limits the utility of the category.

The dimensional models also have advantages and disadvantages. For example, these models retain more information (Eysenck, 1986; Kendell, 1975; Strauss, 1975) and are less likely to label people (Livesley, Schroeder, Jackson, & Lang, 1994). Additionally, Clarke, Watson, and Reynolds (1995) state that another advantage of the dimensional system of classification is that it is less cumbersome. This approach would replace the greater than 300 categories of mental disorders with a few basic dimensions. The authors further assert that a dimensional system offers a greater role for the critical issue of the severity of the disorder.

However, some of the critics (e.g., Millon, 1981; Spitzer & Williams, 1985; Frances, 1990; Wiggins & Schwartz, 1991; Gunderson, Links and Reich, 1991) of the dimensional system of classification point out that there is no consensus as to the number of dimensions that are required to adequately explain mental illness. Furthermore, Millon (1994, p. 28) argued that because dimensions are often cut into categories prior to

communication among professionals, they are “translated” into categories, negating the utility of the dimensional approaches.

Although the above issues have been debated in a number of mental illnesses (e.g., depression, anxiety, schizophrenia) this controversy is particularly relevant regarding Axis II diagnoses (e.g., Borderline Personality Disorder). This is because there are strong arguments for both categorical (DSM IV, 1994) and dimensional (e.g., five factor model, Widiger & Costa, 1994; seven-factor model, Cloninger, Svrakic, Bayon, & Przybeck, 1999; and the interpersonal circumplex, Benjamin, 1993) models of personality disorders.

In the current proposal I will consider one such Axis II diagnosis, Borderline Personality Disorder. There are nine criteria in the DSM-IV (1994) defining BPD (p.654):

- I. frantic efforts to avoid real or imagined abandonment
- II. a pattern of intense and unstable relationships characterized by alternating between extremes of idealization and devaluation
- III. identity disturbance, with a markedly and persistently unstable self-image
- IV. impulsivity in at least two areas that are potentially self-damaging
- V. recurrent suicidal behavior, gestures or threats or self-mutilating behavior
- VI. affective instability due to a marked reactivity of mood
- VII. chronic feelings of emptiness
- VIII. inappropriate, intense anger or difficulty controlling anger
- IX. transient stress related paranoid ideation or severe dissociative symptoms.

Due to the polythetic format of the DSM-IV, only five of the symptoms must be evident for a diagnosis of Borderline Personality Disorder. Although the DSM-IV definition represents the current rubric by which BPD is conceptualized, alternative conceptualizations exist.

*Alternative conceptualizations of Borderline Personality Disorder*

One of the first formulations of the borderline concept was Kernberg's (1967, 1981, 1984) Borderline Personality Organization (BPO). BPO should not be employed as a distinct diagnostic type, but it should be viewed as a supplementary diagnosis that conveys the dimension of "ego" function and "object" relations (Millon, 1992). A number of the features of BPO coincide with the current formulations of a number of DSM-IV Axis II disorders including Borderline Personality Disorder. The BPO concept can have many forms that share some common features (Kernberg, 1979). These features are: identity diffusion, reliance on the primitive defenses of splitting, denial, idealization, devaluation, and projective identification. In Kernberg's, formulation borderlines can have a disturbance in their reality testing in regards to interpersonal relationships. Kernberg (1967, 1981, 1984) postulated that borderlines have disturbed object relations as characterized by perceiving and reacting to others in an exaggerated, distorted, unrealistic, and inappropriate fashion. However, outside of the interpersonal realm the borderline displays adequate reality testing. In Kernberg's (1984) model there exist features that are necessary and sufficient in order to be diagnosed with BPO these are identity diffusion, primitive defensive operations, and capacity for reality testing. In this regard, the conceptualization is more consistent with the categorical

model of classification. However, there is relatively little empirical evidence for this perspective.

An alternative conceptualization (Gunderson et al., 1989) of BPD is that it consists of four areas of dysfunction. The first area of dysfunction is affective disturbances (e.g., depression, anger, anxiety, etc.). The second area of dysfunction is disturbed cognitive processes (e.g., odd thinking, unusual perceptual experiences). The third area of dysfunction relates to impulsivity (e.g., substance abuse, sexual deviance, self-mutilation). The final area of dysfunction is interpersonal relationship difficulties (e.g., intolerance of being alone, abandonment fears).

These criteria are based on the Diagnostic Interview for Borderlines-Revised (DIB-R) (Gunderson & Zanarini, 1992). The DIB-R has been shown to discriminate borderline patients from those with schizophrenia and major depression (Kolb & Gunderson, 1980; Soloff & Ulrich, 1981; Koenigsberg, Kernberg, & Schomer, 1983) as well as other Axis II disorders such as narcissistic and histrionic personality disorder (Zanarini, Gunderson, Frankenberg, & Chauncey, 1989). Although these studies are informative regarding the discriminant validity of BPD, it is not clear whether the construct of BPD itself is internally coherent.

To my knowledge only one study has attempted to identify the latent structure of borderline pathology (Fossati et al., 1999). These authors utilized latent class analysis (LCA) on the features of DSM-IV Borderline Personality Disorder in a mixed group of inpatient and outpatient individuals with both Axis I and Axis II disorders including Borderline Personality Disorder. The authors suggested that the results of their investigation are consistent with a categorical model of the BPD construct. The sample

consisted of: 1) individuals who met five or more diagnostic criteria, 2) individuals who possessed some non-specific maladaptive personality patterns, and 3) individuals with few or none of the BPD criteria. The authors report that, ‘latent class 1 was not only quantitatively different (i.e. number of BPD criteria met) but also qualitatively different from the other latent classes’ (p.77). The authors also found evidence for the dimensional distribution of some temperamentally based BPD characteristics (i.e. impulsivity and inappropriate anger). The authors posit that ‘BPD should be considered as a definite personality disorder, deeply intertwined with dimensionally distributed temperamental characteristics’ (p.77).

In summary, controversy persists regarding the nature of BPD, but remarkably little research has been undertaken to investigate its nature. Some of these issues can be addressed using more sophisticated statistical techniques that inform classification issues.

#### *Classification of phenomena*

There are a number of familiar methods for determining the latent structure of concepts. These include ANOVA, factor analysis, cluster analysis, admixture analysis, and taxometrics. The simplest method, Analysis of Variance (ANOVA) has been used in attempting to answer questions of taxonicity by detecting mean differences among groups on relevant variables. ANOVA has been used in a study in an attempt to delineate the uniqueness of Borderline Personality Disorder (Zanarini, Gunderson, Frakenburg, Frances, & Chauncey, 1990). However, as Waldman and Lilienfeld (2001, p.521) point out, “ANOVA designs cannot be used to resolve questions of taxonicity, as even large mean differences may merely reflect substantial differences along one or more dimensions.”

The primary objective of factor analysis is to reduce the number of variables to a few underlying constructs (i.e., factors). Studies have used factor analysis to investigate DSM-III and DSM-III-R personality disorders (e.g. Austin & Deary, 2000; Chatzistavrakis, Vaslamatzis, Markidis, & Christodoulou, 1999). However, a fundamental problem with this approach to classification is that it assumes a dimensional model since individuals receive a continuous score on all of the factors (Morey, 1988). Indeed, even categorical constructs can result in a dimensional model (Widiger, 1992).

Cluster analysis has also been used to identify latent structures including DSM-III and DSM-III-R personality disorders (e.g. Torgersen, Skre, Onstad, & Edvardsen, 1993; Dowson & Berrios, 1991; Morey, 1988). The primary aim of cluster analysis is to identify categorical subgroups of individuals using a given measure of similarity. The central problem with clustering algorithms is that a clustering method will always place objects into groups. The key to using cluster analysis is knowing when these groups are “real and not imposed by the method” (Aldenderfer & Bashfield, 1984, p.160). Grove and Andreasen (1986) point out that cluster analysis may be more suited for confirmatory rather than exploratory methods of evaluating the latent structure of a given set of data. Therefore, for the purposes of investigating whether a category exists the method is ill suited.

Another statistical technique that has been used for the purposes of identifying the latent structure of data is admixture analysis. Admixture analysis is primarily used to examine whether the data are best represented by a unimodal or bimodal distribution. This is done by examining the distribution of canonical coefficient scores derived from discriminant function analyses for evidence of bimodality. Although it seems natural to

assume that if the data of a categorical construct were represented graphically, a bimodal or multimodal distribution would occur (Gangestad & Snyder, 1985; Meehl & Golden, 1982); in practice bimodality is a rarity in social sciences. This is because bimodality occurs when there is minimal overlap between the two distributions. This is rarely the case in the social sciences. Also, the existence of bimodality does not imply two categories. Studies have identified bimodal distributions in dimensional data such as aptitude and suggestibility (O' Connor, 1941; Stukat, 1958).

In summary, all of the aforementioned statistical techniques are lacking either in sensitivity or specificity when a researcher is attempting to establish the latent structure of a construct. However, there exists a statistical technique (i.e., taxometrics), which is more appropriate for examining questions relating to taxonicity.

#### *Taxometrics*

A taxon is a "type", "natural category" or a "nonarbitrary class" (Meehl, 1992, p.120; Waller, 1996, p.303). Therefore, mathematical methodologies for identifying taxons are known as taxometric methods. One of the advantages of the taxometric investigations is that these methods utilize statistical procedures to identify latent taxons, rather than relying on theoretical models to determine the outcome of the statistical procedure.

The use of the word taxon is not intended to serve only as a facilitator of communication among professionals in the field. Rather, it implicitly endorses the philosophical position that there exist certain psychological types and phenomenon that are qualitatively distinct. Taxometrics uses indicators which are imperfect correlates of the underlying construct. Assuming at least two indicators are available for any

construct, one can conduct taxometrics. The most widely used taxometric procedure is Maximum Covariance Analysis (MAXCOV).

Trull, Widiger, and Guthrie (1990) provide a succinct example of the nature of the MAXCOV analysis using the categorical variable of sex as an example. Suppose we devise a self-report measure with eight items that attempts to identify individuals of the male sex. The questions range from "likes to drive fast" (designated as indicator "i") to "is employed in a traditionally male occupation (mechanic)" (designated as indicator "j"). The questionnaire would then be administered to a mixed sample of subjects comprising both males and the females. Then two items "i" and "j" would be set aside in order to perform the first iteration of the procedure and on the basis of the responses we would then form seven subgroups of individuals (those that score 0 on the scale, to those that score 6 on the scale). For each subsample the covariance between "i" and "j" can be computed. This procedure is repeated for each possible pair of indicators (28 in all; eight items taken two at a time). Finally, the covariances are averaged across the 28 possible pairs for each of the seven subgroups.

Individuals who are in the subgroup that endorsed a total of six items are relatively homogeneous and composed of almost entirely men; we would call these individuals members of the taxon group. In this subgroup the correlation between any two of the questionnaire items should approach zero. This is because the indicators are selected to give adequate separation between the taxon and complement groups (good validity). Furthermore, the indicators should separately assess distinct facets of the construct and therefore be uncorrelated within the taxon or complement groups (no nuisance covariance). Alternatively, those individuals who score a total of zero on the

questionnaire are likely to be homogenous as well, being composed primarily of women and are members of the complement group. The maximum correlation between any two indicators will occur in the subsample that possesses an even number of taxon members and nonmembers (called HITMAX). The HITMAX is the interval where the most variation between the questionnaire items will occur. In this case the HITMAX would occur where individuals score a three on the scale.

If the construct were categorical when the averaged covariances between “*i*” and “*j*” are plotted as a function of the values on the seven point scale (0 to 6 items endorsed) there would be a peak at the middle of the distribution and values that approach zero at either extreme of the distribution. If, however, the data were best described using a dimensional rubric, then no such peak should occur and the correlation between the indicators should be roughly uniform throughout the distribution of scores. Those that score a three on a 7-item scale assessing height are not quantitatively or qualitatively different than those scoring a zero or a six on the scale. Therefore, roughly equivalent covariances will occur for all groups. The individuals that score a three on the questionnaire are not composed of two extreme cases (giants or midgets) but rather individuals whose height varies around three units.

Although the taxometric procedure has been shown to be robust in a series of Monte Carlo studies (Meehl & Yonce, 1996), the inventors of these procedures recommend using consistency tests in clinical applications. Consistency tests are attempts to increase the validity of the results by using multiple samples, multiple measures of a construct or multiple taxometric procedures. Multiple samples should be used in order to ensure that the results were not merely an artifact of the sample utilized,

such as using a clinical and nonclinical sample of participants. Meehl stresses the importance of using multiple measures of a construct in order to apply taxometric procedures to different conjectured indicators of a latent taxa (e.g. for the taxa of depression, BDI scores, dexamethasone suppression test scores, etc.). Lastly, multiple taxometric procedures should be used in order to replicate the results of the original procedure. These additional techniques include MAMBAC (Meehl & Yonce, 1994) and MAXEIG (Waller & Meehl, 1998). Both are alternative procedures to investigate questions of taxonicity. In the MAMBAC procedure one makes successive cuts on an input variable and at each cut the mean for subjects above the cut is subtracted from the mean for subjects below the cut. MAXEIG is a multivariate version of the MAXCOV procedure and uses conditional eigenvalues in the same manner covariances are utilized in the MAXCOV procedure.

Studies have utilized the relatively new method of taxometric analysis to investigate various phenomenon. These studies have examined the latent structure of schizotypy, (Lenzenweger & Korfine, 1992, 1995), social anhedonia (Blanchard, Gangestad, Brown & Horan, 2000), behavioral inhibition (Woodward, Lenzenweger, Kagan, Snidman & Arcus, 2000), sexual orientation and gender identity (Gangestad, Bailey & Martin, 2000), bulimia nervosa (Gleaves et al., 2000), tardive dyskinesia (Golden, Campbell & Perry, 1982), depression (Haslam & Beck, 1994; Ruscio & Ruscio, 2000) psychopathy (Harris, Rice, & Quinsey, 1994) dissociation, (Waller, Putnam, & Neil, 1996), and worry (Ruscio, Borkovec, & Ruscio, 2001).

*Taxometric studies of Borderline Personality Disorder*

Trull, Widiger, and Gutherie (1990) conducted a taxometric investigation of the Borderline Personality Disorder criteria. The authors used chart reviews of inpatients at a psychiatric unit to determine whether the patients met DSM-III-R criteria for BPD. They used the DSM-III-R criteria to conduct a MAXCOV analysis. These authors concluded that their results were ambiguous because of a right-handed peak covariance curve rather than a central peak (i.e. in the middle of the distribution) but interpreted the results as supportive of dimensionality. However, Meehl and Yonce (1996) point out specifically that the shape of the distribution for the Trull et al. (1990) borderline data “was cusped at the high end as expected for a small base rate taxon (though this curve was misinterpreted by the authors)” (p.1113). Therefore, the authors’ conclusion that Borderline Personality Disorder is a dimensional construct is not entirely consistent with the data. Indeed, Meehl and Yonce point out that the shape of the covariance curve was consistent with a low base rate taxon. Furthermore, one of the major caveats when using taxometric techniques is to conduct consistency tests. Consistency tests are attempts to increase the validity of the results by using multiple samples, multiple taxometric procedures, or multiple measures of a construct. These authors did not conduct any form of consistency test and therefore it is not clear to what extent the results are generalizable.

*Current study*

I employed taxometric analysis (i.e. MAXCOV) in order to investigate the underlying structure of the BPD diagnosis. To conduct MAXCOV analyses (Meehl, 1965,1968,1973; Meehl & Golden 1982) it is necessary to identify a number of indicators that are thought to be related to the conjectured latent constructs. In the present study, I

defined Borderline Personality Disorder using two current conceptualizations. First, I used the symptoms that are currently listed in the DSM-IV, as they are operationalized in the Structured Clinical Interview for the DSM-IV second version (SCID-II) screening questionnaire (First, M.B., Gibbon, M., Spitzer, R.L., Williams, J.B.W., & Benjamin, L.S., 1997). Second, I used the Personality Assessment Inventory (PAI, Morey, 1991). The use of two assessment measures to investigate the latent structure of the borderline concept allowed consistency across measures.

I used archival data to test the hypothesis that Borderline Personality Disorder is a categorical construct. To rule out the possibility that my method of analysis was not sensitive in distinguishing dimensional and categorical constructs, I examined the taxonicity of two constructs that are thought to be taxonic and dimensional respectively. These constructs are handedness and worry. Worry has been shown to be dimensional (Ruscio, Borkovec, & Ruscio, 2001). Although I am not aware of any studies of the taxonicity of handedness, theoretically it is most likely to produce a taxonic curve. I used the Handedness Questionnaire (Oldfield, 1971) to examine the taxonicity of handedness and the Worry Domains Questionnaire (Tallis, Eysenck, & Mathews, 1992) to examine the taxonicity of worry.

## CHAPTER 2

### METHOD

#### *Participants*

Participants were recruited from the undergraduate psychology courses at the University of Georgia who were enrolled for either the Fall 1999, Fall 2000, Spring 2000, or Spring 2001 semester. The Borderline questionnaires were included in a larger packet of self-report instruments in a study of the prevalence of PTSD in undergraduate students.

#### *Measures*

##### SCID-II Personality Disorder Screening Questionnaire

Assessment of Borderline Personality Disorder was conducted using SCID-II Screen Questionnaire (First et al, 1997). The SCID-II Screen questionnaire was designed for dual purposes. The first is to screen large amounts of individuals that could be expected to have a personality disorder. The second purpose of the questionnaire is to form a basis for a clinical interview. Ekselius, Lindstrom, von Knorring, Bodlund, and Kullgren (1993) attempted to compare the validity of the full SCID screen questionnaire with the diagnostic interview, and the authors found high reliability ( $r = .78$ ) between the two methods in being able to assess personality pathology. However, the authors found the agreement for the borderline subscale of the SCID screen and the SCID interview to be fair ( $\kappa = .49$ ) and that the borderline scale was highly sensitive to borderline features (sensitivity = 85.7%) but overinclusive (specificity = 67.3%). Furthermore, Ouimette and Klein (1995) found that the personality disorder scales were relatively

stable over time. The test-retest reliability for the Borderline scale of the SCID screen was fair ( $\kappa = .61$ ). For the purposes of this study I used only the questions that tap Borderline Personality Disorder symptomatology. The questionnaire consists of fourteen items to be answered dichotomously and assess the nine DSM-IV diagnostic criteria. However, Carey (1994) found the borderline subscale of the SCID screen to have only fair agreement ( $\kappa = .34$ ) with SCID-II interview diagnosis of the disorder. Therefore, I used a more reliable and valid measure of borderline pathology, i.e., the Personality Assessment Inventory (Morey, 1991).

#### Personality Assessment Inventory

The Personality Assessment Inventory (Morey, 1991) is a 344 item self-report questionnaire consisting of 22 non-overlapping scales, which include eleven clinical scales. For the current study, I used the Borderline Features Scale (BOR) of the PAI. Four response options are available for each item ranging from false, not at all true to very true. The BOR scale measures four specific features of the syndrome: (a) Affective Instability (BOR-A), (b) Identity Problems (BOR-I), (c) Negative Relationships (BOR-N), and (d) Self-Harm (BOR-S). The four subscales are analogous to the symptom clusters reflected in the DSM-III-R criteria. Bell-Pringle, Pate, and Brown (1997) found the overall PAI score to be more accurate than the MMPI-2 overall score in classifying psychiatric inpatients. Additionally, the authors reported that the discriminant function of the PAI-clinical scales was more useful in classifying participants than was the MMPI-2 discriminant function. Morey (1991) reported that the borderline scale in college students has good internal consistency (coefficient alpha = .86) and that the inter-item correlations were low in college samples ( $r = .21$ ). The test-retest reliability for the

college sample is .82. Trull (2001) also found that the PAI-BOR has a .69 correlation with the Structured Interview for DSM-IV Personality Disorder Criteria- Borderline Module (SIDP-BOR) (Pfohl, Blum, & Zimmerman, 1994) and a .77 correlation with the Diagnostic Interview for Borderlines-Revised (DIB-R) (Gunderson & Zanarini, 1992) in a college sample.

#### Oldfield Handedness Questionnaire

Handedness was assessed using the Handedness Questionnaire (Oldfield, 1971). The questionnaire consists of fourteen items that assess the frequency of using the right, left or both hands during routine daily activities such as writing, brushing teeth, etc. In a review of the Handedness Questionnaire, McFarland and Anderson (1980) found that the questionnaire was assessing a single construct and exhibited high test-retest reliability.

#### Worry Domains Questionnaire

Worry was assessed using the Worry Domains Questionnaire (WDQ) (Tallis, Eysenck, & Mathews, 1992). The WDQ is a measure of nonpathological worry and yields a global score that is calculated by summing scores on five subscales: (1) relationships, (2) lack of confidence, (3) aimless future, (4) work incompetence, and (5) financial. Stoeber (1998) found that the WDQ was highly internally consistent with a Cronbach's alpha of .91. The authors also found that the WDQ displayed high stability with a test-retest reliability of .85. Furthermore, the subscales of the questionnaire displayed test-retest correlations of at least .80, except for the work incompetence with a correlation of .71.

*Procedure*

Participants were given the Borderline module of the SCID-II Screen questionnaire (First et al., 1997), the PAI-Borderline subscale (Morey, 1991), the Worry Domains Questionnaire (Tallis, Eysenck, & Mathews, 1992), and the Handedness Questionnaire (Oldfield, 1971) as part of a larger packet of questionnaires.

*Data Analysis*

I analyzed the data using the MAXCOV-HITMAX procedure. Multiple consistency tests were performed on the data in order to ensure the results were not spurious. These consistency tests included; establishing the congruence of base rate estimates across various permutations of the procedure, the use of multiple samples for the constructs of handedness and worry, and the use of multiple measures of BPD. A detailed explanation of the mathematics upon which MAXCOV is based is provided in Appendix A.

## CHAPTER 3

### RESULTS

#### *Selection and Construction of Indicators*

Due to a data collection error the last item of the PAI, ‘I’m careful about how I spend my money’ was omitted. However, the item is redundant with another PAI item, ‘I spend money too easily.’ The internal consistency was not affected (24 item questionnaire  $N = 142$  Cronbach’s  $\alpha = .87$  and 23 item questionnaire  $N = 237$  Cronbach’s  $\alpha = .86$ ). Additionally, in a factor analysis of the PAI in college students, Jackson and Trull (2002) found that these two items did not load highly on the impulsivity factor as expected. Therefore, this error may not affect the suitability of using the twenty-three item questionnaire for taxometric analyses.

In conducting taxometric analyses, indicator selection is of primary importance. Indicators should adequately discriminate between the conjectured taxon and complement groups and be relatively uncorrelated within groups (i.e., have low nuisance covariance). Poor indicators may confound the results of taxometric analyses. The expected standard deviation between the means of conjectured latent taxon and complement groups is important to detecting taxonicity. In order to estimate the average separation between indicators, one can correlate the indicators in the conjectured taxon and complement groups as well as in the full sample to obtain an aggregate average correlation. Indicators should be correlated highly in the full sample. Low correlations in the taxon and complement groups reflect low nuisance covariance. Correlations equal

to or less than .3 have a negligible outcome on taxometric analyses (Meehl & Yonce, 1996). Once these correlations are obtained, one can substitute them into an equation that estimates average separation of paired indicators if taxa are present in the sample (Meehl & Yonce, 1996, Appendix B). Meehl recommends that items have an average of a 2.00 SD difference between the means of the conjectured taxon and complement groups but concedes that “no one knows the lower limit” (p.1094). Lenzenweger (1992; 1995) found evidence for a schizotypal taxon among college students using the Chapman Scales that have a 1.00 SD between latent means. I employed a number of techniques in order to select reliable and valid indicators to subject to taxometric analyses.

#### Handedness Questionnaire

The reliability of the Handedness Questionnaire in the sample was good Cronbach's alpha = .82. Items whose content was indirectly related to the underlying construct were eliminated (e.g., Were you adopted?). In an effort to reduce nuisance covariance, items that correlated highly with one another were combined to form a single indicator. Pairing items decreases nuisance covariance by minimizing redundancy between indicators which would lead to high covariation between these indicators. The pairing technique resulted in four composite variables (see Table 1). The average inter-item correlation in the full sample was  $r = .55$ . and  $r = .18$  in the conjectured taxon and complement groups. The average separation of the indicators was 1.80 SD. Therefore, the handedness indicators were sufficiently powerful to conduct taxometric analyses.

Table 1

## Intercorrelations of paired Handedness Questionnaire items

---

Item (Which hand would you prefer to use)	Intercorrelation
a. Writing b. Drawing	.77
a. Throwing b. Scissors	.45
a. Toothbrush b. Knife (without fork)	.50
a. Spoon b. Striking match (hand holding match) c. Opening box (lid)	.38

Worry Domains Questionnaire

The reliability of the Worry Domains Questionnaire was good (Cronbach's alpha = .93). In order to construct the best set of indicators that could detect a taxon if it exists, only the items with the highest item-total correlation were retained for the analyses.

Sixteen items had an item-total correlation  $>.5$ . Items highly correlated with each other were paired, theoretically decreasing nuisance covariance. Items that were paired had similar manifest content or assessed the same hypothesized underlying construct. The resulting procedures retained eight paired indicators (see Table 2). The average inter-item correlation for the conjectured taxon and complement groups (upper 10% of the score distribution) was  $r = .21$ . The average correlation of the items in the full sample was  $r = .53$ . This resulted in an average of 1.70 SD separation between the means of the conjectured taxon and complement groups. The psychometric properties of the paired indicators parallel those obtained by Ruscio, Borkovec and Ruscio (2001). These authors

obtained a  $r = .15$  average correlation in the taxon and complement group and an average correlation in the full sample of  $r = .61$  resulting in a 2.17 SD between latent means.

Therefore, I concluded that the indicators are sufficiently powerful to detect latent taxonicity.

Table 2

Item-total correlations and intercorrelations for Worry Domains Questionnaire items

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Item (I worry)	Item-total r	Intercorrelation
a. That my future job prospects are not good	.56	.31
b. That my money will run out	.54	
a. That I will not keep my work load up to date	.58	.46
b. That I might make myself look stupid	.62	
a. That I feel insecure	.64	.69
b. That I lack confidence	.66	
a. That I haven't achieved much	.67	.56
b. That I'll never achieve my ambitions	.68	
a. That life may have no purpose	.56	.51
b. That I am not loved	.58	
a. That I leave work unfinished	.58	.60
b. That I make mistakes at work	.59	
a. That I am unattractive to the opposite sex	.62	.68
b. That others will not approve of me	.69	
a. That I have no concentration	.58	.47
b. That I don't work hard enough	.60	

### Personality Assessment Inventory

The PAI exhibited good reliability in our sample (Cronbach's alpha = .86). In order to identify valid and reliable indicators of Borderline Personality Disorder, potential indicators were item analyzed. Twelve items were selected that possessed the highest item-total correlation ( $r \geq .4$ ). I attempted to reduce the amount of nuisance covariance between the items by pairing items that had the highest correlations with each other which resulted in six composite variables (Table 3). Trull (1995) found that a raw score of 38 (equivalent T score  $\geq 70$ ) suggests prominent BPD symptoms. Therefore, only participants scoring 38 or more and in the upper 10% of the score distribution were selected as the latent taxon group. The latent complement group used in the consistency tests was the lower 10% of the score distribution. The six composite variables had negligible nuisance covariance in the conjectured taxon and complement groups (average  $r = .13$ ). Additionally, in the total sample average inter-item correlations were  $r = .44$ . This resulted in the items having an average separation of 1.50 SD. The estimated standard deviation for this data set was lower than the other data sets; however, it is possible to detect taxonicity with standard deviations less than 2.00 (Lenzenweger 1993). Therefore, the indicators should be sufficiently powerful to detect taxonicity if it exists.

### SCID -II Screening Questionnaire

The reliability for the SCID-II screen was fair (Cronbach's alpha = .66). A number of items assess the same diagnostic indicator; therefore, the items of the SCID-II Screen Questionnaire were transformed to reflect the nine DSM-IV criteria. Each individual transformed SCID-II item reflected a diagnostic criterion. Therefore, the items should be valid indicators of Borderline Personality Disorder. The average inter-item

Table 3

## Item-total correlations and intercorrelations of paired PAI items

Paired PAI Items	Item-Total r	Intercorrelation
a. My mood can shift quite suddenly	.52	.57
b. My moods get quite intense	.62	
a. My attitude about myself changes a lot	.53	.50
b. Sometimes I feel very empty inside	.61	
a. My relationships have been stormy	.54	.30
b. I've made some real mistakes in the people I've picked as friends	.42	
a. I worry a lot about other people leaving me	.53	.43
b. People once close to me have let me down	.44	
a. I have little control over my anger	.49	.39
b. I've had times when I was so mad I could not do enough to express my anger	.45	
a. My mood is very steady	.54	.38
b. I've always been a pretty happy person.	.50	

correlation for the full sample was  $r = .17$  and  $r = .12$  in the conjectured taxon and complement groups. The estimated average separation of the indicators was .25 SD. In an effort to increase the validity of the questionnaire, only those items with the highest item-total correlation were included in the variable construction (affective instability was eliminated). Additionally, items sharing high inter-item correlations were paired (see Table 4) in an effort to reduce the effects of nuisance covariance. This resulted in an average inter-item correlation for the full sample of  $r = .3$  and  $r = .2$  in the conjectured

taxon and compliment group. This resulted in an average separation of the indicators of .80 SD. Combining the variables in this manner increased the validity of the indicators; however, the separation between latent means was lower than had been used in previous taxometric analyses. Due to the items poor discrimination between conjectured groups, any inferences based on the results of taxometric analyses should be interpreted with caution.

Table 4

Item-total correlations and intercorrelations for paired SCID-II Screen items

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Item	Item-total r	Intercorrelation
a. Frantic efforts to avoid real or imagined abandonment	.30	.21
b. A pattern of intense and unstable relationships characterized by alternating between extremes of idealization and devaluation	.36	
a. Identity disturbance, with a markedly and persistently unstable self-image	.40	.27
b. Inappropriate, intense anger or difficulty controlling anger	.41	
a. Impulsivity in at least two areas that are potentially self-damaging	.33	.13
b. Recurrent suicidal behavior, gestures or threats or self-mutilating behavior	.28	
a. Chronic feelings of emptiness	.39	.29
b. Transient stress related paranoid ideation or severe dissociative symptoms	.28	

#### *MAXCOV Analyses*

In MAXCOV-HITMAX analyses, the covariance for a pair of output indicators is calculated over levels of the input indicator and the results are represented graphically.

NATAX 2.5 (Amir, 2002) was used to conduct taxometric analyses. This program allows for the selection of certain statistical parameters prior to conducting the MAXCOV-HITMAX analyses. NATAX 2.5 allows for the selection of the following parameters: number of pairs in order to calculate a covariance (how many pairs of indicators need to be present in order to calculate a covariance for the interval/slab), number of covariances to calculate a mean (over how many permutations of the procedure does a covariance need to be present in a slab in order to calculate a mean covariance for the overall graph), the size of the slabs (i.e., intervals on the abscissa) in standard deviational units, and the use of smoothing procedures.

Parameter settings have a significant influence on the results of MAXCOV analyses and therefore selection should be theoretically motivated. For example, if the slab sizes and pairs in a slab are large (i.e., number of observations), then the covariance generated will be stable. However, the results might not be valid because the large slab size reduces the number of points generated by the MAXCOV graph. The true latent structure of the data may be obfuscated by the truncated graph. Alternatively, if the slab size and number of pairs in a slab are low, the number of points on the graph increases. However, there is the potential of sacrificing the stability of the covariances produced by observations in the slab. When selecting slab size, it is important to take into account the number of people in the sample and the separation between the latent group means. Furthermore, Waller and Meehl (1998) suggest using Tukey's 4(3RSR)2H (1977) running medians smoothing procedure for more easily interpretable results and more accurate hitmax estimates. Therefore, all analyses were conducted using this smoothing procedure. Meehl also advocates the use of consistency tests in order to buttress results

of the taxometric analyses. Therefore, consistency across samples was initiated in all analyses if possible.

### Handedness Questionnaire

#### Sample 1

The large sample size ( $N = 618$ ) and separation between group means is the ideal condition in which to conduct taxometric analyses. The four paired indicators resulted in six unique MAXCOV-HITMAX graphs. Therefore, the number of covariances in order to calculate a mean was set at five. The number of pairs in order to calculate a covariance was set at ten due to the large sample size. The cuts along the input indicator were set at ( $SD = .50$ ). The average graph is presented in Figure 1. The graph shows a pronounced peak in the distribution, which indicates the presence of a latent taxon. Furthermore, the large maximum covariance  $r = .53$  reflects the large separation between taxon and complement means. As the distance between the latent means decreases, covariances are attenuated.

#### Sample 2

Identical parameters for Sample 2 ( $N = 618$ ) were used in the MAXCOV-HITMAX analyses. The four composite variables resulted in six individual graphs. The average graph is presented in Figure 2. The graph clearly delineates a latent taxon. Once again, the maximum covariance is large ( $r = .65$ ). Congruence of base rate estimates across samples is used as a consistency test. The base rate of Sample 1 (base rate = .41) is similar to the base rate of Sample 2 (base rate = .52). The similarity of base rate estimates as well as the similar MAXCOV curves demonstrates that the taxometric procedure is able to identify a known categorical variable.

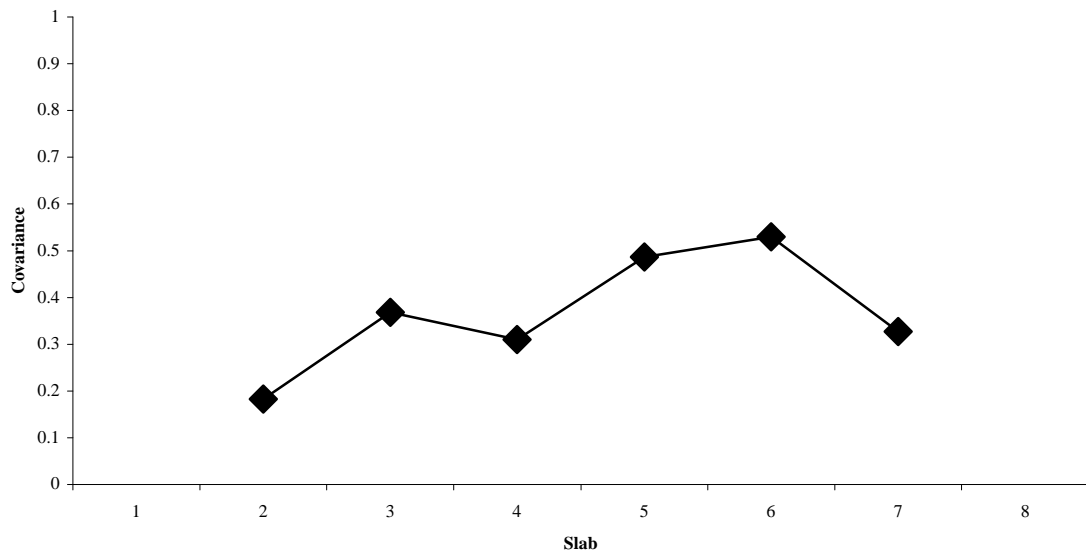


Figure 1

MAXCOV graph of paired handedness items in Sample 1

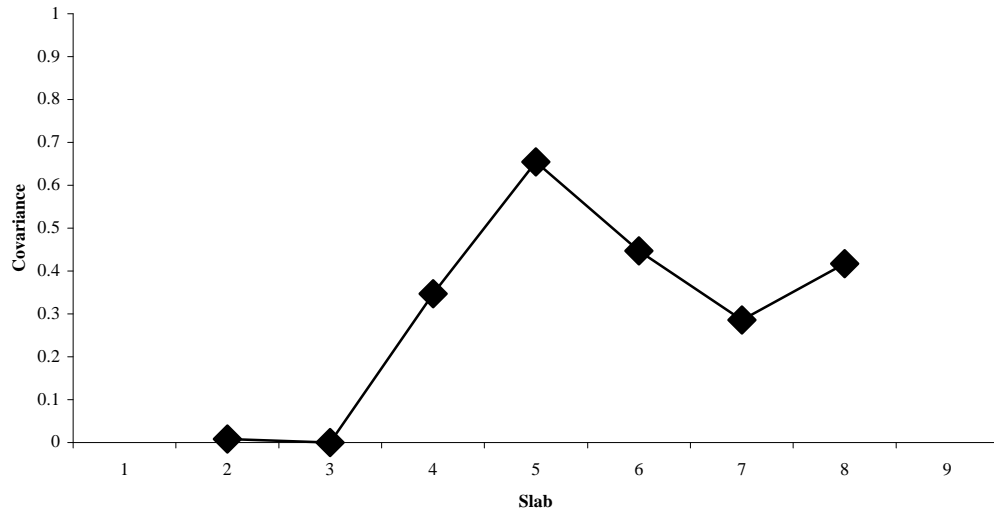


Figure 2

MAXCOV graph of paired handedness items in Sample 2

Worry Questionnaire

Sample 1

MAXCOV analyses were conducted on the eight composite worry variables that resulted in 28 distinct graphs. The number of covariances in order to calculate a mean was increased to 20. The other parameters remained the same due to comparable sample size ( $N = 548$ ) and separation of latent means. The average graph is presented in Figure 3. The graph is consistent with a dimensional variable in that no clear peak appeared in the distribution of covariances.

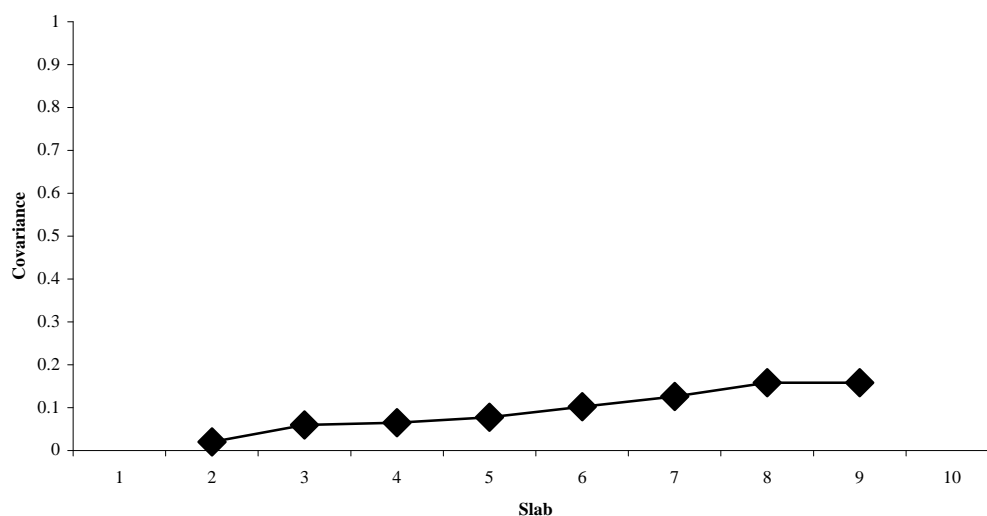


Figure 3

MAXCOV graph of paired worry items in Sample 1

Sample 2

The parameters for Sample 2 ( $N = 547$ ) are identical to Sample 1. The average MAXCOV graph (Figure 4) clearly displays a latent dimensional variable. No peak in the distribution is present and the graph is relatively flat. Furthermore, base rate estimates across samples are disparate (Sample 1 = .23 Sample 2 = .72) The results are congruous with previous taxometric studies of worry (Ruscio, Borkovec, & Ruscio, 2001) that demonstrated the latent dimensional structure of worry. In this study, the

average inter-item covariance for the full sample was  $r = .61$  and  $r = .15$  for the conjectured taxon and complement means which resulted in an average 2.17 SD on paired indicators.

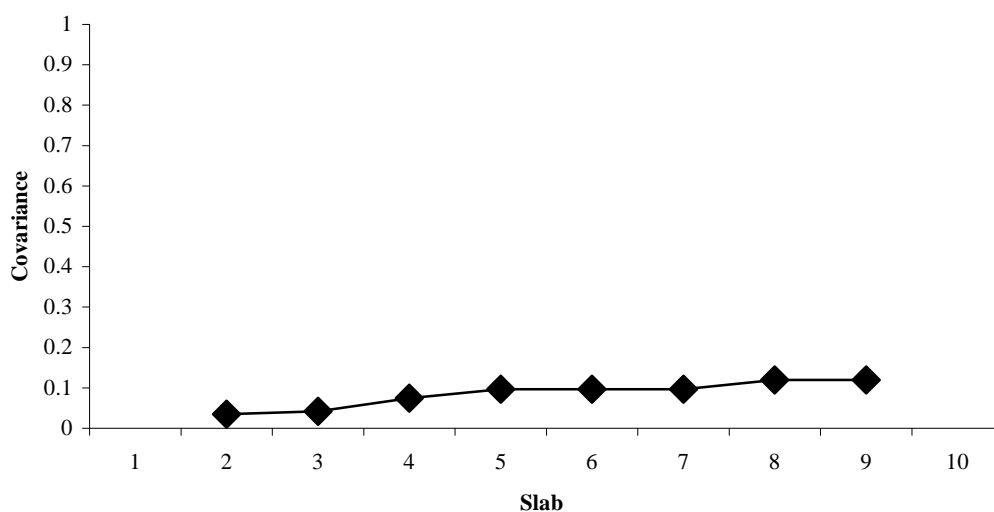


Figure 4

MAXCOV graph of paired worry items in Sample 2

#### PAI-BOR Questionnaire

Six composite variables produced 15 MAXCOV graphs. Therefore, the number of covariances in order to calculate a mean was set at 10. Due to the smaller sample size ( $N = 379$ ), the number of pairs in order to calculate a covariance was set at 5. Although the sample size was smaller the separation between latent means was roughly equivalent to previous analyses which allowed for the slab size to be set at .50 SD. The average graph is presented in Figure 5. The MAXCOV graph exhibits a clear peak at the end of the distribution, which is indicative of a low base rate taxon. The base rate estimate of the latent taxon is .12, which is congruent with estimates of BPD in the general population. Unfortunately, due to a small number of participants, the results could not be

replicated. Alternatively, a second measure of Borderline Personality Disorder was utilized as a consistency test.

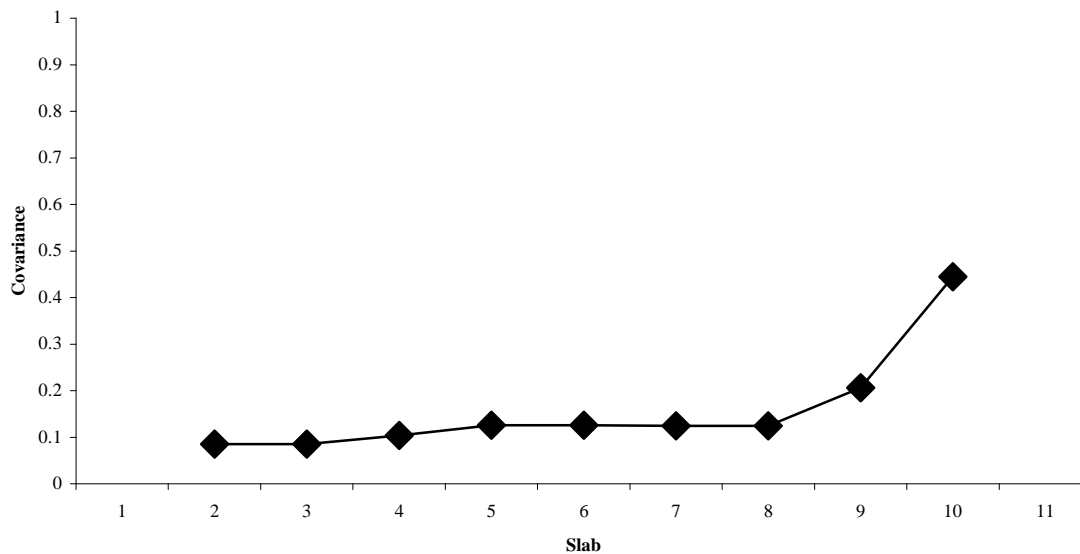


Figure 5

MAXCOV graph of paired PAI-BOR items

#### SCID-II Screen Questionnaire

The four paired SCID-II items resulted in six different MAXCOV graphs. Therefore, the number of covariances in order to calculate a mean was set at five. The number of pairs in order to calculate a covariance was set at ten due to the relatively large sample size ( $N = 523$ ). The size of the slabs was set at .75 SD due to the decreased discrimination of the indicators. Figure 6 presents the MAXCOV graph for the paired SCID-II items. The graph appears to indicate a latent dimensional variable. However, caution must be exercised when interpreting the results of the SCID-II Screen due to the low internal consistency of the questionnaire and the small separation of the indicators. Inferences should be tentative because there is an elevated probability that the resulting graph is spurious.

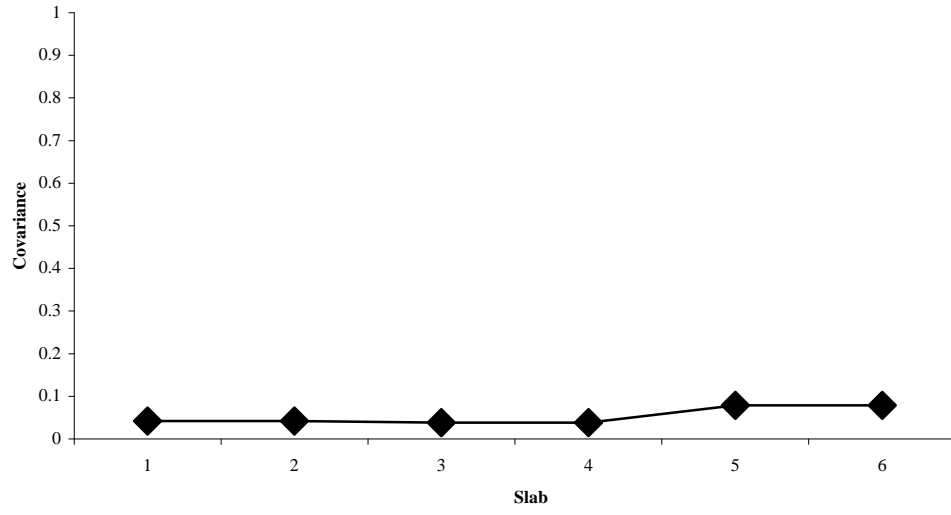


Figure 6

MAXCOV graph of paired SCID-II Screen items

## CHAPTER 4

### DISCUSSION

The purpose of the present study was twofold: a) to determine if the taxometric analyses employed could identify a known categorical (i.e., handedness) and a known dimensional variable (i.e., worry), and b) to determine the latent structure of Borderline Personality Disorder in a nonclinical population. The MAXCOV-HITMAX analyses was able to accurately identify latent dimensionality and a latent taxon. Borderline Personality Disorder assessed by the Personality Assessment Inventory appears to be taxonic and the base rate is approximately .14. The manifest covariance curve was peaked towards the upper end of the distribution, which is indicative of a low base rate taxon. However, taxometric analyses of Borderline Personality Disorder assessed by the SCID-II Screen revealed a clearly dimensional latent variable. I cannot unequivocally prove the results of the analyses clearly support the hypothesis of the latent taxonicity of Borderline Personality Disorder. However, because the PAI possesses better psychometric properties than the SCID-II Screen and is a valid measure of BPD, such a position is justifiable. The results from the taxometric analyses of the PAI presented here are consistent with those achieved by Trull, Widiger, and Guthrie (1990) who examined the taxonicity of BPD in psychiatric inpatients.

The results generally supported BPD as a “natural kind.” However, certain features of the PAI are critical to discuss. It is important to note that the presence of a taxon was detected even though certain hypothesized features of BPD are not assessed by

the PAI. The PAI does not assess any behaviors relating to recurrent suicidality, suicidal gestures or threats, and only one question relates to self-mutilating behaviors. Although these features are not essential, they are the factors that often present in individuals diagnosed with the disorder. The PAI does not include questions regarding mild psychotic experiences, dissociation, or stress-induced paranoid ideation. Although the omissions may detract from the results of the taxometric analyses of BPD, they may also have the advantage that the results of the analyses cannot be ascribed to the categorical nature of schizotypal features (aberrant perceptual experiences) or the result of recurrent suicidality.

The majority of the items retained for taxometric analyses were members of the affective instability subscale of the PAI (6 of the 12 items). The remaining items loaded on the identity problems (3 of the 12 items) and the negative relationship subscale (3 of the 12 items). It is possible to conceptualize identity problems and negative relationships as a consequence of emotional instability. Identity problems could be a manifestation of an individual's inability to gain a coherent sense of identity due to erratic behavior across various situations precipitated by strong emotional reactions. Furthermore, negative relationships could result from the emotional demands placed on others by borderline patients. These demands could be the result of the borderline patient's dependence on others to fulfill their emotional needs. It seems possible that the underlying factor resulting in taxonicity for borderline features is emotional instability. It has been conjectured that the essential feature of BPD is emotional dysregulation hypothesized to result from a biological deficit (Linehan, 1993). However, it is interesting to note that due to a low correlation, the only item of the SCID-II Screen that was not used in

taxometric analyses was the affective instability criterion. This result could merely reflect the fact that only one item on the original questionnaire related to this criterion.

It is important to note that the PAI is assessing the presence of significant borderline features, not Borderline Personality Disorder. In fact Trull (1995) found that only 13% of the undergraduates characterized as having high scores on the PAI (raw score  $\geq 38$ ) received a DSM-IV BPD diagnosis. Perhaps what is being assessed is the *forme fruste* of BPD, similar to Meehl's (1989; 1990) concept of schizotaxia.

Participants in the study may be displaying an inchoate form of the disorder and a number of intervening variables determine whether the disorder is manifested. One explanation is Meehl's "environmental mold taxa" which are the result of being exposed to "formal or informal learning experiences—precepts, models, and reinforcement schedules—acquire motives, cathexes, cognitions, and act dispositions that the social group 'teachers' tend to transmit together" (1992, p. 149). Alternatively, the expression of the disorder could be influenced by the synergistic effect of modeling, biological predispositions, and temperament.

The results of the analyses serve to inform psychology as to whether discrete entities in psychopathology exist. The results are inconsistent with the current zeitgeist in personality research that the latent structure of personality disorders is dimensional. However, the results are consistent with the DSM-IV conceptualization of Borderline Personality Disorder as a distinct category. Perhaps a synthesis between these two perspectives can be achieved. Gunderson, Links, and Reich (1991) propose that the dimensional view of personality disorders might be appropriate for disorders with less severe functional impairment (e.g., dependent personality disorder), and that a categorical

approach is appropriate for the most severe personality disorders (e.g., borderline personality disorder). However, it is also possible dimensional traits that are expressed phenotypically could result in a manifest categorical variable.

A possible criticism of the present study is the use of an undergraduate population who on the whole are relatively high functioning and less likely to present with borderline symptomatology. However, there are several cogent reasons for selecting an undergraduate population in order to identify participants with borderline features. As Morey (1991) points out the types of difficulties that underlie borderline diagnoses: identity issues, interpersonal problems, and behavioral acting out are more commonly observed in younger adults compared to older adults in both community and clinical samples. Furthermore, Gunderson and Zanarini (1987) found that BPD was relatively prevalent in nonclinical populations and McGlashen (1986), and Harpur, Hare, and Hakstian (1989) discovered that the prevalence of borderline as well as other disorders decreases with age. Therefore, college undergraduates may manifest the symptomatology of BPD. Finally, by using an undergraduate population, it is conceivable that there will be heterogeneity within the population of interest, thereby circumventing the restriction of range phenomena.

One of the limitations of the present study is that multiple taxometric procedures were not used when analyzing the data. Meehl and Yonce (1996) stress the importance of consistency tests in order to bolster the confidence in the latent taxonic structure ('bootstrapping'). Future studies should replicate the results of the present study by employing various taxometric procedures (e.g., MAXEIG, MAMBAC) and assess the similarity of base rate estimates across various taxometric procedures. Furthermore, a

larger sample should be employed in order to replicate the results of the present analyses. Subjecting an additional valid and reliable questionnaire assessing BPD to taxometric analyses would serve as an additional consistency test. If the taxonic conjecture is correct, then the results should be consistent across samples and measures. Additionally, it would be advisable when using a self-report measure to bring the participants in to fill out the questionnaire again in order to control for the effect of state-like conditions influencing the response patterns. Clearly, more research needs to be undertaken before the validity of the taxonic conjecture of Borderline Personality Disorder is established.

## REFERENCES

- Aiskal, H.S., Chen, S.E., Davis, G.C., et al. (1985). Borderline: an adjective in search of a noun. Journal of Clinical Psychiatry, *46*, 41-48.
- Aiskal, H.S. Depression in the historical perspective. Paper presented at the 144<sup>th</sup> annual meeting of the American Psychiatric Association. New Orleans: LA 1991.
- Aldenderfer, M.S., & Bashfield, R.K. (1984). Cluster analysis. Sage University Paper Series on Quantitative Applications in the Social Sciences (Paper No. 07-044). Beverly Hills, CA: Sage.
- Austin, E., & Deary, I.J. (2000). The 'four A's': A common framework for normal and abnormal personality? Personality and Individual Differences, *28*, 977-995.
- Bell-Pringle, V.J., Pate, J.L., & Brown, R.C. (1997). Assessment of Borderline Personality Disorder using the MMPI-2 and the Personality Assessment Inventory. Assessment, *4*, 131-139.
- Benjamin, L.S. (1993). Interpersonal diagnosis and the treatment of personality disorders. New York: Guilford Press.
- Blanchard, J.J., Gangestad, S.W., Brown, S.A., & Horan, W. P. (2000). Hedonic capacity and schizotypy revisited: A taxometric investigation of social anhedonia. Journal of Abnormal Psychology, *109*, 87-95.
- Cantor, N., Smith, E.E., French, R.D., & Mezzich, J. (1980). Psychiatric diagnoses as prototype categorization. Journal of Abnormal Psychology, *89*, 181-193.

Chatzistavrikis, G.N., Vaslamatzis, G., Markidis, M., & Christodoulou, G.N. (1999). Factor analysis of DSM-III-R personality disorders: Implications for classifying and assessing personality disorders. Psychiatrika,10, 279-290.

Clark, L.A., Watson, D., & Reynolds, S. (1995). Diagnosis and classification of psychopathology: Challenges to the Current System and Future Directions. Annual Review of Psychology, 46, 121-153.

Cloninger, C.R., Svrakic, D.M., Bayon, C., & Przybeck, T.R. (1999). Measurement of psychopathology as variants in personality. In C.R. Cloninger (Ed.), Personality and Psychopathology, (pp.33-65). Washington, D.C.: American Psychiatric Press

Dowson, J.H.& Berrios, G.E. (1991). Factor structure of DSM-III-R personality disorders shown by self-report questionnaire: Implications for classifying and assessing personality disorders. Acta Psychiatrica Scandinavica,84, 555-560.

Eskelius, L., Lindstrom, E., von Knorring, L. Bodlund, O., Kullgren, G. (1993). SCID interviews and the SCID Screen questionnaire as diagnostic tools for personality disorders in DSM-III-R. Acta Psychiatrica Scandinavica, 187, 120-123.

Eysenck, H.J. (1986). A critique of contemporary classification and diagnosis. In T. Millon & G.L. Klerman (Eds. Contemporary directions in psychopathology: Toward the DSM-IV. (p.73-98). New York: Guilford.

First, M.B., Gibbon, M., Spitzer, R.L., Williams, J.B.W., Benjamin, L.S. (1997). SCID II Personality Questionnaire. Washington D.C.: American Psychiatric Press.

Fossati, A., Cesare, M., Bagnato, M., Donati, D., Namia, C., Novella, L. (1999). Latent Structure analysis of DSM-IV Borderline Personality Disorder criteria.

Comprehensive Psychiatry, 40, 72-79.

Frances, A. (1990). Conceptual problems of psychiatric classification. Paper presented at the 143<sup>rd</sup> Annual Meeting of the American Psychological Association. New York.

Gangestad, S.W., Bailey, M.J., & Martin, N.G. (2000). Taxometric analysis of sexual orientation and gender identity. Journal of Personality and Social Psychology, 78, 1109-1121.

Gangestad, S., & Snyder, M. (1985). "To carve nature at its joints": On the existence of discrete classes in personality. Psychological Review, 92, 317-349.

Gleaves, D.H., Lowe, M.R., Snow, A.C., Green, B.A., & Murphy-Eberenz, K.P. (2000). Continuity and discontinuity models of bulimia nervosa: A taxometric investigation. Journal of Abnormal Psychology, 109, 56-68.

Golden, R.R., Campbell M., & Perry, R. (1987). A taxometric method for diagnosis of tardive dyskinesia. Journal of Psychiatric Research, 21, 233-241.

Grayson, D.A. (1987). Can categorical and dimensional views of psychiatric illness be distinguished? British Journal of Psychiatry, 151, 355-361.

Grove, W.M., Andreasen, N.C. (1986). Multivariate statistical analysis in psychopathology. In T. Millon & G.L. Klerman (Eds.), Contemporary directions in psychopathology: Toward the DSM-IV. (347-362). New York: Guilford.

Gunderson, J.G., & Zanarini, M.C. (1987). Current overview of the borderline diagnosis. Journal of Clinical Psychiatry, 48 (suppl.), 5-11.

Gunderson, J.G., Philips, K.A. (1991). A current view of the interface between borderline personality disorder and depression. American Journal of Psychiatry, 148, 967-975.

Gunderson, J.G., Links, P.S., & Reich, J.H. (1991). Competing models of personality disorders. Journal of Personality Disorders, 5, 60-68.

Gunderson, J.G., & Zanarini, M.C. (1992). Diagnostic Interview for Borderlines-Revised (DIB-R). Belmont, MA: Author.

Gunderson, J.G., Sabo, A. N. (1993). The phenomenological and conceptual interface between borderline personality disorder and PTSD. American Journal of Psychiatry, 150, 19-27.

Harpur, T.J., Hare, R.D., & Hakstian, R. (1989). A two-factor conceptualization of psychopathy: Construct validity and implications for assessment. Psychological Assessment, 1, 6-17.

Harris, G.T., Rice, M.E., Qunsey, V.L. (1994). Psychopathy as a taxon: Evidence that psychopaths are a discrete class. Journal of Consulting and Clinical Psychology, 62, 387-397.

Haslam, N., Beck, A.T. (1994). Subtyping major depression: a taxometric analysis. Journal of Abnormal Psychology, 103, 686-692.

Herman, J.L., van der Kolk, B. (1987). Traumatic antecedents of borderline personality disorder. In Psychological Trauma. Ed. By van der Kolk, B.A., Washington D.C. American Psychiatric Press. p.111-126.

Jackson, K.M. & Trull, T.J. (2002). The factor structure of the Personality Assessment Inventory-Borderline Features (PAI-BOR) Scale in a Nonclinical Sample. Journal of Personality Disorders, 15, 536-545.

Kendell, R.E. (1975). The role of diagnosis in psychiatry. Oxford, England: Blackwell Scientific Publications.

Kernberg, O.F. (1967) Borderline Personality Organization. Journal of the American Psychoanalytic Association, 15, 641-685.

Kernberg, O.F. (1981). Structural Interviewing, Psychiatric Clinics of North America, 4, 169-195).

Kernberg, O.F. (1984). Severe Personality Disorders. New Haven, CT: Yale University Press.

Klein, Donald, F. (1999). Harmful dysfunction, disorder, disease, illness and evolution. Journal of Abnormal Psychology, 108, 421-429.

Koenigsberg, H.W., Kernberg, O.F., & Schomer, J. (1983). Diagnosing borderline conditions in an outpatient setting. Archives of General Psychiatry, 49, 49-53.

Kolb, J.E., & Gunderson, J.G. (1980). Diagnosing borderline patients with a semi-structured interview. Archives of General Psychiatry, 37, 37-41.

Korfine, L., & Lenzenweger, M.F. (1995). The taxonicity of schizotypy: A replication. Journal of Abnormal Psychology, 104, 26-31.

Lenzenweger, M.F., Korfine, L. (1992). Confirming the latent structure and base rate of schizotypy: A taxometric analysis. Journal of Abnormal Psychology, 104, 567-571.

Linehan, Marsha (1993). Cognitive Behavioral Treatment of Borderline Personality Disorder. New York: Guilford Press.

Livesley, J.W., Schroeder, M.L., Jackson, D.N., & Jang, K.L. (1994). Categorical distinctions in the study of personality disorder: Implications for classification. Journal of Abnormal Psychology, 103, 6-17.

McFarland, K., Anderson, J. (1980). Factor stability of the Edinburgh Handedness Inventory as a function of test performance, age and sex. British Journal of Psychology, 71, 135-142.

McGlashan, T.H. (1986). The Chestnut Lodge follow-up study III. Long term outcome of borderline patients. Archives of General Psychiatry, 43, 20-30.

Meehl, P.E. (1965). Detecting latent clinical taxa by fallible quantitative indicators lacking an accepted criterion. (report No. PR-65-2). Minneapolis: University of Minnesota Research Laboratories of the department of psychiatry.

Meehl, P.E. (1968). Detecting latent clinical taxa, II: A simplified procedure, some additional hitmax cut locations, a single-indicator method, and miscellaneous theorems. (Rep. No. PR-68-2). Minneapolis: University of Minnesota Research Laboratories of the department of psychiatry.

Meehl, P.E. (1973). MAXCOV-HITMAX: A taxonomic search for loose genetic syndromes. In Psychodiagnosis; Selected Papers. (p.200-224). Minneapolis: University of Minnesota Press.

Meehl, P.E., & Golden, R. (1982). Taxometric Methods. In P. Kendall & J. Butcher (Eds.). Handbook of research methods in clinical psychology. (9.127-181). New York: Wiley.

Meehl, P.E. (1989). Schizotaxia Revisited. Archives of General Psychiatry, 46, 935-944.

Meehl, P.E. (1990). Toward an integrated theory of schizotaxia, shizotypy, and schizophrenia. Journal of Personality Disorder, 4, 1-99.

Meehl, P.E. (1992). Factors and Taxa, Traits and Types, Differences of Degree and Differences in Kind. Journal of Personality, 60, 117-174.

Meehl, P.E. & Yonce, L.J. (1994). Taxometric analysis I: Detecting taxonicity with two quantitative indicators using means minus below a sliding cut (MAMBAC procedure). Psychological Reports, 74, 1059-1274.

Meehl, P.E., & Yonce, L.J. (1996). Taxometric analyses II: Detecting Taxonicity using covariance of two quantitative indicators in successive intervals of a third indicator (MAXCOV procedure). Psychological Reports, 78, 1091-1227.

Millon, T. (1969). Modern Psychopathology. Prospect Heights, I.L. Waveland Press.

Millon, T. (1981). Disorders of personality. DSM-III: Axis II. New York, Guilford.

Millon, T. (1992). The borderline construct. In Borderline Personality Disorder Clinical and Empirical Perspectives. New York: New York. Guilford Press, pp.3-23.

Millon, T. (1993). Borderline personality disorder: a psychosocial epidemic. Borderline Personality Disorder: Etiology and Treatment. Ed. Paris, J. Washington D.C. American Psychiatric Press. 197-210.

Millon, T., (1994). Disorders of Personality: DSM-IV and beyond. New York, NY. Wiley Interscience Publication.

Morey, L.C. (1988). The categorical representation of personality disorder: a cluster analysis of the DSM-III-R features. Journal of Abnormal Psychology, 97, 314-321.

Morey, L.C. (1991). The Personality Assessment Inventory: Professional Manual. Odessa, Florida: Psychological Assessment Resources.

Murphy, E.A. (1964). One cause? Many causes? The argument from the bimodal distribution. Journal of Chronic Disease, 17, 301-324.

O' Connor, J. (1941). The too many aptitude women. Boston Massachusetts Human Engineering Laboratory.

Oldfield, R.C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. Neuropsychologia, 1, 97-113.

Paris, M.D. (1994). Borderline Personality Disorder: a multidimensional approach. Washington, D.C. American Psychiatric Press.

Pfol, B., Blum, N., & Zimmerman, M. (1994). Structured Interview for DSM-IV Personality: SIDP-IV. Iowa City, IA: Author.

Ruscio, J. & Ruscio, A.M. (2000). Informing the Continuity Controversy: A Taxometric Analysis of Depression. Journal of Abnormal Psychology, 109, 473-487.

Ruscio, A. M., Borkovec, T.D., & Ruscio, J. (2001). A Taxometric Investigation of the Latent Structure of Worry. Journal of Abnormal Psychology, 110, 413-422.

Soloff, P.H., & Ulrich, R.F. (1981). Diagnostic interview for borderline patients: A replication study. Archives of General Psychiatry, 38, 686-692.

Spitzer, R.L., Williams, J.B.W., Gibbon, M., & First, M.B. (1987). Structured Clinical Interview for DSM-III-R personality disorders (SCID-II). N.Y. New York State Psychiatric Institute.

Spitzer, R.L. (1997). Brief comments from a psychiatric nosologist weary from his own attempts to define mental disorder. Why Ossorio's definition muddles and Wakefield's 'harmful dysfunction' illuminates issues. Clinical Psychology: Science and Practice, 4, 259-261.

Spitzer, R., & Williams, J. (1985). Classification of mental disorders. In H.I. Kaplan & B.J. Sadok (Eds). Comprehensive textbook of psychiatry (pp.591-613). Baltimore, MD: Williams & Wilkins.

Stoeber, J. (1998). Reliability and validity of two widely-used worry questionnaires: Self-report and self-peer convergence. Personality and Individual Differences, 24, 887-890.

Strauss, J.S. (1975). A comprehensive approach to psychiatric diagnosis. American Journal of Psychiatry, 132, 1193-1197.

Stukat, K.G. (1958). Suggestibility: A factorial and experimental analysis. Stockholm: Almqvist and Wiksell.

Tallis, F., Eysenck, M.W. Mathews, A. (1992). A questionnaire for the measurement of nonpathological worry. Personality and Individual Differences, 13, 161-168.

Torgersen, S., Skre, I., Onstad, S., & Edvardsen, J. (1993). The psychometric-genetic structure of DSM-III-R personality disorder criteria. Journal of Personality Disorders, 7, 196-213.

Trull, T.J., Widiger, T.A., Guthrie, P. (1990). Categorical Versus Dimensional Status of Borderline Personality Disorder. Journal of Abnormal Psychology, 99, 40-48.

Trull, T.J. (1995). Borderline Personality Features in Nonclinical Young Adults: 1. Identification and Validation. Psychological Assessment, 7, 33-41.

Trull, T.J. (2001). Relationship of borderline features to parental mental illness, childhood abuse, axis I disorder, and current functioning. Journal of Personality Disorders, 15, 19-32.

Tukey, J.W. (1977). Exploratory Data Analysis. Reading, MA: Addison-Wesley.

Waldman, I.D., Lilienfeld, S.O. (2001). Applications of taxometric methods to problems of comorbidity: Perspectives and challenges. Clinical Psychology: Science and Practice, 8, 520-527.

Waller, N.G., Putnam, F.W., Carlson, E.B. (1996). Types of dissociation and dissociative types: A taxometric analysis of dissociative experiences. Psychological Methods, 1, 300-321.

Waller, N.G. & Meehl, P.E. (1998). Multivariate Taxometric Procedures. Thousand Oaks: A, Sage Publications.

Widiger, T.A. & Trull, T.J. (1991). Diagnosis and Clinical Assessment. Annual Review of Psychology, 42, 109-133.

Widiger, T.A. (1992). Categorical versus dimensional classification: Implications from and for research. Journal of Personality Disorders, 6, 287-300.

Widiger, T.A., & Costa, P.T. (1994). Personality and personality disorders. Journal of Abnormal Psychology, 103, 78-91.

Widiger, T.A., & Sanderson, C. (1995). Toward a dimensional model of Personality Disorders. New York, NY: Guilford.

Widiger, T.A. & Clark, L.A. (2000). Toward DSM-V and the Classification of Psychopathology. Psychological Bulletin, 126, 946-963.

Wiggins, O.P., & Schwartz, M.A. (1991). Research into personality disorders: The alternatives of dimensions and ideal types. Journal of Personality Disorders, 5, 69-81.

Woodward, S.A., Lenzenweger, M.F., Kagan, J. Snidman, N., & Arcus, D. (2000). Taxonic structure of infant reactivity: Evidence from a taxometric perspective. Psychological Science, 11, 296-301.

Zanarini, M.C., Gunderson, J.G., Frakenburg, F.R., & Chauncey, D.L. (1989). The Revised Diagnostic Interview for Borderlines: Discriminating BPD from Other Axis II Disorders. Journal of Personality Disorders, 3, 10-18.

Zanarini, M.C., Gunderson, J.G., Frakenburg, F.R., & Chauncey, D.L. (1990). Discriminating borderline personality disorder from other axis II disorders. American Journal of Psychiatry, 147, 161-167.

## APPENDIX A

The General Covariance Mixture Theorem on which MAXCOV is predicated is as follows:

$$Cov_i(yz) = Pcov_t(xy) + Qcov_c(xy) + PQ(\bar{x}_t - \bar{x}_c)(\bar{y}_t - \bar{y}_c) \quad (1)$$

Where:

$Cov(xy)$  is the covariance of  $x$  and  $y$  in the total (i.e. mixed) sample

$P$  is the base rate of taxon members in the total sample

$Q = 1-P$  equals the base rate of the nontaxon (complement) members in the total sample

$Pcov_t(xy)$  is the weighted indicator covariance in the taxon ( $t$ ) class

$Qcov_c(xy)$  is the weighted indicator covariance in the complement ( $c$ ) class

$PQ(\bar{x}_t - \bar{x}_c)(\bar{y}_t - \bar{y}_c)$  is the weighted cross product of the latent class mean differences

The first two terms in the equation will equal zero when the within class covariations are zero. That is in a group of taxon or nontaxon members it is expected that covariances between indicators will be zero due to extreme range restriction. In this case a mixed sample covariance is a function of the taxon base rate ( $P$ ) and the differences between the two indicator means in the latent classes. For example if  $x$  and  $y$  are uncorrelated in the latent taxa,

$$Cov(xy) = PQ(\bar{x}_t - \bar{x}_c)(\bar{y}_t - \bar{y}_c). \quad (2)$$

Nuisance covariance denotes the within class covariation in the taxon, complement or both groups. The above equation implies that when the taxon and complement covariances are zero the covariance in the mixed sample is a simple function of the profile of the indicator means and the taxon base rate. In Monte Carlo runs summarized by Meehl and Golden (1982, Table 5.2, p. 163) the authors have shown that MAXCOV accurately estimates a key taxometric parameter, known as the hitmax point whenever nuisance correlations are less than .50.

Finally, an estimation of the grand base rates and indicator validities is obtained. This is important because estimations over various iterations serve as consistency tests in MAXCOV analyses. Recall that:

$$cov_i(yz) = p_i q_i (\bar{y}_t - \bar{y}_c) (\bar{z}_t - \bar{z}_c) \quad (3)$$

the latent indicator means do not have a subscript  $I$  because they do not change over  $x$  slabs. The equation simplifies by letting:

$$\Delta \bar{y} = (\bar{y}_t - \bar{y}_c), \text{ and } \Delta \bar{z} = (\bar{z}_t - \bar{z}_c), \text{ and } K = \Delta \bar{y} \Delta \bar{z}. \quad (4)$$

Therefore,  $K$  is the cross product of the crude latent validities and the output covariance can be expressed as a function of  $K$ :

$$\text{cov}_i(yz) = p_i q_i K. \quad (5)$$

This equation cannot be solved because the number of unknowns  $p_i$  and  $K$ ; remember  $q_i = 1 - p_i$ . Therefore, the knowledge of even one  $p_i$  would allow us to solve the equation in the general case (over  $x$ -slabs), because  $K$  is a constant. There is fortunately one good estimate of  $p_i$ . The  $x$ -slab containing the hitmax score,  $p_i \approx .50$  and  $p_i q_i \approx .25$ . This implies that in the hitmax ( $h$ ) interval,

$$\text{cov}_h(yz) = \frac{1}{4} K. \text{ By simple rearrangement: } K = 4 \text{ cov}_h(yz).$$

Now that we have determined  $K$  we can solve for the remaining  $p_i$ . Remember that  $q_i = (1 - p_i)$ :

$$\text{cov}_i(yz) = (p_i - p_i^2)K, \quad (6)$$

then:

$$Kp_i^2 - Kp_i + \text{cov}_i(yz) = 0. \quad (7)$$

This equation is a quadratic in  $p_i$  and can be solved by a well-known method delineated below:

$$X = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}. \quad (8)$$

In terms our example  $a = K$ ,  $b = -K$ , and  $c = cov_i(yz)$ . The two roots of the quadratic are obtained by solving:

$$p_i = \frac{K \pm \sqrt{K^2 - 4cov_i(yz)}}{2k}. \quad (9)$$

The quadratic has two roots, the smaller root is chosen for  $x$ -slabs below the hitmax cut and the larger root is for  $x$ -slabs above the hitmax cut. Then for each subsample, we multiply the conditional taxon rate by the  $x$ -slab sample size to estimate  $n_{ti}$ , the number of taxon members in each  $x$ -slab. Then we total the resulting values to estimate  $N_t$ , the number of taxon members in the total sample. Finally,  $N_t$  is divided by the total sample size,  $N$ , to calculate the grand taxon base rate:

$$P = (\sum n_{ti})/N. \quad (10)$$

In our running example we have let  $x$  function as an input variable and  $y$  and  $z$  as output valuables. To complete the study, we must repeat the aforementioned steps of this chapter two additional times: letting  $y$  function as an input variable in the first analysis and  $z$  as an input variable in the second analysis. These additional analyses are conducted partially to estimate the hitmax and other parameters of  $y$  and  $z$ . After completing these runs we would have three nonredundant estimates of the taxon base rate. In later analyses we can use the average (or median) of these estimates as our best value for  $P$ . The variance of the estimates is also an informative quantity known as a MAXCOV consistency test.

Note: The above example is provided by Waller and Meehl (1998) pp. 11-25.

## APPENDIX B

Correlations generated by taxon mixtures

Considering various combinations of base rate P, mean taxonic separations  $\bar{d}$  (on both indicators), and nuisance correlations  $r_t$  [=  $r_c$  in complement class], we can write latent equations: If  $\sigma_x = \sigma_y = 1$  within classes (so that  $cov_t = r_t$  and  $cov_c = r_c$ ),

$$Cov(xy) = Pcov_t(xy) + Qcov_c(xy) + PQ\bar{d}_x\bar{d}_y \quad (1)$$

$$= r_t + PQ\bar{d}^2 \quad \text{since } \bar{d}_x = \bar{d}_y \text{ and } r_t = r_c \quad (2)$$

$$var(x) = p\sigma_{tx}^2 + Q\sigma_{cx}^2 + PQ\bar{d}_x^2 \quad (3)$$

$$= 1 + PQ\bar{d}_x^2 \quad (4)$$

$$var(y) = 1 + PQ\bar{d}_y^2 = var(x) \quad (5)$$

Then the observed  $r$  of a mixed group is

$$R_{mix} = \frac{cov(xy)}{\sqrt{var_x var_y}} = \frac{cov_{xy}}{var(x)} \quad (6)$$

$$= \frac{r_t + PQ\bar{d}^2}{1 + PQ\bar{d}^2} \quad (7)$$

Note: The above example is provided by Meehl and Yonce (1996) pp.1146