Published in final edited form as:

Personal Disord. 2012 July ; 3(3): 228–246. doi:10.1037/a0027953.

Refining the Phenotype of Borderline Personality Disorder: Diagnostic Criteria and Beyond

Michael N. Hallquist, Ph.D. and

Department of Psychiatry, University of Pittsburgh Medical Center

Paul A. Pilkonis, Ph.D.

Department of Psychiatry, University of Pittsburgh Medical Center

Abstract

Borderline personality disorder (BPD) is a heterogeneous disorder, and previous analyses have parsed its phenotype in terms of subtypes or underlying traits. We refined the BPD construct by testing a range of latent variable models to ascertain whether BPD is composed of traits, latent classes, or both. We also tested whether subtypes of BPD could be distinguished by anger, aggressiveness, antisocial behavior, and mistrustfulness, additional putative indicators drawn from Kernberg's (1967, 1975) theory of BPD. In a mixed clinical and nonclinical sample ($n = 362$), a factor mixture model consisting of two latent classes (symptomatic and asymptomatic) and a single severity dimension fit the DSM-IV BPD criteria data better than latent class or factor analytic approaches. In the second analytic phase, finite mixture modeling of the symptomatic latent class ($n = 100$) revealed four BPD subtypes: angry/aggressive, angry/mistrustful, poor identity/low anger, and prototypical. Our results support a hybrid categorical-dimensional model of the BPD DSM criteria. The BPD subtypes emerging from this model have important implications for treatment and etiological research.

Keywords

Borderline personality disorder; latent variable modeling; mixture modeling; anger; identity disturbance

Borderline Personality Disorder (BPD) is a complex psychiatric disorder characterized by affective instability, interpersonal dysfunction, identity disturbance, impulsivity, and self-injury (American Psychiatric Association, 2000). Despite the significant societal burden, subjective distress, and poor outcomes associated with BPD, the phenotype is not well understood relative to other forms of psychopathology (New, Triebwasser, & Charney, 2008). Improving the construct validity of BPD has been impeded, in part, by the considerable heterogeneity reflected in theoretical conceptualizations (Kernberg, 1975), as well as the DSM diagnostic criteria, which encompass diverse cognitive, behavioral, and affective features. The DSM-IV defines nine criteria for BPD, five of which must be present for a diagnosis, resulting in 256 possible combinations that can yield a BPD diagnosis.

The heterogeneity of the construct has impeded efforts to clarify the etiology of the disorder as well as possible biomarkers and endophenotypes (Gottesman & Gould, 2003). Heterogeneity among patients diagnosed with BPD has also posed challenges to developing coherent treatment strategies and identifying mechanisms of effective treatment (Lynch,

Trost, Salsman, & Linehan, 2007), although there is growing evidence for the efficacy of several psychosocial treatments (Clarkin, Levy, Lenzenweger, & Kernberg, 2007). Despite problems with heterogeneity, data from family, twin, longitudinal, and biological research suggest that BPD is a meaningful clinical construct that should be refined rather than discarded (for a review, see Paris, 2007).

Two primary statistical approaches to parsing heterogeneity within BPD have been explored in several studies: variable-centered and person-centered analyses (Clifton & Pilkonis, 2007). Variable-centered approaches identify trait dimensions that characterize BPD, whereas person-centered approaches identify homogeneous subgroups of individuals with BPD. Both approaches have yielded important information about the phenotype, although hybrid models that integrate these approaches may provide the greatest insight (Muthén, 2006), and an important goal here is to highlight their utility for describing heterogeneity within BPD.

Variable-centered Approaches

Variable-centered approaches to parsing the BPD diagnostic criteria have typically relied on exploratory and confirmatory factor analyses, which seek to reduce several indicators of a construct to a few salient dimensions. Exploratory factor analytic (EFA) studies have suggested that the BPD criteria represent two (Rosenberger & Miller, 1989; Whewell, Ryman, Bonanno, & Heather, 2000), three (Blais, Hilsenroth, & Castlebury, 1997; Clarkin, Hull, & Hurt, 1993; Rusch, Guastello, & Mason, 1992; Sanislow, Grilo, & McGlashan, 2000), or four factors (Becker, McGlashan, & Grilo, 2006), but the factor structure has been unstable and theoretically incoherent across samples. Moreover, EFA studies have varied in their samples, with four studies selecting from psychiatric samples and three studies sampling only individuals with BPD.

Several research reports have attempted to extend and validate multidimensional models of BPD generated from EFA using confirmatory factor analysis (CFA). Other CFA studies have tested whether the DSM BPD criteria represent a unidimensional construct (i.e., all criteria load on a single factor). All of the CFA studies to date have found substantial support for a parsimonious one-factor solution and little support for more complex multidimensional models (Clifton & Pilkonis, 2007; Feske, Kirisci, Tarter, & Pilkonis, 2007; Fossati et al., 1999; Johansen, Karterud, Pedersen, Gude, & Falkum, 2004; Sanislow et al., 2002). Although Sanislow and colleagues (2002) argued for a three-factor CFA solution in a mixed psychiatric sample, correlations among the factors were extremely high (r s ranging from .90–.99).

Person-centered Approaches

Rather than parsing heterogeneity in terms of continuous latent traits, person-centered analyses attempt to classify individuals into BPD subtypes that are assumed to represent more homogeneous forms of the disorder. Latent class analysis (LCA; Hagenaars & McCutcheon, 2002) has been the major statistical tool used in such endeavors. In principle, latent class analysis is ideally suited to detect distinctive BPD subtypes, but it is also possible for LCA to extract latent classes that differ primarily in terms of disorder severity, not phenomenology (Bornovalova, Levy, Gratz, & Lejuez, 2010). When LCA supports the existence of two or more latent classes that differ by severity, the mean severity level for each class provides potential information about cut-points along a continuous severity dimension, but it is difficult to argue that true subtypes have been identified (Markon & Krueger, 2006).

LCA has been applied to the DSM BPD criteria in five studies to date (Bornovalova et al., 2010; Clifton & Pilkonis, 2007; Fossati et al., 1999; Shevlin, Dorahy, Adamson, & Murphy, 2007; Thatcher, Cornelius, & Clark, 2005), with the general finding that two or more latent classes are supported by the data, but that these are differentiated primarily in terms of severity (as opposed to criterion profiles). The number of latent classes selected has varied among studies, ranging from two to four with no clear correspondence among the classes across different studies. In general, individuals in higher severity classes are more likely to have comorbid psychopathology, adverse life events, and suicide attempts (Shevlin et al., 2007).

Subtyping BPD using Features beyond the DSM Criteria

Given that LCAs of the DSM criteria have failed to identify distinct subtypes, one interpretation is that the BPD criteria identify common features of the disorder but are insufficient to account for heterogeneity in the phenotype – that is, the diagnostic criteria tell us how persons with BPD are similar but provide little information about how they may differ. Several researchers have suggested that the BPD phenotype should be expanded to incorporate features that help to resolve heterogeneity within BPD (Clifton & Pilkonis, 2007; Critchfield, Clarkin, Levy, & Kernberg, 2008; Lenzenweger, Clarkin, Yeomans, Kernberg, & Levy, 2008), although there is uncertainty about which features are of greatest value.

In this spirit, three studies have explored additional indicators of BPD in hopes of identifying distinct subtypes. Critchfield and colleagues (2008) explored whether dimensional scores for all other DSM-IV PDs could differentiate among 90 adult BPD patients. Using Q-factor analysis, they found three subgroups: avoidant/obsessive-compulsive, paranoid/schizotypal, and histrionic/narcissistic (although 32% of the sample could not be classified into one of these subgroups). Bradley and colleagues (2005) also utilized Q-factor analysis to identify potential subtypes in 81 adolescent outpatients diagnosed with BPD. Their results supported the existence of four BPD subtypes: high-functioning internalizing, histrionic, depressive internalizing, and angry externalizing. Finally, Lenzenweger and colleagues (2008) used finite mixture modeling to explore the relevance of aggressive, paranoid, and antisocial personality features in resolving BPD subtypes in a sample of 90 patients diagnosed with BPD. On the basis of Kernberg's theory emphasizing the role of anger in BPD (Kernberg & Caligor, 2005), they identified three BPD subtypes: high-functioning, aggressive/non-paranoid, and non-aggressive/paranoid. In brief, extant attempts to resolve BPD heterogeneity using indicators apart from the BPD diagnostic criteria have supported the existence of subtypes, although these analyses have been guided by different research questions and subtype indicators.

Synthesizing Person-centered and Variable-centered Approaches

To date, analytic approaches to parsing heterogeneity in BPD have utilized statistical methods that are suited to the identification of subgroups (e.g., LCA) or factors (e.g., EFA), but not to the comparison or combination of subtypes and factors. Markon and Krueger (2006) demonstrated that person-centered and variable-centered analyses can be compared directly using the Bayesian Information Criterion (BIC, a parsimony-adjusted index of model fit), such that the model with the lowest BIC – whether continuous or categorical – best represents the latent structure of the data. Although this contribution provides useful leverage when deciding upon the latent structure of empirical data, the “true” nature of BPD may include continuous and discontinuous aspects. For example, individuals with BPD may vary dimensionally in terms of symptom severity, but the expression of the disorder may be qualitatively different in subpopulations (e.g., a more affectively dysregulated form versus a

predominantly impulsive form). Such heterogeneity cannot be accommodated by conventional models; recent computational and statistical innovations, however, provide a new class of hybrid models that integrate categorical and continuous latent variables (Muthén, 2006). In the current study, we used factor mixture modeling (FacMM), a hybrid latent variable model that combines CFA and LCA (Lubke & Muthén, 2005), to probe the latent structure of the DSM BPD criteria.

The present study had two primary aims: 1) to resolve the latent structure of the DSM-IV BPD criteria using person-centered, variable-centered, and hybrid latent variable models; and 2) to explore additional, theoretically justified indicators of BPD among individuals with the phenotype with the intention of identifying qualitatively distinct subgroups. Our approach was divided into two phases that addressed the above aims in sequence. First, we compared latent variable models of the BPD diagnostic criteria in a large mixed clinical and community sample. In view of the evidence for one-factor models of BPD from previous CFA studies, we hypothesized that the best-fitting model for Phase 1 would be a factor mixture model that included a single latent factor (BPD severity), but more than one latent class. At a minimum, we expected at least two classes—a symptomatic class and an asymptomatic class (i.e., those who match the diagnostic prototype versus those who do not, respectively; Clifton & Pilkonis, 2007).

In Phase 2 of our analyses, our aim was to differentiate among individuals with significant BPD symptomatology using four theoretically coherent variables—anger, aggressiveness, antisocial behavior, and mistrustfulness—that might have greater sensitivity to individual differences among persons with BPD than the DSM criteria alone. We selected these variables as potential differentiators among individuals with the BPD phenotype on the basis of Kernberg's theory (Kernberg & Caligor, 2005), as well as recent empirical data supporting the utility of these variables in identifying BPD subtypes (Lenzenweger et al., 2008; Morse et al., 2009). Briefly, Kernberg's model of BPD (and more broadly, borderline personality organization [BPO]) distinguishes between individuals with high versus low levels of anger, where intense anger is a core motivational component of severe BPD. Further, among those characterized by high anger, there is a distinction between individuals who project their anger onto others in the form of interpersonal mistrustfulness versus those who direct anger toward others as interpersonal aggression and antisocial behavior. Of note, Kernberg's (1975) theory of BPO encompasses a wide range of constructs and conjectures, including the role of identity diffusion in BPD and the importance of primitive defenses in severe personality pathology. Our study focused specifically on anger and its manifestations as theoretically coherent variables that have considerable potential to differentiate among subtypes of BPD in empirical data.

We hypothesized that three subtypes would be mixed in our Phase 2 BPD-symptomatic sample: an angry aggressive/antisocial class, an angry mistrustful class, and a less severe class with low levels of anger, aggressiveness, and mistrustfulness. Phase 2 sought to parse heterogeneity *within* the BPD phenotype, not among individuals who are largely asymptomatic (cf. Lenzenweger et al., 2008). Drawing on our Phase 1 FacMM results, Phase 2 excluded individuals who were largely asymptomatic, while retaining a latent class of 100 individuals with syndromal levels of BPD symptomatology. To validate and characterize subtypes identified during Phase 2, we compared groups in terms of normal and abnormal personality, interpersonal problems, psychiatric impairment, and demographic factors. We anticipated that comparisons on these factors would provide convergent evidence for the validity of each subtype. For example, we predicted that external measures of aggression and disinhibition would be highest in the aggressive/antisocial class, whereas mistrustfulness would be highest and history of marriage would be lowest in the angry/mistrustful class.

Methods

Participants

Participants were 362 adults recruited from psychiatric outpatient, medical, university, and general community settings. We recruited three groups on the basis of an initial clinical screening: individuals with BPD (3 or more symptoms; $n = 111$); individuals with other PDs ($n = 116$); and individuals without PD symptomatology ($n = 135$). Ninety-four participants (26%) met the diagnostic threshold for BPD, whereas 268 (74%) were not diagnosed with BPD. Potential participants with mental retardation, psychotic disorder, or any major medical illness with significant central nervous system symptoms (e.g., Parkinson's disease) were excluded. The mean age of participants was 39.98 ($SD = 11.29$) and 256 (71%) were female. In terms of race, 282 (78%) identified as White, 71 (20%) as African American, six as Asian American (2%), and three (1%) as Other. The study protocol was approved by the University of Pittsburgh Institutional Review Board. All participants completed the study voluntarily, provided written informed consent, and received monetary compensation for their effort.

Measures

Consensus ratings of Axis I and Axis II psychopathology—A complete description of the consensus rating process used in our research has been provided in previous reports (Pilkonis et al., 1995), and we provide a brief summary here. At intake, each participant completed at least three two-hour assessment sessions with a single interviewer. Assessments included structured diagnostic interviews for Axis I (First, Gibbon, Spitzer, & Williams, 1995) and Axis II disorders (*SCID-II*; First, Spitzer, Gibbon, & Williams, 1997, and *SIDP-IV*; Pfohl, Blum, & Zimmerman, 1997), as well as a semistructured interview of interpersonal and developmental experiences (Heape, Pilkonis, Lambert, & Proietti, 1989). Interviewers ($n = 21$) had at least a master's degree in psychology or social work and were trained directly by the senior investigator (PAP).

After these evaluations, the primary interviewer presented the case to a research team of three or more individuals during a three-hour case conference. All available data (historical and current) were reviewed and discussed at the conference, and judges were given access to all interview data (Axis I symptomatology, life events, personality features, and social and developmental history). Self-report questionnaires were completed in a separate session and judges were blind to self-report data. Based on the available information, judges assigned consensus ratings of zero ("absent"), one ("present"), or two ("marked") for each DSM-IV PD criterion. For 15 cases chosen at random, Axis II diagnostic interviewers were independently rated by four judges, and interrater agreement regarding PD symptoms was strong: Borderline $ICC = 0.80$, Antisocial $ICC = 0.69$, and Paranoid $ICC = 0.77$.

During the case conference, judges diagnosed Axis I disorders after conferring about current and lifetime symptoms. Judges also rated global psychiatric impairment using the Global Assessment of Functioning (GAF) scale from DSM-IV.

Depressive symptoms—Current symptoms of depression were assessed at intake by the primary clinical evaluator using the Hamilton Depression Rating Scale (Hamilton, 1960), an established 17-item clinician-administered interview measuring depressed mood, somatic symptoms, and cognitive symptoms of depression. A single dimensional score representing depressive symptoms was calculated by summing all HAMD items.

Anxiety symptoms—Current symptoms of anxiety were assessed by the primary clinical evaluator using the Hamilton Anxiety Scale (Hamilton, 1969), a 14-item clinician-

administered interview measuring anxious mood, attentional problems, somatic symptoms of anxiety, tension, and fear. All HAMA items were summed to form a current anxiety score.

Mistrustfulness—Interpersonal mistrustfulness was measured by the DSM-IV Paranoid PD diagnostic criteria (assessed by consensus intake) and a subset of items from the Inventory of Interpersonal Problems (IIP; Horowitz, Rosenberg, Baer, Ureno, & Villasenor, 1988). Scores for each Paranoid PD criterion were summed to create a single dimensional score reflecting the severity of interpersonal mistrustfulness. In addition, a content analysis of the IIP revealed 4 items that specifically measured interpersonal mistrustfulness (e.g., “I am too suspicious of other people”). The IIP is a well-established 127-item self-report questionnaire assessing difficulties in interpersonal relatedness that has previously been demonstrated to be sensitive to PDs (Pilkonis, Kim, Proietti, & Barkham, 1996). The IIP-Mistrustfulness subscale was internally consistent, Cronbach’s $\alpha = .78$, and it correlated with Paranoid PD scores, $r(91) = .30, p = .004$.

Aggressiveness and antisocial behavior—A dimensional score for adult antisocial behavior was derived by summing the individual criteria scores for DSM-IV Antisocial PD. In addition, 9 items from the IIP specifically measuring aggressiveness were summed to create an IIP-Aggressiveness subscale (e.g., “I fight with other people too much.”). This subscale was internally consistent, $\alpha = .87$, and correlated with the Antisocial PD scores, $r(91) = .29, p = .005$.

Normal and abnormal personality—Participants for the Phase 2 analyses completed the Schedule for Nonadaptive and Adaptive Personality – Second Edition (Clark, Simms, Wu, & Cassilas, in press). This self-report test consists of 390 true-false items that tap twelve dysfunctional personality traits and three major dimensions of personality: Positive Emotionality, Negative Emotionality, and Disinhibition. Internal consistency for SNAP-2 subscales is strong and test-retest reliability is high (Clark et al., in press). The SNAP-2 has been extensively validated in clinical and nonclinical populations and its ability to identify clinically significant personality dysfunction and to differentiate among personality disorders has been documented (Morey et al., 2003). In our study, Phase 2 BPD subtypes were compared in terms of the three SNAP-2 normative personality scales, as well as seven dysfunctional traits relevant to BPD: Aggression, Dependency, Entitlement, Impulsivity, Manipulativeness, Mistrust, and Self-Harm.

Because data were combined from different research protocols, only 65 of the 100 participants retained for Phase 2 analyses had completed the SNAP-2. Consequently, multiple imputation (Rubin, 1987) was used to recover estimates of the trait and temperament scales for the remaining 35 individuals. Variables in the imputation model included eight IIP interpersonal circumplex scales (Alden, Wiggins, & Pincus, 1990); five IIP PD screening scales (Pilkonis et al., 1996); HAMD and HAMA scores; GAF ratings; and dimensional scores for all DSM-IV PDs. Fifty complete datasets with imputed SNAP-2 scores were generated using a bootstrapping-based expectation maximization algorithm implemented in the *Amelia II* package (Honaker, King, & Blackwell, 2010) for *R* (R Development Core Team, 2011), and parameter estimates for SNAP-2 analyses were combined across datasets based on Rubin (1987).

Interpersonal sensitivity and ambivalence—Individuals with BPD are often highly sensitive to perceived interpersonal rejection (Ayduk et al., 2008) and frequently struggle to integrate positive and negative aspects of relationships (Kernberg & Caligor, 2005). To characterize interpersonal problems across Phase 2 latent classes, participants completed two

of the IIP personality disorder screening scales: Interpersonal Sensitivity and Interpersonal Ambivalence (Pilkonis et al., 1996). These scales have previously demonstrated high sensitivity and specificity for detecting Cluster B PDs (Stern, Kim, Trull, Scarpa, & Pilkonis, 2000).

Results

Phase 1: Characterizing the Latent Structure of the DSM-IV BPD Criteria

Analytic approach—The major aim of our Phase 1 analyses was to compare the evidence for categorical, dimensional, and hybrid models of the BPD diagnostic criteria using latent class, factor analytic, and factor mixture models, respectively. We first conducted an LCA of the BPD criteria that sought to parse the sample into more homogeneous subgroups. Next, given extant empirical support for a unidimensional model of the BPD criteria, we fit a one-factor confirmatory factor analysis where each criterion loaded on a single BPD severity factor (cf. Fossati et al., 1999). For FacMMs, two different parameterizations were explored: a restrictive strong measurement invariance model and a partial measurement invariance model (Clark et al., under review). Finally, best-fitting models from each analytic approach were compared in order to identify the most parsimonious representation of the latent structure of BPD.

There are several parameterizations of FacMM that differ in the extent to which they permit between-class variation in factor loadings, means, and variances, as well as item thresholds in the case of ordered categorical data (Clark et al., under review). The parameterization chosen can affect fundamentally the interpretation of latent factors across classes, as well as the basis for class divisions. FacMM can be conceptualized as a multiple-groups CFA where group membership is an unknown (latent) variable. For factors to represent the same trait across latent classes in a FacMM, strong measurement invariance (SMI) must be present (i.e., factor loadings and thresholds must be equal across classes; Clark et al., under review; Meredith, 1993). Latent classes in SMI FacMMs account for non-normality in the underlying factor distribution such that each latent class has a unique factor mean and variance, and factors represent the same construct across classes. This parameterization is plausible in our study, in part, because of evidence from the five-class LCA of qualitative differences in BPD severity (see below), suggesting possible discontinuity along an underlying severity dimension.

Although SMI is desirable for interpreting differences across subpopulations, it is often too restrictive in heterogeneous data, where one or more items are likely to function differentially across classes (Byrne, Shavelson, & Muthén, 1989). At the other extreme, a FacMM that allows all item thresholds and factor loadings to differ across classes may provide greater leverage on the question of distinct subtypes, but at the expense of interpretable latent factors, thereby complicating the interpretation of subtypes versus continua. Partial measurement invariance (PMI; Byrne et al., 1989) represents an attractive middle ground because selected item thresholds are freed across classes only where there is evidence of differences in item endorsements that are not accounted for by the factor alone, while item thresholds that are invariant across classes are fixed to equality. To the extent that a minority of items loading on a single factor violates measurement invariance, the factor retains its substantive meaning across classes (here, severity on a unitary BPD dimension).

All models were estimated using Mplus version 6.0 (Muthén & Muthén, 2010) software. BPD diagnostic criteria were coded as absent (0), present (1), or marked (2). In order to compare among models, a maximum likelihood estimator with robust standard errors was used because it yields a model log-likelihood estimate, which forms the basis of model

selection criteria including BIC and AIC. We have reported the second-order-corrected AIC, AIC_c (Sugiura, 1978), which is appropriate for situations where the ratio of subjects to parameters is small (< 40 ; Burnham & Anderson, 2002). The number of latent classes in nested LCAs, FinMMs, and FacMMs was decided on the basis of the bootstrapped likelihood ratio test (BLRT), which uses nonparametric bootstrap resampling to compare a k -class model to a model with $k-1$ classes (McLachlan & Peel, 2000). Simulation studies have demonstrated that the BLRT is sensitive to the true number of latent subgroups (Nylund, Asparouhov, & Muthén, 2007).

Person-centered analysis: Latent class analysis—Starting with a one-class model, we sequentially fit $k+1$ -class LCA models until the BLRT p was nonsignificant ($p > .05$), signifying that the $k+1$ -class model did not improve over the k -class model (McLachlan & Peel, 2000; Nylund et al., 2007). Multi-class models were also compared in terms of interpretability to ensure that the extraction of additional classes was conceptually justified.

The BLRT supported the existence of 5 BPD latent classes, $-2LL_{diff}(19) = 52.84$, $BLRT\ p < .0001$. The 5-class solution parsed individuals both by severity and by distinctive BPD features. As detailed below, however, the LCA model fit considerably worse than CFA and FacMM models. Thus, we do not interpret here the characteristics of each latent class because the model does not provide a parsimonious representation of the DSM-IV BPD criteria.

Variable-centered analysis: Confirmatory factor analysis—We tested a one-factor CFA model of the BPD criteria, where each criterion loaded on a single latent severity dimension. The one-factor solution fit the data well: $\chi^2(26) = 55.89$, $p < .001$, CFI = .96, RMSEA = .056, with standardized factor loadings ranging from .60–.88 (all p s $< .001$).

Hybrid latent variable analysis: Factor mixture modeling (FacMM)—We first identified the best-fitting SMI FacMM, which permitted class variation only in the means and variances of the BPD severity factor. We then tested for violations of measurement invariance in the SMI FacMM and developed a PMI FacMM that permitted criterion-level variation across classes for selected criteria¹. Of note, the best-fitting SMI FacMM served as a necessary starting point for testing item invariance using PMI FacMMs (Clark et al., under review).

Strong measurement invariance FacMM: The BLRT preferred a 2-class SMI FacMM solution relative to one- and three-class models, $BLRT\ p < .0001$. BIC and AIC_c were also lowest for the two-class solution, corroborating this decision. The two-class model divided individuals into an asymptomatic class ($n = 293$) and a symptomatic class ($n = 69$).

Partial measurement invariance FacMM: Building on the two-class SMI FacMM solution above, BPD criteria violating measurement invariance were identified by estimating nine FacMMs, one per item, where each model fixed a single item threshold to equality across the two classes, while allowing other thresholds to vary (Clark et al., under review). In each model, 16 item threshold difference parameters were computed (two per criterion because the data were trichotomous), and the number of significant thresholds was tabulated across models to identify items that varied across classes independent of the BPD severity factor. Three items had many significant threshold difference tests across models (p s $< .05$):

¹To ensure that we were not ignoring important between-class variation in diagnostic criteria, we also tested a FacMM parameterization that was maximally flexible, permitting class variation in factor loadings and variances, as well as item thresholds (FacMM-5; S. L. Clark et al., under review). This model fit the data considerably worse than SMI and PMI models (owing to overparameterization) and is not reported here.

frantic efforts to avoid abandonment (16/16 tests), identity disturbance (15/16 tests), and inappropriate anger (11/16 tests), whereas all other criteria had far fewer significant tests (ranging from 2–6, median = 3.5). These findings indicated that frantic efforts, identity disturbance, and inappropriate anger exhibited class-specific variation not sufficiently accounted for by the BPD severity factor.

Consequently, a two-class PMI FacMM for the BPD criteria was estimated where item thresholds for these three items were allowed to vary, while others were held equal across classes. AIC_c and BIC values were lower for the PMI model than the SMI model, supporting its superior fit (Table 1). Similar to the two-class SMI solution, the latent classes divided participants into a largely asymptomatic class ($n = 262$) and a symptomatic class ($n = 100$; see Figure 1). Class-varying threshold parameters represent systematic differences between the groups in the endorsement levels of a particular criterion, after accounting for the large between-class differences in BPD severity. Interpretation of class-varying thresholds indicated that the frantic efforts to avoid abandonment and identity disturbance criteria were less prevalent in the symptomatic class than expected based on differences in mean BPD severity between classes. Conversely, inappropriate anger was quite prevalent in the symptomatic class relative to the asymptomatic class, exceeding the difference accounted for by mean severity. Because all other thresholds exhibited measurement invariance across latent classes, endorsement differences on the other 6 BPD criteria are attributable to differences in BPD severity.

Comparing person-centered, variable-centered, and hybrid models of BPD—

Among the CFA, LCA, and FacMM models tested, the two-class PMI FacMM fit the DSM-IV BPD criteria best according to AIC_c and BIC indices (Table 1). A comparison of Akaike weights (Burnham & Anderson, 2002) across models suggested virtually no support for the SMI FacMM, CFA, or LCA models relative to the PMI FacMM. The PMI FacMM model is consistent with the interpretation that a single BPD severity dimension exists (i.e., the diagnosis coheres), but that there are two subpopulations that differ discontinuously in mean severity. Further, the PMI FacMM identified three diagnostic criteria that were not captured adequately by a single severity dimension, suggesting important heterogeneity in these criteria that requires further exploration.

Characterizing the best-fitting model: Two-class PMI FacMM—Although model selection criteria supported the superiority of the 2-class PMI FacMM, it is important to verify that the identified subgroups differ on important outcomes of interest and are not the result of a statistical artifact. First and foremost, the two subgroups differed markedly in the number of BPD criteria present: Asymptomatic $M = 1.37$ ($SD = 1.66$), Symptomatic $M = 5.93$ ($SD = 1.37$), and this difference was significant, $t(360) = 23.17$, $p < .0001$. In addition to BPD severity differences, the symptomatic group was, on average, significantly younger, more frequently female, less educated, less likely to be employed, and less likely to be currently married (Table 2). These group differences are consistent with the demographic profile of individuals with BPD, who are typically female, of younger age, and with significant psychiatric disability.

Phase 2: Differentiating among BPD Subtypes using Additional Markers

To test the hypothesis that individuals with the BPD phenotype can be divided into subtypes differentiated by anger, aggressiveness, antisocial behavior, and mistrustfulness, data from individuals in the Phase 1 PMI FacMM symptomatic class ($n = 100$) were analyzed using finite mixture modeling (FinMM). In addition to the inappropriate anger criterion, two diagnostic criteria were carried forward into Phase 2 because of evidence that these were heterogeneous in the Phase 1 analyses and not fully accounted for by dimensional or hybrid

models. Thus, the indicators for the Phase 2 FinMMs were: 1) frantic efforts to avoid abandonment DSM-IV BPD criterion, 2) identity disturbance BPD criterion, 3) inappropriate anger BPD criterion, 4) self-reported mistrustfulness (IIP-Mistrustfulness), 5) DSM-IV Paranoid PD features, 6) self-reported aggressiveness (IIP-Aggressiveness), and 7) DSM-IV Antisocial PD features.

FinMM refers to a broader class of mixture-based clustering methods designed to reveal latent subgroups nested within the data (McLachlan & Peel, 2000). Although we were agnostic regarding dimensional versus categorical data analytic techniques in Phase 1, we selected FinMM for Phase 2 analyses. This decision was supported by our *a priori* reasoning about the intention of the analysis and by the data themselves. More specifically, we selected indicators for Phase 2 that were likely to differentiate persons with the BPD phenotype and that were *not* hypothesized to represent an underlying dimension.²

Phase 2 FinMM model selection—As detailed in Table 3, the BLRT selected a 4-class FinMM ($n_s = 28, 27, 20,$ and 20) as the best-fitting model, and there was a high degree of certainty about the class membership of each individual, *entropy* = .83 (average conditional probability of latent class membership = .90 for all classes; Celeux & Soromenho, 1996). The mean levels of each indicator across latent classes are displayed in Figure 2.

For heuristic purposes, each class was given a descriptive name introduced here and used below. Latent class 1 ($n = 28$), “Angry/Mistrustful,” included persons with high levels of mistrustfulness, moderate aggressiveness/antisocial behavior, low identity disturbance, and low efforts to avoid abandonment. Latent class 2 ($n = 27$), “Poor Identity/Low Anger”, was characterized predominantly by high identity disturbance and low anger, as well as relatively low levels of antisocial behavior and mistrustfulness. Latent class 3 ($n = 25$), “Prototypical”, exhibited low levels of most of the markers considered, rather low mistrustfulness, and moderate levels of inappropriate anger. Latent class 4 ($n = 20$), “Angry/Aggressive,” contained a subset of individuals with rather high antisocial behavior, aggressiveness, and frantic efforts to avoid abandonment, as well as moderate levels of anger, mistrustfulness, and identity disturbance.

Characterizing Phase 2 latent classes—Although it is inherently interesting that FinMM uncovered phenomenologically distinct latent subgroups, our results were corroborated further by significant group differences on other measures of interest. Specifically, the groups were compared on sex, age, education level, income, marital history, and race. We also compared groups in terms of BPD symptom severity, overall psychiatric impairment, psychiatric comorbidity, and interpersonal problems characteristic of BPD. Lastly, in order to better characterize the personality differences among groups, we compared the groups on seven traits of personality dysfunction and three normal personality factors measured by the SNAP-2.

In order to reduce the number of pairwise comparisons made among groups, each class was compared only with the Prototypical class using focused linear contrasts with the mean square error term and 96 degrees of freedom from the overall model (Rosnow & Rosenthal, 1988). Also, given the large number of group comparisons related to personality differences on the SNAP-2, we applied an adaptive two-stage step-up procedure to control the false discovery rate (i.e., the proportion of Type I errors among rejected null hypotheses) at $\alpha = .05$ (Benjamini, Krieger, & Yekutieli [BKL], 2006).

²Moreover, both one-factor CFA and multi-factor EFA fit the Phase 2 data poorly. Details are available from the corresponding author.

Latent class differences on demographic variables: Individuals in the Angry/Aggressive class were significantly younger than the Prototypical class ($t = -3.31, p = .001$), but the Poor Identity/Low Anger and Angry/Mistrustful classes did not significantly differ from the Prototypical group (Table 4). There were no significant group differences in terms of sex ratios, years of education, or annual income, $ps > .05$.

Because of the small proportion of individuals who self-identified as Asian American ($n = 2$) or Other ($n = 2$), tests of group differences by race were restricted to White and African American participants. The Poor Identity/Low Anger class was largely White, whereas the Prototypical class contained members of both races, and this difference was significant, $\chi^2(1) = 12.94, p < .0001$. No other racial comparisons with the Prototypical class were significant, $ps > .05$. Fewer people in the Angry/Aggressive and Angry/Mistrustful classes had ever been married relative to the Prototypical class, $\chi^2(1) = 5.51, 3.13, ps = .03$ and $.10$, respectively. After controlling for age, however, only the Angry/Mistrustful class was marginally associated with lower rates of marriage (binomial logistic regression $z = -1.72, p = .08$).

Psychiatric impairment and comorbidity: The latent classes differed significantly in terms of the number of DSM-IV BPD criteria present, $F(3, 96) = 9.88, p < .0001$ (Table 4). Because of the substantive importance of severity distinctions among classes in LCA/FinMM, all pairwise comparisons among groups were computed using Tukey's HSD post hoc test. The Angry/Aggressive class had more BPD criteria than all other classes, $adj. ps < .01$. No other pairwise comparisons of severity were significant. We did not identify any differences among groups in terms of global psychiatric impairment (GAF), currently anxiety symptoms (HAMA), current depressive symptoms (HAMD), number of current or past Axis I disorder, or the number of comorbid Axis II PDs, $ps > .10$. Thus, the Phase 2 BPD subtypes identified do not appear to represent group differences in psychiatric impairment.

Nonsuicidal self-injury (NSSI) and suicide attempts: Binomial logistic regression models revealed that the Poor Identity/Low Anger class had significantly higher rates of recent (within the past two years) and lifetime NSSI relative to the Prototypical class, $zs = 2.64$ and $2.45, ps = .008$ and $.01$, respectively. Recent NSSI was also higher in the Angry/Aggressive class relative to the Prototypical class, $z = 1.98, p = .05$. There was a trend toward lower rates of lifetime suicide attempts in the Angry/Mistrustful class relative to the Prototypical class, $z = -1.68, p = .09$, and the greater number of suicide attempts in the Poor Identity/Low Anger class than the Angry/Mistrustful class was significant, $z = 2.42, p = .03$.

Interpersonal problems: Interpersonal sensitivity differed significantly among the classes, $F(3, 96) = 15.27, p < .0001$. Pairwise comparisons revealed three levels of interpersonal sensitivity: high (Angry/Mistrustful and Angry/Aggressive), medium (Poor Identity/Low Anger), and low (Prototypical), $adj. ps < .05$. The classes also differed in terms of interpersonal ambivalence, $F(3, 96) = 9.81, p < .0001$. More specifically, the Angry/Mistrustful and Angry/Aggressive classes reported higher ambivalence than the Prototypical Class, $adj. ps < .01$. Further, the Angry/Mistrustful class had higher levels of ambivalence than the Poor Identity/Low Anger class, $adj. p = .02$. Although the Angry/Mistrustful class reported the highest levels of ambivalence, the difference from the Angry/Aggressive class was not significant, $adj. p = .40$.

Normal and abnormal personality comparisons among classes (SNAP-2): The Angry/Mistrustful class reported significantly higher levels of Mistrust relative to the Prototypical class, $t = 2.55, BKL p = .03$. The Poor Identity/Low Anger class was characterized by significantly lower Aggression relative to the Prototypical class, $t = -3.20, BKL p = .004$.

(see Table 5). The Angry/Aggressive class reported significantly higher levels of Aggression ($t = 3.18$, $BKL p = .004$), Manipulativeness ($t = 2.41$, $BKL p = .05$), and Disinhibition ($t = 2.68$, $BKL p = .02$) relative to Prototypical.

Discussion

Previous research has explored the heterogeneity of the BPD phenotype primarily by using either person-centered or variable-centered analyses to search for subtypes or traits, respectively, that might clarify distinctive aspects of this complex disorder. Many of these efforts have centered on the DSM diagnostic criteria for BPD, with some consensus that the BPD criteria measure a unidimensional construct reflecting severity (Clifton & Pilkonis, 2007). Our study extended previous efforts to parse the heterogeneity in BPD in two ways: 1) factor mixture models were compared with CFA and LCA models to test whether the latent structure of the DSM criteria includes categorical and continuous aspects; and 2) theoretically derived indicators of BPD beyond the DSM criteria were used to differentiate among symptomatic individuals.

In Phase 1 of our analyses, we compared person-centered, variable-centered, and hybrid models of the DSM-IV BPD criteria in a mixed clinical sample. These analyses supported the superiority of a unitary severity dimension over a person-centered subtyping approach, consistent with a dimensional conception of BPD. That said, both SMI and PMI FacMMs fit the BPD considerably better than CFA and LCA models, suggesting that the latent structure of BPD is more nuanced than traditional models can accommodate. The best-fitting model of the DSM-IV BPD criteria was a PMI FacMM characterized by a symptomatic class and an asymptomatic class, with large mean differences in BPD severity, as well as more focal differences on inappropriate anger, frantic efforts to avoid abandonment, and identity disturbance.

Support for the FacMM over other models could have emerged for at least two reasons. First, there may be a subgroup of the population whose symptoms fit the BPD phenotype, whereas the remaining group has only isolated symptoms that do not fit (as opposed to a simple dimensional account where each additional BPD symptom confers impairment). This interpretation is consistent with recent factor mixture modeling of a Finnish cohort, in which a subgroup had several symptoms characteristic of ADHD, whereas another subgroup had few symptoms, despite both groups varying dimensionally on the underlying traits of ADHD (Lubke et al., 2007). Second, the extraction of a symptomatic BPD subgroup may reflect diagnostic rating strategies insofar as clinicians are encouraged to rate symptoms of BPD to the extent that they match the overall prototype. For example, the BPD chronic emptiness criterion might be rated as absent in a chronically depressed patient who endorses emptiness but has no other features of BPD. Dimensional approaches to PD classification are in development for DSM-5, which may shift the psychometric evidence for the BPD syndrome as features of BPD are rated apart from the notion of a prototype (Pilkonis, Hallquist, Morse, & Stepp, 2011).

Distinguishing Among Putative Subtypes of BPD

The identification of a unitary severity dimension underlying the DSM-IV BPD criteria is consistent with the intellectual history of the modern DSM system, which sought to identify diagnostic criteria that were internally consistent and could be reliably assessed (Spitzer, Endicott, & Gibbon, 1979). Past psychometric analyses have found that the BPD diagnostic criteria are essentially unidimensional (Clifton & Pilkonis, 2007), and item-level analyses suggest that each criterion contributes information to a coherent diagnosis (Feske et al., 2007). Despite the evidence for the psychometric coherence of the DSM BPD criteria, the extensive literature on heterogeneity in BPD leaves one to wonder whether this disorder is

as homogeneous as the DSM criteria that identify it. More likely is the possibility that the DSM criteria identify the features of BPD that are shared by many patients but not those that differentiate among them.

In Phase 2 of our analyses, we used FinMM to test the idea that putative subtypes of BPD could be distinguished using features beyond the DSM BPD criteria. On the basis of previous theoretical and empirical literature (Kernberg & Caligor, 2005; Lenzenweger et al., 2008), we sought to identify subgroups of individuals with the BPD phenotype that differed in terms of anger, aggressiveness, antisocial behavior, and mistrustfulness. In addition, our Phase 1 analyses revealed that the frantic efforts to avoid abandonment and identity disturbance criteria exhibited greater heterogeneity than could be accounted for by a model treating BPD as a unitary construct. Thus, we also included these as potential differentiators of BPD subgroups in Phase 2. Our hypotheses about BPD subtypes were largely borne out: the best-fitting FinMM revealed an Angry/Aggressive subgroup, an Angry/Mistrustful subgroup, a Poor Identity/Low Anger subgroup, and a Prototypical subgroup with low aggression and mistrustfulness.

We characterized and validated the four subtypes using relevant clinical, personality, interpersonal functioning, and demographic variables not included in the FinMM. The Angry/Aggressive subgroup had the highest levels of aggression, manipulativeness, and disinhibition on the SNAP-2, as well as elevated interpersonal sensitivity and ambivalence. Individuals in the Angry/Aggressive subgroup were also younger, had elevated levels of NSSI, and had more severe BPD symptoms. Frantic efforts to avoid abandonment were distinctive of the Angry/Aggressive group (75% rated strongly present compared to 36% present in the Prototypical group). Thus, the Angry/Aggressive group represents a form of BPD characterized by antisocial behavior, aggression, disinhibition, and dysfunctional bids to maintain interpersonal relationships. This group comports with Kernberg's theory that some individuals with BPD externalize their anger in the form of aggressiveness and antisocial behavior, and our results extend this idea by describing the interpersonal ambivalence characteristic of this subgroup.

Although inappropriate anger was also evident in the Angry/Mistrustful group, this class was distinguished by elevated interpersonal mistrustfulness and much lower levels of identity disturbance and frantic efforts to avoid abandonment relative to the Angry/Aggressive group. On external measures, individuals in the Angry/Mistrustful group had high levels of interpersonal sensitivity and SNAP-2 mistrustfulness, marginally lower history of marriage, and the highest levels of interpersonal ambivalence. These data point to a subtype of BPD characterized by considerable concerns about interpersonal relationships, particularly the fear of being harmed or exploited. Indeed, previous literature has documented both heightened discrimination of facial affect (Fertuck et al., 2009; Lynch et al., 2006) and hypervigilance to social rejection cues in BPD (Ayduk et al., 2008). The features of the Angry/Mistrustful class are also consistent with the idea that some persons with BPD project their own anger onto others, resulting in perceived malevolence and ambivalence about relationships (Kernberg, 1967), although it is difficult to test the role of projection per se in the relationship between angry affect and mistrustfulness.

The Poor Identity/Low Anger class aligned with our expectation of a subgroup with relatively few features of aggressiveness, antisocial behavior, and mistrustfulness. Contrary to our hypothesis, however, BPD symptoms were not lower in this class than in the others. Moreover, inappropriate anger was largely absent in this group, whereas identity disturbance was present in 82% of the group. SNAP-2 Aggression was relatively low in this group, and there was a high rate of NSSI. Thus, the Poor Identity/Low Anger group appears to represent

a distinctive presentation of BPD in which a poor sense of self and self-injurious behaviors are prominent features and anger is relatively uncommon (see also Morse et al., 2009).

Finally, the Prototypical class had moderate levels of inappropriate anger but was low on mistrustfulness, aggressiveness, antisocial behavior, frantic efforts to avoid abandonment, and identity disturbance. Consistent with the low mistrustfulness observed, we also found that interpersonal sensitivity and ambivalence were lowest in the Prototypical class and history of marriage was higher than other classes. Self-injury was also lower in the Prototypical class than the Angry/Aggressive and Poor Identity/Low Anger classes. The characteristics of this class align with the prevalent notion that emotional dysregulation and anger are defining features of the disorder (Linehan, 1993; New et al., 2008).

Although the identification of Angry/Aggressive and Angry/Mistrustful subgroups replicates the antisocial and paranoid BPD subtypes identified by Lenzenweger and colleagues (2008), our subtypes were less purely antisocial or mistrustful relative to their results (Figure 2). Nevertheless, the base rates of the Angry/Mistrustful and Angry/Aggressive subtypes are remarkably close to those reported in the Lenzenweger (approximately 25% each).

Conclusions

In a mixed clinical sample, we found that the DSM-IV BPD criteria do a reasonably good job of measuring a unitary disorder, yet there may be two subpopulations that differ discontinuously in mean severity. Future research on the continuity of the individual BPD criteria may be beneficial insofar as we identified heterogeneity in three criteria that could not be explained by a dimensional account. Our findings also demonstrate the utility of using additional putative features of BPD to differentiate among subgroups of individuals whose clinical presentations differ qualitatively. In particular, our results illustrate the utility of measuring aggression, antisocial behavior, and mistrustfulness in individuals with BPD symptoms.

Although we did not hypothesize that the frantic efforts to avoid abandonment and identity disturbance criteria would differentiate among BPD subgroups, these features proved useful in this capacity. Frantic efforts to avoid abandonment were observed almost exclusively in the Angry/Aggressive class, suggesting that this feature represents an interpersonal manifestation of impulsive, aggressive behavior (New et al., 2009). In addition, the identity disturbance criterion divided the BPD subtypes into those with identity problems versus those without.

These findings are novel, and future research is needed to replicate and validate the identified subtypes. In particular, unique characteristics of our sample may have influenced the basis for subgroup identification and it would be worthwhile to explore whether similar subtypes would emerge in a sample with different levels of aggression, antisocial behavior, and mistrustfulness. Although there have been many empirical studies exploring the role of anger and aggressiveness in BPD (e.g., Lynch et al., 2006; Morse et al., 2009; New et al., 2009), identity disturbance has received little attention in the psychometric and empirical literatures, and it is likely that further articulation of this construct would improve our understanding of BPD (Wilkinson-Ryan & Westen, 2000). For example, Kernberg's theory posits that problems with identity are present in most individuals with BPD, yet identity disturbance was only evident in two of the subtypes in our study.

Even if preliminary, our distinctions among BPD subtypes may help to identify more homogeneous forms of the disorder that, in turn, can inform treatment decisions. Indeed, one potentially fruitful direction would be to explore whether empirically supported treatments for BPD, such as Dialectical Behavior Therapy (Linehan, 1993), differ in efficacy across

subgroups (cf. Hopwood et al., 2011). In addition, future basic research on BPD may benefit from exploring aggressiveness, identity disturbance, and mistrustfulness as moderating variables insofar as these may help to elucidate associations that are obscured when a heterogeneous BPD sample is considered as a whole. The features we selected to differentiate among BPD subtypes were derived from an aspect of Kernberg's theory of BPD and are only a small subset of potential features that may help to clarify heterogeneity within the BPD phenotype. We hope that future research will test additional features of BPD drawn from other theories and empirical studies that may enrich our understanding of this complex disorder.

Acknowledgments

This research was supported in part by grants from the National Institute of Mental Health (F32 MH090629, PI: Hallquist; R01 MH056888, PI: Pilkonis).

References

- Alden LE, Wiggins JS, Pincus AL. Construction of circumplex scales for the Inventory of Interpersonal Problems. *Journal of Personality Assessment*. 1990; 55:521–536. [PubMed: 2280321]
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR*. 4th ed.. Washington, DC: American Psychiatric Publishing; 2000.
- Ayduk O, Zayas V, Downey G, Cole AB, Shoda Y, Mischel W. Rejection sensitivity and executive control: Joint predictors of borderline personality features. *Journal of Research in Personality*. 2008; 42:151–168. [PubMed: 18496604]
- Becker DF, McGlashan TH, Grilo CM. Exploratory factor analysis of borderline personality disorder criteria in hospitalized adolescents. *Comprehensive Psychiatry*. 2006; 47:99–105. [PubMed: 16490567]
- Benjamini Y, Krieger AM, Yekutieli D. Adaptive linear step-up procedures that control the false discovery rate. *Biometrika*. 2006; 93:491–507.
- Blais MA, Hilsenroth MJ, Castlebury FD. Content validity of the DSM-IV borderline and narcissistic personality disorder criteria sets. *Comprehensive Psychiatry*. 1997; 38:31–37. [PubMed: 8980869]
- Bornovalova MA, Levy R, Gratz KL, Lejuez CW. Understanding the heterogeneity of BPD symptoms through latent class analysis: Initial results and clinical correlates among inner-city substance users. *Psychological Assessment*. 2010; 22:233–245. [PubMed: 20528051]
- Bradley R, Conklin CZ, Westen D. The borderline personality diagnosis in adolescents: Gender differences and subtypes. *Journal of Child Psychology and Psychiatry*. 2005; 46:1006–1019. [PubMed: 16109003]
- Burnham, KP.; Anderson, DR. *Model selection and multi-model inference: A practical information-theoretic approach*. 2nd ed.. New York: Springer; 2002.
- Byrne BM, Shavelson RJ, Muthén BO. Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin*. 1989; 105:456–466.
- Celeux G, Soromenho G. An entropy criterion for assessing the number of clusters in a mixture model. *Journal of Classification*. 1996; 13:195–212.
- Clark, LA.; Simms, LJ.; Wu, KD.; Cassilas, A. *Schedule for Nonadaptive and Adaptive Personality: Manual for administration, scoring, and interpretation*. 2nd ed.. Minneapolis, MN: University of Minnesota Press; (in press)
- Clark SL, Muthén BO, Kaprio J, D'Onofrio BM, Viken R, Rose RJ. Models and strategies for factor mixture analysis: Two examples concerning the structure underlying psychological disorders. (under review).
- Clarkin JF, Hull JW, Hurt SW. Factor structure of borderline personality disorder criteria. *Journal of Personality Disorders*. 1993; 7:137–143.

- Clarkin JF, Levy KN, Lenzenweger MF, Kernberg OF. Evaluating three treatments for borderline personality disorder: A multiwave study. *American Journal of Psychiatry*. 2007; 164:922–928. [PubMed: 17541052]
- Clifton A, Pilkonis PA. Evidence for a single latent class of Diagnostic and Statistical Manual of Mental Disorders borderline personality pathology. *Comprehensive Psychiatry*. 2007; 48:70–78. [PubMed: 17145285]
- Critchfield KL, Clarkin JF, Levy KN, Kernberg OF. Organization of co-occurring Axis II features in borderline personality disorder. *British Journal of Clinical Psychology*. 2008; 47:185–200. [PubMed: 17845740]
- Fertuck EA, Jekal A, Song I, Wyman B, Morris MC, Wilson ST, Brodsky BS, et al. Enhanced “Reading the Mind in the Eyes” in borderline personality disorder compared to healthy controls. *Psychological Medicine*. 2009; 39:1979–1988. [PubMed: 19460187]
- Feske U, Kirisci L, Tarter RE, Pilkonis PA. An application of item response theory to the DSM-III-R criteria for borderline personality disorder. *Journal of Personality Disorders*. 2007; 21:418–433. [PubMed: 17685837]
- First, MB.; Gibbon, M.; Spitzer, RL.; Williams, JBW. User’s guide for the structured clinical interview for DSM-IV Axis I disorders (SCID-I, Version 2.0). Washington, DC: American Psychiatric Press; 1995.
- First, MB.; Spitzer, RL.; Gibbon, M.; Williams, JBW. User’s guide for the structured clinical interview for DSM-IV personality disorders (SCID-II, Version 2.0). Washington, DC: American Psychiatric Press; 1997.
- Fossati A, Maffei C, Bagnato M, Donati D, Namia C, Novella L. Latent structure analysis of DSM-IV borderline personality disorder criteria. *Comprehensive Psychiatry*. 1999; 40:72–79. [PubMed: 9924881]
- Gottesman II, Gould TD. The endophenotype concept in psychiatry: Etymology and strategic intentions. *American Journal of Psychiatry*. 2003; 160:636–645. [PubMed: 12668349]
- Hagenaars, JA.; McCutcheon, AL. *Applied Latent Class Analysis*. 1st ed.. Cambridge University Press; 2002.
- Hamilton A. Diagnosis and rating of anxiety. *British Journal of Psychiatry*. 1969; 3:76–79.
- Hamilton M. A rating scale for depression. *Journal of Neurology, Neurosurgery, and Psychiatry*. 1960; 23:56–62.
- Heape, CL.; Pilkonis, PA.; Lambert, J.; Proietti, JM. *Interpersonal relations assessment*. Pittsburgh, PA: Department of Psychiatry, University of Pittsburgh; 1989.
- Honaker, J.; King, G.; Blackwell, M. *Amelia II: A program for missing data*. 2010. Retrieved from <http://CRAN.R-project.org/package=Amelia>
- Hopwood CJ, Morey LC, Skodol AE, Sanislow CA, Grilo CM, Ansell EB, McGlashan TH, et al. Pathological personality traits among patients with absent, current, and remitted substance use disorders. *Addictive Behaviors*. 2011; 36:1087–1090. [PubMed: 21782347]
- Horowitz LM, Rosenberg SE, Baer BA, Ureno G, Villasenor VS. Inventory of interpersonal problems: Psychometric properties and clinical applications. *Journal of Consulting and Clinical Psychology*. 1988; 56:885–892. [PubMed: 3204198]
- Johansen M, Karterud S, Pedersen G, Gude T, Falkum E. An investigation of the prototype validity of the borderline DSM-IV construct. *Acta Psychiatrica Scandinavica*. 2004; 109:289–298. [PubMed: 15008803]
- Kernberg OF. Borderline personality organization. *Journal of the American Psychoanalytic Association*. 1967; 15:641–685. [PubMed: 4861171]
- Kernberg, OF. *Borderline Conditions and Pathological Narcissism*. New York: Jason Aronson; 1975.
- Kernberg, OF.; Caligor, E. Lenzenweger, Mark F.; Clarkin, John F. *Major theories of personality disorder*. 2nd ed. New York, NY, US: Guilford Press; 2005. A Psychoanalytic Theory of Personality Disorders; p. 114–156.(2005), xiii.
- Lenzenweger MF, Clarkin JF, Yeomans FE, Kernberg OF, Levy KN. Refining the phenotype of borderline personality disorder using finite mixture modeling: Implications for classification. *Journal of Personality Disorders*. 2008; 22:313–331. [PubMed: 18684047]

- Linehan, MM. Cognitive-Behavioral Treatment of Borderline Personality Disorder. Guilford Press; 1993.
- Lubke GH, Muthén BO. Investigating population heterogeneity with factor mixture models. *Psychological Methods*. 2005; 10:21–39. [PubMed: 15810867]
- Lubke GH, Muthén BO, Moilanen IK, McGough JJ, Loo SK, Swanson JM, Yang MH, et al. Subtypes versus severity differences in attention-deficit/hyperactivity disorder in the Northern Finnish Birth Cohort. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2007; 46:1584–1593. [PubMed: 18030080]
- Lynch TR, Rosenthal MZ, Kosson DS, Cheavens JS, Lejuez CW, Blair RJR. Heightened sensitivity to facial expressions of emotion in borderline personality disorder. *Emotion*. 2006; 6:647–655. [PubMed: 17144755]
- Lynch TR, Trost WT, Salsman N, Linehan MM. Dialectical behavior therapy for borderline personality disorder. *Annual Review of Clinical Psychology*. 2007; 3:181–205.
- Markon KE, Krueger RF. Information-theoretic latent distribution modeling: Distinguishing discrete and continuous latent variable models. *Psychological Methods*. 2006; 11:228–243. [PubMed: 16953702]
- McLachlan, G.; Peel, D. *Finite Mixture Models*. New York: John Wiley & Sons; 2000.
- Meredith W. Measurement invariance, factor analysis and factorial invariance. *Psychometrika*. 1993; 58:525–543.
- Morey LC, Warner MB, Shea MT, Gunderson JG, Sanislow CA, Grilo C, Skodol AE, et al. The representation of four personality disorders by the Schedule for Nonadaptive and Adaptive Personality dimensional model of personality. *Psychological Assessment*. 2003; 15:326–332. [PubMed: 14593832]
- Morse JQ, Hill J, Pilkonis PA, Yaggi K, Broyden N, Stepp SD, Reed LI, et al. Anger, preoccupied attachment, and domain disorganization in borderline personality disorder. *Journal of Personality Disorders*. 2009; 23:240–257. [PubMed: 19538080]
- Muthén BO. Should substance use disorders be considered as categorical or dimensional? *Addiction*. 2006; 101(Suppl 1):6–16. [PubMed: 16930156]
- Muthén, LK.; Muthén, BO. *Mplus User's Guide*. 6th ed.. Los Angeles, CA: Muthén and Muthén; 2010.
- New AS, Hazlett EA, Newmark RE, Zhang J, Triebwasser J, Meyerson D, Lazarus S, et al. Laboratory induced aggression: a positron emission tomography study of aggressive individuals with borderline personality disorder. *Biological Psychiatry*. 2009; 66:1107–1114. [PubMed: 19748078]
- New AS, Triebwasser J, Charney DS. The case for shifting borderline personality disorder to Axis I. *Biological Psychiatry*. 2008; 64:653–9. [PubMed: 18550033]
- Nylund KL, Asparouhov T, Muthén BO. Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling*. 2007; 14:535–569.
- Paris J. The nature of borderline personality disorder: Multiple dimensions, multiple symptoms, but one category. *Journal of Personality Disorders*. 2007; 21:457–473. [PubMed: 17953501]
- Pfohl, B.; Blum, N.; Zimmerman, M. *Structured Interview for DSM-IV Personality*. Washington, DC: American Psychiatric Publishing; 1997.
- Pilkonis PA, Hallquist MN, Morse JQ, Stepp SD. Striking the (Im)proper balance between scientific advances and clinical utility: Commentary on the DSM-5 proposal for personality disorders. *Personality Disorders: Theory, Research, and Treatment*. 2011; 2:68–82.
- Pilkonis PA, Heape CL, Proietti JM, Clark SW, McDavid JD, Pitts TE. The reliability and validity of two structured diagnostic interviews for personality disorders. *Archives of General Psychiatry*. 1995; 52:1025–1033. [PubMed: 7492254]
- Pilkonis PA, Kim Y, Proietti JM, Barkham M. Scales for personality disorders developed from the Inventory of Interpersonal Problems. *Journal of Personality Disorders*. 1996; 10:355–369.
- R Development Core Team. *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing; 2011.
- Rosenberger P, Miller G. Comparing borderline definitions: DSM-III borderline and schizotypal personality disorders. *Journal of Abnormal Psychology*. 1989; 98:161–169. [PubMed: 2708659]

- Rosnow RL, Rosenthal R. Focused tests of significance and effect size estimation in counseling psychology. *Journal of Counseling Psychology*. 1988; 35:203–208.
- Rubin, DB. *Multiple Imputation for Nonresponse in Surveys*. New York: Wiley & Sons; 1987.
- Rusch KM, Guastello SJ, Mason PT. Differentiating symptom clusters of borderline personality disorder. *Journal of Clinical Psychology*. 1992; 48:730–738. [PubMed: 1452761]
- Sanislow CA, Grilo CM, McGlashan TH. Factor analysis of the DSM-III-R borderline personality disorder criteria in psychiatric inpatients. *American Journal of Psychiatry*. 2000; 157:1629–1633. [PubMed: 11007717]
- Sanislow CA, Grilo CM, Morey LC, Bender DS, Skodol AE, Gunderson JG, Shea MT, et al. Confirmatory factor analysis of DSM-IV criteria for borderline personality disorder: Findings from the Collaborative Longitudinal Personality Disorders Study. *American Journal of Psychiatry*. 2002; 159:284–290. [PubMed: 11823272]
- Shevlin M, Dorahy M, Adamson G, Murphy J. Subtypes of borderline personality disorder, associated clinical disorders and stressful life-events: A latent class analysis based on the British Psychiatric Morbidity Survey. *British Journal of Clinical Psychology*. 2007; 46:273–281. [PubMed: 17806204]
- Spitzer RL, Endicott J, Gibbon M. Crossing the border into borderline personality and borderline schizophrenia: The development of criteria. *Archives of General Psychiatry*. 1979; 36:17–24. [PubMed: 760694]
- Stern BL, Kim Y, Trull TJ, Scarpa A, Pilkonis PA. Inventory of Interpersonal Problems Personality Disorder Scales: Operating characteristics and confirmatory factor analysis in nonclinical samples. *Journal of Personality Assessment*. 2000; 74:459–471. [PubMed: 10900572]
- Sugiura N. Further analysis of the data by Akaike's Information Criterion and the finite corrections. *Communications in Statistics, Theory, and Methods*. 1978; A7:13–26.
- Thatcher DL, Cornelius JR, Clark DB. Adolescent alcohol use disorders predict adult borderline personality. *Addictive Behaviors*. Special Issue: Trends in the treatment of adolescent substance abuse. 2005; 30:1709–1724.
- Whewell P, Ryman A, Bonanno D, Heather N. Does the ICD 10 classification accurately describe subtypes of borderline personality disorder? *British Journal of Medical Psychology*. 2000; 73:483–494. [PubMed: 11140789]
- Wilkinson-Ryan T, Westen D. Identity disturbance in borderline personality disorder: An empirical investigation. *American Journal of Psychiatry*. 2000; 157:528–541. [PubMed: 10739411]

Figure 1. Two-class partial measurement invariance FacMM solution for the DSM-IV BPD criteria.
Note. Thresholds for three criteria varied across classes: frantic efforts to avoid abandonment, identity disturbance, and inappropriate anger.

Figure 2.

Class means (dots) and standard errors (lines) for Phase 2 FinMM classes.

Note. All variables have been standardized to z-scores ($M = 0$, $SD = 1$) to allow for comparable interpretations across items that have different scales.

Table 1

Model fit comparisons among best-fitting FacMM, CFA, and LCA analyses of DSM-IV BPD criteria, sorted by BIC

Model	LL	BIC	AIC _c	Number of Parameters	Akaike <i>w</i>
2-class PMI FacMM	-2099.53	4411.15	4279.25	36	1.0
2-class SMI FacMM	-2127.48	4431.71	4320.58	30	1.06×10^{-9}
1-factor CFA	-2139.26	4437.60	4337.06	27	2.80×10^{-13}
5-class LCA	-2045.11	4644.04	4345.11	94	5.0×10^{-15}

Note. The 2-class PMI FacMM model, highlighted in bold, fit best among all models considered, according to BIC and AIC_c. LL=model log-likelihood; BIC=Bayesian Information Criterion; AIC_c=Akaike's Information Criterion—Corrected (Sugiura, 1978); Akaike *w*=Akaike weight, the evidence in favor of a model relative to all models tested (for details, see Burnham & Anderson, 2002).

Demographic comparisons between symptomatic and asymptomatic classes identified by the best-fitting 2-class PMI FacMM for the DSM-IV criteria.

Table 2

Variable	Symptomatic Class (<i>n</i> = 100)		Asymptomatic Class (<i>n</i> = 262)		Group difference
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Age	37.38	11.14	40.98	11.20	$t(360) = -2.75, p = .007$
% Female	85%		65.27%		$\chi^2(1) = 12.67, p = .0004$
Years of education	14.25	2.19	15.16	2.00	$t(360) = -3.76, p = .0004$
Income (US dollars)	17070.71	18867.96	36541.50	27190.63	$t(350) = -6.53, p < .0001$
% White	73%		79.77%		$\chi^2(1) = .91, p = .34$
% Currently employed	32%		61.07%		$\chi^2(1) = 23.40, p < .0001$
% Currently married	20%		35.50%		$\chi^2(1) = 7.39, p = .007$

Table 3

Model fit statistics for Phase 2 finite mixture models

Number of latent classes	LL	BIC	AIC _c	Number of parameters	-2LL _{diff}	BLRT <i>p</i>
1	-969.87	2004.22	1972.69	14		
2	-924.74	1950.79	1906.62	22	90.28	< .0001
3	-909.63	1957.41	1906.21	30	30.22	< .0001
4	-891.43	1957.85	1907.45	38	36.39	< .0001
5	-878.06	1967.95	1929.70	46	26.74	.10

Note. The 4-class FinMM, highlighted in bold, fit best among the FinMMs considered, according to the BLRT *p*. LL=model log-likelihood; BIC=Bayesian Information Criterion; AIC_c=Akaike's Information Criterion—Corrected; -2LL_{diff} = -2 * the model log-likelihood difference between the *k*-class model and the *k*-1-class models; BLRT=Bootstrapped Likelihood Ratio Test.

Table 4
Demographic, psychiatric impairment, and interpersonal comparisons for Phase 2 latent classes

Variable	Latent Class					
	Prototypical		Poor Identity/ Low Anger		Angry/Mistrustful	
	M	SD	M	SD	M	SD
Age	41.20	11.79	36.30	9.82	39.82	11.28
%Female	84.00%		92.59%		75.00%	
Years of education	14.32	2.47	14.91	2.34	13.91	1.93
Income (US dollars)	19800.00	23517.72	16018.52	16397.40	14166.67	14935.76
%White	60.00%		96.30%		60.71%	
%Ever Married	60.00%		48.15%		35.71%	
BPD symptoms	5.32	1.80	6.07	1.54	5.25	1.65
GAF Score	51.74	6.03	49.63	4.65	49.82	4.76
Hamilton Anxiety	22.04	8.29	24.41	8.63	25.00	9.00
Hamilton Depression	19.96	7.27	22.93	7.76	22.11	8.43
Number of Current Axis I Disorders	3.16	1.84	2.85	1.26	2.75	1.51
Number of Past Axis I Disorders	1.28	1.17	1.15	1.10	.96	1.00
Number of Comorbid PDs	1.0	.5	.96	.52	1.21	.57
IIP-PD Interpersonal Sensitivity	18.22	6.72	24.84	8.29	29.96	6.86
IIP-PD Interpersonal Ambivalence	8.57	5.52	13.13	6.64	18.50	7.85
Non-suicidal self-injury (past 2 yrs)	25.0%		63.0%		34.6%	
Non-suicidal self-injury (lifetime)	48.0%		81.5%		59.3%	
Suicide attempt (past 2 yrs)	41.7%		44.4%		22.2%	
Suicide attempt (lifetime)	64.0%		74.1%		40.7%	

Note. Values printed in boldface are significantly different from the Prototypical class, $p < .05$.

Table 5

Normal and abnormal personality comparisons among Phase 2 latent classes

SNAP-2 Scale (T)	Latent Class									
	Prototypical		Poor Identity/ Low Anger		Angry/Mistrustful		Angry/Aggressive		M	SD
	M	SD	M	SD	M	SD	M	SD		
Positive Temperament	32.41	8.17	36.28	12.23	31.45	10.31	37.46	10.01		
Negative Temperament	67.07	6.40	65.52	5.38	68.05	6.04	68.54	7.01		
Disinhibition	54.75	10.83	53.86	9.45	56.87	11.26	67.32	11.51		
Aggression	64.55	12.93	51.60	10.96	69.71	12.48	79.40	17.03		
Dependency	59.88	15.00	63.04	14.61	57.69	13.19	67.57	15.11		
Entitlement	43.51	11.06	44.04	12.25	51.73	13.72	48.62	15.31		
Impulsivity	57.53	11.90	55.78	8.88	55.41	10.77	64.97	10.82		
Manipulativeness	55.74	13.62	54.47	12.37	57.55	15.11	69.03	15.20		
Mistrust	67.94	11.47	63.28	13.11	77.78	8.56	73.29	8.38		
Self-Harm	86.10	14.18	84.82	13.95	81.81	15.31	90.08	13.00		

Note. Scores are *T*-values (*M* = 50, *SD* = 10) relative to SNAP-2 norms. Means printed in boldface are significantly different from the Prototypical class, *BKL* *p* < .05.