Published in final edited form as:

J Pers Disord. 2012 October ; 26(5): 793–803. doi:10.1521/pedi.2012.26.5.793.

A Comparison of Latent Class, Latent Trait, and Factor Mixture Models of *DSM-IV* Borderline Personality Disorder Criteria in a Community Setting: Implications for *DSM-5*

Christopher Conway,
University of California, Los Angeles

Constance Hammen, and
University of California, Los Angeles

Patricia A. Brennan
Emory University

Abstract

With the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* scheduled for publication in 2013, researchers continue to debate the optimal classification of borderline personality disorder (BPD). Much of the discussion has focused on the relative merits of dimensional versus categorical classification schemes for BPD. Advances in statistical technologies have made it possible to adjudicate between continuous and categorical models of BPD using quantitative methods, yet no prior studies have attempted such a comparison. The current study directly compares the fit dimensional, categorical, and hybrid models of BPD in a large community sample ($N = 700$) of young adults at risk for psychopathology due to elevated rates of maternal depression. BPD symptoms were assessed using the Structured Clinical Interview for *DSM-IV* Axis II Personality Disorders (SCID-II). Latent class, latent trait, and factor mixture models of SCID-II symptoms were estimated, and a latent trait model provided superior fit to the data, supporting a dimensional conceptualization of borderline pathology. The nosological implications of these results are discussed with respect to a “hybrid” model of BPD diagnosis currently under consideration for *DSM-5*.

Keywords

borderline personality disorder; latent trait modeling; latent class analysis; factor mixture modeling; young adulthood; nosology

With the next iteration of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* scheduled to appear in 2013, debate over how borderline personality disorder (BPD) should be represented in future classification systems has intensified in recent years. Many theorists argue that BPD constitutes a discrete condition, in line with the categorical representation of PDs in current nosologies (e.g., *DSM-IV-TR*; American Psychiatric Association, 2000). From this perspective, there are clear boundaries distinguishing BPD from other diagnostic classes and from normality. In contrast, other investigators support a dimensional conceptualization of BPD, which assumes that borderline pathology varies

Correspondence: Correspondence concerning this article should be addressed to Christopher Conway, Department of Psychology, University of California, Los Angeles, CA 90095. Phone and fax: 310-825-6086. conwayc@ucla.edu.

Financial Disclosures

The authors report no biomedical financial interests or potential conflicts of interest.

continuously in the general population and is therefore present in all individuals to some degree (Trull, Widiger, & Guthrie, 1990).

Advances in statistical technologies have made it possible to adjudicate between these models of BPD using quantitative methods. Thus, there is potential for *DSM* revisions to be informed by empirical evidence, as opposed to *a priori* assumptions about the nature of BPD. Indeed, this perspective is consistent with a set of revision principles articulated by the *DSM-5* Task Force that specifically state that all modifications to the *DSM* will be grounded in empirical evidence (Kupfer, Regier, & Kuhl, 2008). In the current study, we use latent variable modeling techniques to investigate the underlying structure of *DSM-IV* BPD criteria in a community sample of young adults. More precisely, we assess the relative fit of categorical (i.e., latent class), dimensional (i.e., latent trait), and hybrid (i.e., factor mixture) models of BPD symptomatology. To our knowledge, these quantitative models of BPD liability have never been directly compared in previous research.

Several studies have modeled a categorical latent structure of BPD criteria using latent class analysis (LCA). LCA represents patterns of symptom co-occurrence in terms of a specific number of mutually exclusive latent groups or classes (McCutcheon, 1987). In the initial LCA study, Fossati and colleagues (1999) reported a three-class solution in a sample of consecutively admitted inpatients and outpatients. The latent classes included an asymptomatic group, a group endorsing only the impulsivity and anger BPD criteria, and a severe BPD group with high rates of clinician-rated endorsement across all criteria. This typology of latent classes was later replicated by Thatcher et al. (2005) in a sample of young adults recruited from treatment centers and the community. In contrast, Clifton and Pilkonis (2007) found evidence for two latent classes in a mixed clinical and nonclinical sample, one with a high likelihood of symptom endorsement during semistructured clinical interviews and one with a low likelihood. Additionally, other investigations have supported a four-class solution consisting of a low-BPD class, two intermediate classes, and a high-BPD class (Bornovalova, Levy, Gratz, & Lejuez, 2010; Shevlin, Dorahy, Adamson, & Murphy, 2007).

Latent trait modeling (LTM), also referred to as item response modeling, is an alternative approach to understanding the latent structure of BPD. In LTM, each BPD criterion is related to continuously-distributed, unifying dimension of borderline pathology. Confirmatory factor analysis (CFA) results from studies carried out in clinical and nonclinical populations have provided evidence for a unidimensional BPD construct (Aggen, Neale, Roysamb, Reichborn-Kjennerud, & Kendler, 2009; Feske, Kirisci, Tarter, & Pilkonis, 2007; Johansen, Karterud, Pedersen, Gude, & Falkum, 2004). It is noteworthy that one frequently-cited study reported a three-factor solution for *DSM-IV* BPD criteria, suggesting multiple latent traits may underlie the expression of BPD symptomatology (Sanislow et al., 2002). However, extremely high correlations between the three factors ($.90 < r_s < .99$) indicate that a one-factor model was likely more tenable for these data.

Factor mixture models (FMM) incorporate features of both LCA and LTM, permitting a latent structure that is simultaneously categorical and continuous (Lubke & Muthén, 2005). That is, FMM allows for the classification of individuals into BPD diagnostic groups or subtypes and, at the same time, accounts for within-class differences in severity of disorder with a continuous latent variable. Despite its flexibility in explaining both continuous and discontinuous features of psychopathology, FMM has not been widely applied in PD research (cf. Lenzenweger, Clarkin, Yeomans, Kernberg, & Levy, 2008).

Owing to the different assumptions of the various latent variable modeling methodologies, studies based on these different techniques have produced contradictory results and, in turn, have led to divergent conceptualizations of BPD. To take a preliminary step toward

resolving the uncertainty over the latent structure of BPD, a direct comparison of dimensional, categorical, and hybrid models of BPD is needed. The utility of this empirical approach has been demonstrated in prior quantitative studies of externalizing behaviors and syndromes (e.g., Krueger, Markon, Patrick, & Iacono, 2005; Walton et al., 2011); yet, to date, no such studies have been carried out to probe the latent structure underlying *DSM-IV* BPD criteria. This represents an important limitation in the scientific literature guiding *DSM* revisions. To address this gap in our knowledge, the current study compares the fit of latent trait, latent class, and factor mixture models of BPD criteria assessed in a community-based sample of young adults.

Method

Participants

A sample of 815 youth was selected from the Mater-University Study of Pregnancy (MUSP) in Brisbane, Australia (Keeping et al., 1989), which followed a birth cohort of over 5,000 mothers and their offspring born between 1981 and 1984 at the Mater Misericordiae Mother's Hospital to study children's health and development. This sample was originally selected to study the intergenerational transmission of depression, and, as such, mothers who endorsed experiences with depression based on peripartum evaluations were oversampled. Complete details of the sampling procedures have been published elsewhere (Hammen, Shih, Altman, & Brennan, 2003).

Of the 815 youth who were in the initial sample, 700 (362 females) completed the target measures for the current study at youth age 20. The sample was 92% Caucasian and 8% minority (Asian, Pacific Islander, and Aboriginal), with median family income falling in the lower middle class and mothers' median education level at grade 10. Based on the Structured Clinical Interview for *DSM-IV* (SCID; First, Spitzer, Gibbon, & Williams, 1995) administered at youth age 20 to 682 of the mothers, 390 (57.2%) had a history of major depressive disorder. Youth participating at age 20 did not differ from those participating at age 15 but not 20 in terms of family income at age 15, $t(782) = -1.49$, $p = .14$, maternal depression history by age 15, $\chi^2(1, 815) = .18$, $p = .67$, youth depression history by age 15, $\chi^2(1, 815) = .20$, $p = .65$, or youth history of any psychiatric diagnosis by age 15, $\chi^2(1, 815) = 1.33$, $p = .25$. Youth not participating at age 20 were more likely to be male, $\chi^2(1, 815) = 11.08$, $p < .01$.

Procedures

Interviews and questionnaires were administered to youth in their homes at youth at age 20. Interviewers were advanced graduate students in psychology, and were blind to maternal depression status and youth prior psychiatric history. All participants gave their written informed consent, and were compensated for their time. All procedures were approved by the University of California, Los Angeles, Institutional Review Board, Emory University Investigations Committee, and the University of Queensland Ethics Review Committee.

Measures

BPD criteria were assessed using the Structured Clinical Interview for *DSM-IV* Axis II Personality Disorders, Version 2.0 (SCID-II, First, Spitzer, Gibbon, Williams, & Benjamin, 1994). The SCID-II is a semistructured interview containing 140 items organized by Axis II diagnosis. Following recommended administration procedures (First et al., 1994), the interview was preceded by administration of the corresponding SCID-II self-report questionnaire, which features all items included in the SCID-II interview except for those assessing criterion A of Antisocial Personality Disorder. The self-report questionnaire was used to screen for the presence of all PD symptoms, such that interviewers probed only

those items that participants had endorsed on the self-report form (First et al., 1994). The SCID-II provides at least one item to assess each BPD criterion. Three criteria (numbers 3, 5, and 8) are assessed with multiple items and, following previous work on latent variable modeling of BPD (Markon, 2010), if interviewers judged any one of these items to be present the criterion was scored as present. The SCID-II interview yields both a dimensional and a categorical assessment of BPD. The mean number of BPD criteria endorsed in the entire sample was 1.43 ($SD = 1.97$), and the number of BPD diagnoses was 40 (5.71%). These values are slightly higher than previous estimates from community studies of SCID-II PD that report a BPD prevalence of 1–4% (Crawford et al., 2005; Maier, Lichtermann, Kingler, Heun, & Hallmayer, 1992) but is consistent with a sample at risk for psychopathology. Cronbach's alpha for the set of nine criteria was .78, a value comparable to ones reported in past psychometric evaluations of BPD criteria (e.g., Johansen et al., 2004). Kappa coefficients indexing the interrater reliability for each symptom across a randomly-selected sample of 34 respondents ranged from .76 to 1.0 (median = .96).

Statistical Modeling

To compare structural models of BPD, we fit latent trait, latent class, and factor mixture models to the nine *DSM-IV* BPD criteria. LTM is used to relate individual differences on a latent trait to differences in item response patterns (Hambleton, Swaminathan, & Rogers, 1991). The basic unit of LTM analyses is the item response function (IRF), which indicates how the probability of endorsing a given BPD criterion changes according to one's standing on the latent borderline trait. The IRF is defined by two parameters: difficulty and discrimination. Item difficulty refers to the location on the latent trait at which participants have a 50% chance of endorsing that criterion. Greater levels of the latent borderline trait are needed to endorse criteria with higher difficulties. Item difficulty and the latent borderline trait are both scaled on a z-score metric ($M = 0$, $SD = 1$). Thus, a difficulty value of 1.0 for a given BPD symptom would signify that individuals at 1 standard deviation above the mean on the latent borderline trait have a 50% chance of exhibiting that particular symptom. The discrimination parameter represents how well a BPD criterion differentiates between individuals at contiguous values on the latent trait. For criteria with relatively large discriminations, the probability of endorsing the criterion changes rapidly across the range of the latent trait surrounding the criterion's difficulty parameter.

In contrast to LTM, a LCA approach assumes that the covariance of BPD criteria is explained by a specific number of unobserved classes or types (McCutcheon, 1987). Two parameters are estimated from the data in LCA, namely the conditional probability parameter and the class membership parameter. The conditional probability parameter indicates the probability of endorsing a specific criterion for each latent class, whereas the class membership parameter estimates the proportion of the sample that falls into each latent class. In the current study, we fit models with one to four latent classes, based on previous LCA findings in BPD research.

FMM can be thought of as a variation on traditional LCA in which the assumption of conditional independence of the observed variables is relaxed, such that observed variables within each class are assumed to share variance due to the influence of an underlying continuous latent variable (Masyn, Henderson, & Greenbaum, 2010). There are several varieties of FMM that differ with respect to whether (a) strong measurement invariance is imposed across classes and (b) the latent factor has a parametric distribution (Muthén, 2008). In the current analyses, we set the factor variance to zero within each class, constrained factor loadings and thresholds to be equal across classes, and allowed factor means to vary across classes (see the description of latent class factor analysis in Muthén, 2006). To be consistent with LCA analyses, we fit factor mixture models with up to four classes.

In accordance with prior work that has compared the fit of latent variable models to determine whether liability to externalizing disorders is categorical or dimensional in nature (Krueger et al., 2005), we used the Bayesian information criterion (BIC; Schwartz, 1978) to compare model fit across the three models. Comparison of BIC values indicates which model most parsimoniously and accurately represents the pattern of co-occurrence among BPD criteria (Lin & Dayton, 1997). Additionally, the Lo-Mendell-Rubin likelihood ratio test (LRT; Lo, Mendell, & Rubin, 2001) was used to compare latent class models with k versus $(k-1)$ classes. Significant LRT values indicate superior fit for the model with k classes.

Given that studies have occasionally reported gender differences in the prevalence of BPD symptoms (e.g., Widiger & Trull, 1993), the consistency of LTM, LCA, and FMM results across gender was examined. Analyses revealed that the pattern of results was equivalent for males and females, and, as such, results presented below reflect analyses conducted in the entire sample. All analyses were conducted in Mplus (Muthén & Muthén, 1998–2007) using robust maximum likelihood estimation with a logit link function.

Results

Comparison of Latent Trait, Latent Class, and Factor Mixture Models

The LTM approach assumes that a single latent dimension is able to account for the covariation among BPD criteria. We tested this assumption in a preliminary analysis by conducting a one-factor CFA of the tetrachoric correlations among symptoms. The correlation matrix used for this analysis is presented in Table 1. The unidimensional CFA model provided an excellent fit to the data according to several fit indices ($\chi^2(23) = 25.49$, $p = .33$; comparative fit index = .99; Tucker-Lewis index = .99; root mean square error of approximation = .01).

Table 2 presents the comparison between the unidimensional, latent class, and factor mixture models. We report the number of parameters, log-likelihood, and BIC for each, with lower BIC values indicating better model fit. We also report p -values from LRT significance tests between the latent class models. According to both the LRT and BIC, the two-class solution represented the best-fitting latent class model. Among the factor mixture models, the BIC favored the three-class solution. Most importantly, according to BIC values, the latent trait model clearly provided the superior fit to the data when compared to the various latent class and factor mixture models.

Item-Level Analyses

After establishing the superior fit of the latent trait model, supplementary analyses were conducted to clarify the nature of the latent borderline trait. To be specific, the item parameters (i.e., difficulty and discrimination) characterizing each BPD criterion were examined (see Table 3). The difficulty parameters ranged from 1.10 to 1.86 ($M = 1.40$), signaling that the BPD criteria indexed the upper end of the borderline continuum in this sample. In other words, participants needed to possess moderately high levels (i.e., approximately 1 standard deviation above the mean) of borderline pathology to have a 50% chance of endorsing even the least severe BPD criterion. The most severe, or difficult to endorse, BPD criteria were stress-linked paranoia ($b = 1.86$) and unstable interpersonal relationships ($b = 1.67$). Endorsement of either of these criteria indicated relatively high standing on the borderline trait. Conversely, intense anger ($b = 1.10$) and affective instability ($b = 1.20$) marked the less severe end of the borderline spectrum.

Regarding discrimination parameters, the most discriminating items were chronic emptiness ($a = 3.00$), affective instability ($a = 2.47$), and recurrent suicidality ($a = 1.99$). These criteria were most effective in distinguishing among (i.e., providing a rank-order of) individuals

with similar levels of borderline pathology. Stated somewhat differently, these criteria provided the most information about how much of the latent borderline trait each individual possessed. In contrast, the impulsivity criterion ($\alpha = 1.16$) was clearly the least reliable item, providing the least information about an individual's location on the borderline dimension.

Discussion

The representation of BPD in *DSM-5* has been a topic of mounting interest in the field of personality disorders. In particular, researchers have been divided regarding the important point of whether BPD should be conceptualized as a continuous or discrete construct. Recently, the *DSM-5* Personality Disorders Workgroup proposed a hybrid dimensional-categorical model for PD assessment that would retain the categorical diagnosis of BPD as a borderline “type” and introduce a complementary dimensional rating system of personality traits relevant to BPD (see <http://www.dsm5.org>). The current study compared the fit of latent trait, latent class, and factor mixture models of *DSM-IV* BPD criteria and found that borderline pathology was continuously-distributed in a community sample of young adults, thus offering some support for the integration of a dimensional perspective on BPD assessment into the *DSM*.

Our findings are consistent with previous psychometric investigations of *DSM-IV* BPD criteria that have found evidence for a unitary latent trait—referred to as “BPD-ness” by Gunderson and colleagues (2011)—underlying BPD symptomatology (Aggen et al., 2009; Feske et al., 2007; Gunderson et al., 2011; Johansen et al., 2004). We extend prior work by explicitly demonstrating that this statistical model provides a better explanation of observed rates of BPD symptoms relative to latent class models, which posit the existence of distinct borderline types, and factor mixture models, which represent BPD as both a categorical and continuous entity.

At the same time, it may be possible to reconcile the present findings with previous research that has found evidence for distinct classes of BPD. Nearly all prior reports of latent borderline types have revealed groups that are graded in severity (Trull, Distel, & Carpenter, 2011). That is, the latent classes appear to represent varying degrees of severity on an underlying continuum of borderline pathology. For example, the typology of Fossati et al. (1999) included an asymptomatic group, a group endorsing only the anger and impulsivity criteria (corresponding to two of the least severe criteria in the current study; see Table 3), and a group with high rates of endorsement across all criteria. Therefore, it can be argued that latent class results are actually compatible with a dimensional perspective on BPD liability (Trull et al., 2011; see also Krueger et al., 2005).

It is important to note that the current results do not address the issue of which personality traits should be used to create the profile of BPD-relevant traits that is planned for *DSM-5* (cf. Skodol et al., 2011). Data from large correlational studies linking PDs to normal and pathological personality traits can be used to determine the number and nature of traits relevant to each of the six types (i.e., antisocial, avoidant, borderline, narcissistic, obsessive-compulsive, and schizotypal) currently under consideration for *DSM-5* (e.g., Krueger & Eaton, 2010; Simms, 2007; Trull, Widiger, Lynam, & Costa, 2003). Instead, our findings provide some evidence that a continuous rating of overall borderline severity would be a valid complement to, or—pending further study—replacement for, the categorical borderline type. For clinicians with insufficient time to rate patients on numerous BPD-relevant personality traits proposed for *DSM-5*, a single BPD severity score would provide a mechanism for recording a dimensional rating of borderline pathology. Thus, while the current analyses reveal relatively poor fit for a hybrid latent structure of BPD, they support

the inclusion of a dimensional rating scheme in the hybrid assessment model for PD proposed for *DSM-5*.

Apart from the issue of including dimensional rating systems in *DSM-5*, the current data may also be used to inform the definition of the new borderline type, which, as of this writing, is still under revision. Several investigators have advocated for an empirically-based diagnostic algorithm that goes beyond the current polythetic classification system, in which any five out of nine symptoms is sufficient for a BPD diagnosis (e.g., Gunderson, 2010). Our results indicate that BPD criteria could be assigned weights reflecting the severity of borderline pathology associated with a particular symptom. For example, based on the difficulty parameters from the current LTM analyses, a presentation featuring paranoid ideation and identity disturbance would be indicative of greater BPD severity than a presentation featuring intense anger and chronic emptiness, all else being equal. Yet, the proposed *DSM-5* BPD criteria treat all symptoms or traits as equally important in determining the presence of the borderline type (see <http://www.dsm5.org>). Future LTM studies would do well to investigate how criterion difficulty and discrimination parameters may be used to develop more sophisticated diagnostic protocols that improve the validity of the borderline diagnosis.

There are several limitations of the current study that may be useful in guiding future research. First, participants were all 20 years old, and results may differ among other age groups. Age is not only (inversely) related to BPD severity, it is also associated with particular symptom presentations (e.g., impulsivity and suicidal behaviors decline with older age), suggesting that the nature of borderline pathology may change across developmental periods (Stepp & Pilkonis, 2008; Zanarini et al., 2007). Second, the current sample was overselected for maternal depression, and this may have influenced BPD symptom presentation in offspring. Further investigation of the latent structure of BPD signs and symptoms in epidemiological samples is recommended. Third, although we consider the use of a semistructured interview to assess *DSM-IV* BPD to be a strength of the current study, it is possible that results would differ across BPD assessment methods (e.g., self- and informant-report) in terms of rates of symptoms endorsement and/or factor structure.

In sum, this study used latent variable modeling techniques to compare categorical, dimensional, and hybrid models of BPD liability in the same sample. To our knowledge, this is the first direct comparison of these models in the BPD literature. Results supported a latent trait model, in which BPD criteria are scaled along a single latent continuum of borderline pathology. This finding is consistent with proposals to integrate a dimensional rating system of PD into the next edition of the *DSM*. Further, the item response modeling results suggested that BPD criteria could be rank-ordered with respect to severity and ability to discriminate between people possessing different levels of the borderline trait. This information may prove useful in refining diagnostic algorithms for the borderline type in *DSM-5*.

Acknowledgments

The authors greatly appreciate the assistance of Robyne LeBrocq, Cheri Dalton Comber, and Sascha Hardwicke (project coordinators) and their interview staff. Thanks also to the original MUSP principals, William Bor, MD, Michael O'Callaghan, MD, and Professor Gail Williams. This study was supported by NIMH R01 MH052239 to Brennan, Hammen, and Najman.

References

- Aggen SH, Neale MC, Røysamb E, Reichborn-Kjennerud T, Kendler KS. A psychometric evaluation of the DSM-IV borderline personality disorder criteria: Age and sex moderation of criterion functioning. *Psychological Medicine*. 2009; 39:1967–1978. [PubMed: 19400977]
- American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. (4th ed Text Revision). Washington, DC: Author; 2000.
- 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]
- 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]
- Crawford TN, Cohen P, Johnson JG, Kasen S, First MB, Brook JS. Self-reported personality disorder in the children in the community sample: Convergent and prospective validity in late adolescence and adulthood. *Journal of Personality Disorders*. 2005; 19:30–52. [PubMed: 15899719]
- 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.; Spitzer, RL.; Gibbon, M.; Williams, JWB. *Structured Clinical Interview for DSM-IV Axis I disorders*. Washington, D.C.: American Psychiatric Press; 1995.
- First, MB.; Spitzer, RL.; Gibbon, M.; Williams, JWB.; Benjamin, L. *Structured clinical interview for DSM-IV Axis II personality disorders*. Version 2.0. New York: New York State Psychiatric Institute; 1994.
- Fossati A, Maffei C, Bagnato M. Latent structure analysis of DSM-IV borderline personality disorder. *Comprehensive Psychiatry*. 1999; 40:72–79. [PubMed: 9924881]
- Gunderson JG. Revising the borderline diagnosis for DSM-V: An alternative proposal. *Journal of Personality Disorders*. 2010; 24:694–708. [PubMed: 21158594]
- Gunderson JG, Zanarini MC, Choi-Kain LW, Mitchell KS, Jang KL, Hudson JI. Family study of borderline personality disorder and its sectors of psychopathology. *Archives of General Psychiatry*. 2011; 68:753–762. [PubMed: 21727257]
- Hambleton, RK.; Swaminathan, H.; Rogers, HJ. *Fundamentals of item response theory*. Newbury Park: Sage; 1991.
- Hammen CL, Shih JH, Altman T, Brennan PA. Interpersonal impairment and the prediction of depressive symptoms in adolescent children of depressed and nondepressed mothers. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2003; 42:571–577. [PubMed: 12707561]
- 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]
- Keeping JD, Najman JM, Morrison J, Western JS, Andersen MJ, Williams GM. A prospective longitudinal study of social, psychological and obstetric factors in pregnancy: response rates and demographic characteristics of the 8556 respondents. *BJOG: An International Journal of Obstetrics & Gynaecology*. 1989; 96:289–297.
- Krueger RF, Eaton NR. Personality traits and the classification of mental disorders: Toward a more complete integration in DSM-5 and an empirical model of psychopathology. *Personality Disorders: Theory, Research, and Treatment*. 2010
- Krueger RF, Markon KE, Patrick CJ, Iacono WG. Externalizing psychopathology in adulthood: a dimensional-spectrum conceptualization and its implications for DSM-V. *Journal of Abnormal Psychology*. 2005; 114:537–550. [PubMed: 16351376]
- Kupfer DJ, Regier DA, Kuhl EA. On the road to DSM-V and ICD-11. *European Archives of Psychiatry and Clinical Neuroscience*. 2008; 258:2–6. [PubMed: 18985287]
- Lin TH, Dayton CM. Model selection information criteria for non-nested latent class models. *Journal of Educational and Behavioral Statistics*. 1997; 22:249–264.

- Lo Y, Mendell NR, Rubin DB. Testing the number of components in a normal mixture. *Biometrika*. 2001; 88:767–788.
- Maier W, Lichtermann D, Klingler T, Heun R, Hallmayer J. Prevalences of personality disorders (DSM-III-R) in the community. *Journal of Personality Disorders*. 1992; 6:187–196.
- Markon KE. Modeling psychopathology structure: A symptom-level analysis of Axis I and II disorders. *Psychological Medicine*. 2010; 40:273–288. [PubMed: 19515267]
- Markon KE, Krueger RF. Information-theoretic latent distribution modeling: distinguishing discrete and continuous latent variable models. *Psychological Methods*. 2006; 3:228–243. [PubMed: 16953702]
- Masyn KE, Henderson CE, Greenbaum PE. Exploring the latent structures of psychological constructs in social development using the dimensional-categorical spectrum. *Social Development*. 2010; 19:470–493.
- McCutcheon, AL. Latent class analysis. Newbury Park: Sage; 1987.
- Muthén, LK.; Muthén, BO. Mplus User's Guidek, 5th edn. Los Angeles: Muthén & Muthén; 1998–2007.
- Sanislow CA, Grilo CM, Morey LC, Bender DS, Skodol AE, Gunderson JG, McGlashan TH. 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]
- Schwartz G. Estimating the dimension of a model. *The Annals of Statistics*. 1978; 6:461–464.
- 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]
- Simms LJ. The big seven model of personality and its relevance to personality pathology. *Journal of Personality*. 2007; 75:65–94. [PubMed: 17214592]
- Skodol AE, Clark LA, Bender DS, Krueger RF, Morey LC, Verhuel R, Oldham JM. Proposed changes in personality and personality disorder assessment and diagnosis for DSM-5 part I: Description and rationale. *Personality Disorders: Theory, Research, and Treatment*. 2011; 2:4–22.
- Stapp SD, Pilkonis PA. Age-related differences in individual DSM criteria for borderline personality disorder. *Journal of Personality Disorders*. 2008; 22:427–432. [PubMed: 18684054]
- Thatcher DL, Cornelius JR, Clark DB. Adolescent alcohol use disorders predict adult borderline personality. *Addictive Behavior*. 2005; 30:1709–1724.
- Trull TJ, Distel MA, Carpenter RW. DSM-5 borderline personality disorder: At the border between a dimensional and a categorical view. *Current Psychiatry Report*. 2011; 13:43–49.
- Trull TJ, Widiger TA, Guthrie P. Categorical versus dimensional status of borderline personality disorder. *Journal of Abnormal Psychology*. 1990; 99:40–48. [PubMed: 2307765]
- Trull TJ, Widiger TA, Lynam DR, Costa PT Jr. Borderline personality disorder from the perspective of general personality functioning. *Journal of Abnormal Psychology*. 2003; 112:193–202. [PubMed: 12784828]
- Walton KE, Ormel J, Krueger RF. The dimensional nature of externalizing behaviors in adolescence: Evidence from a direct comparison of categorical, dimensional, and hybrid models. *Journal of Abnormal Child Psychology*. 2011; 39:553–561. [PubMed: 21210204]
- Widiger, TA.; Trull, TJ. Borderline and narcissistic personality disorders. In: Adams, H.; Sutker, P., editors. *Comprehensive handbook of psychopathology*. 2nd ed.. New York: Plenum Press; 1993. p. 371-394.
- Zanarini MC, Frankenburg FR, Reich DB, Silk KR, Hudson JI, McSweeney LB. The subsyndromal phenomenology of borderline personality disorder: A 10-year follow-up study. *American Journal of Psychiatry*. 2007; 164:929–935. [PubMed: 17541053]

Table 1

Tetrachoric Correlations for the Nine Borderline Personality Disorder Criteria

Criterion	1	2	3	4	5	6	7	8	9
1. Intense anger	—								
2. Affective instability	.426	—							
3. Chronic emptiness	.541	.514	—						
4. Impulsivity	.408	.316	.376	—					
5. Self-injury	.562	.515	.445	.460	—				
6. Abandonment concerns	.488	.620	.507	.423	.599	—			
7. Identity disturbance	.539	.633	.615	.473	.622	.708	—		
8. Unstable relationships	.582	.436	.415	.481	.497	.616	.615	—	
9. Paranoia/dissociation	.549	.518	.465	.295	.545	.602	.621	.511	—

All correlations are significant at the .01 level.

Table 2

Fit Results for Latent Trait, Latent Class, and Factor Mixture Models

Model	<i>k</i>	BIC	Log-likelihood	LRT <i>p</i> -value
Latent trait	18	4686.42	−2284.30	
Latent class				
1 class	9	5461.93	−2701.51	
2 classes	19	4752.36	−2314.00	< .001
3 classes	29	4753.96	−2282.07	.27
4 classes	39	4803.55	−2274.14	.28
Factor mixture				
2 classes	20	4758.90	−2314.00	
3 classes	21	4709.37	−2286.96	
4 classes	23	4714.90	−2282.18	

k = number of free parameters; BIC = Bayesian information criterion; LRT = Lo-Mendell-Rubin likelihood ratio test

Table 3

Two-Parameter Logistic Item Response Theory Model Parameter Estimates for Nine Borderline Personality Disorder Criteria

Criterion	Parameter	
	Difficulty (<i>a</i>)	Discrimination (<i>b</i>)
Intense anger	1.10	1.86
Affective instability	1.20	2.47
Chronic emptiness	1.22	3.00
Impulsivity	1.28	1.16
Self-injury	1.36	1.99
Abandonment concerns	1.43	1.77
Identity disturbance	1.46	1.60
Unstable relationships	1.67	1.79
Paranoia/dissociation	1.86	1.93

Criteria are presented in order of increasing difficulty.