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A Taxometric Investigation of Unipolar Depression in the National Comorbidity Survey

James J. Prisciandaro and John E. Roberts
University at Buffalo, State University of New York

Ongoing debate has questioned whether unipolar depression is a dimensional or categorical phenomenon. Although past studies using taxometric methods have supported a dimensional interpretation, each has suffered from methodological limitations. The present study was designed to overcome these limitations through reanalysis of the National Comorbidity Survey. Two indicator sets were constructed from the depression-relevant questions of the Composite International Diagnostic Interview. Participants who endorsed the lifetime occurrence of significant depressed mood or anhedonia (n = 4,577) were submitted to 2 nonredundant taxometric procedures (maximum eigenvalue and means above minus below a cut), additional consistency tests, and recently developed simulation techniques. All results converged on a dimensional solution. The implications of these findings on assessment, treatment, and research design are discussed.

Keywords: taxometrics, depression, dimensional, categorical, National Comorbidity Survey

Ongoing debate has focused on whether unipolar depression is categorical in nature (i.e., not continuous with normal human functioning and/or subsyndromal conditions) or dimensional (i.e., a quantitative elevation on a continuum of depression-relevant features found in all people). Although this often heated debate (see Coyne, 1994; Flett, Vredenburg, & Krames, 1997) has largely been guided by indirect evidence, Meehl and colleagues (Meehl, 1973; Meehl & Yonce, 1994, 1996; Waller & Meehl, 1998) have developed taxometric statistical methods that test the existence of latent discontinuities (i.e., boundaries) in a data set. Collectively, these procedures (e.g., maximum covariance [MAXCOV], means above minus below a cut [MAMBAC], maximum eigenvalue [MAXEIG]) compare observed data to a latent taxonic model, the general covariance mixture theorem (Meehl, 1973),[1] by examining the relations among indicators of a hypothesized taxonic (i.e., categorical) entity. If the observed relationships among indicators conform to the predictions made by the general covariance mixture theorem, a taxonic interpretation is made. These methods may result in fewer false positives than alternative statistical procedures (e.g., cluster analytic techniques; Cleland, Rothschild, & Haslam, 2000) and are viewed by many as the cutting-edge statistical approach to testing latent boundaries (Solomon, Haaga, & Arnow, 2001).

Previous Taxometric Investigations of Depressive Constructs

Three taxometric studies have investigated the latent structure of unipolar depression (Franklin, Strong, & Greene, 2002; A. M. Ruscio & Ruscio, 2002; J. Ruscio & Ruscio, 2000) by using self-report measures of depressive symptomatology in clinical and college-student samples, and all have converged on a dimensional solution. However, these studies are not without limitations. First, Solomon et al. (2001) have suggested that spurious dimensional findings can result if a sample is significantly overrepresented by taxon members. This concern is potentially relevant to J. Ruscio and Ruscio's (2000) psychiatric inpatient sample, which likely contained a very high base rate of current major depressive episodes. Second, previous studies have sampled unique populations that potentially differ from the general population in meaningful ways. It is unknown whether the dimensional results found in past research apply to the population as a whole or only to the specific groups of individuals that have been studied in previous investi-

James J. Prisciandaro and John E. Roberts, Department of Psychology, University at Buffalo, State University of New York.

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Correspondence concerning this article should be addressed to John E. Roberts, Department of Psychology, University at Buffalo, State University of New York, Park Hall, Box 604110, Amherst, NY 14260-4110. E-mail: robertsj@buffalo.edu

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$$\mathrm{cov}(xy) = P\mathrm{cov}_t(xy) + Q\mathrm{cov}_c(xy) + PQ(\bar{x}_t - \bar{x}_c)(\bar{y}_t - \bar{y}_c),$$

where cov(xy) is the covariance of x and y in the total (mixed) sample; P is the base rate of taxon members in the total sample; Q is 1–P, the base rate of the complement (nontaxon) members in the total sample; $P\mathrm{cov}_t(xy)$ is the weighted indicator covariance in the taxon class; $Q\mathrm{cov}_c(xy)$ is the weighted indicator covariance in the complement class; and $PQ(\bar{x}_t - \bar{x}_c)(\bar{y}_t - \bar{y}_c)$ is the weighted cross-product of the latent class mean differences.

gations (i.e., psychiatric inpatients and male veterans in J. Ruscio & Ruscio, 2000; psychiatric inpatients and outpatients in Franklin et al., 2002; and college students in A. M. Ruscio & Ruscio, 2002). Third, each of these studies relied on self-report measures of depression. As Solomon et al. (2001) noted, "analyses based on self-report measures are somewhat ambiguous in their implications for the continuity issue, because elevated self-report scores may reflect various kinds of negative affect and psychological disorders other than unipolar clinical depression" (p. 504). When taken out of the context of a major depressive episode, variance in point measures of self-reported depressive symptoms partially reflects transient distress that does not meet the severity or duration criteria imposed by the fourth edition of the *Diagnostic and Statistical Manual* (*DSM–IV*; American Psychiatric Association, 1994) for "clinically significant" depression (Coyne, 1994; Coyne & Schwenk, 1997). Furthermore, self-reported depressive symptoms can often reflect physical illness or the side effects of medication (Coyne & Schwenk, 1997). Additionally, many items on self-report measures do not represent diagnostic symptoms of depression (e.g., irritability). Consequently, these self-report instruments can be thought of as measures of nonspecific (often transient) distress. Consistent with this concern, a number of studies have demonstrated moderate correlations between measures of nonspecific negative affectivity and self-report measures of depressive symptoms (see Watson & Clark, 1984). Thus, the above-mentioned taxometric studies of unipolar depression may be better characterized as taxometric investigations of distress.

In addition to the three taxometric studies discussed above, several studies have focused on proposed subtypes of major depression. Two of these studies reportedly uncovered an endogenous depression taxon (Grove et al., 1987; Haslam & Beck, 1994). However, these studies suffered from various methodological and interpretational difficulties, such as insufficient consistency testing and the taxonic interpretation of ambiguous findings (see J. Ruscio, 2004; J. Ruscio & Ruscio, 2000). An additional taxometric investigation of the melancholic (i.e., endogenous) depressive subtype reportedly uncovered a melancholic taxon in a sample of adolescents (Ambrosini, Bennett, Cleland, & Haslam, 2002). However, the principal component analysis used to select the melancholic indicators for this study may have parsed item variance on the basis of differences in item difficulty (i.e., the level of symptom severity assessed by each indicator; Lenzenweger, 2004), making any resulting interpretations problematic. Specifically, the two-component solution suggested by this analysis consisted of a component largely reflecting items from a diagnostic interview and another component reflecting items from a self-report measure of depressive symptoms. Although the former was labeled the melancholia component, it included indicators not typically associated with melancholic depression (e.g., hopelessness, irritability) and excluded indicators commonly associated with melancholia (e.g., excessive guilt). Furthermore, certain items from the interview were included in the melancholia indicator set, even though parallel items from the self-report measure were not (e.g., loss of appetite, depressed mood, fatigue, social avoidance). In addition to this concern, the MAMBAC curves from this study could be interpreted as consistent with the presence of a dimensional construct represented by skewed indicators (J. Ruscio, Ruscio, & Keane, 2004).

Another taxometric study (Beach & Amir, 2003) investigated the depressive construct of involuntary defeat syndrome (Gilbert, 1992), purportedly an evolved homeostatic disturbance adaptive in the context of an individual's repeated failed attempts at group dominance. Several of the taxometric curves in this study rose monotonically to a right-end cusp, suggestive of either a low base rate taxon or the presence of a latent dimension represented by substantially skewed indicators (A. M. Ruscio & Ruscio, 2002). When viewed in the context of earlier dimensional findings (e.g., J. Ruscio & Ruscio, 2000), results from a replication study supported the latter interpretation (J. Ruscio, Ruscio, & Keane, 2004).

Because of the problems identified in the aforementioned studies, Solomon et al. (2001) have argued that further taxometric investigations of unipolar depression, using structured interview methods on large representative samples with known lifetime diagnostic base rates of depressive disorders, are needed to resolve the continuity issue. The present study attempted to address this request through secondary analysis of the National Comorbidity Survey (NCS; Kessler, 2002).

The Present Study

The NCS obtained a large ($N = 8{,}098$) nationally representative sample of the U.S. population and administered a structured diagnostic interview (Composite International Diagnostic Interview [CIDI]; Robins et al., 1988) to each of its participants. Using this structured interview data helped to ensure that indicators reflected depressive symptomatology, as opposed to transient distress or other psychological or physiological maladies. However, although fully structured diagnostic interviews like the CIDI represent an advantage over self-report measures because of their greater adherence to formal diagnostic criteria (including duration requirements) and the ability of interviewers to engage in some limited probing of participants' responses, some view such interviews as "interviewer-administered questionnaire[s]" (Coyne, 1994, p. 32). Specifically, these interviews may not provide sufficient probing of interviewees' initial responses and may rely too heavily on participants' knowledge of the assessed concepts (Coyne, 1994). This issue notwithstanding, the benefits of using multiple methods of measurement to answer substantive research questions have been acknowledged for over 40 years (Campbell & Fiske, 1959). Thus, to ensure that past taxometric results have not been unduly influenced by their method of evaluation, the present study used a different method of assessment from previous research.

Using a nationally representative sample with a known diagnostic base rate of major depressive episodes afforded us a safeguard against erroneously finding a dimensional structure as a result of the sample being overrepresented by taxon members. Using a community sample aided in the generalizability of our findings to the public as a whole, as opposed to a specific subsample of depressed individuals. Finally, assessing for lifetime, rather than point prevalent, symptoms of depression ensured that all participants in our sample who had ever experienced periods of significant depressive symptomatology were considered as potential taxon members in our analyses. This method of assessment also afforded a potentially more valid base rate estimation of major depressive episodes in our sample (Solomon et al., 2001), as past episodes of major depression would be included in this base rate.

Two semi-independent indicator sets were constructed from the lifetime depressive symptom questions in the CIDI by using *DSM–IV* (American Psychiatric Association, 1994) criteria for a major depressive episode and the results from an exploratory factor analysis. Using multiple, diversely created indicator sets provided a riskier test of the structural hypothesis. This procedure also increased the probability that results, if convergent, were not specific to the idiosyncrasies of any one particular indicator set. Multiple taxometric procedures were used on each of these indicator sets to provide the converging lines of evidence required for structural inference with taxometric methods. Additional consistency tests and recently developed simulation techniques were also implemented to provide further structural evidence and to guide the proper interpretation of taxometric results. We believe that this analytic plan afforded a relatively stringent test of the structural nature of unipolar depression and overcame several limitations of past taxometric research regarding depression. Although no structural predictions are necessary when undertaking a taxometric analysis (Meehl, 2004), the available evidence (e.g., J. Ruscio & Ruscio, 2000) suggested that we would reach a dimensional solution.

Method

Sample and Measure

The NCS obtained a nationally representative group of individuals through probabilistic sampling of the U.S. population, with an 82.6% response rate (Kessler et al., 1994). The full sample was administered a structured diagnostic interview, the CIDI (Robins et al., 1988), which included an assessment of individuals' lifetime occurrence of clinically significant depressive symptoms (in accordance with *Diagnostic and Statistical Manual* revised third edition [*DSM–III–R*] diagnostic criteria; American Psychiatric Association, 1987). Test–retest and interrater reliability of diagnoses of depressive disorders were good in field trials of the CIDI (κs = .71 and .95, respectively; Wittchen, 1994). Interrater reliability of individual depressive symptoms in the CIDI has also been found to be adequate (κs ranged from .69 to over .90; Wacker, Battegay, Muellejans, & Schloesser, 1990; Wittchen, 1991). Additionally, concordance between CIDI and the Structured Clinical Interview for *DSM–III–R* (Spitzer, Williams, Gibbon, & First, 1992) diagnoses of major depressive episodes in a subsample of individuals interviewed in the NCS was acceptable (κ = .53; Kessler et al., 1998).

In the NCS, only those participants who endorsed the lifetime occurrence of a 2-week period of sad mood or loss of interest in activities completed the remainder of the diagnostic interview concerning depressive symptoms. Because the proposed taxometric analyses required full diagnostic information regarding symptoms of unipolar depression, the subsample of individuals who endorsed the lifetime occurrence of sad mood or loss of interest (n = 4,577) was used in our analyses. This reduced sample contained more females than males (55.5% vs. 44.5%), was predominantly White (77.5%; 10.7% Black, 8.7% Hispanic, and 3.1% other), and ranged in age from 15 to 58 years old, with a mean age of 33.4 years (SD = 10.4). The base rate of diagnosed lifetime major depressive episodes in our subsample was 32% (base rate of current major depressive episodes = 7.9%), in comparison with the 17% diagnostic base rate in the full sample (current base rate = 4.4%). Although overrepresentation by taxon members can be problematic for taxometric research (Solomon et al., 2001), the present sample contained a moderate base rate of diagnosed depression, which is ideal for these types of analyses (Meehl & Yonce, 1994, 1996; J. Ruscio, Ruscio, & Keane, 2004). Such distributions produce centrally peaked taxonic plots.

Indicator Set Construction

Indicators of unipolar depression were drawn from the section of the CIDI that assessed for lifetime symptoms of depression. Each of the selected items asked participants whether they had ever experienced a 2-week or longer period of a specific depressive symptom. Two indicator sets were constructed for taxometric investigation from these data to provide semi-independent lines of converging evidence for a taxonic or dimensional solution (Meehl, 1995a; J. Ruscio & Ruscio, 2004b). The first indicator set ("symptom factor scores") was constructed by factor analyzing the 28 questions from the CIDI designed to assess for lifetime depressive symptoms that contained no dependencies (i.e., questions that were asked only to those who answered previous dependent questions affirmatively).[2] Factor analysis was conducted to add greater range to these dichotomous indicators in order to overcome some of the difficulties in interpretation and loss of power associated with the taxometric analysis of dichotomous variables (J. Ruscio, 2000). Exploratory factor analysis was conducted by using principal axis factoring (i.e., common factor analysis) with a promax (oblique) rotation of factors (under the assumption that dimensions of syndromal depression should be related). A four-factor solution was maximally interpretable and was thus rotated to simple structure. We selected items loading greater than or equal to .32 on a single factor with cross-loadings less than .32 on all other factors. The first factor was largely represented by cognitive symptoms of depression and included worthlessness, guilt, sinfulness, inferiority, lack of self-confidence, indecision, concentration difficulties, slow or mixed-up thoughts, psychomotor retardation, and loss of pleasure. The second factor was represented by vegetative–somatic symptoms of depression and included loss of appetite; loss of weight; and early, middle, and late insomnia. The third factor was composed solely of items measuring suicidal ideation and behavior and included the wish to die, thoughts about committing suicide, and active suicide attempts. Finally, the fourth factor was composed of reverse-vegetative symptoms—namely, increases in appetite and weight. The correlations between the factors ranged from small (r = .21 between the vegetative–somatic and suicidal ideation and behavior factors) to moderate (r = .43 between the cognitive and vegetative–somatic factors). Regression-based factor scores using all factor loadings were assigned to participants, which were in turn used as indicators in the subsequent taxometric analyses.

The second indicator set ("*DSM*-clustered symptoms") was constructed by using depressive symptom items from the CIDI both with and without dependencies. In the case of dependent items, if participants answered "no" to the first of a set of dependent questions (e.g., "Has there ever been 2 weeks or more when you lost interest in most things like work, hobbies, or things you usually liked to do for fun?"), they were assigned a total score of 0 for that set. If participants answered "yes" to the first of a set of dependent questions, their total score was determined by their response to the subsequent follow-up question (e.g., "Did you ever completely lose all interest in things like work or hobbies or things you usually liked to do for fun?"). Specifically, if they answered "no" to the follow-up question, their total score was designated as 1 (reflecting their affirmative response to the previous question). If they answered "yes" to the follow-up question, their

[2] However, one of the items in this set was constructed to include a variation of a dependency. In the NCS, participants who answered negatively to the question "In your lifetime, have you ever had 2 weeks or more when nearly every day you felt sad, blue, or depressed?" were asked the question "Have you ever had 2 weeks or more when nearly every day you felt down in the dumps, low, or gloomy?" In the present study, participants who answered affirmatively to either of these questions were given a score of 1 for depressed mood, as both of these reflect the same question worded differently.

total score was designated as 2. These 3-point scales were constructed for 14 of the 28 dichotomous indicators.[3] The assembled scales and the remaining 14 dichotomous symptom items from the previous indicator set were converted to *z* scores and summed according to the nine symptom clusters of a major depressive episode in the *DSM–III–R*. Thus, the second set contained semicontinuous measures of these symptom clusters (with scales ranging from 3 to 10 points): (a) depressed mood, (b) anhedonia (decreased interest and/or pleasure), (c) appetite and/or weight disturbance, (d) sleep disturbance, (e) psychomotor disturbance, (f) fatigue, (g) worthlessness and/or guilt, (h) impaired concentration and/or indecisiveness, and (i) suicidal ideation and behavior.

Taxometric Analyses

Overview. Across taxometric procedures, a continuous indicator is designated as "input" and the pattern of relationships among other indicators ("output") is examined in subsamples ordered by successive cuts on the input variable. This analysis is performed several times, using multiple procedures, various combinations of input/output variable assignment, and additional consistency checks. Across these diverse methods and indicator sets, conclusions regarding the taxonic or dimensional structure of the studied construct are made by looking for a consistent pattern of results. Monte Carlo research (e.g., Meehl & Yonce, 1994, 1996; J. Ruscio, 2000) has supported the ability of taxometric procedures to distinguish between taxonic and dimensional structures in artificially created data sets varying in latent structure and parameters known to affect taxometric analyses (e.g., sample size, indicator validity, nuisance covariation, indicator skew). Research has also supported the ability of taxometric procedures to correctly identify well-known latent taxa (e.g., biological sex; Meehl, 1973) in real data. Additionally, taxometric methods have been used in over 60 substantive structural investigations (Haslam & Kim, 2002).

MAXEIG. MAXEIG (Waller & Meehl, 1998) is a multivariate extension of the MAXCOV procedure (Meehl, 1973) that allows simultaneous use of all indicator variables, resulting in a potentially more powerful statistical procedure. To begin this procedure, one indicator from a given set was designated as input. The relationship among all remaining variables in that set was examined in successive subsamples of cases ordered along the input variable. Subsamples were created by dividing the sample into 50 windows with 90% overlap.[4] Within each window, the covariance matrix of output variables (with variance values replaced with *0*s, leaving only covariances) was factor analyzed, and the eigenvalue of the first principal factor was plotted (reflecting the magnitude of covariance among indicators) (J. Ruscio & Ruscio, 2004c). Eigenvalues for each overlapping window were plotted according to the window's standing on the input indicator. Because dividing the sample into overlapping windows results in the arbitrary sorting of cases possessing equal value on the input indicator, internal replications were implemented to eliminate this unwanted source of variation. Ten internal replications were produced, in which tied cases were randomly re-sorted, and the resulting 10 curves were combined into one taxometric curve by averaging the eigenvalue estimates for each subsample (J. Ruscio, 2003). Ten internal replications were used because initial evidence suggests that 5 to 10 replications produce sufficiently clear results (J. Ruscio & Ruscio, 2004b). This procedure was repeated with each indicator, in turn, serving as input. To maximize interpretability, all curves within a given indicator set were combined by averaging the eigenvalue estimates for each subsample to produce a more reliable taxometric curve. A peaked graph would suggest the presence of a taxon, whereas a nonpeaked graph would suggest the presence of a latent dimensional structure.

MAMBAC. The MAMBAC (Meehl & Yonce, 1994) procedure was executed on each input/output variable configuration of each indicator set. Summed input indicators were created by removing one indicator from a given set to serve as output and summing the remaining indicators from that set to serve as input. These composite indicators were produced to provide a more reliable rank ordering of cases along the input indicator and to increase statistical power by allowing all data to be included in each analysis (J. Ruscio & Ruscio, 2004c). Fifty cuts were made along each summed input variable, with the first and last cuts made 25 cases from the tail ends of the input variable's score distribution to reduce the influence of excessive sampling error on mean-difference calculations (J. Ruscio & Ruscio, 2004c). At each division, the mean of the output variable below the cut was subtracted from the mean of the output variable above the cut, and this value was plotted. To reduce error produced by the arbitrary sorting of tied cases, 10 internal replications were performed on each configuration of input and output. The results of these replications were combined to form one taxometric curve (J. Ruscio & Ruscio, 2004c). This procedure was repeated until all variables in a given indicator set had served as output. To maximize interpretability, all curves within a given indicator set were then combined by averaging the mean-difference estimates at each division along the input indicators. A peaked graph would suggest the presence of a taxon, whereas a concave graph would suggest the presence of a latent dimensional structure.

Consistency tests. Many of the consistency checks recommended by Meehl (1995a) entail the use of multiple nonredundant taxometric procedures with all possible combinations of chosen indicators, drawn from multiple indicator sets. An especially severe test involves the comparison of taxometric curves derived from different analytic techniques (e.g., MAXEIG and MAMBAC) using different indicator sets (Meehl, 1995a). Meehl also suggested considering the consistency of base rates estimated by taxometric procedures as converging evidence for the presence of a latent taxon. Although recent evidence suggests that highly convergent base rate estimates can be readily produced by either a latent taxon or a latent dimension, highly divergent base rate estimates (across procedures, across indicator configurations, across indicator sets) provide support for latent dimensional structure (e.g., J. Ruscio, 2004a; J. Ruscio & Ruscio, 2004a, 2004b).

Additional consistency checks include the case-removal consistency test (J. Ruscio, 2000), the inchworm consistency test (Waller & Meehl, 1998), and the taxometric analysis of simulated comparison data using fit indices specific to data created with similar distributional properties (e.g., skew, kurtosis, sample size) to the research data (J. Ruscio, Ruscio, & Meron, 2003). To perform the case-removal consistency test, derived base rate estimates were averaged within each indicator set for each taxometric procedure (i.e., MAXEIG and MAMBAC). Then, the lowest scoring quartile of cases on a measure of the sum of all indicators in a given set was removed from each sample and all analyses were rerun. If a taxon was present, the removal of low-scoring cases (presumably complement members) would have produced predictable increases in each averaged base

[3] Two slight variations of this procedure were also used. The first involved the combination of responses to the two questions used to assess for depressed mood mentioned in Footnote 2. Additionally, to assess for increases and decreases in weight, participants were asked, "Have you ever lost weight without trying to as much as 2 pounds a week for several weeks or as much as 10 pounds altogether?" If they answered affirmatively to this question, they were then asked, "During any of these periods, how much weight did you lose?" We dichotomized responses to the latter question ($\leq$ 10 lb = 0, $>$ 10 lb = 1) and calculated 3-point scales for this set of questions in the manner described in the text.

[4] Although these parameters are somewhat arbitrary, dividing the sample into 50 evenly spaced cuts for covariance or mean-difference calculations has been shown to provide clear, interpretable results (J. Ruscio & Ruscio, 2004b, 2004c). Furthermore, when using overlapping windows, a 90% degree of overlap has been customarily used since the technique's introduction (J. Ruscio & Ruscio, 2004b).

rate estimate (estimated base rate ÷ .75 = predicted base rate). Substantial deviations from these predicted base rates would have suggested a dimensional solution.

The inchworm consistency test (Waller & Meehl, 1998) was performed on each input/output configuration of variables for each indicator set, resulting in four curves per configuration; each successive curve contained a greater number of overlapping windows than the previous one (i.e., 25, 50, 75, and 100 windows). As the number of overlapping windows increased, a genuine taxonic peak would have become more pronounced. Alternatively, if the rising curves were the result of the indicators' positively skewed distributions (symptom factor scores: mean skew = 0.72; *DSM*-clustered symptoms: mean skew = 0.49), this pattern would not have emerged.

Finally, the comparison of simulated taxonic and dimensional data and observed data provided a valuable interpretational tool as well as a consistency check. J. Ruscio et al.'s (2003) simulation technique approximated the observed data's indicator distributions, full-sample indicator correlation matrix, and within-class indicator correlations by using an iterative procedure.[5] To reduce the effect of sampling error on the reproduced correlation matrices, 10 sets of taxonic and dimensional simulation data were created and underwent the same analytic procedures as the observed data. Initial research regarding this method suggests that using 10 sets each of simulated dimensional and taxonic data provides sufficient evidence for deciding whether taxonic and dimensional latent structures can be distinguished in a given data set (J. Ruscio et al., 2003). Therefore, 20 sets of simulated taxonic and dimensional data were created for each indicator set, and these sets were submitted to the same taxometric procedures as the research data. If the output from created taxonic and dimensional data was clearly distinguishable, one could visually compare the results from the observed data with the created data and decide which simulated curves provided the closest match to the observed curves (J. Ruscio et al., 2003). In addition to these visual comparisons, fit indices (i.e., root-mean-square residual [RMSR]) between the taxometric curves of the simulated taxonic and dimensional data and the taxometric curves of the observed data were calculated for each indicator set. A lower RMSR reflects better fit.

Results

Two indicator sets were constructed following the previously detailed methodology. The first indicator set (i.e., symptom factor scores; n = 4,466) was composed of factor scores derived from four obtained factors of depressive symptoms, and the second set (*DSM*-clustered symptoms; n = 4,363) featured indicators constructed to reflect the nine symptoms of *DSM*-diagnosed depression. Item–total correlations, which served as a crude a priori index of indicator validity (J. Ruscio & Ruscio, 2004c), were acceptable for each of the indicator sets (mean rs = .56 and .58, respectively). Accordingly, indicator validity parameters (i.e., standardized between-group mean differences, calculated with Cohen's effect size d) estimated by the taxometric programs were also acceptably high (mean indicator validity = 1.75 and 1.36, respectively; see Meehl, 1995a). Additionally, within-class correlations, approximated by averaging the absolute values of correlations between all indictors within the lowest and highest scoring quartiles of the sample (Golden & Meehl, 1979),[6] were acceptably low (mean rs = .11 and .07, respectively; see Meehl, 1995b). The constructed indicator sets were submitted to two nonredundant taxometric procedures, MAXEIG and MAMBAC (J. Ruscio, 2004b) on the R Version 1.9 platform (R Core Development Team, 2004).

MAXEIG

The averaged MAXEIG results for each of the indicator sets are presented in the leftmost panels of Figure 1, alongside the averaged results from the simulated taxonic (middle) and simulated dimensional (far right) data for each set. These results are all consistent with a dimensional solution (i.e., the presence of a latent dimensional structure): In other words, none of the indicator sets' plots contained a taxonic peak. Additionally, both of the averaged research curves more closely resembled their respective simulated dimensional curves than their simulated taxonic curves, and calculated RMSR values confirmed this superior fit (see Table 1).

Consistent with a dimensional interpretation, base rate estimates produced by MAXEIG analyses were divergent with an average standard deviation of 0.07 (range = 0.19 to 0.45). Following targeted case removal, deviations from predicted base rate increases were substantial for both indicator sets (deviations = .13 and .09, respectively) and in the opposite direction than would be predicted given the presence of a latent taxon for the first indicator

[5] Dimensional simulation data were created by simulating indicator scores as varying on a single factor of item endorsement. In contrast, simulated taxonic data were created by combining two separate sets of simulated dimensional data. One simulated dimensional data set was created on the subset of the sample that likely contained a very high proportion of taxon members, whereas the second was created on the subset that likely contained a lower proportion. To isolate these subsamples, a criterion variable was created by dividing the full sample according to their standing on a measure of total item endorsement and the estimated base rate of putative taxon members. Because the base rate of lifetime major depressive episodes was 32% in the present study, the highest scoring 32% of individuals on a measure of total item endorsement in each indicator set were given one score on the criterion variable, whereas the lowest scoring 68% were given a different score (for details regarding this procedure, see J. Ruscio et al., 2003). Results from analyses using this method of taxonic data simulation are reported in the body of the article. Because the nature of simulated taxonic data can vary on the basis of the method used to assign individuals to the taxon or complement, additional simulations were conducted with varying program-generated taxon base rates to evaluate the generalizability of inferences made from simulated data in the present study. A distinct base rate was simulated for the implementation of each taxometric program on each indicator set (i.e., a total of four additional base rates were used). These base rates ranged from 18% to 38% and reflected the taxon base rates estimated by each taxometric procedure (i.e., MAXEIG and MAMBAC) for each indicator set. Results from analyses using these base rates for simulating taxonic data were very similar to those reported in the present article and were uniformly supportive of a dimensional interpretation of the data. These results are available on the Web at http://www.drtprogram.cjb.net/taxometric.supplement.pdf

[6] Absolute values were taken because it is the effect of the magnitude of nuisance covariation on each taxometric graph that hinders taxometric analyses. Because of a mixture of negative and positive correlations in each indicator set, the averaged estimates of nuisance covariation would have been deceptively low if actual values had been used.

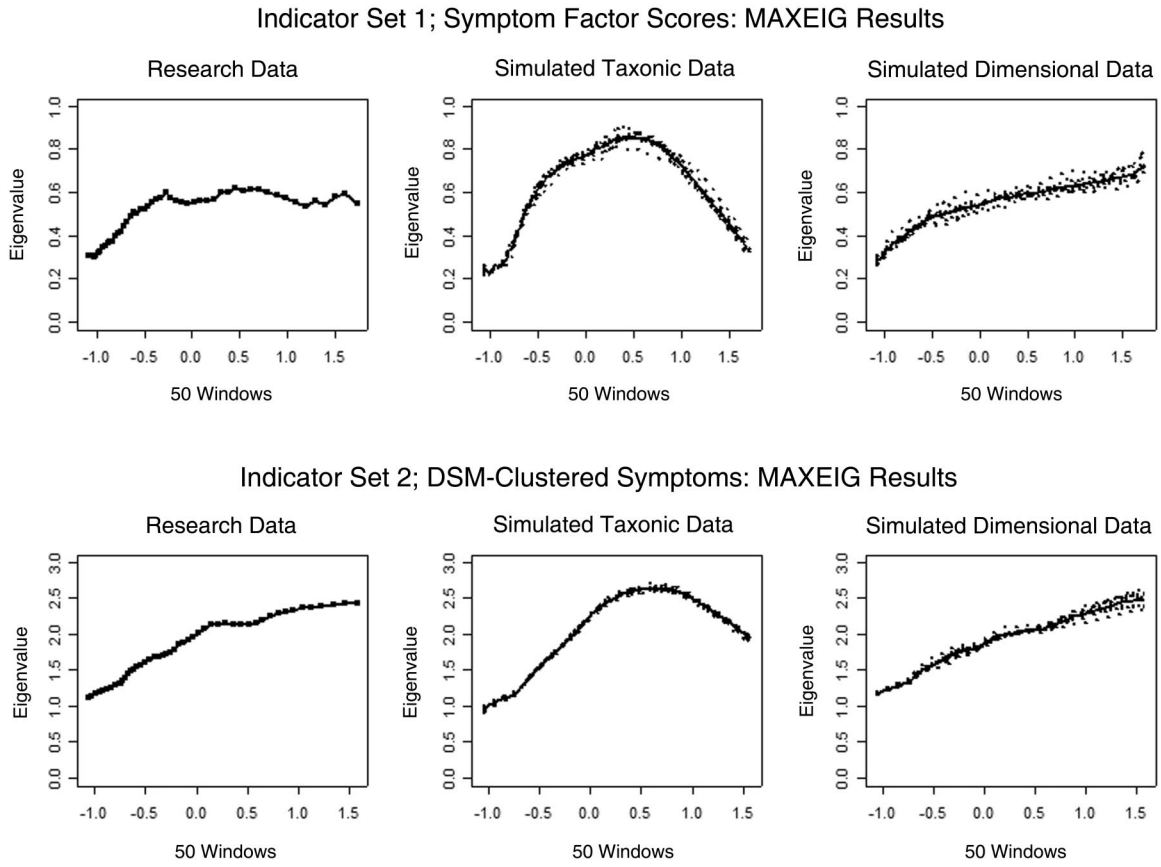

Figure 1. Averaged maximum eigenvalue (MAXEIG) results. DSM = *Diagnostic and Statistical Manual of Mental Disorders*.

set, further suggesting a dimensional interpretation of the data. Results from implementing the inchworm consistency test on each indicator set provided evidence against the presence of a low base rate taxon in our sample. As the number of overlapping windows increased, no individual or averaged curve changed significantly in any of the indicator sets. One such representative averaged MAXEIG curve, from the second indicator set, is presented in Figure 2. The other curves were all of similar form.

Table 1
Root-Mean-Square Residual (RMSR) Scores Between Taxometric Curves Produced by Research Data and Their Respective Simulated Taxonic and Dimensional Curves

Indicator set	RMSR between research & sim. dim. curves	RMSR between research & sim. taxonic curves	Ratio of RMSR values favoring dim. structure
MAXEIG analyses			
1. Symptom factor scores	.053[a]	.150	2.84:1
2. *DSM*-clustered symptoms	.070[a]	.245	3.48:1
MAMBAC analyses			
1. Symptom factor scores	.012[a]	.019	1.57:1
2. *DSM*-clustered symptoms	.005[a]	.011	2.07:1

Note. sim. = Simulated; dim. = Dimensional; MAXEIG = maximum eigenvalue; *DSM* = *Diagnostic and Statistical Manual of Mental Disorders*; MAMBAC = means above minus below a cut.
[a] Indicates superior fit between a given indicator set's research curve and either its simulated taxonic or dimensional curve.

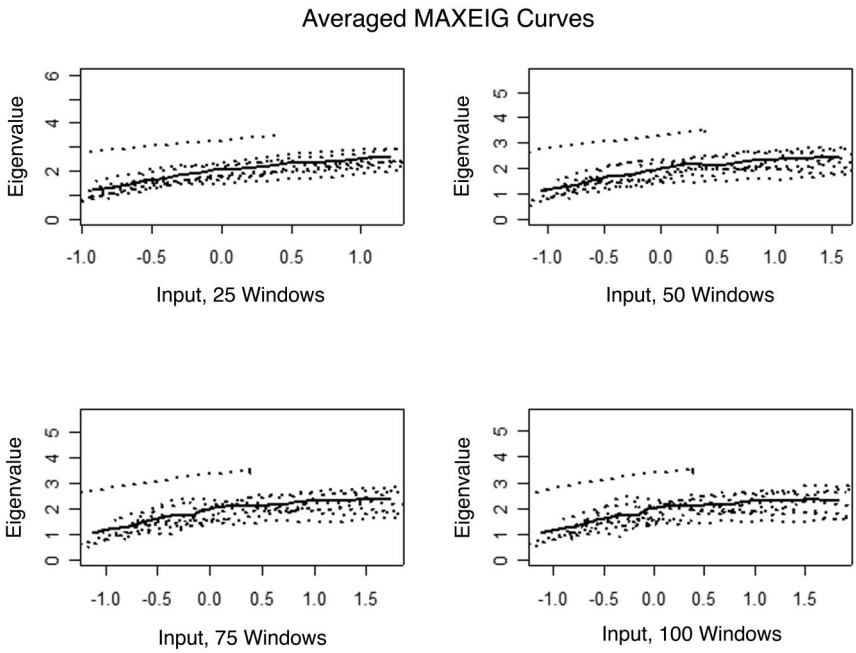

Figure 2. Results from the inchworm consistency test conducted on the second indicator set. MAXEIG = maximum eigenvalue.

MAMBAC

The averaged MAMBAC results for each of the indicator sets are presented in the leftmost panels of Figure 3, alongside the averaged results from the simulated taxonic (middle) and dimensional (far right) data for each set. These results are all consistent with a dimensional solution. Specifically, none of the averaged research curves contained a taxonic peak, and all of the averaged research curves more closely resembled their respective simulated dimensional curves than their simulated taxonic curves. Finally, a dimensional interpretation was further supported by superior statistical fit among the research curves and their simulated dimensional curves than between the research and simulated taxonic curves (see Table 1 for RMSR values).

Consistent with a dimensional interpretation, base rate estimates produced by MAMBAC were divergent (J. Ruscio & Ruscio, 2004c) with an average standard deviation of 0.15 (range = 0.15 to 1.00). Across both MAXEIG and MAMBAC procedures, base rate estimates diverged with an average standard deviation of 0.11 (range = 0.15 to 1.00), strongly suggesting a dimensional interpretation of the data. Following targeted case removal, deviations from the predicted base rates were ample (deviations = .24 and .36, respectively) and in the opposite direction than would be predicted given the presence of a latent taxon, further supporting a dimensional interpretation.

Discussion

The present study provides strong evidence that depression, as defined from a symptom-focused *DSM* perspective, is best conceptualized as a dimensional construct. In an epidemiological sample of over 4,000 individuals who reported the lifetime occurrence of a 2-week period of sad mood or loss of interest in activities, the depression-relevant questions from the structured CIDI interview were combined in two meaningful ways and submitted to various taxometric procedures and consistency tests. The results from MAXEIG and MAMBAC analyses unequivocally supported a dimensional interpretation of the data through both superior visual and statistical fit to the taxometric results of simulated dimensional data compared to the results of simulated taxonic data. A number of additional consistency tests (specifically, the inchworm consistency test, the case removal consistency test, and base rate divergence) also supported a dimensional interpretation. These consistent results, combined with the methodological strengths of the present study, suggest that *DSM*-defined syndromal depression is dimensional in nature.

The present study represented several methodological strengths over past research. First, using structured interview data provided a distinct and arguably superior source for indicators of a major depressive episode than the self-report measures typically used in the previous literature (Coyne, 1994). Additionally, assessing for the lifetime occurrence of depressive symptoms, as opposed to the point occurrence of these symptoms, allowed for a potentially more valid a priori base rate estimate to guide taxometric interpretation (Solomon et al., 2001). Considering a large nationally representative community sample with a known diagnostic base rate of major depression guarded against the possibility of an erroneous dimensional conclusion resulting from too few complement members. Use of a large representative sample also aided with the generalizability of our findings to the population as a whole and reduced the potential influence of sampling error on our

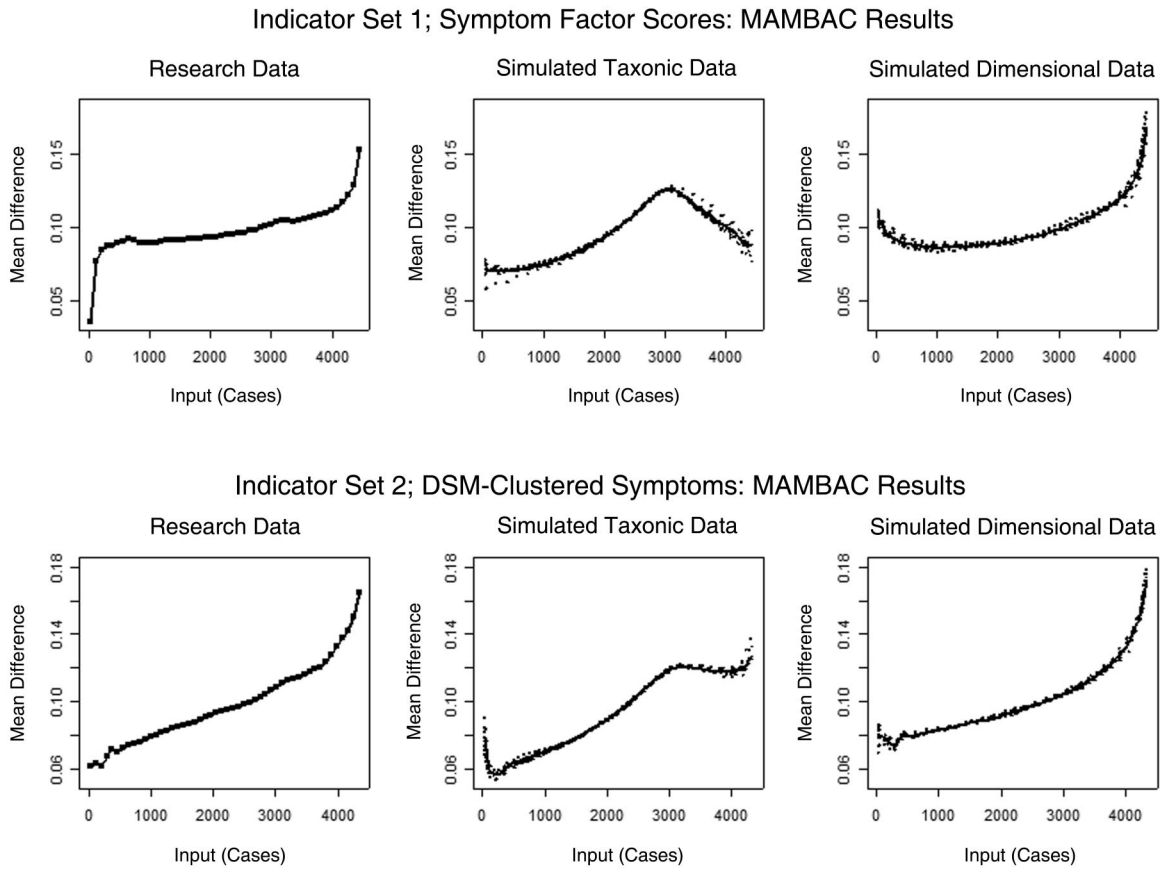

Figure 3. Averaged means above minus below a cut (MAMBAC) results. DSM = *Diagnostic and Statistical Manual of Mental Disorders*.

results. Constructing and analyzing multiple indicator sets provided a risky test of the structural hypothesis; convergent results across multiple indicator sets using multiple analytic techniques provide strong support for a dimensional interpretation. Furthermore, structural investigation of the indicator sets was conducted following guidelines for a rigorous and thorough taxometric analysis (i.e., multiple nonredundant procedures executed on all possible permutations of indicators, with little nuisance covariation, in a sufficiently large sample, along with ample consistency testing). Finally, state-of-the-art simulation procedures and fit indices were implemented to aid in the interpretation of taxometric findings.

Viewed within the framework of previous taxometric studies of unipolar depression, the present study suggests that it is unlikely that unipolar depression represents a categorical construct. Specifically, several studies (i.e., Franklin et al., 2002; A. M. Ruscio & Ruscio, 2002; J. Ruscio & Ruscio, 2000), using various measures and methods on diverse populations, have now been conducted and have all supported a dimensional interpretation of unipolar depression. Additionally, these studies have operationalized depression in various ways (e.g., low positive emotionality in Franklin et al., 2002; syndromal depression in J. Ruscio & Ruscio, 2000), suggesting that many varied conceptualizations of depression may be characterized by dimensional structures. Furthermore, a recent study suggests that cognitive vulnerability to depression may also be a dimensional phenomenon (Gibb, Alloy, Abramson, Beevers, & Miller, 2004).

The implications of this robust finding should be integrated into current standards of research and practice. Defining depression as a dimensional phenomenon (i.e., existing on a continuum that varies in severity with normal human experience) would subsequently influence decisions regarding research design, statistical analysis, assessment, and treatment. For example, categorical selection methods for research (e.g., *DSM* categorization of major depression) would seem arbitrary and methodologically weak given the results reported by this and similar studies. Such practice could reduce statistical power (Cohen, 1983), obfuscate the conceptual nature of the construct, disguise potential nonlinear relationships between depressive severity and other variables of interest (J. Ruscio & Ruscio, 2004a), and potentially create spurious statistically significant effects (Maxwell & Delaney, 1993). Because of these weaknesses, correlational research designs would likely replace group comparison designs in the study of depression (J. Ruscio & Ruscio, 2004a). Such correlational designs would represent a shift in current sampling practices as variation at all levels of depressive severity would be required to accurately investigate depressive phenomena. In order to obtain appropriate

samples of participants for research, as well as to properly assess depression in other settings, assessment devices developed to demarcate individuals' placement on the latent dimension or dimensions of depressive severity would need to be further developed. Existing measures of depressive severity may not necessarily reflect the latent dimensional structure of depression.

Additionally, given that a number of other psychiatric conditions, such as post-traumatic stress disorder (A. M. Ruscio, Ruscio, & Keane, 2002) and generalized anxiety disorder (A. M. Ruscio, Borkovec, & Ruscio, 2001), appear to be dimensional, comorbidity between depressive conditions and related psychiatric conditions may need to be reconceptualized. Currently, an individual falling on a dimension common to multiple psychiatric disorders may be diagnosed with several artificial categorical disorders (Haslam, 2003). If typically co-occurring conditions are found to be dimensional, future research should aim to develop (a) dimensional models to describe this overlap and (b) dimensional methods to assess these conditions (e.g., Clark & Watson, 1991).

Finally, the issue of clinical significance may need to be revisited and grounded in a sound practical basis. Meaningful definitions of clinically significant (or treatment-necessitating) depression are important because these definitions partially determine the allocation of treatment resources. However, because research suggests that there is no inherent discontinuity in depressive severity, current definitions of clinically significant depression would appear to be largely arbitrary. The arbitrariness of current definitions is problematic, in part because many cases falling below diagnostic thresholds tend to have similar levels of impairment as individuals diagnosed with major depressive disorder (Flett et al., 1997). Empirical connections between depressive severity and clinically relevant outcomes, such as role impairment, can and arguably should be used to aid decisions regarding treatment (e.g., J. Ruscio & Ruscio, 2004a). However, the distinction between an acceptable amount of impairment and an amount that is cause for concern will ultimately be decided through cost–benefit analyses of treatment for different levels of depressive severity and the availability of treatment resources. Although this situation may seem troubling (i.e., making treatment decisions based on practical rationale), it is preferable to basing decisions on the presence or absence of an arbitrary number of *DSM* criteria.

Embedded in these arguments is a call for the rethinking and redesigning of diagnostic criteria for depression in upcoming versions of the *DSM* to reflect the construct's dimensional nature. A dimensional diagnostic system could describe individuals' depressive conditions in terms of their elevations on a dimension or dimensions of depressive symptom severity. Before such a system can be developed, however, research is needed to further explore the dimensional structure of depression. Previous factor analytic investigations have been largely inconsistent, suggesting between one and seven dimensions of unipolar depression, depending on the type of samples, measures, and analytic techniques used in such investigations (e.g., see Beck, Steer, & Garbin, 1988; Radloff, 1977). Whether depression is best characterized by one or multiple dimensions (related laterally or organized hierarchically), whether depression-relevant dimensions consist partly of features not commonly associated with pure depression (e.g., anxiety), and whether a consistent dimensional structure can be demonstrated using diverse populations and methods of measurement should be established by future research.

Although the results from the present study suggest that *DSM*-defined depression is characterized by a dimensional structure, we cannot assume that taxometric analyses of depressive constructs that deviate significantly from the *DSM* (syndromal) conceptualization of depression will also result in a dimensional solution. Alternative conceptualizations of depression (e.g., low positive emotionality) were not tested in the present study. It is also possible that further investigations of associated symptoms not included in the formal diagnostic criteria (e.g., various somatic complaints) will result in a taxonic solution. If an important aspect of a construct under consideration is not covered by the set of indicators submitted to a taxometric analysis, one cannot claim that this aspect of the construct has been tested (Widiger, 2001). Likewise, it is possible that results could vary across different methods of assessment (e.g., between self-report and interview measures or between two different self-report measures; Campbell & Fiske, 1959).

One limitation of the current study was that the CIDI provided unequal coverage of depressive symptoms. For example, depressed mood was measured with one dichotomous indicator, whereas suicidal ideation and behavior was measured with four dichotomous indicators. Because of this unequal coverage, it is possible that the present research tested a depressive construct relatively dominated by suicidal ideation and behavior. Related to this concern, the effect of submitting indicators with varying response scales to taxometric procedures has not been systematically studied in the literature and could have exerted an unknown influence on our results. It should therefore be a priority of future Monte Carlo research to investigate this issue. Also as a result of the structure of the CIDI, only those participants who endorsed the lifetime occurrence of sad mood or loss of interest in activities were included in our analyses. Because these participants were selected from the full community sample, it is possible that the sample used in the present study differed in meaningful ways (i.e., other than being relatively more elevated on a dimension of depressive severity) from the population of individuals who did not report experiencing a 2-week period of sadness or loss of interest in activities in their lifetime. It will therefore be important for future taxometric studies of depression to sample unselected community populations to aid in the generalizability of the present findings. On a related note, because approximately half of the NCS participants were excluded from our analyses, the present study cannot test the possibility of a very high base rate depressive taxon (i.e., one whose prevalence is approximately 50% or greater) in the general population. Finally, because of the structure of the CIDI, reported depressive symptoms did not necessarily occur simultaneously in all participants. In other words, the interview established whether each of the symptoms had ever been experienced for 2 weeks or longer but did not determine whether these symptoms co-occurred. However, in a subset of participants who reported experiencing three or more symptoms of depression over their lifetime, 91% of them reported that they had experienced these symptoms concurrently. Furthermore, additional analyses suggested that the dimensional findings reported above held for the subsample of participants who explicitly reported depressive symptoms from a specific 2-week period of their lives.[7]

In conclusion, the results from the present study suggest that syndromal *DSM*-defined depression is characterized by a latent dimensional structure. Although several previous studies have consistently supported this conclusion, the present study represents a number of methodological advantages over past research. The dimensional structure of depression needs to be taken into consideration when developing new assessment devices, treatment plans, research strategies, and diagnostic conceptualizations.

[7] The subsample of NCS participants who were asked to report the occurrence of depressive symptoms during a particular 2-week period of their lives ($n = 2{,}887$) was analyzed separately to ensure that our dimensional results held up in a sample of individuals whose symptoms necessarily occurred simultaneously. To be eligible for this sample, participants had to have reported experiencing at least three depressive symptoms over their lifetimes that included, or were in addition to, either sad mood or anhedonia. Additionally, these individuals had to have reported experiencing either sad mood or anhedonia and at least one additional symptom concurrently at some point in their lives. Two indicator sets were constructed from the depressive symptom questions from the CIDI following the same procedures as reported previously, with one significant exception: Individuals who reported that a specific depressive symptom was completely due to the effects of illness, injury, medication, drugs, or alcohol were considered as not presenting with that symptom of depression (because it was likely a symptom of some other condition). The resulting indicator sets were submitted to the same analytic procedures as described earlier, with a 52% diagnostic base rate of major depressive episodes (i.e., the base rate of major depressive episodes in this subsample) used to simulate taxonic data (see Footnote 5). The results from these analyses strongly suggested a dimensional interpretation of the data. None of the indicator sets' plots contained a taxonic peak, all of the averaged research curves more closely resembled their respective simulated dimensional curves than their simulated taxonic curves, and calculated RMSR values confirmed this superior fit. Additionally, all of the performed consistency tests supported a dimensional interpretation. These results are available on the Web at http://www.drtprogram.cjb.net/taxometric.supplement.pdf

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