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Revisiting the Latent Structure of Eating Disorders: Taxometric Analyses With Nonbehavioral Indicators

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Researchers have debated whether clinical eating disorders are best conceptualized as one extreme along a continuum of degree or as qualitatively different from less severe eating disturbances. Taxometric analysis, a set of procedures that assess the structure of a given disorder by detecting whether a latent taxon exists among its indicators, has just begun to be applied to eating disorder research. Its application to this domain may clarify whether eating disorders best conform to a dimensional (i.e., continuum) or taxonic model. The latent structure of eating disorders was examined in a sample of 532 college women by using 2 popular taxometric procedures (i.e., maximum covariance analysis and latent mode analysis) with 5 nonbehavioral indicators of eating disorder symptomatology. Results across procedures suggest that the data are more indicative of a dimensional solution, as no latent taxon was uncovered.

There is a long-standing debate as to whether the latent structure of eating disorders is best conceptualized as occurring along a continuum of degree or as qualitatively distinct from less severe eating disturbances such as chronic dieting (Gleaves, Lowe, Snow, Green & Murphy-Eberenz, 2000; Lowe et al., 1996; Mintz & Betz, 1988; Nylander, 1971; Stice, Ziemba, Margolis, & Flick, 1996; Tylka & Subich, 1999). Within this debate, counseling psychologists (e.g., Hotelling, 2001; Mazzeo & Espelage, 2002; Mintz & Betz, 1988; Scarano & Kalodner-Martin, 1994; Tylka & Subich, 1999) often have conceptualized eating disorders as dimensional (i.e., assuming a continuous linear relationship between correlates of eating disorders and eating disorder symptomatology), as this perspective is consistent with the profession's attention to understanding the entire spectrum of normal and abnormal behavior. Further, several counseling psychologists (e.g., Mazzeo & Espelage, 2002; Scarano & Kalodner-Martin, 1994; Tylka & Subich, 1999) have promulgated that attending to all levels of eating disturbances may deepen understanding of the etiology, development, prevention, and treatment of both clinical and subclinical eating disorders.

Other professionals, however, have suggested that clinical eating disorders differ qualitatively from less severe forms of weight and eating concerns and thus should be studied separately (Bruch, 1973; Gleaves, Lowe, Snow, et al., 2000; Ruderman & Besbeas, 1992). Two criteria must be met for this discontinuity perspective to be upheld. First, people who meet all behavioral criteria for a clinical eating disorder must have significantly higher levels of common nonbehavioral indicators of eating disorders than do people with no behavioral symptoms of eating disorders and people with some behavioral symptoms of eating disorders. Second, people with some behavioral symptoms of eating disorders must not have significantly different levels of common nonbehavioral indicators of eating disorders than do people with no symptoms of eating disorders (Lowe et al., 1996).[1]

Research examining the latent structure of eating disorders often has produced opposing findings (e.g., Lowe et al., 1996; Tylka & Subich, 1999, 2002b), some in support of continuity and some in support of discontinuity. In this research, common indicators of clinical eating disorders typically are evaluated as to whether they systematically vary in a continuous linear fashion with levels of eating disorder symptomatology. When these findings are examined closely, it appears that the discrepant results may be due to researchers using different indicators of clinical eating disorders. Researchers who use behavioral indicators such as binging and purging often have found more evidence suggestive of discontinuity. For instance, Lowe et al. (1996) found that scores on a measure of binge eating did not vary in a linear fashion with placement along a bulimia continuum in a sample of community women. Use of such behavioral variables, however, could be viewed as confounding indicators (i.e., binging and purging behavioral symptoms) with the criterion (bulimic symptomatology).

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[1] We make a distinction between indicator and symptom. *Indicator* is a general term, whereas *symptom* is a specific behavioral term. In the context of eating disorder research, indicators may include behavioral symptoms as well as other nonbehavioral characteristics such as body dissatisfaction and poor interoceptive awareness, but symptoms specifically refer to behavioral characteristics such as binging and purging.

However, researchers who define the eating disorder continuum according to psychological (e.g., body dissatisfaction), sociocultural (e.g., pressure for thinness), and/or cognitive (e.g., perceptions of effectiveness and safety of maladaptive weight control techniques) indicators often have found evidence of continuity. For instance, Mintz and Betz (1988) found that body dissatisfaction, self-esteem, and internalization of the thin-ideal stereotype varied in a linear fashion with respect to women's placement into groups along the eating disorder continuum. Similarly, Stice et al. (1996) found that high school and college women's levels of pressure to be thin, internalization of the thin-ideal stereotype, negative affect, and body dissatisfaction increased concomitantly with increases in their placement into groups along the eating disorder continuum. Further, Tylka and Subich (1999, 2002b) determined that neuroticism, poor interoceptive awareness, interpersonal distrust, maturity fears, impulse regulation, social inhibition, and perceptions of the effectiveness and safety of maladaptive weight control techniques varied meaningfully as a function of high school and college women's group ranks along the eating disorder continuum. In fact, the few studies that found evidence of discontinuity among psychological indicators (e.g., Ruderman & Besbeas, 1992) often included small cell sizes and/or did not use psychometrically sound measures to classify women into groups along the eating disorder continuum (Stice, Killen, Hayward, & Taylor, 1998).

The above studies suggest that many nonbehavioral indicators of clinical eating disorders indeed vary in a consistent, linear fashion with respect to increases in eating disorder symptomatology, but studies using behavioral indicators of binging and purging suggest some support for the perspective that eating disorders are not purely continuous. All of the previously described literature, however, is limited in that the statistical analyses used in these studies do not allow one to draw legitimate conclusions about the latent structure of eating disorders. Specifically, the previously outlined studies all used between-group designs such as analysis of variance and/or trend analysis; these analytic strategies do not address the relations among the indicators of eating disorders. Yet, in fact, it is the pattern of the relations among indicators that reflects the latent structure of a given disorder (Meehl, 1995).

A research design promulgated as an adequate methodology to study the latent structure of psychological disorders is taxometric analysis (e.g., Meehl, 1995; Meehl & Yonce, 1996). Taxometric analysis is proposed to be able to detect whether a latent taxon exists among the statistical patterns of the relations between indicators of a given disorder; this is accomplished via independent analyses that serve to converge upon a latent structure (i.e., dimensionality or taxonicity; Meehl, 1995). A *taxon*, then, is an underlying entity that drives the relations between common indicators of a disorder; it can be composed of any number of biological vulnerabilities, environmental conditions, or both (Waller & Meehl, 1998). Accordingly, a taxon may play a part in what separates people with bona fide clinical eating disorders from those with less severe or no eating disturbances.

Taxometric analysis has begun to be used to investigate the continuity versus discontinuity debate regarding eating disorders. Gleaves, Lowe, Snow, et al. (2000) found that the relations among three behavioral indicators of bulimia (i.e., binging behavior, purging behavior, and reports of not being or feeling in control around food) were indicative of a latent taxon for bulimia within a mixed sample of nonclinical college women and women with bulimia from a residential treatment center. Yet, when performing their analyses with only the nonclinical sample of women, two other indicators of bulimia (i.e., dietary restraint and body dissatisfaction) did not appear to be indicative of a latent taxon. Further, Gleaves, Lowe, Green, Cororve, and Williams (2000) used taxometric procedures within a mixed sample of college women and women with bulimia from a residential treatment center and found some evidence for continuity (most often among indicators that did not assess binging and purging behaviors) but more evidence for discontinuity. Again, they primarily found evidence for a latent taxon among the relations of several of the binging and purging behavioral indicators.

The pattern of findings derived from the above studies mirrors to a large degree that derived from the previously described between-group studies (e.g., Lowe et al., 1996; Stice et al., 1996). That is, the results of studies using taxometric analysis suggest discontinuity when binging and purging indicators of eating disorders are used but seem to suggest continuity when indicators such as dietary restraint and body dissatisfaction are used. We argue that binging and purging indicators should not be included in research investigating the latent structure of eating disorders, as support for the discontinuity perspective may be inflated when these indicators are used. That is, because researchers classify women as bulimic or nonbulimic on the basis of symptoms that include binging and purging, the taxon that emerges from research incorporating binging and purging as indicators likely is an artifact of confounding indicators with the criterion. Further, if binging and purging are examined with other nonbehavioral indicators within the same analysis, the indices used to evaluate the overall appearance of the data are likely to detect the artifactual taxon resulting from the inclusion of the symptoms of binging and purging and consequently will indicate taxonicity. Only careful examination of all individual indicator combinations would avert such a mistaken conclusion of taxonicity.

Previous findings of taxonicity when studying the latent structure of eating disorders also may be inflated for other reasons. Many researchers deliberately have mixed women from specified clinical (i.e., residential treatment centers) and nonclinical (i.e., college) groups together for the taxometric analyses. Such intentional mixing of clinical and nonclinical groups may foster an artificial taxonicity, especially when the indicators used (i.e., binging and purging behaviors) are similar to the criteria (i.e., bulimic symptomatology) used initially to separate individuals into clinical and nonclinical groups (L. Yonce, personal communication, February 28, 2001; N. Waller, personal communication, June 14, 2002).[2] Indeed, when using taxometric procedures, it has been suggested that the latent structure of a given disorder is better estimated when researchers "take the population as it comes" (L. Yonce, personal communication, February 28, 2001).

Clearly, many questions remain to be answered regarding the latent structure of eating disorders. Given the fact that evidence for the taxonicity of eating disorders has been derived from behavioral (i.e., binging and purging) indicators, and given the questions that have been raised about the use of such indicators, it seems an

[2] Leslie Yonce and Niels Waller each have authored numerous conceptual and empirical articles on the subject of taxometric analysis and are recognized experts in this domain.

appropriate next step for research to investigate the latent structure of eating disorders using taxometric analysis with psychological and sociocultural indicators without incorporating binging and purging indicators within the study design. Therefore, we used taxometric analysis with a sample of college women to explore the relations between five nonbehavioral indicators of clinical eating disorders (i.e., body dissatisfaction, neuroticism, poor interoceptive awareness, internalization of the thin-ideal stereotype, perceived pressure for thinness); this decision was based on Waller and Meehl's (1998) and L. Yonce's (personal communication, February 28, 2001) recommendations that researchers use indicators from different domains, do not use indicators that directly are used to classify individuals with the disorder, and do not concoct mixed samples of clinical and nonclinical participants when conducting taxometric procedures. We chose the five specific indicators after an extensive review of the literature[3] revealed that they are suitable for taxometric analysis. Specifically, they are consistently related to and predictive of clinical eating disorder symptomatology, they discriminate individuals with clinical eating disorders from asymptomatic individuals by a relatively wide margin, they represent different domains (i.e., psychological and sociocultural) relevant to eating disorder symptomatology, and they are not used as part of the diagnostic criteria for clinical eating disorders (i.e., to avoid confounding indicators with the criterion; N. Waller, personal communication, June 14, 2002).

The present study, then, has the potential to contribute to theory, practice, and research on eating disturbances by increasing professionals' understanding of the latent structure of eating disorders. Findings of dimensionality (i.e., continuity) would support conceptualizations of psychological and sociocultural characteristics as increasing concomitantly with levels of eating disorder symptomatology, as well as the use of instruments such as the Eating Disorder Inventory–2 (EDI-2; Garner, 1991), the Eating Attitudes Test–26 (Garner, Olmsted, Bohr, & Garfinkel, 1982), and the Bulimia Test—Revised (BULIT–R; Thelen, Farmer, Wonderlich, & Smith, 1991) that are based on the assumption that women can have different degrees of eating disturbance. If, however, a taxon is found within the data, research then could be aimed at determining its composition.

Method

Participants

A sample of 532 college women from undergraduate psychology classes ($n = 433$) and sororities ($n = 99$) at two large midwestern universities and one regional campus of a large midwestern university completed surveys of their eating habits and levels of body dissatisfaction, neuroticism, self-esteem, poor interoceptive awareness, internalization of the thin-ideal stereotype, and perceived pressure for thinness. This sample size exceeded the minimum of 300 cases needed for taxometric analysis (e.g., Meehl, 1995). As no differences were found in the demographics of the psychology students and sorority women, the total sample is described. The mean age of the sampled women was 22.40 ($SD = 6.92$) years. Of the participants, 31% were freshmen, 23% were sophomores, 24% were juniors, 18% were seniors, and 4% were postbaccalaureate or graduate students. Regarding racial identification, 12% identified as African American, 78.5% identified as Caucasian, 5% identified as Latina, 2% identified as Asian American, 0.5% identified as Native American, 0.5% identified as biracial, and 1.5% left the item blank. Women were targeted because the latent structure of eating disorders has been studied almost exclusively with women (Tylka & Subich, 1999, 2002a).

Instruments

Body Shape Questionnaire—Revised–10 (BSQ–R-10; Mazzeo, 1999). The BSQ–R-10 assesses overall levels of body image preoccupation or body dissatisfaction. Each of its 10 items is rated on a 6-point scale ranging from 1 (*never*) to 6 (*always*). The total score is obtained by averaging the items, with higher scores indicating greater body dissatisfaction. This total score was used to represent the body dissatisfaction indicator. The BSQ–R-10 yields reliable and valid scores among samples of college women. In particular, Mazzeo (1999) found the internal consistency reliability of the BSQ–R-10 to be .96 ($\alpha = .97$ for the present study). Further, Mazzeo (1999) found that, via exploratory and confirmatory factor analyses, all of its items loaded highly on one factor, and it was related to other common measures of body dissatisfaction, supporting its unidimensionality and concurrent validity.

NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992) Neuroticism subscale. The Neuroticism subscale of the NEO-FFI is proposed to measure the tendency for individuals to display characteristics related to emotional instability (Costa & McCrae, 1992). Raw scores from its 12 items (each rated on a 5-point scale ranging from 0 [*strongly disagree*] to 4 [*strongly agree*]) are summed and then transformed into *T* scores using the normative tables provided with the inventory; higher *T* scores indicate higher levels of neuroticism. For this study, participants' transformed scores represented the indicator of neuroticism. Scores on the Neuroticism subscale have adequate internal consistency reliability (alpha estimates ranged from .84 to .92; Costa & McCrae, 1992; Tylka & Subich, 1999) and adequate test–retest reliability over a 3-month interval ($r = .79$; Costa & McCrae, 1992). For the present study, alpha was .90. Scores on the Neuroticism subscale have demonstrated adequate construct validity, as they were related as expected to measures of psychological well-being, depression, coping, and anxiety (Costa & McCrae, 1992). In terms of evidence of convergent and discriminant validity, Neuroticism subscale scores have been shown to correlate with a measure of neuroticism based on adjective self-reports and not to correlate highly with other five-factor model subscales (Costa & McCrae, 1992).

EDI-2 (Garner, 1991) Interoceptive Awareness subscale. This subscale is composed of 10 questions that assess psychological characteristics reflecting the degree to which one is confused about one's own feelings and one's degree of awareness of bodily sensations such as hunger and satiety. Participants are instructed to rate each item according to a 6-point scale ranging from *always true of me* to *never true of me*. The responses *never true of me*, *rarely true of me*, and *sometimes true of me* receive a score of 0, and the responses *often true of me*, *usually true of me*, and *always true of me* receive scores of 1, 2, and 3, respectively. Items then are transformed into percentile scores, as specified in the EDI-2 manual, with higher scores indicating poorer interoceptive awareness; these percentile scores were the poor interoceptive awareness indicator in the analyses. Researchers have found evidence that the EDI-2 Interoceptive Awareness subscale is internally consistent, with an alpha of .81 found for a nonclinical sample and an alpha of .83 found for an anorexic sample (Garner, 1991). For the present study, alpha was .87. Further, its scores have been shown to be reliable over a 3-week period ($r = .85$; Wear & Pratz, 1987). Construct validity of the EDI-2 Interoceptive Awareness subscale is supported by the relations between its scores and therapist–consultant ratings of poor interoceptive awareness for a sample of anorexic patients ($r = .51$; Garner, 1991).

Sociocultural Attitudes Towards Appearance Questionnaire–Internalization subscale (SATAQ-I; Heinberg, Thompson, & Stormer, 1995). The SATAQ-I was used to assess the internalization of the thin-ideal stereotype

[3] Contact Tracy L. Tylka for this review.

indicator for the present study. This subscale consists of eight items assessing levels of agreement with societal standards of appearance on a 5-point scale ranging from 1 (*completely disagree*) to 5 (*completely agree*). A total score is calculated by averaging the items, with higher scores indicating greater internalization of the thin-ideal stereotype. Items on this subscale show evidence of internal consistency reliability, with an overall scale alpha of .88 for a sample of college women (Heinberg et al., 1995). For this study, alpha was .92. Further, its unidimensionality was supported by factor analyses (Heinberg et al., 1995), and its convergent validity was supported by its relations with other measures assessing beliefs about thinness (Griffiths et al., 1999).

The Perceived Sociocultural Pressure Scale (PSPS; Stice et al., 1996). The PSPS consists of eight items that assess the amount of pressure that women perceive from family, friends, dating partners, and the media to have a thin body. For each item, participants report a 1, indicating no pressure; a 3, indicating some pressure; or a 5, indicating a lot of pressure. The overall perceived pressure score is obtained by averaging the items, with higher overall scores representative of higher perceived pressure to be thin. This overall score represented the indicator of perceived pressure for thinness. Scores on this scale were found to be internally consistent (α = .87) and stable over a 2-week period (r = .93) among samples of high school and college women (Stice et al., 1996). For the present study, alpha was .83. Scale scores were related as expected with body dissatisfaction (Stice et al., 1996) and retrospective reports of parental pressure to lose weight (average r = .51; Thelen & Cormier, 1995), supporting its construct validity.

Questionnaire for Eating Disorder Diagnoses (Q-EDD; Mintz, O'Halloran, Mulholland, & Schneider, 1997). Data generated from this measure were not used in analyzing the actual data set via the taxometric procedures but instead were used to identify the eating disorder status of the participants (i.e., eating disordered vs. noneating disordered). This information was needed foremost to generate the simulated taxonic data set. It was also used to estimate the group mean separation for each indicator, the level of nuisance covariance[4] (i.e., within-group relations), and the actual base rate of the sample.

The Q-EDD was designed to define operationally the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–IV*; American Psychiatric Association, 1994) criteria for eating disorders and classify those individuals who report symptoms consistent with *DSM–IV* criteria for eating disorders (i.e., the eating disorder group), individuals who report some symptoms of eating disorders (i.e., the symptomatic group), and individuals who do not report any symptoms of eating disorders (i.e., the asymptomatic group). Scoring is based on flowchart decision rules specified in the Q-EDD scoring manual. Mintz et al. (1997) examined the psychometric properties of the Q-EDD and found that its scores correspond with scores from other common eating disorder inventories, it was superior to the BULIT–R when differentiating between bulimic and nonbulimic individuals, and it had a 98% accuracy rate for differentiating between individuals with clinical eating disorders and individuals without clinical eating disorders (i.e., determined by clinician diagnoses), supporting its validity. Further, its test–retest reliability over a 2-week period was adequate (κ = .64; Mintz et al., 1997).

Because women had to be classified as either having or not having an eating disorder for purposes of establishing group mean separation, nuisance covariance, and base-rate information, we had to judge whether to place women who indicated some, but not all, symptoms of eating disorders into either the eating disordered or the asymptomatic group. This decision was made carefully, as placement of all symptomatic women into either the asymptomatic or eating disorder group would not provide the best estimates of the nuisance covariance (i.e., it would be inaccurately inflated) and of the base rate (i.e., it would be either overestimated or underestimated) within the actual data set. Further, the simulated taxonic data generated would be misleading.

It can be argued that there is wide variability among women who are classified within the symptomatic group (i.e., they could report only one symptom or almost all the symptoms of eating disorder symptomatology; Tylka & Subich, 1999). Therefore, we decided to examine each participant within this category on an individual basis by examining her specific reported symptoms of eating disorder symptomatology. We placed a woman who was initially classified into the symptomatic group according to Q-EDD scoring criteria into the eating disorder group only if she met all of the following criteria: (a) a body mass index between 17.6 and 19.0, (b) reporting her weight and/or body shape influenced how she felt about herself very much or extremely, (c) reporting being very much or intensely afraid of becoming fat and gaining weight, (d) reporting feeling fat in certain body parts or all over her body and/or considering herself to be overweight or heavier, and (e) reporting how little she weighed was not a serious problem. Our rationale for including these women in the eating disorder group was that they met all of the criteria for anorexia, except that their weight was in the low-normal range and they did not report amenorrhea. Six percent of the women met these relatively conservative criteria. If a woman did not meet all of these criteria or did not meet the *DSM–IV* criteria for anorexia, bulimia, or eating disorder not otherwise specified (EDNOS), she was classified into the asymptomatic group (71.7% of the sample). Approximately 12.3% of the sample met the Q-EDD scoring criteria indicative of anorexia (.4%), bulimia (4.3%), or EDNOS (7.6%) and were placed in the eating disorder group. Therefore, the base rate of the total sample was estimated to be .18. For this study, two independent raters classified women into the eating disorder or asymptomatic group; any discrepancy was discussed until full agreement was achieved.

Procedure

Undergraduate women in psychology classes were recruited through posted flyers and class announcements, and sorority women were recruited at the beginning of one of their chapter meetings. Women either were tested in small groups by an undergraduate experimenter or took the packet of questionnaires home to fill out. Of the women who took the packet home to fill out, 94% returned them fully completed (100% of the women who filled out the packet within a small group returned them fully completed). The Q-EDD was administered first, and the remaining questionnaires were counterbalanced to control for order effects. After the experiment, women were given a form that listed local counseling clinics and their phone numbers in case they experienced distress when filling out the questionnaires. Women from undergraduate psychology classes received course credit for their participation. Each sorority was given a monetary donation (i.e., $3 per completed packet) for the involvement of its members.

Taxometric Procedures

Taxometric methodologies were used to examine the relations among common indicators of clinical eating disorders. These procedures are based on the assumption that indicators of a given disorder relate to one another differently when a latent taxon is present than when a latent taxon is absent. Specifically, they use coherent cut kinetics (Meehl & Yonce, 1996) that examine the indicator relations by moving "cuts" on a designated input variable and studying the statistical behavior of the other variables in the

[4] Consistent with the propositions of taxometric analysis (Waller & Meehl, 1998), indicators were expected to be related when the entire sample of women (i.e., both groups: women with eating disorders and women without eating disorders) was examined but were not expected to be related when the groups were examined independently. If substantial relations (defined as $r > .50$) exist between indicators when groups are examined independently, significant nuisance covariance is present within the data and study results may be contaminated.

cut regions (Meehl & Yonce, 1996). If the output-variable statistics are logically ordered and the indicator relations yield a qualitative boundary suggesting two distinct groups, a taxon is said to be present within the data set. A taxon is believed to be absent if two underlying groups are not detected and instead only quantitative differences are found among the indicator relations.

Taxometrics differ from many other statistical procedures in that it does not rely on traditional null hypothesis significance tests but instead on the convergence of evidence from multiple quasi-independent procedures that serve to uphold one latent structure (i.e., either taxonic or dimensional) and refute the other (Waller & Meehl, 1998). Each procedure provides a "check" (i.e., consistency test) for the results from other taxometric procedures, with confidence in the results increasing when the findings across procedures are in agreement. Therefore, it is important that consistency is found between taxometric procedures before suggestions regarding the latent structure of a disorder are made (Waller & Meehl, 1998). Also, results obtained from simulated dimensional and taxonic data can be used as benchmarks of comparison for interpreting the results obtained from the actual data set (A. M. Ruscio, Ruscio, & Keane, 2002).

When determining specific taxometric procedures to use for analyzing our data, we considered those methods that are widely used to detect the presence or absence of a taxon within a data set, offer the clearest guidelines for interpreting findings, offer ways to estimate the overall appearance of the data (rather than only provide graphic information based on some indicators), have been used in previous examinations of the continuity/discontinuity debate within eating disorders, and are recommended procedures based on our research question (N. Waller, personal communication, June 14, 2002). Therefore, maximum covariance analysis (MAXCOV) was chosen, as it met all of these criteria, and latent mode analysis (L-Mode) was selected, as it met all but one of these criteria (i.e., it has not been used to explore the continuity–discontinuity debate within eating disorders). Using two taxometrics procedures to analyze data is both conventional (e.g., Gleaves, Lowe, Snow, et al., 2000) and acceptable (e.g., Meehl, 1995; Waller & Meehl, 1998). The computer program R, a system for statistical and graphic computation, is used to perform these procedures.

MAXCOV is the most widely used procedure from the coherent cut kinetics method (Waller & Meehl, 1998). For each analysis within MAXCOV, three of the indicators are plotted within a graph that indicates whether the data measure a latent taxon or a latent dimension. For each analysis, one indicator is designated as the input variable, and two other indicators are designated as output variables. The scores from the two output variables are sorted according to the ordered input scores. Next, the sorted input scores are divided into a series of contiguous and nonoverlapping subsamples (i.e., slabs), and the covariance is computed between the output variables within each slab. If a taxon is present, the covariances will vary systematically as a function of the proportion of taxon members in the slab, and in successive slabs, the output covariances will increase from 0 to a maximum and then decrease to 0. If a taxon is not present, then the output covariances should be relatively constant across the slabs. Graphically speaking, if the resultant MAXCOV function forms a peak or a hump (i.e., an inverted ∪-shape), a latent taxon is suggested to be present within the group of indicators. If the MAXCOV function forms a line or a U-shape, however, a latent taxon is not detected. This procedure is repeated for all possible triads of indicators (Waller & Meehl, 1998). Additionally, MAXCOV computes an overall goodness-of-fit index (GFI) and an overall base-rate standard deviation derived from the individual input–output indicator analyses that help researchers determine whether a latent taxon is present or absent within their data set.

L-Mode is based on the assumption that the indicator relations could produce a latent factor that could be either continuous (i.e., indicating the absence of a latent taxon) or take on two discrete values that distinguish group (i.e., eating disorder, noneating disorder) membership (i.e., indicating the presence of latent taxon; Waller & Meehl, 1998). Specifically, this procedure is completed by (a) conducting an exploratory factor analysis on the covariances between all indicators; (b) extracting a one-factor solution; (c) computing factor score estimates for the first, unrotated factor; (d) using these estimates to compute the factor-score probability density distribution; (e) examining the distribution of scores on the first principal factor obtained; (f) plotting the factor-score probability density distribution; and (g) inspecting this plot for the presence or absence of a latent taxon (Waller & Meehl, 1998). Unlike MAXCOV, which computes individual input–output indicator graphs and base-rate estimates for all different combinations of indicators, L-Mode is run once, using all available indicators and providing an empirical base-rate estimate.

If a taxon is present within a data set, the factor-score density plot has two prominent humps or modes that reflect the eating disorder and noneating disorder groups. However, dimensionality appears in the plot as one prominent mode with either no additional modes or additional modes that are much less distinct. Strong support for the usefulness of L-Mode for distinguishing taxonic from nontaxonic data has been garnered (Waller & Meehl, 1998).

Results

Indicator Selection and Preliminary Analyses

Before conducting MAXCOV and L-Mode, we examined several characteristics of our data set to ensure that it was capable of identifying a latent taxon. Our estimated base rate (.18) and sample size ($N = 532$) were above the minimum (i.e., .10 for base rate and 300 for sample size) required for taxometric analysis when other conditions are present (i.e., group mean separations on the indicators of at least 1.25 standard deviations, low nuisance covariance [i.e., Pearson correlations at or below .50 between the indicators within each examined group]; Meehl, 1995). We calculated mean separation values between the noneating disorder group and the eating disorder group and found that these groups had mean separation values (i.e., based on the calculation for Cohen's *d*) above 1.25 standard deviations for each indicator. These values ranged from 2.05 standard deviations for the PSPS to 2.95 standard deviations for the BSQ–R-10. Therefore, even though some researchers performing taxometric analysis (e.g., Gleaves, Lowe, Snow, et al., 2000; A. M. Ruscio et al., 2002) selected specific measure items that would produce the greatest mean separation values and then created indicator sets from these items, we decided that the total measure scores were sufficient to use as indicators. Table 1 presents group means and standard deviations across the indicators and relations among the indicators for all participants.

We also examined all indicator relations to ensure that they were not significantly correlated within each group, as indicators are expected to be related across (i.e., between) groups but not within groups. Significant levels of nuisance covariance (rs $> .50$) could obscure the results of the taxometric procedures by rendering them uninterpretable or even misleading. We examined the nuisance covariance within each of our groups and found that all relations were less than .50. The average within-group correlation of indicators for the noneating disorder group was .32; the average within-group correlation of indicators for the eating disorder group was .23. Because the nuisance covariance was within acceptable limits for all within-group indicator relations, and the base rate, sample size, and mean separation values were adequate, it appears that the presence of a latent taxon, if it exists, could be detected within this data set.

Table 1
Relations Among Indicators for All Participants (N = 532) and Indicator Means and Standard Deviations for the Noneating Disorder Group (n = 434) and the Eating Disorder Group (n = 98)

Indicator	1	2	3	4	5
1. BSQ–R-10	—				
2. NEO-FFI–Neuroticism	.54*	—			
3. EDI-2–Intero. Awareness	.62*	.63*	—		
4. SATAQ–Internalization	.70*	.46*	.54*	—	
5. PSPS	.70*	.46*	.52*	.54*	—
Noneating disordered group					
M	2.91	50.09	54.32	3.01	1.88
SD	1.13	10.15	18.41	1.01	0.66
Eating disordered group					
M	5.15	66.49	88.13	4.40	3.42
SD	0.76	7.62	11.47	0.67	0.75

Note. BSQ–R-10 = Body Shape Questionnaire—Revised–10 (body dissatisfaction); NEO-FFI–Neuroticism = NEO Five-Factor Inventory Neuroticism subscale; EDI-2–Intero. Awareness = Eating Disorder Inventory–2 Interoceptive Awareness subscale; SATAQ–Internalization = Sociocultural Attitudes Towards Appearance Questionnaire–Internalization subscale (internalization of the thin-ideal stereotype); PSPS = Perceived Sociocultural Pressure Scale (pressure for thinness).
* $p < .001$.

Simulated Comparison Data Sets

When conducting classification research, it is recommended that researchers simulate comparison data sets to better understand and evaluate their results obtained from the actual data set (A. M. Ruscio et al., 2002). Specifically, simulating data entails generating two sets of data that exactly match the distributional and correlational characteristics of the actual data set but vary in underlying latent structure. One data set is specified to be dimensional, and the other is specified to be taxonic. These simulated comparison data sets are submitted to the same taxometric procedures as the actual data set, and the results obtained from these simulated sets then are used as benchmarks of comparison for the results obtained from the actual data set. If results obtained from the actual data set are similar to the results obtained from the simulated dimensional data, then more evidence is accrued that a latent taxon is not detected within the actual data. Evidence is provided for the presence of a taxon if the results obtained from the actual data set are similar to the results obtained from the simulated taxonic data. Because taxometric analyses do not provide clear criteria for evaluating results, with the exception of the GFI in MAXCOV, these simulated data sets provide help for researchers when interpreting their results.

We used a technique for creating simulated data sets proposed by J. Ruscio, Ruscio, and Meron (2002) that is designed for use with the *S Plus* statistical package. It works by taking the actual data set and holding its distributional and correlational properties constant while systematically varying its latent structure. It perfectly matches the distribution of each indicator in the actual data set while reproducing the full correlation matrix as accurately as sampling error allows. This procedure generates a simulated dimensional data set by automatically matching and reproducing the mean separation values between groups for each indicator and using an iterative procedure that approximates the desired correlation matrix by applying factor loadings to random normal data, pasting the distributions from the actual data set and then observing how much this distributional cut-and-paste has weakened the correlations. A matrix of residual correlations is used to update the simulated dimensional matrix and start over. The procedure iterates, getting closer and closer to the observed correlations while preserving the exact distributions at each step, until a match is achieved that is not improved with additional iterations. A simulated taxonic data set is generated much the same way, the only exception is that the researcher first specifies the group (i.e., eating disorder or noneating disorder) membership of each participant; this specification instructs *S Plus* to repeat this iterative procedure within both groups and to create a latent taxonic structure.

MAXCOV Analyses

We first analyzed the actual and simulated data sets using the MAXCOV procedure. For each MAXCOV analysis, one indicator served as the input variable, and two other indicators served as the output variables; the covariances between indicators were computed across slabs, and a graph was generated. This analysis was repeated for all possible configurations of the indicators, yielding 30 graphs per data set analyzed. If a taxon is present among the relations of the indicators, MAXCOV will generate a GFI greater than .90 (i.e., higher values indicate better "fit" or presence of a taxon), the base-rate standard deviation (i.e., estimated from each individual input–output indicator analysis) will be more similar to the standard deviation obtained by analyzing the simulated taxonic data, and many of the individual input–output indicator graphs will have an inverted U-shape (Waller & Meehl, 1998; N. Waller, personal communication, June 10, 1997). However, if a taxon is not detected by MAXCOV, then the GFI will be equal to or less than .90, the base-rate standard deviation will be more similar to the standard deviation obtained by analyzing the simulated dimensional data, and most of the individual input–output indicator graphs will be flat or have a U-shape.

For the actual data set, the GFI was found to be .85. Table 2 presents the GFIs and the base-rate standard deviations from the

Table 2
Goodness-of-Fit Indices (GFI), Estimated Base Rates (BR), and the Base-Rate Standard Deviations (BRSD) From the Analyses With the Actual Data and the Simulated Comparison Data

	MAXCOV			L-Mode
Data set	GFI	BR	BR*SD*	BR
Actual data set	.85	.29	.14	.34
Simulated dimensional	.86	.35	.17	.30
Simulated taxonic	.93	.31	.06	.27

Note. The MAXCOV (maximum covariance analysis) base-rate estimate reflects the grand taxon base; the L-Mode (latent mode analysis) estimate reflects the empirical base rate. The grand taxon base rate is the best estimate of the base rate for MAXCOV, whereas the empirical base rate is the best estimate of the base rate for L-Mode (N. Waller, personal communication, June 14, 2002). L-Mode does not calculate GFIs and base-rate standard deviations.

individual input–output indicator combinations derived from the actual data set and the simulated comparison data. As can be seen in Table 2, both the actual data and the simulated dimensional data did not produce a good fit with the taxon model, whereas the simulated taxonic data produced a good fit. The base-rate standard deviation produced from the individual input–output indicator combinations appeared to be more similar to the standard deviation obtained via analyzing the simulated dimensional data than to the standard deviation obtained via analyzing the simulated taxonic data. In addition, three independent raters not aware of the purpose of the study were trained to judge whether the individual input–output indicator graphs appeared to be flat or U-shaped rather than shaped like an inverted U. They each took a straight object (e.g., a ruler) to draw a line connecting the graph's end points and noted whether it was straight or whether the graph was below the line (i.e., both indicative of dimensionality) or above the line (i.e., indicative of taxonicity). Raters agreed on all but one graph, yielding 97% agreement, and discussed this graph until everyone agreed on its structure. Overall, they found that 23 out of the 30 graphs (77%) were indicative of dimensionality. Individual input–output indicator graphs for the actual and simulated data sets are not presented because of the number of graphs produced (i.e., 90) but can be obtained by contacting Tracy L. Tylka.

Taken collectively, results derived from MAXCOV suggest that a taxon was not detected and provide initial support for the dimensionality of eating disorders among the set of common psychological and sociocultural indicators. Overall base-rate estimates are also provided for each data set in Table 2. These estimates are not used in determining the latent structure of a data set but give information as to the percentage of the sample that, based on the relations among the indicators, is considered to have the disorder.

L-Mode Analyses

Table 2 also includes the empirical base-rate estimates yielded from L-Mode for the actual and simulated data. Because the determination of whether L-Mode curves better fit a taxonic or a dimensional model is assessed by the visual inspection of graphs, three raters independently evaluated the graph obtained via the actual data set with the graphs obtained via the simulated data sets. Consistent with previous studies using L-Mode (e.g., A. M. Ruscio et al., 2002), raters uninformed of the study's purpose were instructed to indicate whether the graph derived from the actual data resembled more closely the graph derived from the simulated taxonic data or the graph derived from the simulated dimensional data. Then, they were asked to indicate whether each graph (from the actual data set and the simulated data sets) distinctly appeared more unimodal (i.e., one prominent mode or additional modes that are much less distinct) or bimodal. Raters performed this task separately. All raters reported that the indicators produced a unimodal L-Mode curve that best resembled the simulated dimensional data, whereas the simulated taxonic data produced a bimodal distribution. Figure 1 presents the graph derived from the actual data and the graphs derived from the simulated data. These results provide additional support for the conclusion that eating disorders better conform to a dimensional latent structure. Given that many of the indices and graphs of MAXCOV and L-Mode converge on a dimensional latent structure, it appears that a latent taxon is not likely to exist within this set of indicators.

Discussion

For many years, theorists and researchers have questioned whether eating disorders reflect one extreme position located on a continuum of degree or whether they are qualitatively different from less severe eating disturbances (Bruch, 1973; Gleaves, Lowe, Snow, et al., 2000; Mintz & Betz, 1988; Nylander, 1971; Tylka & Subich, 1999). Until recently, researchers typically have examined whether psychological (e.g., Tylka & Subich, 1999), behavioral (e.g., Lowe et al., 1996), sociocultural (e.g., Stice et al., 1996), and cognitive (e.g., Tylka & Subich, 2002b) indicators of clinical eating disorders independently vary according to women's position along the eating disorder continuum without exploring how these indicators interact with each other.

Although previous studies provided initial information as to whether eating disorders lie along a continuum, investigating how indicators relate with one another actually could better determine their latent structure (Meehl, 1995). It is for this reason that taxometric procedures have begun to be used in research on eating disorders (e.g., Gleaves, Lowe, Green, et al., 2000; Gleaves, Lowe, Snow, et al., 2000). Yet, initial investigations used mostly behavioral (i.e., binging and purging) indicators of eating disorders and mixed together approximately equal numbers of college women and women from eating disorder residential treatment centers to form their sample of participants. Taxometric authorities (e.g., N. Waller, personal communication, June 14, 2002; L. Yonce, personal communication, February 28, 2001) have advised against such methodological choices when conducting taxometric analysis, as they may contribute to false detection of the presence of a taxon. Thus, prior to the present research, it remained unknown whether clinical eating disorders are quantitatively or qualitatively different from less severe eating disturbances when other indicators are considered and appropriate sampling procedures are followed. The present research thus broke new ground by investigating psychological and sociocultural indicators of eating disorders within a taxometric framework among a sample of college women.

We selected common psychological (i.e., body dissatisfaction, neuroticism, poor interoceptive awareness) and sociocultural (i.e.,

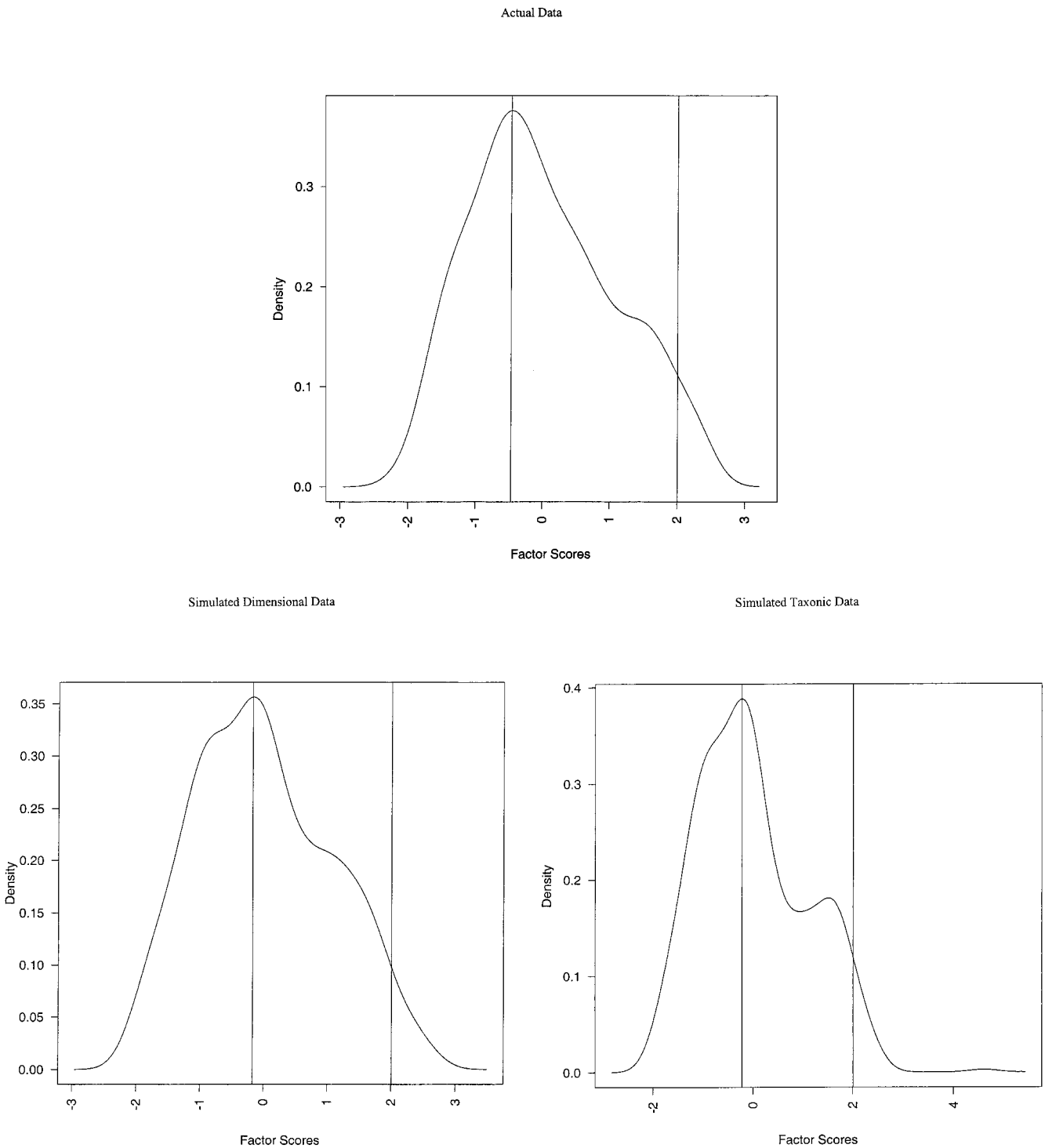

Figure 1. Latent mode analysis graphs derived from the actual data and the simulated data.

internalization of the thin-ideal stereotype, perceived pressure for thinness) indicators of clinical eating disorders and analyzed their relations to one another using two statistically independent taxometric procedures. Simulated dimensional and taxonic comparison data served as benchmarks for evaluating the results obtained from the actual data. Collectively, taxometric procedures performed on the actual data yielded indices and curves inconsistent with the presence of a latent taxon and comparable to results obtained from analyzing simulated dimensional data. These findings offer preliminary evidence for the dimensionality of eating disorders as

assessed by psychological and sociocultural indicators, suggesting that several salient indicators of eating disorders occur along a continuum of degree.

This finding of dimensionality is inconsistent with the results reported by other researchers using taxometric analysis to investigate the latent structure of eating disorders (i.e., Gleaves, Lowe, Green, et al., 2000; Gleaves, Lowe, Snow, et al., 2000). We argue that this discrepancy may be due, at least in part, to our use of different types of indicators and a different sampling strategy. In previous studies, binging and purging behaviors could have coalesced into a latent taxon as a result of concocting mixed samples of clinical and nonclinical participants and/or confounding the indicators (i.e., binge eating and purging) with the criterion (i.e., eating disorder symptomatology) in the analysis. That is, because it is common practice for professionals to identify many types of eating disorders by assessing whether a person engages in binging and purging behaviors, the taxon found by previous researchers when analyzing binging and purging indicators with taxometric methods may be describing only the eating disordered behavior.

This assertion raises many questions regarding the importance and role of binging and purging behaviors in research, theory, and practice. First, there is the question of whether binging and purging behaviors are important underlying factors of eating disorders. Most obviously, these indicators function to differentiate those individuals with clinical eating disorders from those individuals without clinical eating disorders, and as such, they seem valuable in describing manifest symptoms of the disorder. This then leads to the second question: How should these indicators be used in research? We argue they should be considered only as part of the criterion (i.e., eating disorder symptomatology) rather than as a predictor or indicator. Further, although they are behavioral manifestations of bulimia, they should not be used exclusively to describe or represent all eating disorder symptomatology, as this would ignore the eating disorders based on restriction (e.g., anorexia nervosa, restricting subtype; some forms of EDNOS). Third, should theorists consider them within their models explaining eating disorder symptomatology? Again, we argue that they only should be conceptualized as a component of bulimic symptomatology and not used as a predictor of such symptomatology.

Last, there is the question of what degree we should attend to these variables in the prevention and treatment of eating disorders. It seems to us that practitioners should assess these behaviors within their clientele, as they are manifest symptoms of bulimia. In a similar vein, practitioners should be aware of other behavioral manifestations of eating disorders (e.g., restrictive behaviors) that are displayed by their clients. Because, however, these behaviors are *criteria* of the disorder, greater attention to nonbehavioral *predictors* of the disorder is essential to aid professionals in preventing and treating eating disorder symptomatology. On the basis of the results of the present study, practitioners should listen for and help lessen women's moderate to high levels of body dissatisfaction, poor interoceptive awareness, neuroticism, internalization of the thin-ideal stereotype, and pressure for thinness.

It is of special clinical interest that the base-rate estimates generated by the current taxometric procedures averaged .32 (i.e., 32% of women were considered to be included within the eating disorder group).[5] Yet, the base-rate estimate generated by the Q-EDD (which is based on *DSM–IV* criteria for eating disorders) was .12 (it increased to .18 when we included some symptomatic women). Therefore, approximately 20% of the women in our sample did not meet current formal criteria for a clinical eating disorder but had high enough levels of the examined psychological and sociocultural indicators to be placed in the theoretical eating disorder group by the taxometric procedures. This finding, along with the present taxometric results, underscores to us the necessity of attending to individuals with intermediate levels of eating disturbance in practice, as well as in research.

Specifically, it seems imperative that practitioners attend to all levels of eating disturbances with their clients instead of solely focusing on women who meet clinical criteria for eating disorders. For example, women with intermediate levels of eating disturbances have been shown to hold relatively positive views of maladaptive weight control techniques that are known to lead to harmful physical and psychological sequellae (Tylka & Subich, 2002b). Treatment of these women with interventions aimed at changing their beliefs regarding maladaptive weight control techniques might serve to prevent the development of more severe eating disorder symptomatology. Eating disorders have a more favorable prognosis when the eating disturbance is treated earlier in its course (Garfinkel & Garner, 1997), so women with such intermediate levels of eating disturbance might benefit from common treatment methods (e.g., feminist, cognitive–behavioral, interpersonal, and coping strategies approaches [Fallon, Katzman, & Wooley, 1994; Garfinkel & Garner, 1997; Tobin, 2000]) shown to help women with bona fide clinical eating disorders. Obviously, further clinical research is needed to investigate whether women with intermediate levels of eating disturbances indeed benefit from such treatment approaches.

The present study had several significant strengths that promote confidence in the validity of its conclusions. The sample was characterized by various features amenable to taxometric analysis. First, a large sample of college women was drawn instead of creating a mixed sample of college women and women from residential treatment centers. Further, substantial group mean separation was found on the psychological and sociocultural indicators, and these indicators were chosen for their proven strong relation to eating disorder symptomatology. We also selected measures that yield reliable and valid scores. Finally, our interpretation of the results was supported by their close approximation to the simulated dimensional data and their discrepancy from the simulated taxonic data.

Although the findings of the present study are suggestive of dimensionality, it could be that a taxon for eating disorders does exist and has not yet been uncovered. Confidence in our findings, however, is increased by our use of salient indicators of eating disorder symptomatology that have been shown repeatedly to relate to eating disorder symptomatology among women (e.g., Mazzeo, 1999; Stice et al., 1998; Stice et al., 1996; Striegel-Moore & Cachelin, 2001; Tylka & Subich, 1999). Our results suggest that if an eating disorder taxon does exist, it is unlikely to be composed solely of body dissatisfaction, neuroticism, internalization of the thin-ideal stereotype, and/or pressure for thinness indicators. Nev-

[5] Base-rate estimates derived from the taxometric procedures are not likely to be inflated, as they are similar (i.e., .29 for MAXCOV, and .34 for L-Mode), but based on completely different mathematical procedures (N. Waller, personal communication, November 10, 2002).

ertheless, to say definitively that the latent structure of eating disorders is purely continuous is premature; there are several different psychological, relational, sociocultural, and cognitive indicators of eating disorder symptomatology that have not been examined via taxometric analysis. More investigations using taxometric procedures with common indicators of eating disorder symptomatology among different samples of women clearly need to be undertaken. We believe investigation into the latent structure of eating disorders to be very important, as it could inform future research and practice with women with eating disturbances. In particular, this field of inquiry is consistent with the mission of counseling psychology in that it can contribute to our understanding of how eating disorders may develop in women and how to prevent and treat them.

Nevertheless, this study contained limitations that are important to recognize. The sample was limited to predominantly Caucasian women and cannot be generalized to women of color or to men. To date, there has only been one investigation into the latent structure of eating disorders with men (e.g., Tylka & Subich, 2002a), and there have been no investigations in this area with samples of non-Caucasian women. Also, the exclusive use of self-report data may have contributed to monomethod bias. Furthermore, the relative newness of taxometric procedures and the paucity of guidelines for their interpretation (outside of the GFI in MAXCOV) necessitated the use of simulated data sets to serve as benchmarks for comparison when interpreting our results. Finally, some professionals (e.g., Widiger, 2001) have critiqued taxometric procedures, suggesting that they only describe the disorder under investigation and do not fully consider its multifactorial nature.

These issues notwithstanding, we argue that the findings of this study support the dimensionality of eating disorders as assessed by common psychological and sociocultural indicators of clinical eating disorders. These findings provide insight into the latent structure of eating disorders that has been the focus of much theoretical speculation (e.g., Bruch, 1973; Mintz & Betz, 1988; Nylander, 1971; Tylka & Subich, 1999), and we encourage professionals to conceptualize psychological and sociological indicators of eating disorders along a continuum of degree.

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